Environmental Security Technology Certification Program

Final Report

For

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning

Project Number WP-0305

October 2006

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14. ABSTRACT

This demonstration and validation project evaluates a soybean oil derivative (SoyGold 1000) as an alternative to high VOC containing solvent for the rinsing of aeronautical antifriction bearings during DoD Depot level maintenance cleaning. Data analysis and interpretation are based on analytical test results as well as visual inspections performed on test bearings that were processed through the bearing cleaning process. Analytical test results are mixed. SG1000 passed all environmental, occupational, safety and health related tests, but failed a number of the materials compatibility tests including total immersion corrosion for a number of substrate materials, hydrogen embrittlement, nonvolatile residue, and nonvolatile residue with isopropyl alcohol rinse. SG1000 also failed the rinse efficiency test under performance related tests as well as the acidity test under chemical properties. Analytical test results did not meet the acceptance criteria to be qualified as an alternative to MIL-PRF-680 in the rinse step of the bearing cleaning process. During the demonstration, a nonvolatile residue resulted in a film that remained on the bearing surfaces. The demonstration results did not meet the defined acceptance criteria to be qualified as an alternative to MIL-PRF-680 in the rinse step of the bearing cleaning process. Overall SG1000 did not meet the acceptance criteria for analytical testing or the demonstration. SG1000 does not qualify as an alternative to MIL-PRF-680 in the bearing cleaning process.

15. SUBJECT TERMS

SoyGold 1000, soybean oil derivative, alternative solvent, bearing cleaning, MIL-PRF-680

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LIST OF ACRONYMS

AFMC	Air Force Materiel Command
AFRL	Air Force Research Lab
AMCOM	U.S. Army Aviation and Missile Command
APCD	Air Pollution Control District
ARL	U.S. Army Research Lab
ASTM	American Society for Testing and Materials
ATC	U.S. Army Aberdeen Test Center
CAA	Clean Air Act
CAS	Clean Air Solvent
CFR	Code of Federal Regulations
CHPPM	Center of Health Promotion and Preventative Medicine
CLIN	Contract Line Item Number
CTC	Concurrent Technologies Corporation
DoD	Department of Defense
EPA	Environmental Protection Agency
ESTCP	Environmental Security Technology Certification Program
HAP	Hazardous Air Pollutant
IPA	isopropyl alcohol
JTP	Joint Test Protocol
JTR	Joint Test Report
KB	Kauri-Butanol
NADEP	Naval Aviation Depot
NASNI	Naval Air Station North Island
NAVAIR	Naval Air Systems Command
NEHC	Navy Environmental Health Center
NFESC	Naval Facilities Engineering Service Center
QPL	Qualified Products List
SCAQMD	South Coast Air Quality Management District
SG1000	SoyGold 1000
TEI	Temporary Engineering Instruction
VOC	Volatile Organic Compound

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ABSTRACT

The Department of Defense (DoD) has increasingly relied on aqueous-alkaline cleaners to comply with emerging environmental regulations. However, these cleaners are not adequate for some applications, as they have been found to have material compatibility issues such as corrosion of metal surfaces and hydrogen embrittlement. With the environmental concerns related to petroleum-based solvent cleaners, and performance issues of aqueous-alkaline cleaners, it is desirable to validate a new class of organic solvents. These environmentally friendly alternative solvents must be HAP-free, not contribute to emissions of VOCs, and meet DoD material compatibility and performance criteria. This effort evaluates a soybean oil derivative as an alternative for MIL-PRF-680 solvent for the rinsing of aeronautical antifriction bearings during DoD Depot level maintenance cleaning. SoyGold® 1000 (SG1000), produced by AG Environmental Products, LLC, is the solvent that was selected for the demonstration.

The Joint Test Protocol (JTP) defines the acceptance criteria for all phases of the effort including the Phase I screening tests, the Phase II analytical tests, as well as the Phase III demonstration. The acceptance criteria was developed by a joint group led by the Naval Facilities Engineering Service Center and consisted of technical representatives and process stakeholders that identified engineering performance and testing requirements for aeronautical antifriction bearing cleaning. The acceptance criteria are the gauge used to determine whether an alternative solvent passes or fails the tests identified in the JTP. The alternative must pass all tests identified in the JTP and pass the demonstration phase to be an acceptable alternative to MIL-PRF-680 in the rinse step of the bearing cleaning process.

Data analysis, interpretation and evaluation are based on results from Phase I and II screening and analytical tests as well as visual inspections performed on test bearings that were processed through the bearing cleaning line during the Phase III demonstration. Analytical test results for SG1000 were mixed. SG1000 passed all environmental, occupational, safety and health related tests, but failed a number of the materials compatibility tests including total immersion corrosion for a number of substrate materials, hydrogen embrittlement, nonvolatile residue, and nonvolatile residue with isopropyl alcohol rinse. SG1000 also failed the rinse efficiency test under performance related tests as well as the acidity test under chemical properties. The Phase II analytical test results do not meet the acceptance criteria defined in the JTP to be qualified as an alternative to MIL-PRF-680 in the rinse step of the bearing cleaning process.

During the Phase III demonstration, a nonvolatile residue resulted in a film that remained on the bearing surfaces. The demonstration results do not meet the acceptance criteria defined in the JTP to be qualified as an alternative to MIL-PRF-680 in the rinse step of the bearing cleaning process.

Overall SG1000 did not meet the acceptance criteria defined in the JTP for Phase II analytical testing or the Phase III demonstration. SG1000 does not qualify as an alternative to MIL-PRF-680 in the bearing cleaning process.

1. INTRODUCTION

1.1. Background

The use of solvents for cleaning various parts and equipment is widespread. Historically, DoD vehicle, equipment, aircraft, and ship maintenance activities have used petroleum-based solvents to remove dirt, grease, soot, and burned-on carbon from various parts. The majority of these solvents contain photo reactive volatile organic compounds (VOCs), which react with oxides of nitrogen to form ground-level ozone, the primary component of "smog". Additionally, some solvents have been identified in the Clean Air Act (CAA) as potentially toxic compounds and are listed as Hazardous Air Pollutants (HAPs). The Environmental Protection Agency (EPA) tightly regulates these solvents.

As newly enacted environmental regulations become more restrictive in the use of solvents containing VOCs and HAPs, the use of many petroleum-based solvents becomes more expensive due to the required environmental controls and extensive reporting requirements needed for compliance.

In recent years the DoD has increasingly relied on aqueous-alkaline cleaners to comply with emerging environmental regulations. However, these cleaners are not adequate for some applications, as they have been found to have material compatibility issues such as corrosion of metal surfaces and hydrogen embrittlement. Due to these limitations, the DoD continues to use large quantities of petroleum-based solvent cleaners. With the environmental concerns related to petroleum-based solvent cleaners, and performance issues of aqueous-alkaline cleaners, it is desirable to validate a new class of organic solvents. These environmentally friendly alternative solvents must be HAP-free, not contribute to emissions of VOCs, and meet DoD material compatibility and performance criteria.

The use of bio-based solvents in processes such as aeronautical antifriction bearing cleaning has the potential to reduce the volume of petroleum-based solvents used by DoD and reduces the amount of VOCs released into the atmosphere.

1.2. Objectives of the Demonstration

This ESTCP demonstration and validation project evaluates an alternative to high VOC containing solvents for the rinsing of aeronautical antifriction bearings (non-instrument) during DoD Depot level maintenance cleaning.

The information and instructions for the handling and maintenance of aeronautical antifriction bearings are contained in the tri-service technical manual *Maintenance of Aeronautical Antifriction Bearing Cleaning for Organizational, Intermediate, and Depot Maintenance Levels (NAVAIR 01-1A-503, TM55-1500-322-24, T.O. 44B-1-122).* Henceforth, this document will be referred to as the "Bearing Cleaning Technical

Manual". Section 5 of the Bearing Cleaning Technical Manual prescribes the cleaning procedures, equipment, methods, and solvents required to accomplish the bearing cleaning process.

The cleaning of aeronautical antifriction bearings is a process. As illustrated in Figure 1, it involves a sequence of steps that ensures appropriate bearing cleanliness. A typical solvent based cleaning process for used bearings involves the following steps: demagnetize, pre-clean, degrease, carbon removal, hot water rinse, water displacing oil, solvent rinse, dry, inspection, fingerprint neutralizing, and preservation & packaging. The type of contamination on the bearings and whether they are new or used determines which steps of the cleaning process are necessary to adequately clean the bearings. Details of the bearing cleaning process can be found in Section 5-33 of the Bearing Cleaning Technical Manual and in Table 1-1.

Table 1-1 Solvent Based Aeronautical Antifriction Bearing Cleaning Process for Used Bearings

STAGE	FUNCTION	EQUIPMENT	MATERIAL	MINIMUM TIME REQ'D
1	Demagnetize	Demagnetizer	None	30 sec.
2	Pre-Clean	Fluid Agitated Tank	MIL-PRF-6081 (1010) (180°F)	30 min.
3	Degreaser	Fluid Agitated Tank	Xxcel XLS-52	As Needed (5 min. typical)
4	Carbon Removal	Fluid Agitated Tank	Turco 5668 (140°F)	20-30 min.
Optional	Ultrasonic Agitation (optional step)	Ultrasonic Tank	Turco Caviclean	5 min. (maximum)
5	Rinse	Fluid Agitated Tank	DI or RO Water w/Turco Rust Bloc Inhibitor (176°F)	1 min.
6	Water Displacing Oil	Fluid Agitated Tank	MIL-PRF-32033	3-5 min.
7A	Rinse – Step 1	Fluid Agitated Tank	MIL-PRF-680 (Filtered –100μ)	5 min.
7B	Rinse – Step 2	Fluid Agitated Tank	MIL-PRF-680 (Filtered –50 μ)	5 min.
7C	Rinse – Step 3	Fluid Agitated Tank	MIL-PRF-680 (Filtered –10 μ)	5 min.
8	Dry	Isopropyl Alcohol Dryer	Isopropyl Alcohol	As Required
9	Inspection	None	None	As Required
10	Neutralize Fingerprints	Fluid Agitated Tank	MIL-C-15074	5 min.
11	Preserve/Package	As Required	As Required	As Required

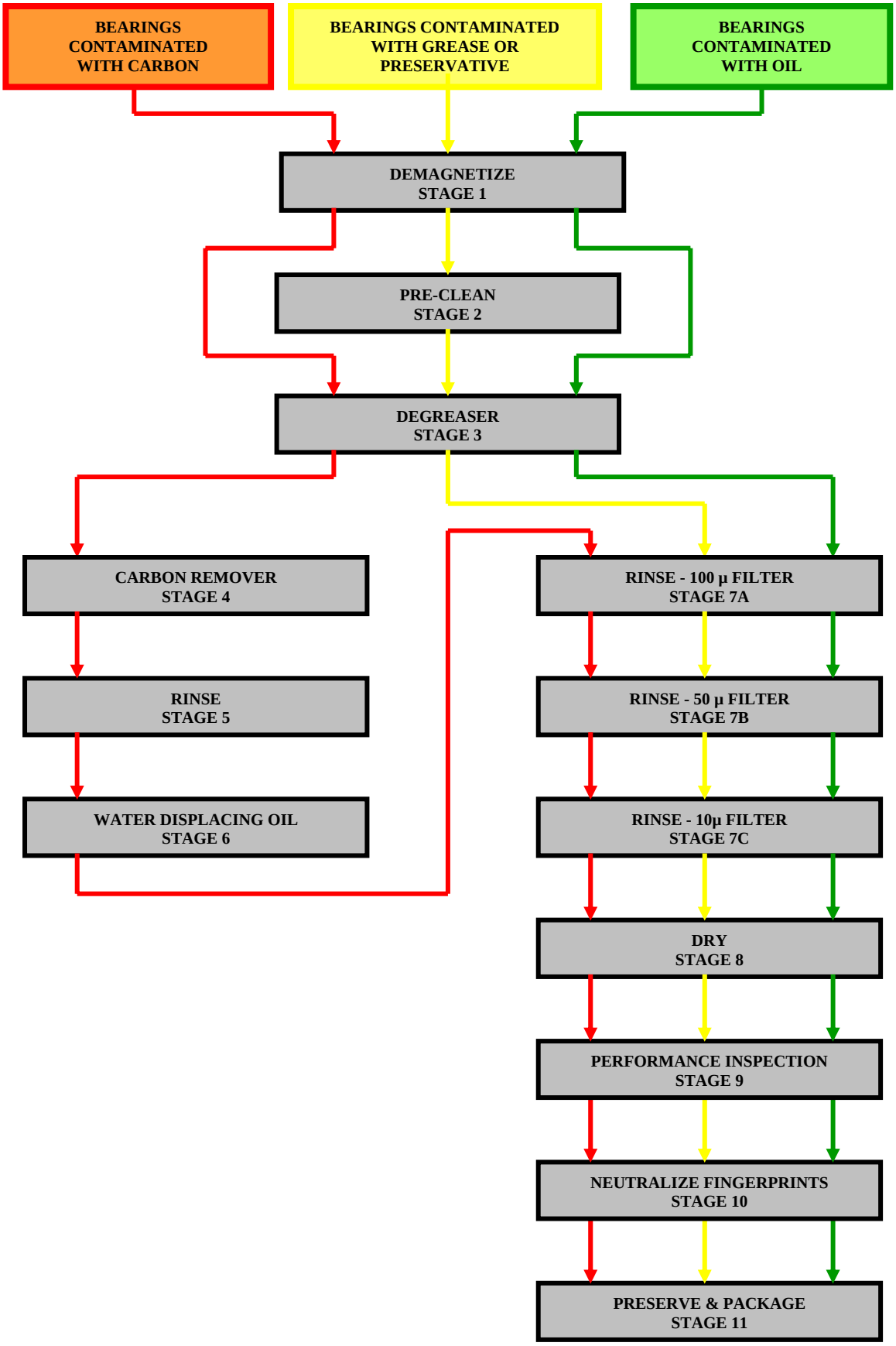

Figure 1-1. Aeronautical Antifriction Bearing Cleaning Process (Used Bearings)

The objective of this demonstration and validation project was to evaluate an alternative solvent for the rinse step of the bearing cleaning process (Step 7 in Table 1-1). According to the Bearing Cleaning Technical Manual, "Every soak or wash step shall be immediately followed by an appropriate filtered solvent rinse. This process is used to remove residual cleaning materials. Solvent, Federal Specification MIL-PRF-680, Type II, shall be used in all cleaning processes except the water detergent process."

It is important to note that the objective of this demonstration was not to obtain a comprehensive DoD-wide replacement for MIL-PRF-680, Type II, but an evaluation of an alternative solvent for the specific task of rinsing aeronautical antifriction bearings during DoD depot level maintenance cleaning. Since MIL-PRF-680, Type II is referenced in the Bearing Cleaning Technical Manual as the required rinsing agent; criteria from MIL-PRF-680, *Performance Specification, Degreasing Solvent* were used throughout the guidance for testing and baseline and/or benchmark performance measures. Table 1-2 summarizes the target solvents, process, application, current specifications, affected programs, and candidate parts.

Table 1-2. Target Solvents Summary for Aeronautical Antifriction Bearing Cleaning

Target Solvents	High VOC containing solvents (Mineral Spirits, Stoddard Solvent, MIL-PRF-680 Type II)
Current Process	Rinsing bearings in fluid agitated tanks
Applications	Aeronautical antifriction bearings (non-instrument bearings)
Guidance Documents	Maintenance of Aeronautical Antifriction Bearing Cleaning for Organizational, Intermediate, and Depot Maintenance Levels (NAVAIR 01-1A-503, TM55-1500-322-24, T.O. 44B-1-122)
Affected Programs	Navy, Army, Air Force Depot level aeronautical antifriction bearing maintenance
Candidate Parts/ Substrates	Parts: Aeronautical antifriction bearings (non-instrument bearings) Substrates: Refer to Table 4-6 for a complete listing of aeronautical antifriction bearing substrate descriptions

1.3. Regulatory Drivers

Emissions from organic solvents are regulated by both Federal (40 Code of Federal Regulations (CFR) 51.100) and State air quality regulations. In addition, local air quality districts may also establish regulations that are even more stringent than the state or federal limits. In California, the San Joaquin Valley Air Pollution Control District (APCD) has established regulations limiting the VOC content of degreasers at 50 g/l. South Coast Air Quality Management District (SCAQMD) has set even more restrictive limits of 25g/l for degreasers using halogenated solvents. It is expected that other jurisdictions countrywide will promulgate similar limits.

Clean Air Act Title III, National Emission Standards for Hazardous Air Pollutants (NESHAP) National Emissions Standards for Aerospace Manufacturing and Rework Facilities, described in 40CFR63 Subpart GG, require the use of solvents with a vapor pressure less that 7 mm Hg and contains no HAPs.

Using MIL-PRF-680 solvent in open-tank parts washers will not meet these regulations. Compliance can be achieved by installing emission control equipment, or by using alternative low VOC, HAP-free solvents. This demonstration attempts to qualify an alternative solvent for rinsing aeronautical antifriction bearings that is HAP-free, contains low VOCs, and will allow continued use of open-tank parts washers without the addition of emissions control equipment.

1.4. Stakeholder/End-User Issues

As described in paragraph 1.3, all DoD activities are under increasing pressure to reduce VOC and HAP emissions from component cleaning lines. Unfortunately, many of the alternative solvents do not meet performance requirements or produce undesirable side effects such as flash corrosion or hydrogen embrittlement. Any alternative solvent must meet all performance, compatibility, and safety requirements, be cost effective, and provide measurable environmental benefit.

SoyGold 1000 (SG1000) is the solvent that was selected for the demonstration. This product is produced by AG Environmental Products, LLC and is derived from soybean oil. AG Environmental Products, LLC was granted the SCAQMD Clean Air Solvent (CAS) Certificate for SG1000 in May 2000. Analysis was performed by the SCAQMD Laboratory using the most recent version of SCAQMD Method 313, *Determination of Volatile Organic Compounds (VOC) by Gas Chromatography/Mass Spectrometry (GC/MS)*. This specification is described in the SCAQMD Clean Air Certification Protocol Planning Rule Development & Area Sources document dated September 2003. In order to be awarded the CAS certificate, the solvent must not contain more than 25 grams per liter (g/L) VOCs, and is used to perform solvent cleaning, finishing, or surface preparation operations.

Company product testing has also shown that SG1000 is readily biodegradable, non-toxic, has low evaporative emissions (less than 0.0005 @ 76°F relative to a n-butyl acetate rating of 1), has a "normal" health rating, a flash point above 200°F, and is reactively stable. This would indicate that it is excellent solvent from an emissions and safe-to-use standpoint for use in the bearing cleaning operation.

For SG1000 to be qualified as an alternative to MIL-PRF-680 in the bearing cleaning process, it must meet the rinsing requirements of the process, and meet all environmental, occupational safety, and health, chemical properties, materials compatibility and performance requirements. If successful, SG1000 could be substituted for MIL-PRF-680 in the rinse step of the aeronautical antifriction bearing cleaning process at all DoD Depots.

2. TECHNOLOGY DESCRIPTION

2.1. Technology Development and Application

The technology demonstrated/validated in this effort is a bio-based, biodegradable, non-toxic, low VOC, HAP-free solvent produced by AG Environmental Products, LLC that is marketed under the product name of SoyGold 1000. It was evaluated as an alternative for MIL-PRF-680 solvent in the rinse step of the aeronautical antifriction bearing cleaning process. SoyGold is the brand name for a family of soy methyl ester (soybean and canola) -based products used in the fuel and chemical industries. SoyGold is a 100% soybean oil based methyl ester. It offers significant environmental, regulatory, and safety benefits as compared to petroleum solvents and fuels.

SG1000 is designed as a direct replacement for petroleum-based solvents used in the removal of heavy greases, oils, and petroleum residues. Methyl Soyate, also known as soybean oil methyl esters and soy methyl ester, is manufactured through the transesterification of soybean oil. The methyl ester is the base for many specialty products, including industrial solvents, and offers natural cleaning and degreasing characteristics with low VOCs, low toxicity and high flash point.

Figure 2-1 illustrates the SG1000 production diagram. Soy oil is heated and reacted with methanol in the presence of a catalyst. The reaction causes the separation of soy oil into methyl ester and glycerine. Following the separation, the glycerine component is sold to industries that produce cosmetics and health aids. The methyl ester component enters a water-wash process where water adheres to impurities that are then removed by filtration. The methyl ester is then dried through a vacuum drying system.

Current soybean production in the United States is over 2 billion bushels per year. Each bushel can be processed to yield over 10 pounds of soybean oil. Once the oil is refined, reacting it with methanol in the presence of a catalyst yields methyl soyate. Manufacturing capacity for methyl soyate is well established in the United States and has grown in recent years to meet increased demand.

$C_3H_5(O_2CR)_3$	+	3MeOH	Cat. →	$3MeO_2CR$	+	$C_3H_5(OH)_3$
Soy Oil		Methanol		Methyl Soyate		Glycerine

Figure 2-1 SG1000 Production Diagram

SG1000 is a methyl soyate based product formulated and produced by AG Environmental Products, LLC. SG1000 has fair solvency with a Kauri-Butanol (KB) value of 59, a high flash point of approximately 330°F, and a boiling point grater than 400°F making it safer to store and handle than most commercial solvents including MIL-PRF-680. Table 2-1 provides a comparison of key physical properties of MIL-PRF-680 and methyl soyate formulated as SG1000.

Table 2-1 Key Physical Properties Comparison

PROPERTY	TEST	MIL-PRF-680 (Type II)	SG1000
Boiling Point	American Society for Testing and Materials (ASTM) D-86	351°F (177°C)	632°F (333°C)
Flash Point	ASTM D-56	141-198°F (61-92°C)	>300°F (>148°C)
KB Value	ASTM D-1133	27-45	59
Physical Form	Appearance	Clear Liquid	Light Yellow Liquid
Specific Gravity (60°F)	ASTM D-1298	0.754 – 0.820 & 60°F	0.882 @ 77°F
Vapor Pressure	ASTM D-2879	2.0 mm Hg @ 68°F	1.8 mm Hg @ 68°F
VOC	EPA Test Method 24	Not required by spec	<25g/l SCAQMD Method 313
Evaporative Emissions	n-butyl acetate=1	Not required by spec	<0.005
Biodegradability	% in Soil in n-days	Not required by spec	95% - 28 days

2.2. Previous Testing of the Technology

For years, the industrial cleaning industry has looked for alternatives to petroleum-based solvents to help comply with increasingly stringent environmental regulations. Recognizing the potential benefits of methyl soyate products as alternatives to petroleum-based solvents, the United Soybean Board funded a series of acute toxicological studies on methyl soyate. The testing was completed under EPA and Food and Drug Administration (FDA) standard testing guidelines under the direction of DL Laboratories,

Brooklyn, NY, and conducted by Product Safety Labs, Inc., of East Brunswick, NJ, and Next Century, Inc., of Newark, DE.

The toxicity study of methyl soyate focused on six tests: acute oral, acute dermal, skin irritation, eye irritation, sensitization and mutagenicity (Table 2-2). Tests found that methyl soyate was practically nontoxic via oral ingestion and dermal application. It was also found that it is a non-irritant to the skin and eyes. Methyl soyate was found to be a potential contact sensitizer in guinea pigs, potentially causing a reaction to those in the general population who may be or become allergic to it. Further testing indicated that there was no evidence of mutagenic activity for methyl soyate.

Table 2-2 DL Laboratories Toxicity Tests - Methyl Soyate

Acute Oral	LD50 > 5,000 mg/kg
Acute Dermal	LD50 > 5,000 mg/kg
Skin Irritation	1.6 (non-irritating)
Eye Irritation	Non-irritating
Skin Sensitization	Moderate Potential
Mutagencity (Ames assay)	None

Previous testing was also conducted by Philip Services Corp. to determine the physical properties, cleaning performance and material compatibility of methyl soyate. Physical properties are listed in Table 2-3.

Table 2-3 Phillip Services Corp Physical Properties Tests - Methyl Soyate

Property	Reference	Value
Evaporation Rate (Butyl Acetate = 1)	ASTM D 3539	0.0098
Vapor Pressure, Mini Method @ 20º C	ASTM D 5191	<1.0 mm Hg
Refractive Index @ 20º C	ASTM D 1218	1.4621
KB Value	ASTM D 1133	57.84
Boiling Point by Gas Chromatography	ASTM D 2887	216.2º C
Flashpoint, Closed Cup	EPA 1010	>200.0º F
Flashpoint, Open Cup	ASTM D 20	> 650.0º F
Heating Value	ASTM 2340	20,000 BTU/lb.
Specific Gravity	SM 2710F	0.8867

Cleaning performance was determined by a combination of tests, including the ability to remove oil, grease, paint and wax from a metal surface, and the ease of rinsing and drying the coupon after cleaning. Tests found that methyl soyate removed greater than 90 percent of swaging oil, honey oil, and cutting fluid, from the metal within three minutes. Approximately 85 to 95 percent of heat transfer oil and quenching oil were also

removed within the same time period. Removal of Lithium grease and wax was more difficult and less effective.

When compared to other cleaners, methyl soyate removed as much or more of the swaging oil and honey oil. It was comparable to D-Limonene and outperformed N-methyl-2-Pyrrolidinone, Dibenzyl Ether and Dipropylene Glycol Monobutyl Ether when removing a buffing compound. Methyl soyate was not able to remove cured test paints from prepared panels. All three did remove fast-dry traffic latex.

In terms of compatibility, tests found that methyl soyate is compatible with most metals, including zinc, titanium, aluminum, stainless steel, nickel, magnesium, 1010 steel, copper and brass. Tests indicate that elastomer compatibility is good with Viton but marginal with other elastomers. Tests also indicate that methyl soyate is compatible with most plastics, including nylon, polyvinyl chloride, polycarbonate, polyester and fluorocarbon polymers; incompatible with acrylonitrile-butadiene-styrene copolymer (ABS) plastic, low density polyethylene (LDPE) and polyurethane; and marginally compatible with high density polyethylene (HDPE), polypropylene and polystyrene.

DL Laboratories also performed tests to determine the VOCs of methyl Soyate. In these tests VOCs were calculated using EPA Method 24 and ASTM D 3960. Results are included in Table 2-4.

Table 2-4 DL Laboratories VOC Testing - Methyl Soyate

SAMPLE	VOLATILE	DENSITY	WATER	VOC MINUS WATER	
	%	lb/gal	%	g/l	lb/gal
1	3.08	7.33	1.08	18	0.2
2	3.58	7.38	0.73	25	0.2
3	6.35	7.35	1.04	47	0.4
4	5.12	7.31	0	45	0.4

2.3. Factors Affecting Cost and Performance

2.3.1. Factors Affecting Cost

Virgin soybean oil is the feedstock for SG1000 and accounts for the majority of the direct production cost of the final product. However, cost is influenced by many factors. As with any product, supply and demand forces constantly affect the price of the basic feedstock. Factors affecting soybean supply include weather, acreage planted (both domestically and internationally) and crop yield. Soybean demand is influenced by international sales and domestic consumption for human and animal food products and an increasing demand for products, such as SG1000, which use soybean oil as an ingredient. In the last several years' soy oil production has increased proportionally with the demand for food and industrial soy oil.

Currently, SG1000 can be purchased for approximately 60 cents per pound ($4.38 per gallon) when purchased in the quantities that would be required for the bearing cleaning process. If demand for this and similar products using methyl soyate rose as a result of increased usage, it is expected that production capacity would also increase, resulting in limited volume cost reductions.

One aspect that will affect overall cost in the bearing cleaning process is the disposal of spent SG1000. Currently, when MIL-PRF-680 becomes contaminated, it is removed from the bearing cleaning line for hazardous waste disposal. Solvent disposal is accomplished by recycling with all costs covered by the value of the recycled material. In the case of SG1000, spent product will have to be disposed of under a separate contract line item number (CLIN) in the base hazardous waste disposal contract. Each CLIN price is negotiated when establishing the overall hazardous waste contract and depends on the types and quantities of waste expected and the disposal method such as landfill, incineration, recycle, etc.

2.3.2. Factors Affecting Performance

Factors affecting the performance of SG1000 as an alternative to MIL-PRF-680 in the bearing cleaning process include any adverse affects on bearing substrate materials, and bearing related components. A comprehensive list of substrate materials, performance and testing requirements, and acceptance criteria has been defined in the Joint Test Protocol (JTP). *Acceptance criteria are the gauge that is used to determine the success or failure of any alternative solvent considered for the bearing cleaning process. Failure to meet the acceptance criteria defined in the JTP indicates negative performance and will result in disqualification of the alternative solvent.*

2.4. Advantages and Limitations of the Technology

Emissions from organic solvents are regulated by Federal (40CFR51.100) and State air quality regulations. In addition, local air quality districts may also establish regulations that are even more stringent than the state or federal limits. In California, the APCD has established regulations limiting the VOC content of degreasers at 50 g/l. SCAQMD has set even more restrictive limits of 25g/l for degreasers using halogenated solvents. It is expected that other jurisdictions countrywide will promulgate similar limits.

Clean Air Act Title III, National Emission Standards for Hazardous Air Pollutants (NESHAP) National Emissions Standards for Aerospace Manufacturing and Rework Facilities, described in 40CFR63 Subpart GG, require the use of solvents with a vapor pressure less that 7 mm Hg and contains no HAPs.

The current use of MIL-PRF-680 in the bearing cleaning process will not meet future emissions standards due to the high VOC content of the solvent. As environmental regulations become more stringent, either a replacement solvent will have to be identified, or vapor recovery and destruction systems will have to be installed on the

bearing cleaning process equipment. Using MIL-PRF-680 solvent in open-tank parts washers will not meet these regulations. Compliance can be achieved by using alternative low VOC, HAP-free solvents. A new class of low VOC, HAP-free solvents that meet the acceptance criteria defined in the JTP will allow continued use of open-tank parts washers without the addition of costly emissions control equipment.

The most cost effective method of achieving compliance with current and future emissions regulations is the replacement of the existing MIL-PRF-680 solvent with a drop-in, low VOC, HAP-free, replacement solvent. The use of other classes of cleaners such as aqueous-alkaline based cleaners in the bearing cleaning process is limited. These cleaners contain low levels of VOCs and when used properly, provide adequate cleaning performance. However, the use of aqueous-based cleaners can lead to material compatibility problems such as surface corrosion, flash rusting, and hydrogen embrittlement of bearing surfaces and therefore are not an acceptable alternative to MIL-PRF-680 petroleum-based solvent currently used in the bearing cleaning process.

3. DEMONSTRATION DESIGN

3.1. Performance Objectives

The performance objectives for the demonstration/validation are defined in the JTP and are included in Table 3-1.

Table 3-1 Performance Objectives

Type of Performance Objective	**Primary Performance Criteria**	**Expected Performance (Metric)**	**Actual Performance** **Objective Met?**
Quantitative	Reduce VOC emissions	Contain less than 50 g/L, preferably less than 25 g/L	Yes
	Eliminate HAPs	Certified as non-hazardous air pollutant	Yes
	Produce low nonvolatile residue	Nonvolatile residue less than 8mg/mL	No
	Produce low nonvolatile residue with isopropyl alcohol rinse	Nonvolatile residue with isopropyl alcohol rinse less than 8mg/mL	No
	Elevated Flash Point	Flash point above 100°C required	Yes
	Low vapor pressure	Vapor pressure ≤ 2.0mm Hg @ 20°C	Yes
	Non-acidic	Solvent to have a pH of ≥ 7.0	No

Type of Performance Objective	Primary Performance Criteria	Expected Performance (Metric)	Actual Performance Objective Met?
	Ability to store for extended periods of time	Solvent must meet all criteria when stored for periods of up to 12 months	Yes
	Provide thorough rinse action	Residual cleaning materials completely removed	Yes
	Provide thorough rinse/cleaning action without requirement for additional rinse time	Rinse time not to exceed time required for MIL-PRF-680 (5-minutes)	Yes
	Produce no corrosion or embrittlement of bearing surfaces	Corrosion and embrittlement not observed	No

The quantitative performance objectives listed in Table 3-1 are taken directly from the JTP where acceptance criteria are clearly defined. SG1000 failed to meet the acceptance criteria for non-volatile residue, non-volatile residue with isopropyl alcohol rinse, acidity, corrosion in a number of substrate materials, and hydrogen embrittlement. Analytical results for all tests identified in the JTP are included in the Joint Test Report (JTR).

3.2. Selecting Test Platforms/Facilities

The objective of this demonstration is to evaluate an alternative solvent for the rinse step in the aeronautical antifriction bearing cleaning process at the DoD Depot level. Within DoD there are several depots that specialize in the cleaning of aeronautical antifriction bearings including: Naval Aviation Depot, Naval Air Station North Island, San Diego, CA; NADEP, Marine Corps Air Station, Cherry Point, NC; NADEP, Jacksonville Naval Air Station, Jacksonville, FL; Ogden Air Logistics Center, Hill Air Force Base, UT; Okalahoma City Air Logistics Center, Tinker Air Force Base, Okalahoma City, OK; Warner-Robbins Air Logistics Center, Robbins Air Force Base, Warner-Robbins, GA; and Corpus Christi Army Depot, Corpus Christi, TX. All of these sites were considered for the demonstration. For reasons listed below, NADEP North Island located in San Diego, CA was selected as the demonstration site:

1. NADEP North Island is located within a reasonable travel distance from the NFESC. This location minimizes the cost of site visits and eases coordination with site personnel during the demonstration.
2. Personnel at the NADEP North Island expressed a strong interest in performing a demonstration project using their bearing cleaning line.
3. NADEP North Island is located within the San Diego non-attainment area resulting in the need to reduce VOC emissions.

4. Installing vapor-recovery equipment or other capital-intensive equipment can only further reduce VOC emissions at the site.
5. The bearing cleaning line at NADEP North Island is representative of DoD-wide aviation depot facilities.

3.3. Test Platform/Facility History/Characteristics

The history of NADEP North Island covers almost the entire life span of Naval aviation. The depot began as the Assembly and Repair Department of the naval air station in 1919; became a separate command known as the Naval Air Rework Facility in 1969; and changed to its current name in 1987. Today, the depot handles maintenance, engineering, logistics, and manufacturing services for the Navy. While the focus is on aircraft, engines, and related component parts for aviation, the depot has recently increased its support to the amphibious, surface, and submarine forces. NADEP North Island provides engineering, calibration, manufacturing, overhaul, and repair services as well as administers engineering/airframe authority for the Navy's F/A-18 Hornet, F-14 Tomcat, E-2C Hawkeye, C-2 Greyhound, and S-3 Viking aircraft programs.

The NADEP is located on the Naval Air Station North Island (NASNI), a 2,802-acre complex located at the northern end of the Silver Strand peninsula that borders the city of Coronado and is surrounded by the Pacific Ocean and the San Diego Bay. The NADEP bearing cleaning line is located within Building 35, in an industrial area of the station.

NADEP North Island is one of a number of similar facilities that provide depot maintenance, major modification, and crash damage repair to Navy aviation assets. It is the largest aviation industrial complex on the West Coast and home to two aircraft carriers and approximately 250 aircraft. Other DoD facilities that have similar industrial operations include:

- NADEP, Marine Corps Air Station, Cherry Point, NC
- NADEP, Jacksonville Naval Air Station, Jacksonville, FL.
- Ogden Air Logistics Center, Hill Air Force Base, UT
- Oklahoma City Air Logistics Center, Tinker Air Force Base, Oklahoma City, OK
- Warner-Robbins Air Logistics Center, Robbins Air Force Base, Warner-Robbins GA
- Corpus Christi Army Depot, Corpus Christi, TX

A map of NASNI is included as Figure 3-1, identifies the building containing the bearing cleaning line and the location of the demonstration project bearing cleaning operation.

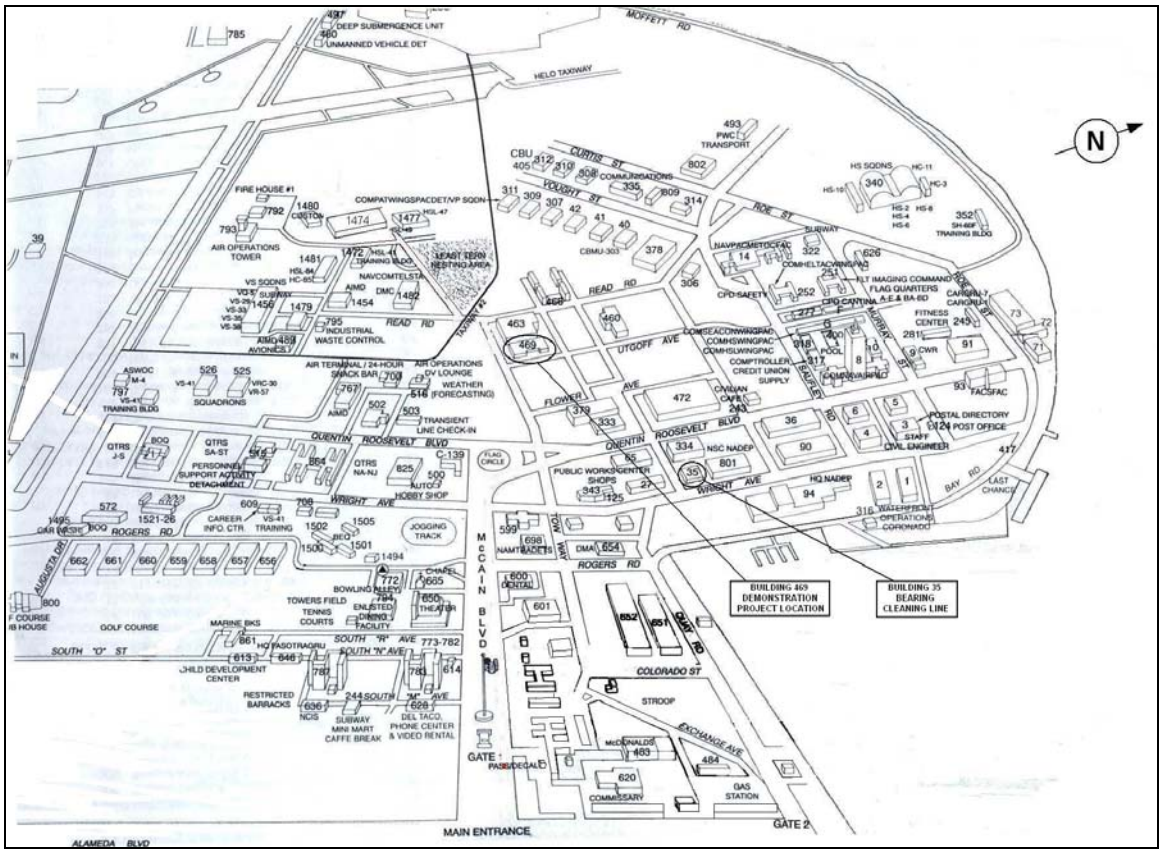

Figure 3-1 Map of NASNI

3.4. Present Operations

The cleaning of aeronautical antifriction bearings at NADEP North Island is performed at the Bearing Shop located in Building 35 using a multi-stage cleaning process. Bearings are processed through the various stages of the cleaning line depending on the type of contamination that is to be removed.

New bearings are separated from used bearings and processed using a slightly different series of cleaning stages. Typically new bearings are coated with preservatives that must be removed and only require minimal cleaning. Conversely, soiled bearings are typically covered with grease and may have a carbon build-up, which requires a more extensive cleaning process. The Bearing Cleaning Technical Manual defines the specifics of the cleaning processes for each category.

Used (dirty) bearings are further segregated into one of three categories depending on the degree and type of contamination. Figure 1-1 shows the eleven cleaning stages and illustrates the cleaning processes for dirty bearings contaminated with grease or preservatives, bearings contaminated with oils, and those contaminated with carbon.

The three rinse stages, identified as 7A, 7B, and 7C, are the stages of interest in this demonstration/validation. In these stages, the bearings are sequentially submersed and agitated in tanks containing MIL-PRF-680 solvent. The wash tanks are equipped with filters to remove particulates from the solvent. Wash tanks in Stage 7A, 7B and 7C are progressively filtered to 100-, 50-, and 10-micron particle sizes. The three-stage rinse removes all cleaning agents from previous stages leaving only MIL-PRF-680 solvent residue on the bearings.

The remaining residue from the MIL-PRF-680 rinse is then removed using IPA vapor and dried during Stage 8 of the bearing cleaning process. Bearings are then passed into the clean room for inspection, fingerprint neutralization, and final preservation and packaging as required.

The current process using MIL-PRF-680 solvent as the rinse agent in Stages 7A-7C does an excellent job of removing cleaning agents from bearing surfaces. As indicated earlier, the objective of this demonstration/validation is to test a low VOC, HAP-free alternative solvent (SG1000) in the rinse step of the bearing cleaning process.

3.5. Pre-Demonstration Testing and Analysis

Testing of the alternative solvent was performed in three phases to evaluate the product's potential throughout the evaluation. Results from each phase were evaluated prior to proceeding to the next phase. Test methods, performance requirements, and acceptance criteria are clearly defined in the JTP and Demonstration Plan.

Phase I screening tests consist of a series of laboratory tests and a toxicity assessment and are used as an inexpensive method to initially screen potential solvents for the bearing cleaning process. Table 3-2 includes the list of the solvent parameters and acceptance criteria used for Phase I analysis.

SG1000 passed all of the screening tests with the exception of the KB value. The KB value was determined to be 58.6, which fell outside the range specified in the acceptance criteria. The process stakeholders were advised that the KB value was outside the range of 27-45 as specified in the acceptance criteria. Stakeholders are not required to adhere to the screening criteria if other information, data, or circumstances substantiate a solvent's potential for the application. The stakeholders agreed that in the rinse step of bearing cleaning process the alternative is not used as a cleaning agent and must only be capable of rinsing the bearing-cleaning agents from the bearing surfaces. Since the KB value is not a critical parameter it was agreed to allow SG1000 to proceed with Phase II testing.

Table 3-2 Screening Criteria for Demonstration Solvent Material (SG1000)

Solvent Parameters	Acceptance Criteria	Criteria Met?
ENVIRONMENTAL, OCCUPATIONAL SAFETY AND HEALTH PROPERTIES		
VOCs	Shall contain less than 50 g/L VOC, be VOC exempt, or a SCAQMD Certified CAS.	Yes SG1000 is a SCAQMD Certified CAS.
HAPs	None	Yes SG1000 does not contain HAPs
Flash Point	> 212° F	Yes Flash point was determined to be 331° F
Toxicity	Shall have no adverse effect on human health when used as intended and shall contain no chemicals listed as carcinogens.	Yes SG1000 passed health hazard assessment performed by Navy Environmental Health Center (NEHC) and passed the Army Center for Health Promotion and Preventative Medicine (CHPPM) toxicity evaluation.
CHEMICAL PROPERTIES		
Vapor Pressure	< 2.0 mm Hg @ 20° C	Yes SG1000 vapor pressure was determined to be < 2.0 mm Hg @ 20° C
KB Value	27 - 45	No SG1000 KB value was determined to be 58.6

3.6. Testing and Evaluation Plan

3.6.1. Demonstration Set-Up and Start-Up

The demonstration phase focused on the rinse step of the bearing cleaning process identified as Stages 7A, 7B, and 7C in Figure 1-1. It was determined that equipment

modifications to the existing bearing cleaning line to facilitate the demonstration would be disruptive and interfere with normal bearing cleaning operations. To minimize the impact on normal bearing cleaning operations, a parallel rinse step was constructed. Routine bearing cleaning operations were performed through the bearing cleaning line as always. The demonstration bearings were processed through the bearing cleaning line until they reached the rinse step. They were then transferred to a parallel rinse tank charged with the demonstration solvent for the prescribed rinse. When complete, the bearings were returned to the bearing cleaning line (Stage 8 of Figure 1-1) to complete the remainder of the cleaning process. This parallel configuration worked well and minimized the impact on routine bearing cleaning operations.

The parallel rinse tank was installed in the NADEP North Island Materials Engineering Laboratory located in Building 469. A KleenTec, Model KT9000 stainless steel industrial parts washer (Figure 3-2) with adjustable agitation and stroke control was used for the parallel rinse step of the demonstration. The tank dimensions are 48-inches long, 27.5-inches wide, by 32-inches deep. It has a soak capacity of 100 gallons, a load capacity of 260-lbs, and is pneumatically operated with 100-psi compressed air.

A sufficient source of compressed air was already present in the materials engineering laboratory and no site preparation was required. A separate multistage filtration system was designed and built to continuously circulate and filter the SG1000 rinse solution (Figure 3-3). The multistage filtration system was configured with 75-, 50-, and 10-micron filter elements and a centrifugal pump sized to provide a nominal fluid flow of approximately 10-gpm. The system pump required an 110VAC, 3.6A electrical source. Sufficient power was readily available in the materials engineering laboratory and no site preparation was required. Prior to the start of the demonstration the parts washer was charged with 100-gallons of new SG1000 product material. A supply of replacement filter elements was maintained throughout the demonstration.

Figure 3-2 KleenTec Model KT9000 stainless steel industrial parts washer

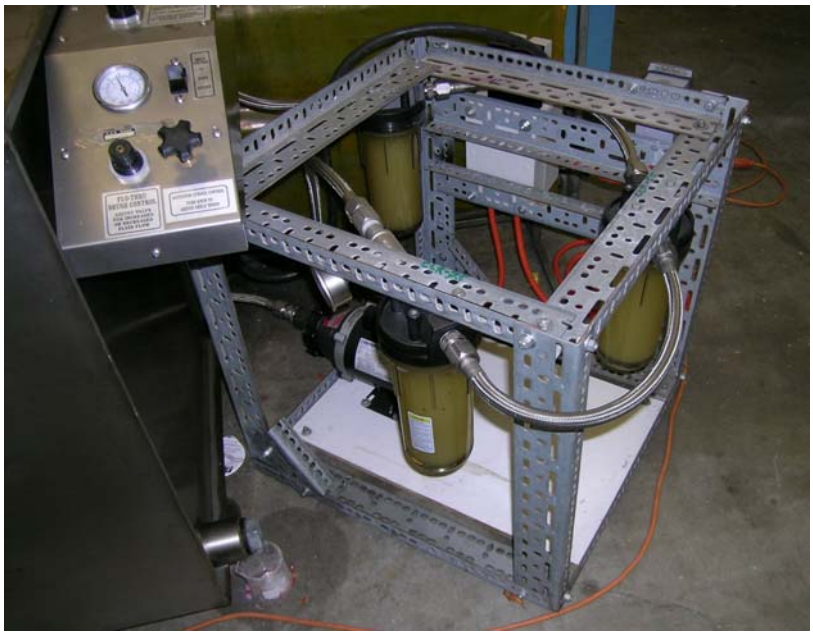

Figure 3-3 Ten-gallon per minute multistage filtration system equipped with 75-, 50-, and 10-micron filter elements

The parts washer and filtration system were plumbed together using 1-inch diameter braided stainless steel reinforced Polytetrafluorethylene hoses. Air and electrical connections were made and the parts washer and filtration system was activated to fill the filter canisters and check for leaks. During the shakedown test the agitation stroke and frequency of the parts cleaning rack was adjusted so that bearings loaded onto the cleaning rack would not break the surface of the fluid. The system was run for approximately 1-hour to remove any debris present in the SG1000 product, parts washer, and hoses and to ensure trouble free operation during the demonstration. The system was then shut down and secured until the start of the demonstration.

3.6.2. Period of Operation

The demonstration phase was performed at the NADEP North Island bearing cleaning facility. Preparations for the demonstration were performed in the months prior to the actual demonstration and included the acquisition of, SG1000 product material, pneumatically driven immersion parts washer, multistage filtration system, test bearings, greases, oils, and preservatives. Preparations also included setup and shakedown testing of the pneumatically driven immersion parts washer and multistage filtration system.

The actual demonstration was completed in approximately 1 week although testing was conducted in two parts. Not all of the bearing contamination products (lubricants, oils and preservatives) identified in Table 3-4 had been received prior to the start of the demonstration. Tests scheduled using two of the contamination products were delayed

due to product availability. Rather than delay the start of the demonstration it was decided to proceed using the products that had been received and complete the last two at a later date. Table 3-3 indicates the period of operation of the bearing cleaning demonstration.

Table 3-3 Bearing Cleaning Demonstration Schedule

BEARING TEST GROUP	BEARING SERIES ID	BEARING PREPARATION DATE	TESTING START DATE	TESTING COMPLETION DATE
1	1	10 MAY 2005	21 JUL 2005	22 JUL 2005
1	2	10 MAY 2005	21 JUL 2005	22 JUL 2005
1	3	10 MAY 2005	21 JUL 2005	22 JUL 2005
1	6	10 MAY 2005	21 JUL 2005	22 JUL 2005
1	7	10 MAY 2005	21 JUL 2005	22 JUL 2005
1	8	10 MAY 2005	21 JUL 2005	22 JUL 2005
1	10	10 MAY 2005	21 JUL 2005	22 JUL 2005
1	12	10 MAY 2005	21 JUL 2005	22 JUL 2005
2	4	21 NOV 2005	21 NOV 2005	22 NOV 2005
2	9	21 NOV 2005	21 NOV 2005	22 NOV 2005

Bearings for Part one of the demonstration were prepared on May 10, 2005. With the exception of bearing series 12, all demonstration bearings were thoroughly cleaned and inspected using the standard bearing cleaning process. Identification tags were fabricated and attached to each bearing. Preservatives/lubricants were applied to bearing series 1, 2, 3, 6, 7, 8, and 10, each bearing was photographed, and bearings were packaged/stored until testing began on July 21, 2005. Group 1 testing was completed on July 22, 2005.

Group 2 bearings were prepared for testing on November 21, 2005. Preservatives/lubricants were applied to bearing series 4 and 9 and photographed. Group 2 testing began on November 21, 2005 and was completed on November 22, 2005.

3.6.3. Amount/Treatment Rate of Material to be Tested

The purpose of the demonstration was to test SG1000 as a low VOC, HAP-free solvent replacement for MIL-PRF-680 in the rinse step of the bearing cleaning process. To perform the demonstration the rinse step was replaced with a separate rinse tank charged with 100-gallons of SG1000 solvent. Test bearings were processed through the normal cleaning process until they reached the MIL-PRF-680 rinse step where they were diverted to the alternative SG1000 rinse tank to remove the cleaning agents used to clean the bearings. The SG1000 rinsed bearings were then returned to the normal cleaning process to complete the remaining steps of the cleaning process.

To test the effectiveness of the SG1000 solvent in the rinse step a selection of typical aeronautical antifriction bearings contaminated with a variety of lubricants/preservatives were processed through the modified bearing cleaning line.

As the cognizant activity for Tri-Service Manual NAVAIR 01-1A-503, which directs inspection, maintenance and repair of aeronautical antifriction bearings, North Island Naval Aviation Depot developed a TEI for the testing of the SG1000 product. The TEI served as a guidance document for sample identification, preparation, photo-documentation, pre-processing, rinsing process, post-processing and reporting. The TEI also specified the types of lubricants/preservatives to be tested as well as the numbers and types of bearings to be processed. A copy of the North Island Naval Aviation Depot TEI is included in Appendix B.

North Island Naval Aviation Depot provided a representative sample of 72 aeronautical antifriction bearings typical of the types normally cleaned on the bearing cleaning line. The bearings were taken from service and prepared for the demonstration. The bearings were divided among three of the five bearing groups including Propulsion (Group A), Airframe (Group B), and Electrical (Group E). Sixty-six of the bearings (22 from each group) were pre-cleaned as specified in Chapter 5 of the Bearing Cleaning Technical Manual. The remaining six bearings (2 from each group) were not cleaned and represented "used" bearings in the dirty condition.

3.6.4. Operating Parameters for the Technology

Bearings cleaned during the demonstration were prepared as described in the North Island Naval Aviation Depot TEI and cleaned in accordance with the NANAIR 01-1A-503 Bearing Cleaning Technical Manual. Bearings were loaded into baskets and batch processed through the bearing cleaning line according to the bearing cleaning flowchart illustrated in Figure 3.5.

3.6.5. Experimental Design

The demonstration was conducted at the NADEP North Island bearing cleaning shop. Cleaning of aeronautical antifriction bearings is performed using a well-defined multi-stage cleaning process. Bearings are processed through the various stages of the cleaning line depending on the type of contamination that is to be removed.

New bearings are separated from used bearings and processed using a slightly different series of cleaning stages. Typically new bearings are coated with preservatives that must be removed and only require minimal cleaning. Conversely, soiled bearings are typically covered with grease and may have a carbon build-up that requires a more extensive cleaning process. The Bearing Cleaning Technical Manual defines the specifics of the cleaning processes for each category.

Used (dirty) bearings are further segregated into one of three categories depending on the degree and type of contamination. Figure 1-1 shows the eleven cleaning stages and

illustrates the cleaning processes for dirty bearings contaminated with grease or preservatives, bearings contaminated with oils, and those contaminated with carbon.

The three rinse stages, identified as 7A, 7B, and 7C, are the stages of interest in this demonstration/validation. In these stages, the bearings are sequentially submersed and agitated in tanks containing MIL-PRF-680 solvent. The wash tanks are equipped with filters to remove particulates from the solvent. Wash tanks in Stage 7A, 7B and 7C are progressively filtered to 100-, 50-, and 10-micron particle sizes. The three-stage rinse removes all cleaning agents from previous stages leaving only MIL-PRF-680 solvent residue on the bearings.

The remaining residue from the MIL-PRF-680 rinse is then removed using IPA vapor and dried during Stage 8 of the bearing cleaning process. Bearings are then passed into the clean room for inspection, fingerprint neutralization, and final preservation and packaging.

To demonstrate the effectiveness of SG1000 as an alternative to MIL-PRF-680 in the rinse step of the bearing cleaning process, a selection of bearings were intentionally contaminated with the types of lubricants/preservatives typically found on bearings that are cleaned in the bearing cleaning line.

Bearing shop technicians applied one of nine lubricates/preservatives to two clean bearings from each group resulting in 54 samples. *It should be noted that the original plan was to include eleven lubricants/preservatives however two were no longer available and were eliminated from the demonstration.* A list of the eleven lubricants/preservatives including the two that were eliminated, is included in Table 3-4. The remaining six bearings included two bearings from each group in the "used" dirty condition and represented bearings in the condition typically received when taken out of service for organizational, intermediate, and depot level maintenance.

A metal tag inscribed with a unique alphanumeric identification was attached to each bearing with a metal retaining wire. The unique identification was created from the letters and numbers illustrated in Table 3-5. The first letter identifies the bearing group (A, B, or E), the number identifies the lubricant or preservative (1, 2, … 11), and the second letter identifies either the prototype (X) or standard (Z) cleaning process. Table 3-6 is a complete list of bearings by sample identification, bearing group, type of lubricant/preservative applied, and cleaning process used to clean the bearing. A link to the corresponding photograph in Appendix C for each prepared bearing is also included.

Test bearings were loaded into standard bearing cleaning baskets and batch processed through the bearing cleaning line using the standard MIL-PRF-680 rinse step or using the alternative SG1000 rinse. Figure 3-4 is a typical bearing-cleaning basket loaded with prepared bearings for processing. Figure 3-5 is a flowchart of the bearing cleaning process used throughout the demonstration.

Figure 3-4. Typical Bearing Cleaning Basket Loaded with Labeled Test Bearings for Processing

Figure 3-5. Bearing Cleaning Process Flowchart

Click link to display photograph of cleaning stage in Appendix D.

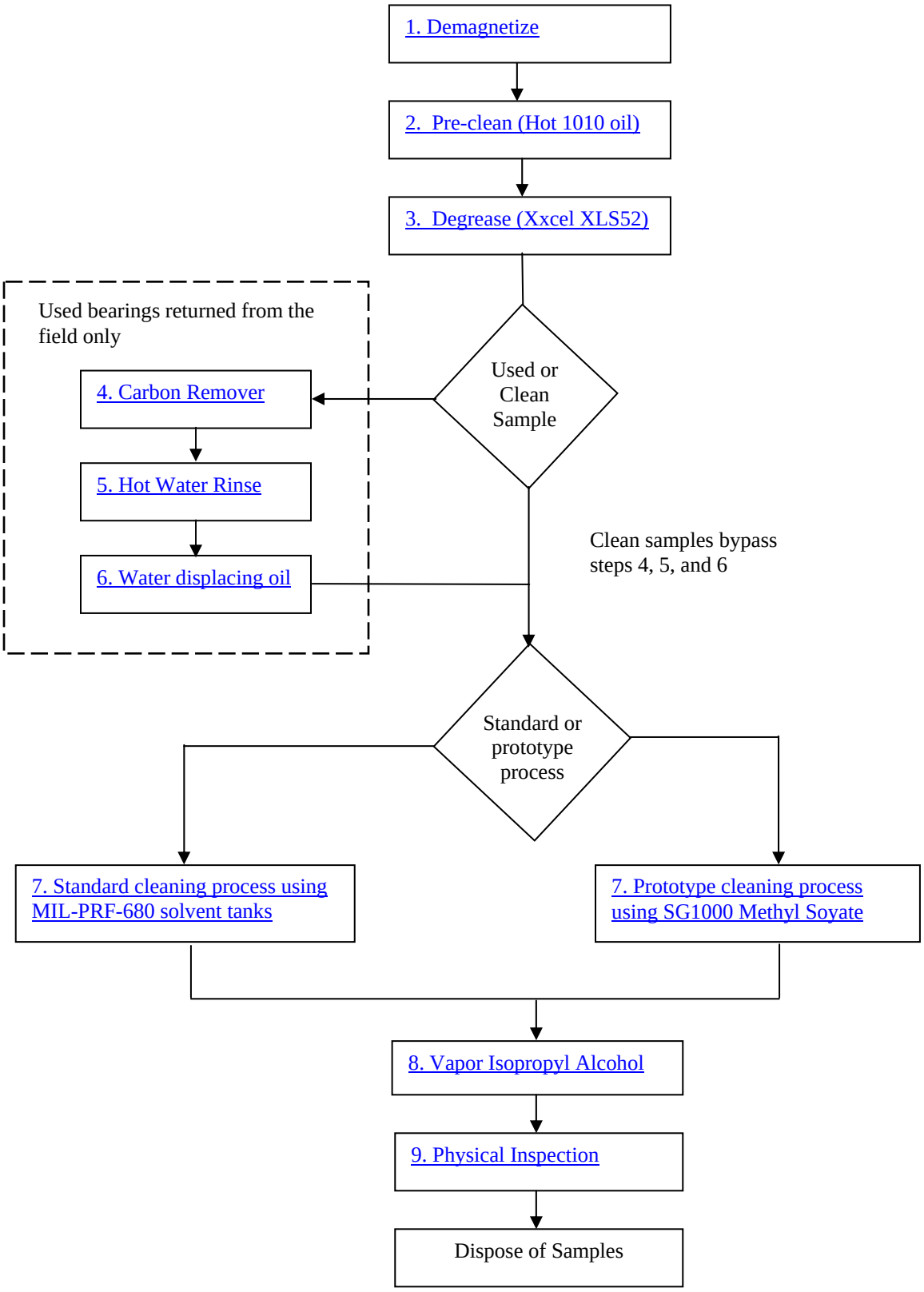

Table 3-4. Lubricants/Preservatives Used in Demonstration			
	Lubricant/Preservative Type	**Issue Date**	**Description**
1	MIL-PRF-81322F	24 Jan 2005	Grease, Aircraft, General Purpose, Wide Temperature Range, NATO Code G-395
2	MIL-PRF-27617F	17 Feb 1998	Grease, Aircraft and Instrument, Fuel and Oxidizer Resistant
3	MIL-PRF-23827C	19 Jun 2002	Grease, Aircraft and Instrument, Gear and Actuator Screw, NATO Code G-354
4	MIL-PRF-81827 AMS-G-81827	May 2001	Grease, Aircraft, High Load Capacity, Wide Temperature Range
5	MIL-PRF-18709	This Lubricant/Preservative was Found to be no Longer Available and Not Included in the Demonstration.	
6	Nye Rheotemp 500	Undated	A Sodium Complex Soap Thickened, Light Viscosity, Ester Grease Intended for High Speed Ball Bearing Applications. Exceptional Wide Temperature Performance.
7	MIL-PRF-23699F	21 May 1997	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code O-156
8	MIL-PRF-6081D	10 Nov 1997	Lubricating Oil, Jet Engine
9	MIL-PRF-7808L	02 May 1997	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
10	MIL-PRF-32033	24 Jul 2000	Lubricating Oil, General Purpose, Preservative (Water Displacing, Low Temperature)
11	MIL-C-11796B	This Lubricant/Preservative was Found to be no Longer Available and Not Included in the Demonstration.	
12	Dirty/Used Bearings Obtained from Field	N/A	N/A

Table 3-5. Characters for Sample Identification					
Column 1 (Bearing Group)		**Column 2 (Lubricant/Preservative Type)**		**Column 3**	
				Prototype Sample	**Standard Sample**
GROUP A PROPULSION	A	MIL-PRF-81322	1	X	Z
GROUP B AIRFRAME	B	MIL-PRF-27617	2		
GROUP E ELECTRICAL	E	MIL-PRF-23827	3		
		MIL-PRF-81827 [3]	4		
		MIL-PRF-18709 [2]	5		
		Nye Rheotemp 500	6		
		MIL-PRF-23699	7		
		MIL-PRF-6081	8		
		MIL-PRF-7808 [3]	9		
		MIL-PRF-32033	10		
		MIL-C-11796 [2]	11		
		Dirty [1]			

[1] Two samples from each group were not cleaned prior to testing and are representative samples of bearings "from the field"

[2] Lubricants/Preservatives specified in sample series 5 and 11 (in red) were no longer available and were not included in the demonstration.

[3] Lubricants/Preservatives specified in sample series 4 and 9 (in blue) were included in the second half of the demonstration testing.

Example: Two bearings selected from Group A, lubricated with MIL-PRF-6081, are designated A8X and A8Z respectively.

Table 3-6. Bearing Identification				
Bearing Sample ID	**Link to Photograph in Appendix C**	**Bearing Group**	**Lubricant/ Preservative**	**Rinse Process**
A1X	Figure C-1	Propulsion	MIL-PRF-81322	Prototype
B1X	Figure C-2	Airframe	MIL-PRF-81322	Prototype
E1X	Figure C-3	Electrical	MIL-PRF-81322	Prototype
A1Z	Figure C-4	Propulsion	MIL-PRF-81322	Standard
B1Z	Figure C-5	Airframe	MIL-PRF-81322	Standard
E1Z	Figure C-6	Electrical	MIL-PRF-81322	Standard
A2X	Figure C-7	Propulsion	MIL-PRF-27617	Prototype
B2X	Figure C-8	Airframe	MIL-PRF-27617	Prototype
E2X	Figure C-9	Electrical	MIL-PRF-27617	Prototype
A2Z	Figure C-10	Propulsion	MIL-PRF-27617	Standard
B2Z	Figure C-11	Airframe	MIL-PRF-27617	Standard
E2Z	Figure C-12	Electrical	MIL-PRF-27617	Standard
A3X	Figure C-13	Propulsion	MIL-PRF-23827	Prototype
B3X	Figure C-14	Airframe	MIL-PRF-23827	Prototype
E3X	Figure C-15	Electrical	MIL-PRF-23827	Prototype
A3Z	Figure C-16	Propulsion	MIL-PRF-23827	Standard
B3Z	Figure C-17	Airframe	MIL-PRF-23827	Standard
E3Z	Figure C-18	Electrical	MIL-PRF-23827	Standard
A4X	Figure C-19	Propulsion	MIL-PRF-81827	Prototype
B4X	Figure C-19	Airframe	MIL-PRF-81827	Prototype
E4X	Figure C-19	Electrical	MIL-PRF-81827	Prototype
A4Z	Figure C-20	Propulsion	MIL-PRF-81827	Standard
B4Z	Figure C-20	Airframe	MIL-PRF-81827	Standard
E4Z	Figure C-20	Electrical	MIL-PRF-81827	Standard
A5X	None	Propulsion	MIL-PRF-18709	None
B5X	None	Airframe	MIL-PRF-18709	None
E5X	None	Electrical	MIL-PRF-18709	None
A5Z	None	Propulsion	MIL-PRF-18709	None
B5Z	None	Airframe	MIL-PRF-18709	None
E5Z	None	Electrical	MIL-PRF-18709	None
A6X	Figure C-21	Propulsion	Rheotemp 500	Prototype
B6X	Figure C-22	Airframe	Rheotemp 500	Prototype
E6X	Figure C-23	Electrical	Rheotemp 500	Prototype
A6Z	Figure C-24	Propulsion	Rheotemp 500	Standard
B6Z	Figure C-25	Airframe	Rheotemp 500	Standard
E6Z	Figure C-26	Electrical	Rheotemp 500	Standard
A7X	Figure C-27	Propulsion	MIL-PRF-23699	Prototype
B7X	Figure C-28	Airframe	MIL-PRF-23699	Prototype
E7X	Figure C-29	Electrical	MIL-PRF-23699	Prototype
A7Z	Figure C-30	Propulsion	MIL-PRF-23699	Standard
B7Z	Figure C-31	Airframe	MIL-PRF-23699	Standard
E7Z	Figure C-32	Electrical	MIL-PRF-23699	Standard

Bearing Sample ID	Link to Photograph in Appendix C	Bearing Group	Lubricant/ Preservative	Rinse Process
A8X	Figure C-33	Propulsion	MIL-PRF-6081	Prototype
B8X	Figure C-34	Airframe	MIL-PRF-6081	Prototype
E8X	Figure C-35	Electrical	MIL-PRF-6081	Prototype
A8Z	Figure C-36	Propulsion	MIL-PRF-6081	Standard
B8Z	Figure C-37	Airframe	MIL-PRF-6081	Standard
E8Z	Figure C-38	Electrical	MIL-PRF-6081	Standard
A9X	Figure C-19	Propulsion	MIL-PRF-7808	Prototype
B9X	Figure C-19	Airframe	MIL-PRF-7808	Prototype
E9X	Figure C-19	Electrical	MIL-PRF-7808	Prototype
A9Z	Figure C-20	Propulsion	MIL-PRF-7808	Standard
B9Z	Figure C-20	Airframe	MIL-PRF-7808	Standard
E9Z	Figure C-20	Electrical	MIL-PRF-7808	Standard
A10X	Figure C-39	Propulsion	MIL-PRF-32033	Prototype
B10X	Figure C-40	Airframe	MIL-PRF-32033	Prototype
E10X	Figure C-41	Electrical	MIL-PRF-32033	Prototype
A10Z	Figure C-42	Propulsion	MIL-PRF-32033	Standard
B10Z	Figure C-43	Airframe	MIL-PRF-32033	Standard
E10Z	Figure C-44	Electrical	MIL-PRF-32033	Standard
A11X	None	Propulsion	MIL-C-11796	None
B11X	None	Airframe	MIL-C-11796	None
E11X	None	Electrical	MIL-C-11796	None
A11Z	None	Propulsion	MIL-C-11796	None
B11Z	None	Airframe	MIL-C-11796	None
E11Z	None	Electrical	MIL-C-11796	None
A12X	Figure C-45	Propulsion	Dirty from field	Prototype
B12X	Figure C-46	Airframe	Dirty from field	Prototype
E12X	Figure C-47	Electrical	Dirty from field	Prototype
A12Z	Figure C-48	Propulsion	Dirty from field	Standard
B12Z	Figure C-49	Airframe	Dirty from field	Standard
E12Z	Figure C-50	Electrical	Dirty from field	Standard

Note:

A dynamic link exists between the figure numbers and Appendix C. Clicking on the figure number will display the corresponding photograph in Appendix C.

Lubricants/Preservatives specified in sample series 5 and 11 (in red) were no longer available and were not included in the demonstration.

Lubricants/Preservatives specified in sample series 4 and 9 (in blue) were included in the second half of the demonstration testing.

3.6.6. Product Testing

A joint group led by the Naval Facilities Engineering Service Center and consisting of technical representatives from Naval Facilities Engineering Command, Naval Air Systems Command, U.S. Army Aberdeen Test Center, U.S. Army Research Lab, U.S. Army Tank Automotive Research, Development, and Engineering Center, U.S. Army Aviation and Missile Command, Air Force Materiel Command, and Air Force Warner Robins Air Logistics Center identified engineering performance and testing requirements for aeronautical antifriction bearing cleaning. This group reached consensus on the test conditions and acceptance criteria to qualify alternatives against critical, technical, and performance requirements. In addition, the Navy Environmental Health Center and the Army Center for Health Promotion and Preventative Medicine performed toxicity evaluations on the demonstration solvent material to determine any occupational safety and health risks associated with worker exposure.

Testing was performed in phases to evaluate SG1000's potential throughout the evaluation. In addition to the physical demonstration of SG1000 in the aeronautical antifriction bearing cleaning process, analytical testing was performed into two phases.

During Phase I testing, SG1000 was screened against a set of solvent parameters and acceptance criteria designed to tentatively qualify or eliminate an alternative solvent before entering costly Phase II analytical testing.

During Phase II testing, a series of analytical tests defined in the JTP were performed by the U.S. Army Aberdeen Test Center. A copy of the JTP was provided to the Army as a guidance document that defined the analytical testing requirements. Tests were divided into several categories including environmental, occupational safety and health tests, chemical properties related tests, materials compatibility tests, and performance criteria related tests.

The acceptance criteria are the gauge used to determine whether an alternative solvent passes or fails the tests identified in the JTP. SG1000 must pass all tests identified in the JTP and pass the demonstration/validation phase to be an acceptable alternative to MIL-PRF-680 in the rinse step of the bearing cleaning process. In addition, SG1000 must meet all performance, compatibility, and safety requirements, be cost effective, and provide measurable environmental benefit.

A detailed report of all analytical testing performed using SG1000 is included in the JTR. The JTR is included in Appendix A. In addition, the JTR also includes a copy of the U.S. Army Aberdeen Tests Center final test report.

3.6.7. Demobilization

According to the Demonstration Plan, all spent and unused portions of SG1000 solvent, sample bearings, and spent filter cartridges were to be disposed of through existing NADEP North Island hazardous waste contracts. In addition, the parts washer and

multistage filtration system were to be removed from the Materials Engineering Laboratory located in Building 469 and returned to NFESC for the appropriate disposition of plant accounted material.

Since testing was to be performed at the NADEP North Island Materials Engineering Laboratory their plant account property managers required that NFESC officially transfer custody of the parts washer, pump and multistage filtration system to their plant account inventory. This hardware is now officially owned by, and the responsibility of, NADEP North Island.

It was decided that rather than disposing of this equipment at the conclusion of the demonstration, it would be permanently located in Building 469 for use by the Materials Engineering Laboratory. In addition, the Materials Engineering Laboratory agreed to retain custody of *all* used and unused SG1000 solvent and filter cartridges for use in the parts washer. The multistage filtration system maintained excellent solvent cleanliness throughout the demonstration and the 100-gallons originally installed in the parts washer was still useful at the conclusion of the demonstration. The Materials Engineering Laboratory continues to use the SG1000 charged parts washer and filtration system for cleaning non-critical and miscellaneous parts. When this material is no longer useful, NADEP North Island will properly dispose of it under their existing hazardous waste contract.

All bearings used during the demonstration were cleaned and transported to NFESC for proper disposal as non-hazardous solid waste.

3.7. Selection of Analytical/Testing Methods

There are no established analytical testing methods used during the bearing cleaning process to determine cleanliness. Bearing cleanliness is determined through visual inspections performed by the bearing artisans during the cleaning process. As bearings progress through the various cleaning stages they are visually inspected prior to entering the next cleaning stage. If bearings are particularly dirty they are returned to the cleaning tanks where they are provided extra soak or agitation time to remove stubborn contaminants. When the bearing artisan is satisfied that the bearing is clean it is allowed to continue through the cleaning process.

Bearings are subjected to a number of rigorous inspections before they are returned to service. Once clean, inspectors perform a number of inspections that include visual examinations to detect surface flaws and service related defects that could cause operational problems and/or bearing failures, dimensional inspections and mechanical testing to determine wear related to high speed, high loads, high temperature and abrasive environments, and nondestructive testing and inspection for determining acceptability of bearings. Guidance for visual, dimensional and nondestructive testing of bearings is included in Sections VII, VIII, and IX of the Bearing Cleaning Technical Manual.

Although these inspections are not intended to determine bearing cleanliness they can reveal cleanliness related issues. During the demonstration the normal MIL-PRF-680 rinse step was replaced with SG1000 product. *The normal process of removing dirt and grime from the process was not changed. The purpose of the rinse step in the bearing cleaning process is to remove the cleaning agents used to clean the soil from the bearing surfaces.* The demonstration was performed to determine whether the SG1000 product could remove the cleaning agents without leaving a residue on the surface of the bearings that is unable to be removed during the remainder of the cleaning process. The detailed inspections described in the previous paragraph were used to make this determination.

Analytical tests specified in the JTP were used to determine whether SG1000 has any environmental, occupational safety and health, chemical properties, materials compatibility, and performance criteria related issues. Analytical test results are included in the JTR.

3.8. Selection of Analytical/Testing Laboratory

Analytical tests identified in the JTP (Phase I and II) were performed by the U.S. Army Aberdeen Test Center with the exception of titanium stress corrosion tests, toxicity clearances, and volatile organic compounds analysis. Titanium stress corrosion tests were performed under Army contract by Scientific Material International, Inc. Toxicity clearances were performed by CHPPM and NEHC. Volatile organic compounds analysis was also performed by CHPPM. A list containing the address of each laboratory is included in Table 3-7.

There were no analytical tests performed during the Phase III Demonstration. Bearing cleanliness was determined through visual inspections performed by the bearing artisans during the cleaning process.

Table 3-7 List of Analytical/Testing Laboratories

LIST OF ANALYTICAL/TESTING LABORATORIES	
Bulk of JTP Analytical Testing	
U.S Army Aberdeen Test Center	U.S. Army Aberdeen Test Center CSTE DTC AT CS R 400 Colleran Road Aberdeen Proving Ground MD 21005-5059
Titanium Stress Corrosion	
Scientific Material International, Inc.	SMI, Inc. 12219 SW 131 Avenue Miami FL 33186-6401
Toxicity Clearances	
U.S Army Center for Health Promotion and Preventative Medicine	U.S Army Center for Health Promotion and Preventative Medicine 5158 Blackhawk Road Aberdeen Proving Ground MD 21010-5422
Navy Environmental Health Center	Navy Environmental Health Center 620 John Paul Jones Circle Suite 1100 Portsmouth VA 23708-2103
Volatile Organic Compound Analysis	
U.S Army Center for Health Promotion and Preventative Medicine	U.S Army Center for Health Promotion and Preventative Medicine 5158 Blackhawk Road Aberdeen Proving Ground MD 21010-5422

4. PERFORMANCE ASSESSMENT

4.1. Performance Criteria

The general performance criteria used to evaluate SG1000 as an alternative for MIL-PRF-680 in the aeronautical bearing cleaning process is summarized in Table 4-1. These performance criteria have been categorized as either primary or secondary.

Table 4-1: Performance Criteria

Performance Criteria	Description	Primary or Secondary
Product Testing	**Environmental, Occupational Safety and Health** **Toxicity –** Shall have no adverse effect on human health when used as intended and shall contain no chemicals listed as carcinogens. **Volatile Organic Compounds –** Shall contain less than 50 g/l VOC, be VOC exempt, or a SCAQMD certified CAS. **Flash Point –** The flash point shall be greater than 100° C (212° F). **Hazardous Air Pollutants –** Shall be HAP-free.	*Primary*
Product Testing	**Chemical Properties** **Vapor Press**ure – The maximum vapor pressure is 2.0 mm Hg @ 20°C **Acidity –** Shall show no evidence of acidity. **Appearance –** Shall be clear and free from suspended matter and undissolved water when observed at ambient conditions.	*Primary*
Product Testing	**Materials Compatibility** **Total Immersion Corrosion –** Shall not cause any indication of staining, etching, pitting, or localized attack; nor shall weight change exceed allowable limits. **Titanium Stress Corrosion –** Shall not cause any microscopic cracking when examined at 500X magnification. **Hydrogen Embrittlement –** Shall not cause hydrogen Embrittlement of cadmium plated AISI 4340 steel.	*Primary*

Performance Criteria	Description	Primary or Secondary
	Stress Corrosion – Shall cause no evidence of cracking. **Nonvolatile Residue** – Shall not have a nonvolatile residue greater than 8 mg/100mL. **Nonvolatile Residue with Isopropyl Alcohol Rinse** – Shall not have a nonvolatile residue greater than 8 mg/100 mL	
Product Testing	**Performance Criteria** **Storage Stability** – After 12-month storage, the solvent shall meet the acceptance criteria for: rinsing efficiency, total immersion corrosion, titanium stress corrosion, hydrogen Embrittlement, stress corrosion, acidity, and appearance. **Rinse Efficiency** – The rinse efficiency shall be equal to or better than MIL-PRF-680.	*Primary*
Hazardous Materials Reduction	The demonstration solvent will reduce the amount of MIL-PRF-680 used in the bearing cleaning process. The reduction in MIL-PRF-680 use will also reduce the amount of VOCs, and HAPs entering the environment.	*Secondary*
Process Waste	As with the current solvent used in the bearing cleaning rinse step, the spent demonstration solvent rinse and filtration elements will be contaminated with bearing cleaning agents, dissolved greases, oils, preservatives and contaminants. This process waste will be disposed of as hazardous waste through existing hazardous waste contracts.	*Secondary*
Factors Affecting Technology Performance	As with the current solvent used in the bearing cleaning rinse step, the demonstration solvent will eventually become saturated with bearing cleaning agents, dissolved greases, oils, preservatives and contaminants that are removed during the cleaning process. The rise in concentration of these materials in the rinse tank will eventually require the rinse solution to be replaced.	*Secondary*

Performance Criteria	Description	Primary or Secondary
Reliability	The demonstration solvent must be chemically compatible with current cleaning agents used in the bearing cleaning process. The demonstration solvent must be chemically compatible and perform effectively with all materials that are normally found in new and used bearings. These materials include preservatives, oils and greases.	*Primary*
Ease of Use	The demonstration solvent must be a drop-in replacement and not significantly affect the bearing cleaning process time. The demonstration solvent shall be chemically compatible with current bearing clean equipment including current parts washers, recirculation pumps and seals, and filtration systems. Use of the demonstration solvent will not require additional manpower or additional skills.	*Primary*
Versatility	The demonstration solvent must be suitable for use at all aeronautical antifriction bearing cleaning locations. The demonstration solvent solution life must meet or exceed MIL-PRF-680. The demonstration solvent is particularly suitable for non-attainment areas (low VOC's).	*Primary*

4.2. Performance Confirmation Methods

The objective of this demonstration is to replace MIL-PRF-680 with SG1000 in the aeronautical antifriction bearing cleaning process. The alternative solvent is expected to be a drop-in replacement, requiring minimal changes to equipment, operating procedures, or personnel protective equipment.

The suitability of SG1000 as a replacement for MIL-PRF-680 depends upon the results of the environmental, occupational and safety and health, chemical properties, materials compatibility and performance tests, as well as the actual demonstration/validation of the

SoyGold product in the bearing cleaning process. *All aspects of the demonstration must be satisfied in order to claim that the demonstration is a success.* The overall success of the demonstration is measured against these criteria.

In addition, testing was performed using both the current and alternative solvent in the rinse tanks. Bearings were individually identified and soiled with a selection of preservatives, oils, and greases as previously described. One group of test bearings was processed through the current bearing cleaning line and a second group through the modified line that included the alternative SG1000 rinse. Bearing inspectors performed visual inspections at each step in the cleaning process for each group of bearings. These data were used to formulate an opinion as to the success of the demonstration phase of the effort. In addition, NADEP North Island Materials Engineering Laboratory also prepared a test report (BR-0028-05) documenting the SG1000 demonstration results. A copy of the test report is included in Appendix E.

Table 4-2 lists the expected and actual performance of the alternative solvent as well as the corresponding performance confirmation methods used to evaluate the alternative. Performance objectives are categorized as either quantitative or qualitative and are listed as either primary or secondary criteria. Actual performance is indicated a "Pass" or "Fail" based on test methods and criteria defined in the JTP. Where performance is indicated as "Fail" or "Mixed Results" the reader is directed to Table 4-3, which lists specifics for each failed test.

Table 4-2 Expected and Actual Performance and Performance Confirmation Methods

Performance Criteria	Expected Performance (pre-demo)	Performance Confirmation Method	Actual Performance (post-demo)
PRIMARY CRITERIA (Performance Objectives – Quantitative)			
Product Testing **Environmental, Occupational Safety and Health**	Toxicity – No adverse effect	Army - CHPPM Regulation 40-5 Navy – NEHC Toxicity test Air Force – FIOH Toxicity test	**Pass** **Pass** N/A, Air Force does not perform this service
	Volatile Organic Compounds <50 g/l VOC, VOC exempt, or SCAQMD CAS certified.	EPA Method 24 or SCAQMD Method 313	**Pass**
	Flash Point - >100°C	ASTM D-93	**Pass**

Performance Criteria	Expected Performance (pre-demo)	Performance Confirmation Method	Actual Performance (post-demo)
Product Testing **Chemical Properties**	Vapor Press - ≤ 2.0 mm Hg @20°C Acidity – No Evidence Appearance – Clear/Free of suspended matter	ASTM D-2879 ASTM D-847 Visual Inspection	**Pass** **Fail** **See Table 4-3** **Pass**
Product Testing **Materials Compatibility**	Total Immersion Corrosion – None Titanium Stress Corrosion – None Hydrogen Embrittlement – None Stress Corrosion – None Nonvolatile Residue - ≤8mg/100 L Nonvolatile Residue with Isopropyl Alcohol Rinse - ≤8mg/100 L	ASTM F-483 ASTM F-945 ASTM F-519 ASTM G-44 ASTM D-1353 ASTM D-1353 (Modified)	**Mixed Results** **See Table 4-3** **Pass** **Fail** **See Table 4-3** **Pass** **Fail** **See Table 4-3** **Fail** **See Table 4-3**
Product Testing **Performance Criteria**	Storage Stability – Stable after 12 months Rinse Efficiency	ASTM F-1105 Standard Test Method for Hydrophobic Surface Film by the Water-Break Test - ASTM F 22	**Pass** **Fail** **See Table 4-3**
PRIMARY CRITERIA (Performance Objectives – Qualitative)			
Effectiveness	Effectiveness of alternative solvent in removing bearing cleaning agents. Residue left on bearing surfaces after rinse step	Visual Inspection Visual Inspection ASTM D-1353 ASTM D-1353 (Modified)	**Pass** Residue left on bearing surfaces **See Table 4-3** **See Table 4-3**
Reliability	Chemically compatible with current cleaning agents used in the bearing cleaning process.		**Pass**

Performance Criteria	Expected Performance (pre-demo)	Performance Confirmation Method	Actual Performance (post-demo)
	Chemically compatible and perform effectively with all materials that are normally found in new and used bearings including preservatives, oils and greases.		**Pass**
Ease of Use	Drop-in replacement – rinse process not affected by solvent substitution. Chemically compatible with current bearing cleaning equipment including current parts washers, recirculation pumps and seals, and filtration systems. Does not require additional manpower or skills.	Standard Operating Procedure Revision ASTM D-4289-03 Operating Experience	**Pass** *** See Note Below** **Pass**
Versatility	Solvent suitable for use at all bearing cleaning locations Solvent is suitable for non-attainment areas (low VOCs).		**Pass** **Pass**
SECONDARY PERFORMANCE CRITERIA (Qualitative)			
Safety	No change is current safety requirements or PPE	Operating Experience	**Pass**
Maintenance	Parts washer filtration system element replacement equal to current solvent. Solvent change interval	Operating Experience Operating Experience	**Pass** **Pass**

*** SG1000 is chemically compatible with existing parts washers, recirculation pumps and filtration hardware in the NADEP North Island bearing cleaning line. Chemical compatibility with existing pump seals, filter seals, and filter elements is not known. These components were not disassembled to verify chemical compatibility so as not to disrupt normal bearing cleaning operations. It is assumed that these minor components would be replaced with Viton seals and chemically compatible filter elements.**

Table 4-3 Failed SG1000 Tests

(Fresh Product Material/Stored Product Material/Both Product Materials)

TEST	CODE	MATERIAL SPECIMEN	STOCK	TEST METHOD	TEST RESULT	NOTES
Kauri Butanol	N/A	N/A	Fresh SoyGold 1000 Product	Standard Test Method for KB Value of Hydrocarbon Solvents - ASTM D 1133	**Fail Fresh**	**(FAILURE DUE TO: Kb value of 58.6 exceeds JTP acceptance criteria range of 27-45)** SoyGold 1000 did not meet the acceptance criteria for Kb value as specified in the JTP. Kb value was determined to be 58.6 which is outside the acceptance criteria of 27-45.
Rinse Efficiency	N/A	N/A	Fresh/Stored SoyGold 1000 Product	Standard Test Method for Hydrophobic Surface Film by the Water-Break Test - ASTM F 22	**Fail Both**	**(FAILURE DUE TO: poor solvent cleaning power of 30.3%)** JTP acceptance criteria requires rinse efficiency equal to or better than MIL-PRF-680. MIL-PRF-680 requires 85% solvency for Types I, II, and III, and 88% solvency for Type IV.
Total Immersion Corrosion	CG-1	Carburizing Grade CEVM Steel, AMS 6276 (SAE 8620)	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail Fresh**	**(FAILURE DUE TO: stains along top and bottom edges on both sides)** At the end of 24 and 168 hours all coupons had slight stains at the top and bottom edges on both sides (see figure F-3.3.1-17 and F-3.3.1-18 of ATC report). The average weight change at the end of the 168-hour inspection was 0.007 mg/cm2. JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	CP-1a	Stainless Steel ASTM A240, Class 410 (Cd plated in accordance with QQ-P-416 Type I)	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail Stored**	**(FAILURE DUE TO: light stains along bottom edges)** At the end of 24 hours the coupons had no discoloration or staining (figure F-3.3.1-23 of ATC report). All coupons had light stains on the bottom edges after 168 hours (fig F-3.3.1-24 of ATC report). The average weight change of the three samples was -0.01 mg/cm2. JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.

Table 4-3 Failed SG1000 Tests

(Fresh Product Material/Stored Product Material/Both Product Materials)

TEST	CODE	MATERIAL SPECIMEN	STOCK	TEST METHOD	TEST RESULT	NOTES
Total Immersion Corrosion	CS-1	Chrome Steel, AISI 52100	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail Both**	**(FAILURE DUE TO: light stains on all coupons)** At the end of 24 and 168 hours all coupons had slight stains over all surfaces (fig F-3.3.1-29 and F-3.3.1-30 of ATC report). The average weight change at the end of the 168-hour inspection was 0.025 mg/cm2.
Total Immersion Corrosion	HT-1	High Temperature Tool Steel, M-50	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail Fresh**	**(FAILURE DUE TO: light stains on all coupons)** The 24-hour inspection showed light stains along the top and bottom edges of all coupons (fig F-3.3.1-37 of ATC report). At the end of 168 hours all coupons had slight stains over all surfaces (fig F-3.3.1-38 of ATC report). The average weight change at the end of the 168-hour inspection was 0.041 mg/cm2.
Total Immersion Corrosion	NI-1	Nickel AMS 5536	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail Stored**	**(FAILURE DUE TO: light stains of two of the three coupons)** At the end of the 24-hour inspection, there was no discoloration or staining (fig F-3.3.1-47 of ATC report). The 168-hour inspection showed slight staining on coupon numbers 2 and 3 (fig F-3.3.1-48 of ATC report). The average weight change of the three samples was 0.02 mg/cm2. JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	PH-1b	Precipitation Hardening Stainless Steel, 16-4PH	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail Fresh**	**(FAILURE DUE TO: excessive weight gain)** At the end of 24 and 164 hours the samples had no discoloration or staining (fig F-3.3.1-53 and F-3.3.1-54 of ATC report). The average weight change of the three samples was 0.048 mg/cm2.

Table 4-3 Failed SG1000 Tests

(Fresh Product Material/Stored Product Material/Both Product Materials)

TEST	CODE	MATERIAL SPECIMEN	STOCK	TEST METHOD	TEST RESULT	NOTES
Total Immersion Corrosion	SS-1	Stainless Steel, AISI 440C	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail Both**	**(FAILURE DUE TO: excessive weight loss and light stains)** At the end of 24 hours, the samples had no discoloration or staining (fig F-3.3.1-65 of ATC report). At the end of hours the coupons had light stains on both sides (fig F-3.3.1-67 of ATC report). The average weight change of the three samples was -0.047 mg/cm2.
Total Immersion Corrosion	ST-1	Steel, SAE 4340	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail Fresh**	**(FAILURE DUE TO: exceeded weight gain and light stains on top and bottom edges)** There were light stains along the top and bottom edges of both the 24-hour and 168 hour coupons (fig F-3.3.1-69 and F-3.3.1-70 of ATC report). The average weight change of the three samples was 0.060 mg/cm2.
Hydrogen Embrittlemen t	ST-3	Steel, AISI 4340	Notch round bar in tension per ASTM F 519, Type 1a	Hydrogen Embrittlement ASTM F 519	**Fail Both**	**(FAILURE DUE TO: all specimens tested fractured to failure within 200 hours)** The lot of specimens used met the sensitivity testing required by ASTM F519. The SoyGold 1000 did not meet the criterion for hydrogen embrittlement for the fresh product material. JTP acceptance criteria specifies that the demonstration solvent material shall not cause hydrogen embrittlement of cadmium plated AISI 4340 steel.
Acidity	N/A	N/A	Fresh/Stored SoyGold 1000 Product	Standard Test Method for Acidity of Benzene, Toluene, Xylenes, Solvent Naphthas, and Similar Industrial Aromatic Hydrocarbons - ASTM D 847	**Fail Both**	**(FAILURE DUE TO: 1.47 mg KOH/L)** The fresh SoyGold 1000 did not meet the acceptance criteria for acidity. JTP acceptance criteria specifies that the demonstration solvent material shall show no evidence of acidity.

Table 4-3 Failed SG1000 Tests

(Fresh Product Material/Stored Product Material/Both Product Materials)

TEST	CODE	MATERIAL SPECIMEN	STOCK	TEST METHOD	TEST RESULT	NOTES
Nonvolatile Residue	N/A	N/A	Fresh SoyGold 1000 Product	Standard Test Method for Nonvolatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer, and Related Products - ASTM D 1353	**Fail Fresh**	**(FAILURE DUE TO: nonvolatile residue estimated to be greater than 84%)** Analysis was performed in accordance with ASTM D1353. Due to chemical make up of SoyGold, little or no signs of evaporation were observed. A definitive value for nonvolatile residue could not be determined.
Nonvolatile Residue with Isopropyl Alcohol Rinse	N/A	N/A	Fresh SoyGold 1000 Product	Standard Test Method for Nonvolatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer, and Related Products - ASTM D 1353	**Fail Fresh**	**(FAILURE DUE TO: nonvolatile residue estimated to be greater than 84%)** Analysis was performed in accordance with ASTM D1353. Due to chemical make up of SoyGold, little or no signs of evaporation were observed. A definitive value for nonvolatile residue could not be determined.

4.3. Data Analysis, Interpretation and Evaluation

Data analysis, interpretation and evaluation are based on results from Phase I and II screening and analytical tests prescribed in the JTP as well as visual inspections performed on test bearings that were processed through the bearing cleaning line during the Phase III demonstration.

It should be noted that data analysis, interpretation and evaluation of Phase I and Phase II testing is discussed in detail in the JTR that is included in Appendix A. For completeness, Phase I and II requirements and test results are presented here as well. The following sections will refer to tables and figures contained in the JTR.

4.3.1. Phase I Screening Test Requirements

During Phase I testing, SG1000 was screened against the solvent parameters and acceptance criteria listed in Table 4-4. The initial screening performed during Phase I was designed to tentatively qualify or eliminate an alternative solvent material before entering Phase II analytical testing. It was *desired* that SG1000 meet the minimum acceptance criteria to progress to Phase II analytical testing.

Table 4-4. Screening Criteria for Alternative Solvent Material

Solvent Parameters	Acceptance Criteria
ENVIRONMENTAL, OCCUPATIONAL SAFETY AND HEALTH PROPERTIES	
VOCs	Shall contain less than 50 g/L VOC, be VOC exempt, or a SCAQMD Certified CAS.
HAPs	None
Flash Point	> 212° F
Toxicity	Shall have no adverse effect on human health when used as intended and shall contain no chemicals listed as carcinogens.
CHEMICAL PROPERTIES	
Vapor Pressure	< 2.0 mm Hg @ 20° C
KB Value	27 - 45
RERFORMANCE CRITERIA RELATED TESTS	
Rinse Efficiency	The rinse efficiency of the alternative solvent shall be equal to or better than MIL-PRF-680.

4.3.1.1. Phase I Screening Test Results

Phase I screening of SG1000 included volatile organic compounds (VOC), flash point, vapor pressure, KB, toxicity, and rinse efficiency tests. Testing was performed on new SG1000 product as well as SG1000 product that had been held in storage for approximately 1 year.

New SG1000 product passed the VOC, flash point, vapor pressure, and toxicity screening tests but failed the KB and rinse efficiency tests as defined by the acceptance criteria specified in the JTP.

Even though SG1000 failed the Phase I KB screening test it was decided that Phase II analytical testing would be performed. The decision was based on the fact that in the bearing cleaning process MIL-PRF-680 is used as a rinse agent to remove the bearing cleaning chemicals. The KB value is a measure of solvent power for a hydrocarbon solvent. Bearing cleaning agents used in the steps prior to the rinse step are where bearing cleaning occurs. In the rinse step of the bearing cleaning process MIL-PRF-680 is not intended as a cleaner and it was determined that KB value was not critical.

A list of all screening tests, test methods, and test results for new as well as stored SG1000 product material is included in Table 8 of the JTR.

4.3.2. Phase II Test Requirements

Analytical testing of the alternative solvent was performed during Phase II by the U.S. Army Aberdeen Test Center. A copy of the JTP was provided to the Army as a guidance document that defined the analytical testing requirements. Tests were divided into several categories including environmental, occupational safety and health tests, chemical properties related tests, materials compatibility tests, and performance related tests. To address long-term storage issues, specific tests were simultaneously performed on solvent that had been held in storage for approximately 1 year.

Table 4-5 includes a complete list of tests performed, test methods used, corresponding section in the JTP, and the acceptance criteria used to gauge the test results. Table 4-6 lists all substrate materials representative of aeronautical antifriction bearing materials that were used to fabricate test coupons, the geometric configuration of each coupon, as well as the corresponding test method.

Table 4-5. Performance and Testing Requirements

Engineering Requirement	Test Method*	JTP Section	Acceptance Criteria
ENVIRONMENTAL, OCCUPATIONAL SAFETY AND HEALTH RELATED TESTS			
Toxicity	N/A	3.1.1	The alternative solvent shall have no adverse effect on human health when used as intended and shall contain no chemicals listed as carcinogens.
Volatile Organic Compounds	EPA Method 24 Or SCAQMD Method 313	3.1.2	The alternative solvent shall contain less than 50g/L VOC, be VOC exempt, or a SCAQMD Certified CAS.
Flash Point	ASTM D 93	3.1.3	The alternative solvent flash point shall be greater than 100°C (212°F).
CHEMICAL PROPERTIES RELATED TESTS			
Vapor Pressure	ASTM D 2879	3.2.1	The alternative solvent maximum vapor pressure is 2.0mm Hg @ 20ºC.
Acidity	ASTM D 847	3.2.2	The alternative solvent shall show no evidence of acidity.
Appearance	N/A	3.2.3	The alternative solvent shall be clear and free from suspended matter and undissolved water when observed at ambient conditions.
MATERIALS COMPATIBILITY RELATED TESTS			
Total Immersion Corrosion	ASTM F 483	3.3.1	The alternative solvent shall not cause any indication of staining, etching, pitting, or localized attack; nor shall weight changes exceed allowable limits.
Titanium Stress Corrosion	ASTM F 945	3.3.2	The alternative solvent shall not cause any microscopic cracking when examined at 500X magnification.
Hydrogen Embrittlement	ASTM F 519	3.3.3	The alternative solvent shall not cause hydrogen embrittlement of cadmium plated AISI 4340 steel.
Stress Corrosion	ASTM G 44	3.3.4	The alternative solvent shall cause no evidence of cracking.

Table 4-5. Performance and Testing Requirements (continued)

Engineering Requirement	Test Method*	JTP Section	Acceptance Criteria
Nonvolatile Residue	ASTM D 1353	3.3.5	The alternative solvent shall not have a nonvolatile residue greater than 8mg/100mL.
Nonvolatile Residue with Isopropyl Alcohol Rinse	ASTM D 1353 (Modified)	3.3.6	The alternative solvent shall not have a nonvolatile residue greater than 8mg/100mL.
PERFORMANCE CRITERIA RELATED TESTS			
Storage Stability	ASTM F 1105	3.4.1	After 12 month storage, the alternative solvent should meet the acceptance criteria for: Rinsing Efficiency, Total Immersion Corrosion, Titanium Stress Corrosion, Hydrogen Embrittlement, Stress Corrosion, Acidity, and Appearance.
Rinse Efficiency	APPENDIX C	3.4.2	The rinse efficiency of the alternative solvent shall be equal to or better than MIL-PRF-680.
***Refer to most current version of test method**			

Table 4-6. Test Specimen Codes and Substrate Descriptions for Aeronautical Antifriction Bearing Cleaning

Code	Specimen	Stock	Test Method
AL-1a	Aluminum, QQ-A-250/4, T3 surface treatment accordance of AMS 2470	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
AL-1b	Aluminum, QQ-A250/4, Bare T3 Alloy	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
AL-1c	Aluminum, QQ-A-250/12, Bare T6 Alloy	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
AL-2a	Aluminum, QQ-A-250/4, T3 surface treatment accordance of AMS 2470	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
AL-2b	Aluminum, QQ-A250/4, Bare T3 Alloy	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
AL-2c	Aluminum, QQ-A-250/12, Bare T6 Alloy	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
BR-1	Brass, AMS 4616	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
BR-2	Brass, AMS 4616	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CG-1	Carburizing Grade CEVM Steel, AMS 6276 (SAE 8620)	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
CG-2	Carburizing Grade CEVM Steel, AMS 6276 (SAE 8620)	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CP-1a	Stainless Steel ASTM A240, Class 410 (Cd plated accordance with QQ-P-416 Type I)	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483

Table 4-6. Test Specimen Codes and Substrate Descriptions for Aeronautical Antifriction Bearing Cleaning (continued)

Code	Specimen	Stock	Test Method
CP-2a	Stainless Steel ASTM A240, Class 410 (Cd plated accordance with QQ-P-416 Type I)	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CP-2b	Cadmium Plated Steel, AISI 410	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CR-1	Cronidur 30	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
CR-2	Cronidur 30	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CS-1	Chrome Steel, AISI 52100	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
CS-2	Chrome Steel, AISI 52100	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CU-1	Copper	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
CU-2	Copper	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
HT-1	High Temperature Tool Steel, M-50	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
HT-2	High Temperature Tool Steel, M-50	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
M-1*	M-50 NiL (AMS 6278)	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
M-2*	M-50 NiL (AMS 6278)	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
NB-1	Nickel Aluminum Bronze, AMS 4640	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
NB-2	Nickel Aluminum Bronze, AMS 4640	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44

Table 4-6. Test Specimen Codes and Substrate Descriptions for Aeronautical Antifriction Bearing Cleaning (continued)

Code	Specimen	Stock	Test Method
NI-1	Nickel AMS 5536	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
NI-2	Nickel AMS 5536	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
PH-1a	Precipitation Hardening Stainless Steel, 17-4PH	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
PH-1b	Precipitation Hardening Stainless Steel, 16-4PH	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
PH-1c	Precipitation Hardening Stainless Steel, 13-8PH	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
PH-2a	Precipitation Hardening Stainless Steel, 17-4PH	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
PH-2b	Precipitation Hardening Stainless Steel, 16-4PH	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
PH-2c	Precipitation Hardening Stainless Steel, 13-8PH	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
RS-1	Rivets, Steel, Corrosion Resistant, AMS 7228	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
RS-2	Rivets, Steel, Corrosion Resistant, AMS 7228	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
SS-1	Stainless Steel, AISI 440C	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
SS-2	Stainless Steel, AISI 440C	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
ST-1	Steel, SAE 4340	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
ST-2	Steel, SAE 4340	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44

Table 4-6. Test Specimen Codes and Substrate Descriptions for Aeronautical Antifriction Bearing Cleaning (continued)

Code	Specimen	Stock	Test Method
ST-3	Steel, AISI 4340	Notch round bar in tension per ASTM F 519, Type 1a	Hydrogen Embrittlement ASTM F 519
TI-1	Titanium, AMS 4911, 6AL-4V	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
TI-2	Titanium, AMS 4911, 6AL-4V	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
TI-3	Titanium, AMS 4916	Same sheet stock, cut parallel to the rolling direction and dimensions 75x 19x1.25 mm, (3.0 x 0.75 x 0.050 in.), hole diameters 7 mm (0.28 in.), offset 13 mm (0.5 in.) from edge	Titanium Stress Corrosion ASTM F 945
TI-4	Titanium, AMS 4911	Same sheet stock, cut parallel to the rolling direction and dimensions 75x 19x1.25 mm, (3.0 x 0.75 x 0.050 in.), hole diameters 7 mm (0.28 in.), offset 13 mm (0.5 in.) from edge	Titanium Stress Corrosion ASTM F 945
VX-1*	Vasco X-2	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
VX-2*	Vasco X-2	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
*Substrate material was not commercially available and eliminated without replacement			

4.3.2.1. Phase II Analytical Test Results

Phase II analytical testing was performed using fresh SG1000 product and SG1000 product that had been held in storage for approximately 1 year. Test results for each are presented in the following sections. Table 4-3 includes a list of all analytical tests that SG1000 failed. This table includes screening tests conducted during Phase I as well as analytical tests performed during Phase II for both new and stored SG1000 product material. Table 4-3 also includes the test name, material specimen, test method used, and notes indicating the explanation for each failure. Tests highlighted in red correspond to

tests failed using fresh SG1000 product material, blue corresponds to tests failed using stored product, and green corresponds to tests failed using both new and used product.

4.3.2.1.1. Phase II Analytical Test Results for Fresh SG1000 Product Material

Phase II analytical tests included total immersion corrosion, stress corrosion, titanium stress corrosion, appearance, hydrogen embrittlement, acidity, nonvolatile residue, and nonvolatile residue with isopropyl alcohol rinse. Table 10 of the JTR in Appendix A lists all Phase II analytical tests performed using fresh SG1000 product material and includes the specimen materials, coupon configuration, test method used, test results, and notes relating test results and acceptance criteria.

Results for total immersion corrosion tests using fresh SG1000 product material are mixed. A total of twenty-one materials were identified in the JTP to be included in the total immersion corrosion tests (see Table 4-6). Of the twenty-one materials, thirteen passed, six failed, and two were not included because the materials were not commercially available (have not been produced for several years).

The fresh SG1000 product material passed all stress corrosion tests. A total of twenty-two materials were identified in the JTP to be included in the stress corrosion tests (see Table 4-6). Of the twenty-two materials, eighteen passed, one material was found to be a duplicate and eliminated, one was not able to be fabricated into the coupon configuration specified in the test method and was eliminated, and two were not included because the materials were not commercially available.

The fresh SG1000 product material passed the titanium stress corrosion and appearance tests, but failed the hydrogen embrittlement, acidity, nonvolatile residue, and nonvolatile residue with isopropyl alcohol rinse tests.

4.3.2.1.2. Phase II Analytical Test Results for Stored SG1000 Product Material

Phase II analytical tests included total immersion corrosion, stress corrosion, titanium stress corrosion, appearance, hydrogen embrittlement, and acidity. Table 11 of the JTR in Appendix A lists all Phase II analytical tests performed using SG1000 product material that had been held in storage for approximately 1 year and includes the specimen materials, coupon configuration, test method used, test results, and notes relating test results and acceptance criteria.

Results for total immersion corrosion tests using stored SG1000 product material are mixed. A total of twenty-one materials were identified in the JTP to be included in the total immersion corrosion tests (see Table 4-6). Of the twenty-one materials, fifteen passed, four failed, and two were not included because the materials were not commercially available.

The stored SG1000 product material passed all stress corrosion tests. A total of twenty-two materials were identified in the JTP to be included in the stress corrosion tests (see Table 4-6). Of the twenty-two materials, eighteen passed, one material was found to be a duplicate and eliminated, one was not able to be fabricated into the coupon configuration specified in the test method and was eliminated. Two were not included because the materials were not commercially available.

The stored SG1000 product material passed the titanium stress corrosion and appearance tests, but failed the hydrogen embrittlement and acidity tests.

4.3.2.1.3. Phase II Toxicity Clearances

In addition, NEHC and CHPPM performed toxicity evaluations to identify any occupational safety and health risks associated with worker exposure. These evaluations are performed and clearances are conditionally approved based on the solvent application or use condition. Clearance for any potentially hazardous product to be used by the DoD is granted or denied independently by each Service.

An administrative health hazard assessment of SG1000 was performed and clearance was granted on 16 May 2005 by NEHC. A copy of the NEHC administrative health hazard assessment for SG1000 is included in Appendix F.

A toxicological evaluation of SG1000 was conducted and a toxicity clearance was granted on 23 February 2005 by CHPPM approving SG1000 as a degreaser. An additional toxicity clearance was also granted by CHPPM on 31 January 2006 approving SG1000 as a cleaner. Copies of toxicity clearances granted by CHPPM are included in Appendix C of the U.S. Army Aberdeen Test Center's Final Analytical Test Report, which is included in Appendix B of the JTR. The JTR is included in Appendix A.

It should be noted that these assessments were "paper studies" and that no analytical testing was performed by NEHC or CHPPM. Assessments were based of Material Safety Data Sheets (MSDS) and product literature provided by the SG1000 manufacturer.

4.3.3. Phase III Demonstration Test Results

The Phase III demonstration and validation portion of this project evaluated SG1000 as an alternative to MIL-PRF-680 for the rinsing of aeronautical antifriction bearings during DoD Depot level maintenance cleaning. Cleaning of aeronautical antifriction bearings is performed using a well-defined multi-stage cleaning process. Bearings are processed through the various stages of the bearing cleaning line depending on the type of contamination that is to be removed. The demonstration was performed at the NADEP North Island bearing cleaning shop and was designed to duplicate the normal bearing cleaning process as specified in the bearing cleaning technical manual.

There are no established analytical testing methods used during the bearing cleaning process to determine cleanliness. Bearing cleanliness is determined through visual inspections performed by the bearing artisans during the cleaning process. The demonstration test results are therefore qualitative rather than quantitative. However, quantitative data collected during Phase II analytical testing supports the qualitative results observed during the Phase III Demonstration.

During the Demonstration Phase it was found that SG1000 solvent successfully removed the chemical agents used to clean the bearings prior to the rinse step of the bearing cleaning process. Bearings processed using MIL-PRF-680 in the rinse step were found to be cleaner than those processed using SG1000. Bearing inspectors also noted that a slight noticeable film remained on the bearing surfaces after the isopropyl alcohol rinse in all but two of the SG1000 bearing series. The MIL-PRF-680 rinse left no noticeable film on the bearing surfaces. This observation was quantified during nonvolatile residue and nonvolatile residue with IPA rinse tests that were performed during Phase II analytical testing. SG1000 failed both the nonvolatile residue and nonvolatile residue with IPA rinse tests. MIL-PRF-680 passed both the nonvolatile residue and nonvolatile residue with IPA rinse tests. Table 4-7 lists the inspection results for all bearings processed using MIL-PRF-680 and SG1000.

Based on the SG1000 demonstration, the NADEP North Island bearing inspector and materials engineer concluded that SG1000 *does* meet the minimum requirements to be used as an acceptable replacement for MIL-PRF-680 as a rinse agent in the bearing cleaning process. These conclusions and comments address nonvolatile residue left on bearing surfaces but do not address material compatibility issues or other acceptance criteria related to analytical tests performed during Phase I and Phase II. NADEP North Island conclusions and comments regarding the results of the demonstration phase are included in their test report dated 19 January 2006, which is included in Appendix E.

The JTP defines the acceptance criteria for all phases of the effort including the Phase I screening tests, the Phase II analytical tests, as well as the Phase III demonstration. We should be reminded that the detailed acceptance criteria specified in the JTP was developed by a joint group led by the Naval Facilities Engineering Service Center and consisted of technical representatives and process stakeholders that identified engineering performance and testing requirements for aeronautical antifriction bearing cleaning. This group reached consensus on the test conditions and acceptance criteria to qualify alternatives against critical, technical, and performance requirements.

The JTP specifies that SG1000 must meet *all* acceptance criteria and perform as well as or better than MIL-PRF-680 in all phases of the demonstration to be considered a success. Demonstration results clearly indicate that SG1000 does not perform as well as MIL-PRF-680 in the rinse step of the bearing cleaning process. Nonvolatile residue results in a film remaining on the bearing surfaces. In addition, SG1000 failed several of the analytical tests performed in Phase I and II, which also indicate that SG1000 does not perform as well as MIL-PRF-680. The SG1000 demonstration results do not meet the

defined acceptance criteria as an alternative to MIL-PRF-680 in the rinse step of the bearing cleaning process.

Table 4-7 Demonstration Results

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning									
Phase III - MIL-PRF-680 Bearing Cleaning Demonstration Test Results *(Standard Rinse)*					**Phase III - SG1000 Bearing Cleaning Demonstration Test Results *(Alternative Rinse)***				
TEST SAMPLE ID	**BEARING GROUP**	**LUBRICANT/ PRESERVATIVE**	**TEST RESULT**	**BEARING INSPECTOR NOTES**	**BEARING INSPECTOR NOTES**	**TEST RESULT***	**LUBRICANT/ PRESERVATIVE**	**BEARING GROUP**	**TEST SAMPLE ID**
A1Z	Propulsion	MIL-PRF-81322	Pass	Negligible remaining grease, no noticeable film	Minimal remaining grease, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-81322	Propulsion	A1X
B1Z	Airframe	MIL-PRF-81322	Pass	Negligible remaining grease, no noticeable film	Minimal remaining grease, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-81322	Airframe	B1X
E1Z	Electrical	MIL-PRF-81322	Pass	Negligible remaining grease, no noticeable film	Minimal remaining grease, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-81322	Electrical	E1X
A2Z	Propulsion	MIL-PRF-27617	Pass	Negligible remaining grease, no noticeable film	Negligible remaining grease, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-27617	Propulsion	A2X
B2Z	Airframe	MIL-PRF-27617	Pass	Negligible remaining grease, no noticeable film	Negligible remaining grease, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-27617	Airframe	B2X
E2Z	Electrical	MIL-PRF-27617	Pass	Negligible remaining grease, no noticeable film	Negligible remaining grease, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-27617	Electrical	E2X
A3Z	Propulsion	MIL-PRF-23827	Pass	Negligible remaining grease, no noticeable film	Minimal remaining grease, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-23827	Propulsion	A3X
B3Z	Airframe	MIL-PRF-23827	Pass	Negligible remaining grease, no noticeable film	Minimal remaining grease, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-23827	Airframe	B3X

Table 4-7 Demonstration Results

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning									
Phase III - MIL-PRF-680 Bearing Cleaning Demonstration Test Results *(Standard Rinse)*					**Phase III - SG1000 Bearing Cleaning Demonstration Test Results *(Alternative Rinse)***				
TEST SAMPLE ID	**BEARING GROUP**	**LUBRICANT/ PRESERVATIVE**	**TEST RESULT**	**BEARING INSPECTOR NOTES**	**BEARING INSPECTOR NOTES**	**TEST RESULT***	**LUBRICANT/ PRESERVATIVE**	**BEARING GROUP**	**TEST SAMPLE ID**
E3Z	Electrical	MIL-PRF-23827	Pass	Negligible remaining grease, no noticeable film	Minimal remaining grease, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-23827	Electrical	E3X
A4Z	Propulsion	MIL-PRF-81827	Pass	Some residual grease & thickener, no noticeable film	Some residual grease & thickener, no noticeable film	Pass	MIL-PRF-81827	Propulsion	A4X
B4Z	Airframe	MIL-PRF-81827	Pass	Some residual grease & thickener, no noticeable film	Some residual grease & thickener, no noticeable film	Pass	MIL-PRF-81827	Airframe	B4X
E4Z	Electrical	MIL-PRF-81827	Pass	Some residual grease & thickener, no noticeable film	Some residual grease & thickener, no noticeable film	Pass	MIL-PRF-81827	Electrical	E4X
A5Z	Propulsion	MIL-PRF-18709	Not Performed	Lubricant / preservative no longer available	Lubricant / preservative no longer available	Not Performed	MIL-PRF-18709	Propulsion	A5X
B5Z	Airframe	MIL-PRF-18709	Not Performed	Lubricant / preservative no longer available	Lubricant / preservative no longer available	Not Performed	MIL-PRF-18709	Airframe	B5X
E5Z	Electrical	MIL-PRF-18709	Not Performed	Lubricant / preservative no longer available	Lubricant / preservative no longer available	Not Performed	MIL-PRF-18709	Electrical	E5X
A6Z	Propulsion	Rheotemp 500	Pass	Some residual grease, no noticeable film	Some residual grease, slight noticeable film	Acceptable, Meets Min Reqmt's	Rheotemp 500	Propulsion	A6X
B6Z	Airframe	Rheotemp 500	Pass	Some residual grease, no noticeable film	Some residual grease, slight noticeable film	Acceptable, Meets Min Reqmt's	Rheotemp 500	Airframe	B6X

Table 4-7 Demonstration Results

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning									
Phase III - MIL-PRF-680 Bearing Cleaning Demonstration Test Results *(Standard Rinse)*					**Phase III - SG1000 Bearing Cleaning Demonstration Test Results *(Alternative Rinse)***				
TEST SAMPLE ID	**BEARING GROUP**	**LUBRICANT/ PRESERVATIVE**	**TEST RESULT**	**BEARING INSPECTOR NOTES**	**BEARING INSPECTOR NOTES**	**TEST RESULT***	**LUBRICANT/ PRESERVATIVE**	**BEARING GROUP**	**TEST SAMPLE ID**
E6Z	Electrical	Rheotemp 500	Pass	Some residual grease, no noticeable film	Some residual grease, slight noticeable film	Acceptable, Meets Min Reqmt's	Rheotemp 500	Electrical	E6X
A7Z	Propulsion	MIL-PRF-23699	Pass	No residual oil, no noticeable film	No residual oil, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-23699	Propulsion	A7X
B7Z	Airframe	MIL-PRF-23699	Pass	No residual oil, no noticeable film	No residual oil, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-23699	Airframe	B7X
E7Z	Electrical	MIL-PRF-23699	Pass	No residual oil, no noticeable film	No residual oil, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-23699	Electrical	E7X
A8Z	Propulsion	MIL-PRF-6081	Pass	No residual oil, no noticeable film	No residual oil, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-6081	Propulsion	A8X
B8Z	Airframe	MIL-PRF-6081	Pass	No residual oil, no noticeable film	No residual oil, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-6081	Airframe	B8X
E8Z	Electrical	MIL-PRF-6081	Pass	No residual oil, no noticeable film	No residual oil, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-6081	Electrical	E8X
A9Z	Propulsion	MIL-PRF-7808	Pass	No residual oil, no noticeable film	No residual oil, no noticeable film	Pass	MIL-PRF-7808	Propulsion	A9X

Table 4-7 Demonstration Results

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning									
Phase III - MIL-PRF-680 Bearing Cleaning Demonstration Test Results *(Standard Rinse)*					**Phase III - SG1000 Bearing Cleaning Demonstration Test Results *(Alternative Rinse)***				
TEST SAMPLE ID	**BEARING GROUP**	**LUBRICANT/ PRESERVATIVE**	**TEST RESULT**	**BEARING INSPECTOR NOTES**	**BEARING INSPECTOR NOTES**	**TEST RESULT***	**LUBRICANT/ PRESERVATIVE**	**BEARING GROUP**	**TEST SAMPLE ID**
B9Z	Airframe	MIL-PRF-7808	Pass	No residual oil, no noticeable film	No residual oil, no noticeable film	Pass	MIL-PRF-7808	Airframe	B9X
E9Z	Electrical	MIL-PRF-7808	Pass	No residual oil, no noticeable film	No residual oil, no noticeable film	Pass	MIL-PRF-7808	Electrical	E9X
A10Z	Propulsion	MIL-PRF-32033	Pass	No residual oil, no noticeable film	No residual oil, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-32033	Propulsion	A10X
B10Z	Airframe	MIL-PRF-32033	Pass	No residual oil, no noticeable film	No residual oil, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-32033	Airframe	B10X
E10Z	Electrical	MIL-PRF-32033	Pass	No residual oil, no noticeable film	No residual oil, slight noticeable film	Acceptable, Meets Min Reqmt's	MIL-PRF-32033	Electrical	E10X
A11Z	Propulsion	MIL-PRF-11796	Not Performed	Lubricant / preservative no longer available	Lubricant / preservative no longer available	Not Performed	MIL-PRF-11796	Propulsion	A11X
B11Z	Airframe	MIL-PRF-11796	Not Performed	Lubricant / preservative no longer available	Lubricant / preservative no longer available	Not Performed	MIL-PRF-11796	Airframe	B11X
E11Z	Electrical	MIL-PRF-11796	Not Performed	Lubricant / preservative no longer available	Lubricant / preservative no longer available	Not Performed	MIL-PRF-11796	Electrical	E11X
A12Z	Propulsion	Dirty from field	Pass	No residual contaminants, no noticeable film	No residual contaminants, slight noticeable film	Acceptable, Meets Min Reqmt's	Dirty from field	Propulsion	A12X

Table 4-7 Demonstration Results

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning									
Phase III - MIL-PRF-680 Bearing Cleaning Demonstration Test Results *(Standard Rinse)*					**Phase III - SG1000 Bearing Cleaning Demonstration Test Results *(Alternative Rinse)***				
TEST SAMPLE ID	**BEARING GROUP**	**LUBRICANT/ PRESERVATIVE**	**TEST RESULT**	**BEARING INSPECTOR NOTES**	**BEARING INSPECTOR NOTES**	**TEST RESULT***	**LUBRICANT/ PRESERVATIVE**	**BEARING GROUP**	**TEST SAMPLE ID**
B12Z	Airframe	Dirty from field	Pass	No residual contaminants, no noticeable film	No residual contaminants, slight noticeable film	Acceptable, Meets Min Reqmt's	Dirty from field	Airframe	B12X
E12Z	Electrical	Dirty from field	Pass	No residual contaminants, no noticeable film	No residual contaminants, slight noticeable film	Acceptable, Meets Min Reqmt's	Dirty from field	Electrical	E12X

* NADEP North Island bearing inspector and materials engineer conclude that SG1000 meets the minimum requirements as an acceptable replacement for MIL-PRF-680 in the rinse step of the bearing cleaning process. These conclusions were based on visual inspections of bearings cleaned during the Phase III Demonstration.

5. COST ASSESSMENT

5.1. Cost Reporting

The objective of this effort was to evaluate and demonstrate SG1000 as a drop-in replacement for MIL-PRF-680 solvent in the aeronautical antifriction bearing cleaning process. Implementing a drop-in replacement would require minimal capital investment. Holding tanks for virgin and spent alternative solvent material are the only significant capital that would be required. Existing bearing cleaning parts washers, pumps, filtration, and piping systems would not be replaced. Minor components such as pump seals, filtration system seals, and filter elements would have to be replaced with product compatible materials. Differences in solvent cost and hazardous waste disposal fees would also be included in the overall cost of implementing any drop in replacement.

5.2. Cost Analysis

A detailed cost analysis was not performed because the demonstration solvent material did not meet the acceptance criteria defined in the JTP.

SG1000 failed several of the Phase II analytical tests including hydrogen embrittlement, acidity, non-volatile residue, non-volatile residue with isopropyl alcohol rinse, rinse efficiency, KB, and total immersion corrosion for a number of material specimens.

The phase III demonstration performed at NASNI also resulted in less than favorable results. A visible residue remained on test bearing surfaces after being rinsed with SG1000 in the bearing cleaning process. This observation is supported with the failure of the non-volatile and non-volatile residue, and rinse efficiency tests that were performed during the Phase II analytical testing.

6. IMPLEMENTATION ISSUES

6.1. Environmental Permits

The JTP specifies that the alternative solvent material must be HAP-free and shall contain less than 50 g/L VOC, be VOC exempt, or be a SCAQMD Certified CAS. These requirements were selected to facilitate the use of the alternative solvent material in the aeronautical antifriction bearing cleaning process without any environmental permits.

6.2. Other Regulatory Issues

Emissions from organic solvents are regulated by both Federal (40CFR51.100) and State air quality regulations. In addition, local air quality districts may also establish regulations that are even more stringent than the state or federal limits. In California, the APCD has established regulations limiting the VOC content of degreasers at 50 g/l. SCAQMD has set even more restrictive limits of 25g/l for degreasers using halogenated

solvents. It is expected that other jurisdictions countrywide will promulgate similar limits.

Clean Air Act Title III, National Emission Standards for Hazardous Air Pollutants (NESHAP) National Emissions Standards for Aerospace Manufacturing and Rework Facilities, described in 40CFR63 Subpart GG, require the use of solvents with a vapor pressure less that 7 mm Hg and contains no Hazardous Air Pollutants (HAPs)

Using MIL-PRF-680 solvent in open-tank parts washers will not meet these regulations. Compliance can be achieved by using alternative low VOC, HAP-free solvents or installing emission control equipment. This demonstration attempted to qualify an alternative solvent for rinsing aeronautical antifriction bearings that is HAP-free, contains low VOCs, and will allow continued use of open-tank parts washers without the addition of emissions control equipment.

6.3. End-User/Original Equipment Manufacturer Issues

As previously stated, SG1000 did not meet the acceptance criteria for several of the tests prescribed in the JTP. The solvent left a visible film on bearing surfaces that was observed during bearing inspection at the end of the bearing cleaning process. Product reformulation may eliminate this problem but would not likely eliminate problems such as hydrogen embrittlement and corrosion issues that were identified during analytical testing. It should also be noted that any product reformulation would require that *all* tests identified in the JTP be repeated.

The stakeholders of the bearing cleaning process identified the analytical tests to be performed and defined the acceptance criteria for each test that any alternative solvent must meet to qualify as a replacement in the rinse step of the bearing cleaning process. The end users are only authorized to use products which have been approved by the process stakeholders and that are on the Qualified Products List (QPL). SG1000 did not meet these criteria and therefore will not be added to the QPL for the aeronautical antifriction bearing cleaning process.

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Bennett Dahlin, Naval Air Depot North Island, Materials Engineering Laboratory, *SoyGold 1000 Demonstration*, BR-0028-05, Test Report, 19 January 2006.

Manny Goulart, Naval Air Depot North Island, Materials Engineering Laboratory, Instructions for Rinse Efficiency Testing of SoyGold 1000 Solvent, Temporary Engineering Instruction, 18 April 2005.

8. POINTS OF CONTACT

Points of Contact for the demonstration are included in Table 8-1.

Table 8-1 Points of Contact

POINT OF CONTACT	ORGANIZATION NAME ADDRESS	PHONE FAX EMAIL	PROJECT ROLE
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9. APPENDICES

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Appendix C - Demonstration Bearings
Appendix D - Bearing Cleaning Process Equipment
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Appendix F - NEHC Administrative Health Hazard Assessment for SG1000

APPENDIX A

Joint Test Report for
Validation of Alternatives to High Volatile Organic Compound
Solvents Used in Aeronautical Antifriction Bearing Cleaning

Environmental Security Technology Certification Program

Joint Test Report

For

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning

May 2006

PREFACE

This report was prepared by the Naval Facilities Engineering Service Center (NFESC) Pollution Prevention Technology Development Branch under Contract Number WP-0305 for the Environmental Security Technology Certification Program (ESTCP).

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U.S. Army Aberdeen Test Center (ATC)
U.S. Army Research Lab (ARL)
U.S. Army Tank Automotive Research, Development, and Engineering Center (TARDEC)
U.S. Army Aviation and Missile Command (AMCOM)
National Defense Center for Environmental Excellence (NDCEE)
Concurrent Technologies Corporation (CTC)
AG Environmental Products L.L.C.
United Soybean Board (USB)

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EXECUTIVE SUMMARY

The DoD has increasingly relied on aqueous-alkaline cleaners to comply with emerging environmental regulations. However, these cleaners are not adequate for some applications, as they have been found to have material compatibility issues such as corrosion of metal surfaces and hydrogen embrittlement. With the environmental concerns related to petroleum-based solvent cleaners, and performance issues of aqueous-alkaline cleaners, it is desirable to validate a new class of organic solvents. These environmentally friendly alternative solvents must be HAP-free, not contribute to emissions of VOCs, and meet DoD material compatibility and performance criteria. This effort evaluates a soybean oil derivative as an alternative for MIL-PRF-680 solvent for the rinsing of aeronautical antifriction bearings (non-instrument) during DoD Depot level maintenance cleaning. SoyGold® 1000 (SG1000), produced by AG Environmental Products, LLC, is the solvent that was selected for the demonstration.

A joint group led by the Naval Facilities Engineering Service Center and consisting of technical representatives from Naval Facilities Engineering Command, Naval Air Systems Command, U.S. Army Aberdeen Test Center, U.S. Army Research Lab, U.S. Army Tank Automotive Research, Development, and Engineering Center, U.S. Army Aviation and Missile Command, Air Force Materiel Command, Air Force Warner Robins Air Logistics Center identified the engineering performance and testing requirements for aeronautical antifriction bearing cleaning. This group reached consensus on the test conditions and acceptance criteria to qualify alternatives against these critical, technical, and performance requirements. A Joint Test Protocol (JTP) was developed that identified all tests and acceptance criteria necessary for an alternative solvent material to be used in the rinse step of the bearing cleaning process.

The acceptance criteria are the gauge used to determine whether an alternative solvent passes or fails the tests identified in the JTP. The alternative must pass all tests identified in the JTP and pass the demonstration/validation phase to be an acceptable alternative to MIL-PRF-680 in the rinse step of the bearing cleaning process. In addition, any alternative solvent must meet *all* performance, compatibility, and safety requirements, be cost effective, and provide measurable environmental benefit.

Analytical test results for SG1000 are mixed. SG1000 passed all environmental, occupational, safety and health related tests, but failed a number of the materials compatibility tests including total immersion corrosion for a number of the substrate materials identified in the JTP, hydrogen embrittlement, nonvolatile residue, and nonvolatile residue with isopropyl alcohol rinse. SG1000 also failed the rinse efficiency test under performance related tests as well as the acidity test under chemical properties. During the initial screening, SG1000 also failed the Kauri-butanol test.

As defined by the acceptance criteria in the JTP, and the requirements of the demonstration plan, it is clear that SG1000 did not meet all necessary analytical testing requirements to be qualified as an alternative to MIL-PRF-680 for the rinse step of the bearing cleaning process.

1. INTRODUCTION

1.1. Background

The use of solvents for cleaning various parts and equipment is widespread. Historically, Department of Defense (DoD) vehicle, equipment, aircraft, and ship maintenance activities have used petroleum-based solvents to remove dirt, grease, soot, and burned-on carbon from various parts. The majority of these solvents contain photo reactive volatile organic compounds (VOCs), which react with oxides of nitrogen to form ground-level ozone, the primary component of "smog". Additionally, some solvents have been identified in the Clean Air Act (CAA) as potentially toxic compounds and are listed as Hazardous Air Pollutants (HAPs). The Environmental Protection Agency (EPA) tightly regulates these solvents.

As newly enacted environmental regulations become more restrictive in the use of solvents containing VOCs and HAPs, the use of many petroleum-based solvents becomes more expensive due to the required environmental controls and extensive reporting requirements needed for compliance.

In recent years the DoD has increasingly relied on aqueous-alkaline cleaners to comply with emerging environmental regulations. However, these cleaners are not adequate for some applications, as they have been found to have material compatibility issues such as corrosion of metal surfaces and hydrogen embrittlement. Due to these limitations, the DoD continues to use large quantities of petroleum-based solvent cleaners. With the environmental concerns related to petroleum-based solvent cleaners, and performance issues of aqueous-alkaline cleaners, it is desirable to validate a new class of organic solvents. These environmentally friendly alternative solvents must be HAP-free, not contribute to emissions of VOCs, and meet DoD material compatibility and performance criteria.

The use of bio-based solvents in processes such as aeronautical antifriction bearing cleaning has the potential to reduce the volume of petroleum-based solvents used by DoD and reduce the amount of VOCs released into the atmosphere.

1.2. Objective

This Environmental Security Technology Certification Program (ESTCP) demonstration and validation project evaluates an alternative to high VOC containing solvents for the rinsing of aeronautical antifriction bearings (non-instrument) during DoD Depot level maintenance cleaning.

The information and instructions for the handling and maintenance of aeronautical antifriction bearings are contained in the tri-service technical manual *Maintenance of Aeronautical Antifriction Bearing Cleaning for Organizational, Intermediate, and Depot Maintenance Levels (NAVAIR 01-1A-503, TM55-1500-322-24, T.O. 44B-1-122).*

Henceforth, this document will be referred to as the "Bearing Cleaning Technical Manual". Section 5 of the Bearing Cleaning Technical Manual prescribes the cleaning procedures, equipment, methods, and solvents required to accomplish the bearing cleaning process.

The cleaning of aeronautical antifriction bearings is a process. As shown in Table 1, it involves a sequence of steps that ensures appropriate bearing cleanliness. A typical solvent based cleaning process for used bearings involves the following steps: demagnetize, pre-clean, degrease, carbon removal, hot water rinse, water displacing oil, solvent rinse, dry, inspection, fingerprint neutralizing, and preservation & packaging. The type of contamination on the bearings and whether they are new or used determines which steps of the cleaning process are necessary to adequately clean the bearings. Details of the bearing cleaning process can be found in Section 5-33 of the Bearing Cleaning Technical Manual and in Table 1.

Table 1 Solvent Based Aeronautical Antifriction Bearing Cleaning Process for Used Bearings

STAGE	FUNCTION	EQUIPMENT	MATERIAL	MINIMUM TIME REQ'D
1	Demagnetize	Demagnetizer	None	30 sec.
2	Pre-Clean	Fluid Agitated Tank	MIL-PRF-6081 (1010) (180°F)	30 min.
3	Degreaser	Fluid Agitated Tank	Xxcel XLS-52	As Needed (5 min. typical)
4	Carbon Removal	Fluid Agitated Tank	Turco 5668 (140°F)	20-30 min.
Optional	Ultrasonic Agitation (optional step)	Ultrasonic Tank	Turco Caviclean	5 min. (maximum)
5	Rinse	Fluid Agitated Tank	DI or RO Water w/Turco Rust Bloc Inhibitor (176°F)	1 min.
6	Water Displacing Oil	Fluid Agitated Tank	MIL-PRF-32033	3-5 min.
7A	Rinse – Step 1	Fluid Agitated Tank	MIL-PRF-680 (Filtered –100μ)	5 min.
7B	Rinse – Step 2	Fluid Agitated Tank	MIL-PRF-680 (Filtered –50 μ)	5 min.
7C	Rinse – Step 3	Fluid Agitated Tank	MIL-PRF-680 (Filtered –10 μ)	5 min.
8	Dry	Isopropyl Alcohol Dryer	Isopropyl Alcohol	As Required
9	Inspection	None	None	As Required
10	Neutralize Fingerprints	Fluid Agitated Tank	MIL-C-15074	5 min.
11	Preserve/Package	As Required	As Required	As Required

The objective of this demonstration and validation project is to evaluate an alternative solvent for the rinse step of the bearing cleaning process (Step 7 in Table 1). According to the Bearing Cleaning Technical Manual, "Every soak or wash step shall be immediately followed by an appropriate filtered solvent rinse. This process is used to remove residual cleaning materials. Solvent, Federal Specification MIL-PRF-680, Type II, shall be used in all cleaning processes except the water detergent process."

It is important to note that the objective of this demonstration is not to obtain a comprehensive DoD-wide replacement for MIL-PRF-680, Type II, but an evaluation of an alternative solvent for the specific task of rinsing aeronautical antifriction bearings during DoD depot level maintenance cleaning. Since MIL-PRF-680, Type II is referenced in the Bearing Cleaning Technical Manual as the required rinsing agent; criteria from MIL-PRF-680, *Performance Specification, Degreasing Solvent* were used throughout the guidance for testing and baseline and/or benchmark performance measures. Table 2 summarizes the target solvents, process, application, current specifications, affected programs, and candidate parts.

Table 2. Target Solvents Summary for Aeronautical Antifriction Bearing Cleaning

Target Solvents	High VOC containing solvents (Mineral Spirits, Stoddard Solvent, MIL-PRF-680 Type II)
Current Process	Rinsing bearings in fluid agitated tanks
Applications	Aeronautical antifriction bearings (non-instrument bearings)
Guidance Documents	Maintenance of Aeronautical Antifriction Bearing Cleaning for Organizational, Intermediate, and Depot Maintenance Levels (NAVAIR 01-1A-503, TM55-1500-322-24, T.O. 44B-1-122)
Affected Programs	Navy, Army, Air Force Depot level aeronautical antifriction bearing maintenance
Candidate Parts/ Substrates	Parts: Aeronautical antifriction bearings (non-instrument bearings) Substrates: Refer to Table 5 for a complete listing of aeronautical antifriction bearing substrate descriptions

1.3. Regulatory Drivers

Emissions from organic solvents are regulated by both Federal (40CFR51.100) and State air quality regulations. In addition, local air quality districts may also establish regulations that are even more stringent than the state or federal limits. In California, the San Joaquin Valley Air Pollution Control District (APCD) has established regulations limiting the VOC content of degreasers at 50 g/l. South Coast Air Quality Management District (SCAQMD) has set even more restrictive limits of 25g/l for degreasers using halogenated solvents. It is expected that other jurisdictions countrywide will promulgate similar limits.

Clean Air Act (CAA) Title III, National Emission Standards for Hazardous Air Pollutants (NESHAP) National Emissions Standards for Aerospace Manufacturing and Rework Facilities, described in 40CFR63 Subpart GG, require the use of solvents with a vapor pressure less that 7 mm Hg and contains no Hazardous Air Pollutants (HAPs)

Using MIL-PRF-680 solvent in open-tank parts washers will not meet these regulations. Compliance can be achieved by installing emission control equipment, or by using alternative low VOC, HAP-free solvents. This demonstration attempts to qualify an alternative solvent for rinsing aeronautical antifriction bearings that is HAP-free, contains low VOCs, and will allow continued use of open-tank parts washers without the addition of emissions control equipment.

1.4. Stakeholder/End-User Issues

As described in paragraph 1.3, all DoD activities are under increasing pressure to reduce VOC and HAP emissions from component cleaning lines. Unfortunately, many of the alternative solvents do not meet performance requirements or produce undesirable side effects such as flash corrosion or hydrogen embrittlement. Any alternative solvent must meet all performance, compatibility, and safety requirements, be cost effective, and provide measurable environmental benefit.

SoyGold® 1000 (SG1000) is the solvent that was selected for the demonstration. This product is produced by AG Environmental Products, LLC and is derived from soybean oil. AG Environmental Products, LLC was granted the South Coast Air Quality Management Districts Clean Air Solvent (CAS) Certificate for SG1000 in May 2000. Analysis was performed by the SCAQMD Laboratory using the most recent version of SCAQMD Method 313, *Determination of Volatile Organic Compounds (VOC) by Gas Chromatography/Mass Spectrometry (GC/MS)*. This specification is described in the SCAQMD Clean Air Certification Protocol Planning Rule Development & Area Sources document dated September 2003. In order to be awarded the CAS certificate, the solvent must not contain more than 25 grams per liter (g/L) VOCs, and is used to perform solvent cleaning, finishing, or surface preparation operations.

Company product testing has also shown that SG1000 is readily biodegradable, non-toxic, has low evaporative emissions (less than 0.0005 @ 76°F relative to a n-butyl acetate rating of 1), has a "normal" health rating, a flash point above 200°F, and is reactively stable. This would indicate that it is excellent solvent from an emissions and safe-to-use standpoint for use in the bearing cleaning operation.

For SG1000 to be qualified as an alternative to MIL-PRF-680 in the bearing cleaning process, it must meet the rinsing requirements of the process, and meet all environmental, occupational safety, and health, chemical properties, materials compatibility and performance requirements. If successful, SG1000 could be substituted for MIL-PRF-680 in the rinse step of the aeronautical antifriction bearing cleaning process at all DoD Depots.

2. ENGINEERING PERFORMANCE AND TEST REQUIREMENTS

A joint group led by the Naval Facilities Engineering Service Center and consisting of technical representatives from Naval Facilities Engineering Command, Naval Air Systems Command, U.S. Army Aberdeen Test Center, U.S. Army Research Lab, U.S. Army Tank Automotive Research, Development, and Engineering Center, U.S. Army Aviation and Missile Command, Air Force Materiel Command, Air Force Warner Robins Air Logistics Center identified engineering performance and testing requirements for aeronautical antifriction bearing cleaning. This group reached consensus on the test conditions and acceptance criteria to qualify alternatives against these critical technical and performance requirements. A Joint Test Protocol (JTP) was prepared that identified all tests and acceptance criteria necessary for an alternative solvent material to be used in the rinse step of the bearing cleaning process. The JTP is included in Appendix A.

Analytical testing was performed in phases to evaluate the alternative solvent material's potential throughout the evaluation. Analytical testing was divided into two phases and also included independent health assessments to ensure the products safety with regard to occupational safety and health.

2.1. Phase I Testing Requirements

During Phase I testing, the alternative solvent material is screened against the solvent parameters and acceptance criteria listed in Table 3. The initial screening performed during Phase I is designed to tentatively qualify or eliminate an alternative solvent material before entering Phase II analytical testing. It is *desired* that the alternative solvent material meet the minimum acceptance criteria to progress to Phase II analytical testing.

In addition, toxicity evaluations were performed by the Navy Environmental Health Center (NEHC) and the Army Center for Health Promotion and Preventative Medicine (CHPPM) to determine any occupational safety and health risks associated with worker exposure. Toxicity evaluations are performed and clearances are conditionally approved based upon the solvent application or use condition. Clearance for any potentially

hazardous product to be used by the DoD is granted or denied independently by each service.

Table 3. Screening Criteria for Alternative Solvent Material

Solvent Parameters	**Acceptance Criteria**
ENVIRONMENTAL, OCCUPATIONAL SAFETY AND HEALTH PROPERTIES	
VOCs	Shall contain less than 50 g/L VOC, be VOC exempt, or a South Coast Air Quality Management District Certified Clean Air Solvent.
HAPs	None
Flash Point	> 212° F
Toxicity	Shall have no adverse effect on human health when used as intended and shall contain no chemicals listed as carcinogens.
CHEMICAL PROPERTIES	
Vapor Pressure	< 2.0 mm Hg @ 20° C
Kauri Butanol Value	27 - 45

2.2. Phase II Testing Requirements

Analytical testing of the alternative solvent was performed during Phase II by the U.S. Army Aberdeen Test Center. A copy of the JTP was provided to the Army as a guidance document that defined the analytical testing requirements. Tests were divided into several categories including environmental, occupational safety and health tests, chemical properties related tests, materials compatibility tests, and performance criteria related tests. To address long-term storage issues, specific tests were simultaneously performed on solvent that had been held in storage for approximately 1 year.

Table 4 includes a complete list of tests performed, test methods used, corresponding section in the JTP, and the acceptance criteria used to gauge the test results. Table 5 lists all substrate materials representative of aeronautical antifriction bearing materials that were used to fabricate test coupons, the geometric configuration of each coupon, as well as the corresponding test method.

Table 4. Performance and Testing Requirements

Engineering **Requirement**	**Test Method***	**JTP Section**	**Acceptance Criteria**
ENVIRONMENTAL, OCCUPATIONAL SAFETY AND HEALTH RELATED TESTS			
Toxicity	N/A	3.1.1	The alternative solvent shall have no adverse effect on human health when used as intended and shall contain no chemicals listed as carcinogens.
Volatile Organic Compounds	EPA Method 24 Or SCAQMD Method 313	3.1.2	The alternative solvent shall contain less than 50g/L VOC, be VOC exempt, or a South Coast Air Quality Management District Certified Clean Air Solvent.
Flash Point	ASTM D 93	3.1.3	The alternative solvent flash point shall be greater than 100°C (212°F).
CHEMICAL PROPERTIES RELATED TESTS			
Vapor Pressure	ASTM D 2879	3.2.1	The alternative solvent maximum vapor pressure is 2.0mm Hg @ 20ºC.
Acidity	ASTM D 847	3.2.2	The alternative solvent shall show no evidence of acidity.
Appearance	N/A	3.2.3	The alternative solvent shall be clear and free from suspended matter and undissolved water when observed at ambient conditions.
MATERIALS COMPATIBILITY RELATED TESTS			
Total Immersion Corrosion	ASTM F 483	3.3.1	The alternative solvent shall not cause any indication of staining, etching, pitting, or localized attack; nor shall weight changes exceed allowable limits.
Titanium Stress Corrosion	ASTM F 945	3.3.2	The alternative solvent shall not cause any microscopic cracking when examined at 500X magnification.
Hydrogen Embrittlement	ASTM F 519	3.3.3	The alternative solvent shall not cause hydrogen embrittlement of cadmium plated AISI 4340 steel.
Stress Corrosion	ASTM G 44	3.3.4	The alternative solvent shall cause no evidence of cracking.

Table 4. Performance and Testing Requirements (continued)

Engineering Requirement	Test Method*	JTP Section	Acceptance Criteria
Nonvolatile Residue	ASTM D 1353	3.3.5	The alternative solvent shall not have a nonvolatile residue greater than 8mg/100mL.
Nonvolatile Residue with Isopropyl Alcohol Rinse	ASTM D 1353 (Modified)	3.3.6	The alternative solvent shall not have a nonvolatile residue greater than 8mg/100mL.
PERFORMANCE CRITERIA RELATED TESTS			
Storage Stability	ASTM F 1105	3.4.1	After 12 month storage, the alternative solvent should meet the acceptance criteria for: Rinsing Efficiency, Total Immersion Corrosion, Titanium Stress Corrosion, Hydrogen Embrittlement, Stress Corrosion, Acidity, and Appearance.
Rinse Efficiency	APPENDIX C	3.4.2	The rinse efficiency of the alternative solvent shall be equal to or better than MIL-PRF-680.
***Refer to most current version of test method**			

Table 5. Test Specimen Codes and Substrate Descriptions for Aeronautical Antifriction Bearing Cleaning

Code	Specimen	Stock	Test Method
AL-1a	Aluminum, QQ-A-250/4, T3 surface treatment accordance of AMS 2470	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
AL-1b	Aluminum, QQ-A250/4, Bare T3 Alloy	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
AL-1c	Aluminum, QQ-A-250/12, Bare T6 Alloy	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
AL-2a	Aluminum, QQ-A-250/4, T3 surface treatment accordance of AMS 2470	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
AL-2b	Aluminum, QQ-A250/4, Bare T3 Alloy	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
AL-2c	Aluminum, QQ-A-250/12, Bare T6 Alloy	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
BR-1	Brass, AMS 4616	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
BR-2	Brass, AMS 4616	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CG-1	Carburizing Grade CEVM Steel, AMS 6276 (SAE 8620)	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
CG-2	Carburizing Grade CEVM Steel, AMS 6276 (SAE 8620)	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CP-1a	Stainless Steel ASTM A240, Class 410 (Cd plated accordance with QQ-P-416 Type I)	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483

Table 5. Test Specimen Codes and Substrate Descriptions for Aeronautical Antifriction Bearing Cleaning (continued)

Code	Specimen	Stock	Test Method
CP-2a	Stainless Steel ASTM A240, Class 410 (Cd plated accordance with QQ-P-416 Type I)	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CP-2b	Cadmium Plated Steel, AISI 410	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CR-1	Cronidur 30	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
CR-2	Cronidur 30	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CS-1	Chrome Steel, AISI 52100	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
CS-2	Chrome Steel, AISI 52100	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CU-1	Copper	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
CU-2	Copper	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
HT-1	High Temperature Tool Steel, M-50	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
HT-2	High Temperature Tool Steel, M-50	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
M-1*	M-50 NiL (AMS 6278)	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
M-2*	M-50 NiL (AMS 6278)	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
NB-1	Nickel Aluminum Bronze, AMS 4640	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
NB-2	Nickel Aluminum Bronze, AMS 4640	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44

Table 5. Test Specimen Codes and Substrate Descriptions for Aeronautical Antifriction Bearing Cleaning (continued)

Code	Specimen	Stock	Test Method
NI-1	Nickel AMS 5536	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
NI-2	Nickel AMS 5536	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
PH-1a	Precipitation Hardening Stainless Steel, 17-4PH	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
PH-1b	Precipitation Hardening Stainless Steel, 16-4PH	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
PH-1c	Precipitation Hardening Stainless Steel, 13-8PH	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
PH-2a	Precipitation Hardening Stainless Steel, 17-4PH	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
PH-2b	Precipitation Hardening Stainless Steel, 16-4PH	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
PH-2c	Precipitation Hardening Stainless Steel, 13-8PH	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
RS-1	Rivets, Steel, Corrosion Resistant, AMS 7228	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
RS-2	Rivets, Steel, Corrosion Resistant, AMS 7228	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
SS-1	Stainless Steel, AISI 440C	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
SS-2	Stainless Steel, AISI 440C	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
ST-1	Steel, SAE 4340	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
ST-2	Steel, SAE 4340	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44

Table 5. Test Specimen Codes and Substrate Descriptions for Aeronautical Antifriction Bearing Cleaning (continued)

Code	Specimen	Stock	Test Method
ST-3	Steel, AISI 4340	Notch round bar in tension per ASTM F 519, Type 1a	Hydrogen Embrittlement ASTM F 519
TI-1	Titanium, AMS 4911, 6AL-4V	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
TI-2	Titanium, AMS 4911, 6AL-4V	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
TI-3	Titanium, AMS 4916	Same sheet stock, cut parallel to the rolling direction and dimensions 75x 19x1.25 mm, (3.0 x 0.75 x 0.050 in.), hole diameters 7 mm (0.28 in.), offset 13 mm (0.5 in.) from edge	Titanium Stress Corrosion ASTM F 945
TI-4	Titanium, AMS 4911	Same sheet stock, cut parallel to the rolling direction and dimensions 75x 19x1.25 mm, (3.0 x 0.75 x 0.050 in.), hole diameters 7 mm (0.28 in.), offset 13 mm (0.5 in.) from edge	Titanium Stress Corrosion ASTM F 945
VX-1*	Vasco X-2	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
VX-2*	Vasco X-2	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
*Substrate material was not commercially available and eliminated without replacement			

3. ALTERNATIVES TESTED

This effort evaluates SG1000 as an alternative low VOC and HAP-free organic (non-aqueous) solvent for the rinse step of the aeronautical antifriction bearing cleaning process. SG1000 is a soybean oil based methyl ester and is manufactured by AG Environmental Products, LLC. The manufacturing process for soy methyl ester (or methyl Soyate) is a simple transesterification of soybean oil and methanol with a sodium hydroxide catalyst. Production of soy methyl esters began in the mid- 1980's for bio-diesel fuel development and is a commercially available product currently used in the private sector for petroleum degreasing, metal cutting applications, adhesive removal, and tool and equipment cleaning. SG1000 has been certified as a "Clean Air Solvent" by the California South Coast Air Quality Management District.

Table 6 provides manufacturer specific information for the alternative solvent material evaluated using the JTP. Table 7 compares important solvent parameters of the alternative solvent (vendor published) to the solvent currently used in the rinse step of the aeronautical antifriction bearing cleaning process.

Table 6. Alternative Solvent Material Selected for Aeronautical Antifriction Bearing Cleaning

Solvent	**Chemical Name**	**Manufacturer**
SoyGold® 1000	Soy Methyl Ester (Methyl Soyate)	AG Environmental Products, LLC 12700 West Dodge Road Omaha, NE 68154 800-599-9209

Table 7. Vendor Published Solvent Properties

Solvent Parameters	**SoyGold® 1000**	**MIL-PRF-680 Type II**
ENVIRONMENTAL, OCCUPATIONAL SAFETY AND HEALTH PROPERTIES		
VOCs	South Coast Air Quality Management District Certified Clean Air Solvent <50 g/L	500-800 g/L
HAPs	None	Yes
Flash Point	425° F (Closed Cup)	141 - 198° F
Toxicity	Non-Toxic (LD_{50} - 17.4 g/kg body weight)	No adverse effects on health
CHEMICAL PROPERTIES		
Vapor Pressure	1.8 mm Hg @ 20° C	< 2.0 mm Hg @ 20° C
Kauri Butanol Value	61	27 - 45

3.1. Phase II Analytical Testing

During coupon acquisition/preparation for Phase II analytical testing, it was found that materials including M1/M2 M-50 NiL (low-carbon, carburizing, bearing steel used for bearings in aircraft jet turbine engines) and VX-1/VX-2 Vasco X-2 (a high temperature bearing and gear material for aerospace applications) listed in Table 5, specified in the Total Immersion and Stress Corrosion Tests of the JTP were not commercially available. These materials were not used in the corrosion tests and were eliminated from the list of substrates. Substitute materials were not selected.

4. TEST RESULTS

As previously indicated, a joint group led by the Naval Facilities Engineering Service Center and consisting of technical representatives from Naval Facilities Engineering Command, Naval Air Systems Command, U.S. Army Aberdeen Test Center, U.S. Army Research Lab, U.S. Army Tank Automotive Research, Development, and Engineering Center, U.S. Army Aviation and Missile Command, Air Force Materiel Command, Air Force Warner Robins Air Logistics Center identified the engineering performance and testing requirements for aeronautical antifriction bearing cleaning. This group reached consensus on the test conditions and acceptance criteria to qualify alternatives against these critical, technical, and performance requirements. A JTP was developed that identified all tests and acceptance criteria necessary for an alternative solvent material to be used in the rinse step of the bearing cleaning process.

The acceptance criteria are the gauge used to determine whether an alternative solvent passes or fails the tests identified in the JTP. The alternative must pass all tests identified in the JTP and pass the demonstration/validation phase to be an acceptable alternative to MIL-PRF-680 in the rinse step of the bearing cleaning process. In addition, the demonstration plan also requires that any alternative solvent must meet *all* performance, compatibility, and safety requirements, be cost effective, and provide measurable environmental benefit.

Phase I and II analytical test results for new, and stored SG1000 product materials are mixed. SG1000 passed all environmental, occupational, safety and health related tests, but failed a number of the materials compatibility tests including total immersion corrosion for a number of the substrate materials identified in Table 5, hydrogen embrittlement, nonvolatile residue, and nonvolatile residue with isopropyl alcohol rinse. SG1000 also failed the rinse efficiency test under performance related tests as well as the acidity test under chemical properties. During the initial screening, SG1000 also failed the Kauri-butanol test.

As defined by the acceptance criteria in the JTP, and the requirements of the demonstration plan, it is clear that SG1000 did not meet all necessary requirements to be qualified as an alternative to MIL-PRF-680 for the rinse step of the bearing cleaning process.

Sections 4.1 and 4.2 present Phase I and II test results for both new SG1000 product and product that had been held in storage for approximately 1 year prior to testing. Analytical test results including all test data are included in the U.S. Army Aberdeen Test Center Final Report Number ATC-9192 *"Final Report, Joint Test Protocol for Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning"*, dated July 2006. A copy of the ATC report is included in Appendix B.

4.1. Phase I Screening Test Results

Phase I screening of the alternative solvent included volatile organic compounds (VOC), flash point, vapor pressure, Kauri-Butanol, toxicity, and rinse efficiency tests. Testing was performed on new SG1000 product as well as SG1000 product that had been held in storage for approximately 1 year.

New SG1000 product passed the VOC, flash point, vapor pressure, and toxicity screening tests but failed the Kauri-Butanol and rinse efficiency tests as defined by the acceptance criteria in the JTP. Table 8 includes a list of all screening tests, test methods, and test results for the new SG1000 product.

Table 8. Phase I SG1000 Screening Tests (Fresh Product Sample)

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning				
Phase I - SoyGold 1000 Screening Tests *(Fresh Product Sample)*				
TEST	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Volatile Organic Compounds (VOC)	SoyGold 1000	Environmental Protection Agency (EPA) Method 8620B, Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)	**Pass**	SoyGold 1000 does not contain detectable amounts of listed VOCs in EPA Method 5030B/8260B, except for trace amounts of naphthalene. Acceptance criteria for VOC is 50 g/L or 5% by total weight.
Flash Point	SoyGold 1000	Standard Tests for Flash Point by Pensky-Martens Closed Cup Tester - ASTM D 93	**Pass**	Flash point for fresh SoyGold 1000 product was determined to be 156 Deg C, (331 Deg F). Acceptance criteria for flash point is >212 Deg F.
Vapor Pressure	SoyGold 1000	Standard Test Method for Vapor Pressure-Temperature Relationship and Initial Decomposition Temperature of Liquids by Isoteniscope - ASTM D 2879	**Pass**	Vapor pressure for fresh SoyGold 1000 product was found to be <2.00 mm Hg. Acceptance criteria for vapor pressure is 2.0 mm Hg.
Kauri Butanol	SoyGold 1000	Standard Test Method for Kauri Butanol Value of Hydrocarbon Solvents - ASTM D 1133	**Fail**	**(FAILURE DUE TO: Kb value of 58.6 exceeds JTP acceptance criteria range of 27-45)** SoyGold 1000 did not meet the acceptance criteria for Kb value as specified in the JTP. Kb value was determined to be 58.6 which is outside the acceptance criteria of 27-45.
Toxicity	SoyGold 1000	Navy Environmental Health Center (NEHC) health hazard assessment	**Pass**	A administrative health hazard assessment of SoyGold 1000 was performed and clearance was granted on 16 May 2005 by NEHC. This was a paper study and no analytical testing was performed.
Toxicity	SoyGold 1000	Army Center for Health Promotion and Preventative Medicine (CHIPPM) toxicity evaluation	**Pass**	A toxicological evaluation of SoyGold 1000 was conducted and a toxicity clearance was granted on 23 February 2005 by CHPPM, APG, Maryland, approving SoyGold 1000 as a degreaser. An additional toxicity clearance was granted on 31 January 2006 approving SoyGold 1000 as a cleaner. This was a paper study and no analytical testing was performed.
Rinse Efficiency	SoyGold 1000	Standard Test Method for Hydrophobic Surface Film by the Water-Break Test - ASTM F 22	**Fail**	**(FAILURE DUE TO: poor solvent cleaning power of 30.3%)** JTP acceptance criteria requires rinse efficiency equal to or better than MIL-PRF-680. MIL-PRF-680 requires 85% solvency for Types I, II, and III, and 88% solvency for Type IV.

Screening tests, test methods, and test results for the stored SG1000 product are shown in Table 9. It should be noted that although additional tests were performed, rinse efficiency is the only *screening test* required in the JTP for the stored product. The stored SG1000 failed the rinse efficiency test as defined by the acceptance criteria.

Table 9. Phase I SG1000 Screening Tests (Stored Product Sample)

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning				
Phase I - SoyGold 1000 Screening Tests *(Stored Product Sample)*				
TEST	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Volatile Organic Compounds (VOC)	SoyGold 1000	Environmental Protection Agency (EPA) Method 8620B, Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)	**Pass Test Not Required by JTP**	JTP acceptance criteria specifies that the demonstration solvent material shall meet the acceptance criteria for storage stability for rinsing efficiency, total immersion corrosion, titanium stress corrosion, hydrogen embrittlement, stress corrosion, acidity, and appearance only. Volatile organic compounds is not a required test under storage stability in the JTP.
Flash Point	SoyGold 1000	Standard Tests for Flash Point by Pensky-Martens Closed Cup Tester - ASTM D 93	**Pass Test Not Required by JTP**	JTP acceptance criteria specifies that the demonstration solvent material shall meet the acceptance criteria for storage stability for rinsing efficiency, total immersion corrosion, titanium stress corrosion, hydrogen embrittlement, stress corrosion, acidity, and appearance only. Flash point is not a required test under storage stability in the JTP.
Kauri Butanol	SoyGold 1000	Standard Test Method for Kauri Butanol Value of Hydrocarbon Solvents - ASTM D 1133	**Fail Test Not Required by JTP**	**(FAILURE DUE TO: Kb value of 58.5 exceeds acceptance criteria range of 27-45)** SoyGold 1000 did not meet the acceptance criteria for Kb value as specified in the JTP. Kb value was determined to be 58.5 which is outside the acceptance criteria of 27-45. JTP acceptance criteria specifies that the demonstration solvent material shall meet the acceptance criteria for storage stability for rinsing efficiency, total immersion corrosion, titanium stress corrosion, hydrogen embrittlement, stress corrosion, acidity, and appearance only. Kauri Butanol is not a required test under storage stability in the JTP.
Rinse Efficiency	SoyGold 1000	Standard Test Method for Hydrophobic Surface Film by the Water-Break Test - ASTM F 22	**Fail Test Required by JTP**	**(FAILURE DUE TO: poor solvency of 30.3%)** JTP acceptance criteria requires rinse efficiency equal to or better than MIL-PRF-680. MIL-PRF-680 requires 85% solvency for Types I, II, and III, and 88% solvency for Type IV.

4.2. Phase II Analytical Test Results

Phase II analytical testing was performed using fresh SG1000 product and SG1000 product that had been held in storage for approximately 1 year. Test results for each are presented in the following sections.

4.2.1. Phase II Analytical Test Results for Fresh SG1000 Product Material

Phase II analytical tests included total immersion corrosion, stress corrosion, titanium stress corrosion, appearance, hydrogen embrittlement, acidity, nonvolatile residue, and nonvolatile residue with isopropyl alcohol rinse. Table 10 lists all Phase II analytical tests performed using fresh SG1000 product material and includes the specimen

materials, coupon configuration, test method used, test results, and notes relating test results and acceptance criteria.

Results for total immersion corrosion tests using fresh SG1000 product material are mixed. A total of twenty-one materials were identified in the JTP to be included in the total immersion corrosion tests (see Table 5). Of the twenty-one materials, thirteen passed, six failed, and two were not included because the materials were not commercially available (have not been produced for several years).

The fresh SG1000 product material passed all stress corrosion tests. A total of twenty-two materials were identified in the JTP to be included in the stress corrosion tests (see Table 5). Of the twenty-two materials, eighteen passed the stress corrosion tests, one material was found to be a duplicate and eliminated, one was not able to be fabricated into the coupon configuration specified in the test method and was eliminated, and two were not included because the materials were not commercially available (have not been produced for several years).

The fresh SG1000 product material passed the titanium stress corrosion and appearance tests, but failed the hydrogen embrittlement, acidity, nonvolatile residue, and nonvolatile residue with isopropyl alcohol rinse tests.

Table 10: Phase II Analytical Tests Performed Using Fresh SG1000 Product Material

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Fresh Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Total Immersion Corrosion	AL-1a	Aluminum, QQ-A-250/4, T3 surface treatment accordance of AMS 2470	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: at the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-1 and F-3.3.1-2 of ATC report, Average weight change of three samples was 0.009 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	AL-1b	Aluminum, QQ-A250/4, Bare T3 Alloy	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: at the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-5 and F-3.3.1-6 of ATC report, Average weight change of three samples was -0.002 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	AL-1c	Aluminum, QQ-A-250/12, Bare T6 Alloy	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: at the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-9 and F-3.3.1-10 of ATC report, Average weight change of three samples was -0.016 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	BR-1	Brass, AMS 4616	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: at the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-13 and F-3.3.1-14 of ATC report, Average weight change of three samples was -0.006 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	CG-1	Carburizing Grade CEVM Steel, AMS 6276 (SAE 8620)	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail**	**(FAILURE DUE TO: stains along top and bottom edges on both sides)** At the end of 24 and 168 hours all coupons had slight stains at the top and bottom edges on both sides (see figure F-3.3.1-17 and F-3.3.1-18 of ATC report). The average weight change at the end of the 168 hour inspection was 0.007 mg/cm2. JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.

Table 10: Phase II Analytical Tests Performed Using Fresh SG1000 Product Material (continued)

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Fresh Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Total Immersion Corrosion	CP-1a	Stainless Steel ASTM A240, Class 410 (Cd plated in accordance with QQ-P-416 Type I)	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: at the end of 24 hr, coupons had no discoloration or staining, see figure F-3.3.1-21 of ATC report. After 168 hr, the test coupons appeared brighter than the control, see fig F-3.3.1-22 of ATC report. Average weight change of three samples was -0.020 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	CR-1	Cronidur 30	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: at the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-25 and F-3.3.1-26 of ATC report, Average weight change of three samples was -0.031 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	CS-1	Chrome Steel, AISI 52100	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail**	**(FAILURE DUE TO: light stains on all coupons)** At the end of 24 and 168 hours all coupons had slight stains over all surfaces (fig F-3.3.1-29 and F-3.3.1-30 of ATC report). The average weight change at the end of the 168 hour inspection was 0.025 mg/cm2.
Total Immersion Corrosion	CU-1	Copper	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: at the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-33 and F-3.3.1-34 of ATC report, Average weight change of three samples was -0.012 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	HT-1	High Temperature Tool Steel, M-50	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail**	**(FAILURE DUE TO: light stains on all coupons)** The 24 hour inspection showed light stains along the top and bottom edges of all coupons (fig F-3.3.1-37 of ATC report). At the end of 168 hours all coupons had slight stains over all surfaces (fig F-3.3.1-38 of ATC report). The average weight change at the end of the 168 hour inspection was 0.041 mg/cm2.
Total Immersion Corrosion	M-1	M-50 NiL (AMS 6278)	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Not Performed**	M-50 NiL (AMS 6278) material not available. According to Army Test Laboratory, five production mills and over a dozen metal suppliers were contacted. This material has not been produced for several years.

Table 10: Phase II Analytical Tests Performed Using Fresh SG1000 Product Material (continued)

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Fresh Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Total Immersion Corrosion	NB-1	Nickel Aluminum Bronze, AMS 4640	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: at the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-41 and F-3.3.1-42 of ATC report, Average weight change of three samples was -0.016 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	NI-1	Nickel AMS 5536	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: at the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-45 and F-3.3.1-46 of ATC report, Average weight change of three samples was 0.001 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	PH-1a	Precipitation Hardening Stainless Steel, 17-4PH	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: at the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-49 and F-3.3.1-50 of ATC report, Average weight change of three samples was 0.005 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	PH-1b	Precipitation Hardening Stainless Steel, 16-4PH	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail**	**(FAILURE DUE TO: excessive weight gain)** At the end of 24 and 164 hours the samples had no discoloration or staining (fig F-3.3.1-53 and F-3.3.1-54 of ATC report). The average weight change of the three samples was 0.048 mg/cm2.
Total Immersion Corrosion	PH-1c	Precipitation Hardening Stainless Steel, 13-8PH	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: at the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-57 and F-3.3.1-58 of ATC report, Average weight change of three samples was -0.031 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	RS-1	Rivets, Steel, Corrosion Resistant, AMS 7228	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: at the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-61 and F-3.3.1-63 of ATC report, Average weight change of three samples was 0.004 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.

Table 10: Phase II Analytical Tests Performed Using Fresh SG1000 Product Material (continued)

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Fresh Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Total Immersion Corrosion	SS-1	Stainless Steel, AISI 440C	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail**	**(FAILURE DUE TO: excessive weight loss and light stains)** At the end of 24 hours, the samples had no discoloration or staining (fig F-3.3.1-65 of ATC report). At the end of hours the coupons had light stains on both sides (fig F-3.3.1-67 of ATC report). The average weight change of the three samples was 0.047 mg/cm2.
Total Immersion Corrosion	ST-1	Steel, SAE 4340	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail**	**(FAILURE DUE TO: exceeded weight gain and light stains on top and bottom edges)** There were light stains along the top and bottom edges of both the 24 hour and 168 hour coupons (fig F-3.3.1-69 and F-3.3.1-70 of ATC report). The average weight change of the three samples was 0.060 mg/cm2.
Total Immersion Corrosion	TI-1	Titanium, AMS 4911, 6AL-4V	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: There was no change in the appearance of the samples during the 24- and 168-hr test, see figure F-3.3.1-73 and F-3.3.1-74 of ATC report, Average weight change of three samples was -0.004 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	VX-1	Vasco X-2	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Not Performed**	Vasco X-2 material not available. According to Army Test Laboratory, five production mills and over a dozen metal suppliers were contacted. This material has not been produced for several years.
Stress Corrosion	AL-2a	Aluminum, QQ-A-250/4, T3 surface treatment accordance of AMS 2470	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	AL-2b	Aluminum, QQ-A250/4, Bare T3 Alloy	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	Al-2c	Aluminum, QQ-A-250/12, Bare T6 Alloy	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	BR-2	Brass, AMS 4616	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.

Table 10: Phase II Analytical Tests Performed Using Fresh SG1000 Product Material (continued)

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Fresh Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Stress Corrosion	CG-2	Carburizing Grade CEVM Steel, AMS 6276 (SAE 8620)	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	CP-2a	Stainless Steel ASTM A240, Class 410 (Cd plated in accordance with QQ-P-416 Type I)	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	CP-2b	Cadmium Plated Steel, AISI 410	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Not Performed**	Duplicate Test, Same as CP-2a
Stress Corrosion	CR-2	Cronidur 30	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Not Performed**	Cronidur 30 material could not be tested using this ASTM due to it's properties. The material could not be made into coupons suitable for stress corrosion testing. The material is extremly hard and would shatter when bent.
Stress Corrosion	CS-2	Chrome Steel, AISI 52100	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	CU-2	Copper	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	HT-2	High Temperature Tool Steel, M-50	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	M-2	M-50 NiL (AMS 6278)	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Not Performed**	M-50 NiL (AMS 6278) material not available. According to Army Test Laboratory, five production mills and over a dozen metal suppliers were contacted. This material has not been produced for several years.
Stress Corrosion	NB-2	Nickel Aluminum Bronze, AMS 4640	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.

Table 10: Phase II Analytical Tests Performed Using Fresh SG1000 Product Material (continued)

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Fresh Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Stress Corrosion	NI-2	Nickel AMS 5536	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	PH-2a	Precipitation Hardening Stainless Steel, 17-4PH	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	PH-2b	Precipitation Hardening Stainless Steel, 16-4PH	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	PH-2c	Precipitation Hardening Stainless Steel, 13-8PH	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	RS-2	Rivets, Steel, Corrosion Resistant, AMS 7228	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	SS-2	Stainless Steel, AISI 440C	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	ST-2	Steel, SAE 4340	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	TI-2	Titanium, AMS 4911, 6AL-4V	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	VX-2	Vasco X-2	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Not Performed**	Vasco X-2 material not available. According to Army Test Laboratory, five production mills and over a dozen metal suppliers were contacted. This material has not been produced for several years.

Table 10: Phase II Analytical Tests Performed Using Fresh SG1000 Product Material (continued)

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Fresh Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Titanium Stress Corrosion	TI-3	Titanium, AMS 4916	Same sheet stock, cut parallel to the rolling direction and dimensions 75 x 19 x 1.25 mm, (3.0 x 0.75 x 0.050 in.), hole diameters 7 mm (0.28 in), offset 13 mm (0.5 in.) from edge	Titanium Stress Corrosion ASTM F 945	**Pass**	**(PASS: There was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material not shall cause any microscopic cracking when examined at 500X magnification.
Titanium Stress Corrosion	TI-4	Titanium, AMS 4911, 6AL-4V	Same sheet stock, cut parallel to the rolling direction and dimensions 75 x 19 x 1.25 mm, (3.0 x 0.75 x 0.050 in.), hole diameters 7 mm (0.28 in), offset 13 mm (0.5 in.) from edge	Titanium Stress Corrosion ASTM F 945	**Pass**	**(PASS: There was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material not shall cause any microscopic cracking when examined at 500X magnification.
Hydrogen Embrittlement	ST-3	Steel, AISI 4340	Notch round bar in tension per ASTM F 519, Type 1a	Hydrogen Embrittlement ASTM F 519	**Fail**	**(FAILURE DUE TO: all specimens tested fractured to failure within 200 hours)** The lot of specimens used met the sensitivity testing required by ASTM F519. The SoyGold 1000 did not meet the criterion for hydrogen embrittlement for the fresh product material. JTP acceptance criteria specifies that the demonstration solvent material shall not cause hydrogen embrittlement of cadmium plated AISI 4340 steel.
Acidity	N/A	N/A	SoyGold 1000	Standard Test Method for Acidity of Benzene, Toluene, Xylenes, Solvent Naphthas, and Similar Industrial Aromatic Hydrocarbons - ASTM D 847	**Fail**	**(FAILURE DUE TO: 1.47 mg KOH/L)** The fresh SoyGold 1000 did not meet the acceptance criteria for acidity. JTP acceptance criteria specifies that the demonstration solvent material shall show no evidence of acidity.
Appearance	N/A	N/A	SoyGold 1000	Visual Inspection	**Pass**	**(PASS: The appearance of the demonstration solvent material was determined to be clear and met the acceptance criteria.** JTP acceptance criteria specifies that the demonstration solvent material shall be clear and free from suspended matter and undissolved water when observed at ambient conditions**.**

Table 10: Phase II Analytical Tests Performed Using Fresh SG1000 Product Material (continued)

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Fresh Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Nonvolatile Residue	N/A	N/A	SoyGold 1000	Standard Test Method for Nonvolatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer, and Related Products - ASTM D 1353	**Fail**	**(FAILURE DUE TO: nonvolatile residue estimated to be greater than 84%)** Analysis was performed in accordance with ASTM D1353. Due to chemical make up of SoyGold, little or no signs of evaporation were observed. A definitive value for nonvolatile residue could not be determined.
Nonvolatile Residue with Isopropyl Alcohol Rinse	N/A	N/A	SoyGold 1000	Standard Test Method for Nonvolatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer, and Related Products - ASTM D 1353	**Fail**	**(FAILURE DUE TO: nonvolatile residue estimated to be greater than 84%)** Analysis was performed in accordance with ASTM D1353. Due to chemical make up of SoyGold, little or no signs of evaporation were observed. A definitive value for nonvolatile residue could not be determined.

4.2.2. Phase II Analytical Test Results for Stored SG1000 Product Material

Phase II analytical tests included total immersion corrosion, stress corrosion, titanium stress corrosion, appearance, hydrogen embrittlement, acidity, nonvolatile residue, and nonvolatile residue with isopropyl alcohol rinse. Table 11 lists all Phase II analytical tests performed using SG1000 product material that had been held in storage for approximately 1 year and includes the specimen materials, coupon configuration, test method used, test results, and notes relating test results and acceptance criteria.

Results for total immersion corrosion tests using stored SG1000 product material are mixed. A total of twenty-one materials were identified in the JTP to be included in the total immersion corrosion tests (see Table 5). Of the twenty-one materials, fifteen passed, four failed, and two were not included because the materials were not commercially available (have not been produced for several years).

The stored SG1000 product material passed all stress corrosion tests. A total of twenty-two materials were identified in the JTP to be included in the stress corrosion tests (see Table 5). Of the twenty-two materials, eighteen passed the stress corrosion tests, one material was found to be a duplicate and eliminated, one was not able to be fabricated into the coupon configuration specified in the test method and was eliminated, and two were not included because the materials were not commercially available (have not been produced for several years).

The stored SG1000 product material passed the titanium stress corrosion and appearance tests, but failed the hydrogen embrittlement and acidity tests. Nonvolatile residue, and nonvolatile residue with isopropyl alcohol rinse tests for the stored product were not required by the JTP and were not performed.

Table 11: Phase II Analytical Tests Performed Using Stored SG1000 Product Material

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Stored Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Total Immersion Corrosion	AL-1a	Aluminum, QQ-A-250/4, T3 surface treatment accordance of AMS 2470	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: At the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-3 and F-3.3.1-4 of ATC report, Average weight change of three samples was 0.02 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	AL-1b	Aluminum, QQ-A250/4, Bare T3 Alloy	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: At the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-7 and F-3.3.1-8 of ATC report, Average weight change of three samples was 0.01 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	AL-1c	Aluminum, QQ-A-250/12, Bare T6 Alloy	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: At the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-11 and F-3.3.1-12 of ATC report, Average weight change of three samples was -0.01 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.

Table 11: Phase II Analytical Tests Performed Using Stored SG1000 Product Material

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Stored Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Total Immersion Corrosion	BR-1	Brass, AMS 4616	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: There was no change in the appearance of the samples during the 24- and 168-hr test, eee figure F-3.3.1-15 and F-3.3.1-16 of ATC report. There was no weight change at the end of the 168-hr inspection.** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	CG-1	Carburizing Grade CEVM Steel, AMS 6276 (SAE 8620)	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: At the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-19 and F-3.3.1-20 of ATC report, Average weight change of three samples was 0.040 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	CP-1a	Stainless Steel ASTM A240, Class 410 (Cd plated in accordance with QQ-P-416 Type I)	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail**	**(FAILURE DUE TO: light stains along bottom edges)** At the end of 24 hours the coupons had no discoloration or staining (figure F-3.3.1-23 of ATC report). All coupons had light stains on the bottom edges after 168 hours (fig F-3.3.1-24 of ATC report). The average weight change of the three samples was -0.01 mg/cm2. JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.

Table 11: Phase II Analytical Tests Performed Using Stored SG1000 Product Material

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Stored Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Total Immersion Corrosion	CR-1	Cronidur 30	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: There was no change in the appearance of the samples during the 24- and 168-hr test, eee figure F-3.3.1-27 and F-3.3.1-28 of ATC report. The average weight change at the end of the 168-hr inspection was -0.030.** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	CS-1	Chrome Steel, AISI 52100	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail**	**(FAILURE DUE TO: light stains on two of the three coupons)** At the end of 24 and 168 hours coupons number 1 and 2 had light stains on the back (fig F-3.3.1-31 and F-3.3.1-32 of ATC report). The average weight change at the end of 168 hour inspection was 0.02 mg/cm2. JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of -0.030mg/cm2/24-hr.
Total Immersion Corrosion	CU-1	Copper	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: At the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-35 and F-3.3.1-36 of ATC report, Average weight change of three samples was -0.01 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.

Table 11: Phase II Analytical Tests Performed Using Stored SG1000 Product Material

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Stored Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Total Immersion Corrosion	HT-1	High Temperature Tool Steel, M-50	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: There was no change in the appearance of the samples during the 24- and 168-hr test, eee figure F-3.3.1-39 and F-3.3.1-40 of ATC report. Average weight change of three samples was 0.04 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.040mg/cm2/24-hr.
Total Immersion Corrosion	M-1	M-50 NiL (AMS 6278)	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Not Performed**	M-50 NiL (AMS 6278) material not available. According to Army Test Laboratory, five production mills and over a dozen metal suppliers were contacted. This material has not been produced for several years.
Total Immersion Corrosion	NB-1	Nickel Aluminum Bronze, AMS 4640	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: At the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-43 and F-3.3.1-44 of ATC report, Average weight change of three samples was -0.01 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.

Table 11: Phase II Analytical Tests Performed Using Stored SG1000 Product Material

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Stored Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Total Immersion Corrosion	NI-1	Nickel AMS 5536	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail**	**(FAILURE DUE TO: light stains of two of the three coupons)** At the end of the 24 hour inspection, there was no discoloration or staining (fig F-3.3.1-47 of ATC report). The 168 hour inspection showed slight staining on coupon numbers 2 and 3 (fig F-3.3.1-48 of ATC report). The average weight change of the three samples was 0.02 mg/cm2. JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	PH-1a	Precipitation Hardening Stainless Steel, 17-4PH	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: There was no change in the appearance of the samples during the 24- and 168-hr test, eee figure F-3.3.1-51 and F-3.3.1-52 of ATC report. Average weight change of three samples was 0.02 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.040mg/cm2/24-hr.
Total Immersion Corrosion	PH-1b	Precipitation Hardening Stainless Steel, 16-4PH	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: There was no change in the appearance of the samples during the 24- and 168-hr test, eee figure F-3.3.1-55 and F-3.3.1-56 of ATC report. There was no weight change at the end of the 168-hr inspection.** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of -0.030mg/cm2/24-hr.

Table 11: Phase II Analytical Tests Performed Using Stored SG1000 Product Material

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Stored Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Total Immersion Corrosion	PH-1c	Precipitation Hardening Stainless Steel, 13-8PH	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: At the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-59 and F-3.3.1-60 of ATC report, Average weight change of three samples was -0.01 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	RS-1	Rivets, Steel, Corrosion Resistant, AMS 7228	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: At the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-63 and F-3.3.1-64 of ATC report, Average weight change of three samples was 0.02 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	SS-1	Stainless Steel, AISI 440C	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Fail**	**(FAILURE DUE TO: very light stains)** At the end of 24 hours the number 2 coupon had light stains on both sides and coupons number 1 and 3 had no discoloration or staining (fig F-3.3.1-67 of ATC report). All coupons had light stains after 168 hours (fig F-3.3.1-68 of ATC report). The average weight change of the three samples was 0.03 mg/cm2. JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.

Table 11: Phase II Analytical Tests Performed Using Stored SG1000 Product Material

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Stored Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Total Immersion Corrosion	ST-1	Steel, SAE 4340	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: At the end of 24 and 168 hr, samples had no discoloration or staining, see figure F-3.3.1-71 and F-3.3.1-72 of ATC report, Average weight change of three samples was -0.02 mg/cm2.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.04mg/cm2/24-hr.
Total Immersion Corrosion	TI-1	Titanium, AMS 4911, 6AL-4V	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Pass**	**(PASS: There was no change in the appearance of the samples during the 24- and 168-hr test, eee figure F-3.3.1-75 and F-3.3.1-76 of ATC report. There was no weight change at the end of the 168-hr inspection.)** JTP acceptance criteria specifies that the demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack: nor shall weight changes exceed allowable limit for average of 3 panels of 0.040mg/cm2/24-hr.
Total Immersion Corrosion	VX-1	Vasco X-2	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483	**Not Performed**	Vasco X-2 material not available. According to Army Test Laboratory, five production mills and over a dozen metal suppliers were contacted. This material has not been produced for several years.
Stress Corrosion	AL-2a	Aluminum, QQ-A-250/4, T3 surface treatment accordance of AMS 2470	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	AL-2b	Aluminum, QQ-A250/4, Bare T3 Alloy	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.

Table 11: Phase II Analytical Tests Performed Using Stored SG1000 Product Material

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Stored Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Stress Corrosion	Al-2c	Aluminum, QQ-A-250/12, Bare T6 Alloy	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	BR-2	Brass, AMS 4616	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	CG-2	Carburizing Grade CEVM Steel, AMS 6276 (SAE 8620)	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	CP-2a	Stainless Steel ASTM A240, Class 410 (Cd plated in accordance with QQ-P-416 Type I)	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	CP-2b	Cadmium Plated Steel, AISI 410	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Not Performed**	Duplicate Test, Same as CP-2a
Stress Corrosion	CR-2	Cronidur 30	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Not Performed**	Cronidur 30 material could not be tested using this ASTM due to it's properties. The material could not be made into coupons suitable for stress corrosion testing. The material is extremly hard and would shatter when bent.
Stress Corrosion	CS-2	Chrome Steel, AISI 52100	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	CU-2	Copper	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.

Table 11: Phase II Analytical Tests Performed Using Stored SG1000 Product Material

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Stored Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Stress Corrosion	HT-2	High Temperature Tool Steel, M-50	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	M-2	M-50 NiL (AMS 6278)	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Not Performed**	M-50 NiL (AMS 6278) material not available. According to Army Test Laboratory, five production mills and over a dozen metal suppliers were contacted. This material has not been produced for several years.
Stress Corrosion	NB-2	Nickel Aluminum Bronze, AMS 4640	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	NI-2	Nickel AMS 5536	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	PH-2a	Precipitation Hardening Stainless Steel, 17-4PH	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	PH-2b	Precipitation Hardening Stainless Steel, 16-4PH	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	PH-2c	Precipitation Hardening Stainless Steel, 13-8PH	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.

Table 11: Phase II Analytical Tests Performed Using Stored SG1000 Product Material

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Stored Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Stress Corrosion	RS-2	Rivets, Steel, Corrosion Resistant, AMS 7228	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	SS-2	Stainless Steel, AISI 440C	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	ST-2	Steel, SAE 4340	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	TI-2	Titanium, AMS 4911, 6AL-4V	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Pass**	**(PASS: After the 90-day exposure, there was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material shall cause no evidence of cracking.
Stress Corrosion	VX-2	Vasco X-2	U-Bend from the same sheet stock per ASTM G 30, type (a)	Stress Corrosion ASTM G 44	**Not Performed**	Vasco X-2 material not available. According to Army Test Laboratory, five production mills and over a dozen metal suppliers were contacted. This material has not been produced for several years.
Titanium Stress Corrosion	TI-3	Titanium, AMS 4916	Same sheet stock, cut parallel to the rolling direction and dimensions 75 x 19 x 1.25 mm, (3.0 x 0.75 x 0.050 in.), hole diameters 7 mm (0.28 in), offset 13 mm (0.5 in.) from edge	Titanium Stress Corrosion ASTM F 945	**Pass**	**(PASS: There was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material not shall cause any microscopic cracking when examined at 500X magnification.

Table 11: Phase II Analytical Tests Performed Using Stored SG1000 Product Material

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Stored Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Titanium Stress Corrosion	TI-4	Titanium, AMS 4911, 6AL-4V	Same sheet stock, cut parallel to the rolling direction and dimensions 75 x 19 x 1.25 mm, (3.0 x 0.75 x 0.050 in.), hole diameters 7 mm (0.28 in), offset 13 mm (0.5 in.) from edge	Titanium Stress Corrosion ASTM F 945	**Pass**	**(PASS: There was no evidence of cracking.** JTP acceptance criteria specifies that the demonstration solvent material not shall cause any microscopic cracking when examined at 500X magnification.
Hydrogen Embrittlement	ST-3	Steel, AISI 4340	Notch round bar in tension per ASTM F 519, Type 1a	Hydrogen Embrittlement ASTM F 519	**Fail**	**(FAILURE DUE TO: all specimens tested fractured to failure within 200 hours)** The lot of specimens used met the sensitivity testing required by ASTM F519. The SoyGold 1000 did not meet the criterion for hydrogen embrittlement for the stored product material. JTP acceptance criteria specifies that the demonstration solvent material shall not cause hydrogen embrittlement of cadmium plated AISI 4340 steel.
Acidity	N/A	N/A	SoyGold 1000	Standard Test Method for Acidity of Benzene, Toluene, Xylenes, Solvent Naphthas, and Similar Industrial Aromatic Hydrocarbons - ASTM D 847	**Fail**	**(FAILURE DUE TO: 0.680 mg KOH/L)** The stored SoyGold 1000 did not meet the acceptance criteria for acidity. JTP acceptance criteria specifies that the demonstration solvent material shall show no evidence of acidity.
Appearance	N/A	N/A	SoyGold 1000	Visual Inspection	**Pass**	**(PASS: The appearance of the demonstration solvent material was determined to be clear and met the acceptance criteria.** JTP acceptance criteria specifies that the demonstration solvent material shall be clear and free from suspended matter and undissolved water when observed at ambient conditions**.**

Table 11: Phase II Analytical Tests Performed Using Stored SG1000 Product Material

Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning						
Phase II - SoyGold 1000 Analytical Tests *(Stored Product Sample)*						
TEST	**CODE**	**SPECIMEN**	**STOCK**	**TEST METHOD**	**TEST RESULT**	**NOTES**
Nonvolatile Residue	N/A	N/A	SoyGold 1000	Standard Test Method for Nonvolatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer, and Related Products - ASTM D 1353	**Not Performed**	JTP acceptance criteria specifies that the demonstration solvent material shall meet the acceptance criteria for storage stability for rinsing efficiency, total immersion corrosion, titanium stress corrosion, hydrogen embrittlement, stress corrosion, acidity, and appearance only
Nonvolatile Residue with Isopropyl Alcohol Rinse	N/A	N/A	SoyGold 1000	Standard Test Method for Nonvolatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer, and Related Products - ASTM D 1353	**Not Performed**	JTP acceptance criteria specifies that the demonstration solvent material shall meet the acceptance criteria for storage stability for rinsing efficiency, total immersion corrosion, titanium stress corrosion, hydrogen embrittlement, stress corrosion, acidity, and appearance only

5. SUMMARY AND RECOMMENDATIONS

As newly enacted environmental regulations become more restrictive in the use of solvents containing VOCs and HAPs, the use of many petroleum-based solvents becomes more expensive due to the required environmental controls and extensive reporting requirements needed for compliance.

In recent years the DoD has increasingly relied on aqueous-alkaline cleaners to comply with emerging environmental regulations. However, these cleaners are not adequate for some applications, as they have been found to have material compatibility issues such as corrosion of metal surfaces and hydrogen embrittlement. With the environmental concerns related to petroleum-based solvent cleaners, and performance issues of aqueous-alkaline cleaners, it is desirable to validate a new class of organic solvents.

These environmentally friendly alternative solvents must be HAP-free, not contribute to emissions of VOCs, and meet DoD material compatibility and performance criteria. The desire to identify a new class of environmentally friendly organic solvents that are HAP-free and low in VOCs was the primary driving force for this effort and led to the selection of SoyGold® 1000 (SG1000), a soybean derivative, as the alternative of interest for use in the rinse step of the aeronautical antifriction bearing cleaning process. The use of bio-based solvents in this process has the potential to reduce the volume of petroleum-based solvents used by DoD and reduces the amount of VOCs released into the atmosphere.

The process of solvent substitution in any process is complex undertaking. Groups such as the Joint Services Solvent Substitution Working Group (JS3WG) endorsed by the Joint Group on Pollution Prevention (JGPP) are actively working on developing protocols and acceptance criteria for a number of solvent substitution efforts. It is the "Joint Service Solvent Substitution Methodology" prepared by the Pollution Prevention Technology Development Branch, at the Naval Facilities Engineering Service Center, that was used as a guidance document in the development of the JTP.

The Naval Facilities Engineering Service Center led a group consisting of technical representatives from Naval Facilities Engineering Command, Naval Air Systems Command, U.S. Army Aberdeen Test Center, U.S. Army Research Lab, U.S. Army Tank Automotive Research, Development, and Engineering Center, U.S. Army Aviation and Missile Command, Air Force Materiel Command, Air Force Warner Robins Air Logistics Center that identified engineering performance and testing requirements for aeronautical antifriction bearing cleaning. This group reached consensus on the test conditions and acceptance criteria to qualify alternatives against these critical, technical, and performance requirements.

A JTP was prepared that identified all tests and acceptance criteria necessary for an alternative solvent to be used in the rinse step of the aeronautical antifriction bearing cleaning process. Acceptance criteria are the gauge used to measure the success or failure of alternatives to MIL-PRF-680 solvent.

Analytical testing was performed in phases to evaluate the alternative solvent material's potential throughout the evaluation. Analytical testing was divided into two phases and also included independent health assessments to ensure the products safety with regard to occupational safety and health.

Phase I and II analytical test results for new, and stored SG1000 product materials are mixed. SG1000 passed all environmental, occupational, safety and health related tests, but failed a number of the materials compatibility tests including total immersion corrosion for a number of the substrate materials identified in the JTP, hydrogen embrittlement, nonvolatile residue, and nonvolatile residue with isopropyl alcohol rinse. SG1000 also failed the rinse efficiency test under performance related tests as well as the acidity test under chemical properties. During the initial screening, SG1000 also failed the Kauri-butanol test.

As defined by the acceptance criteria in the JTP, and the requirements of the demonstration plan, it is clear that SG1000 as currently formulated did not meet all necessary analytical testing requirements to be qualified as an alternative to MIL-PRF-680 for the rinse step of the bearing cleaning process.

It is recommended that SG1000 not be pursued further as an alternative to MIL-PRF-680 solvent in the rinse step of the bearing cleaning process. Although SG1000 did pass a significant number of the analytical tests identified in the JTP it also resulted in material compatibility issues in a number of the substrate materials including corrosion and hydrogen embrittlement.

As indicated in the introduction and JTP, a new class of organic cleaners is sought to replace solvents containing VOCs and HAPs and to replace more environmentally friendly cleaners such as aqueous-alkaline cleaners because they are not adequate for some applications and have been found to produce material compatibility issues such as corrosion on metal surfaces and hydrogen embrittlement. SG1000 produced similar effects in a number of substrate materials identified in the JTP and does not meet the acceptance criteria as an alternative to MIL-PRF-680 in the bearing cleaning process.

6. REFERENCE DOCUMENTS

Documents referenced throughout this report and the JTP are listed in Table 12.

Table 12. Reference Documents

Reference Document	Title	Date	Applicable Section(s) of Reference Document	JTP Test	JTP Section
Army Regulation 40-5	Preventative Medicine	15 Oct 90	Chapter 2, Section I, Paragraph 2-2.o	Toxicity	3.1.1
EPA Method 24	Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings		All	Volatile Organic Compound	3.1.2
SCAQMD Clean Air Solvent Certification Protocol Appendix I Method 313	Determination of Volatile Organic Compounds (VOC) by Gas Chromatography/Mass Spectrometry (GC/MS)		All	Volatile Organic Compound	3.1.2
ASTM D 93	Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester	10 Dec 02	All	Flash Point	3.1.3
ASTM D 2879	Standard Test Method for Vapor Pressure-Temperature Relationship and Initial Decomposition Temperature of Liquids by Isoteniscope	10 Apr 97	All	Vapor Pressure	3.2.1

Table 12. Reference Documents (continued)

Reference Document	Title	Date	Applicable Section(s) of Reference Document	JTP Test	JTP Section
ASTM D 847	Standard Test Method for Acidity of Benzene, Toluene, Xylenes, Solvent Naphthas, and Similar Industrial Aromatic Hydrocarbons	10 Jun 96	All	Acidity	3.2.2
ASTM F 483	Standard Test Method for Total Immersion Corrosion Test for Aircraft Maintenance Chemicals	10 Oct 98	All	Total Immersion Corrosion	3.3.1
ASTM F 945	Standard Test Method for Stress-Corrosion of Titanium Alloys by Aircraft Engine Cleaning Materials	10 Nov 01	All	Titanium Stress Corrosion	3.3.2
ASTM F 519-97	Standard Test Method for Mechanical Hydrogen Embrittlement Evaluation of Plating Processes and Service Environments	10 May 97	All	Hydrogen Embrittle-ment	3.3.3
ASTM G 44	Standard Practice for Exposure of Metals and Alloys by Alternate Immersion in Neutral 3.5 % Sodium Chloride Solutions	10 Dec 99	All	Stress Corrosion	3.3.4
ASTM D 6361	Standard Guide for Selecting Cleaning Agents and Processes	10 Dec 98	Appendix X2	Stress Corrosion	3.3.4

Table 12. Reference Documents (continued)

Reference Document	Title	Date	Applicable Section(s) of Reference Document	JTP Test	JTP Section
ASTM G 30	Standard Practice for Making and Using U-Bend Stress-Corrosion Test Specimens	10 Apr 97	All	Stress Corrosion	3.3.4
ASTM D 1353	Standard Test Method for Nonvolatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer, and Related Products	10 Dec 02	All	Nonvolatile Residue; Nonvolatile Residue with IPA Rinse	3.3.5; 3.3.6
ASTM F 1105	Preparing Aircraft Cleaning Compounds, Liquid Type, Temperature-Sensitive, or Solvent-Based, for Storage Stability Testing	10 Mar 03	All	Storage Stability	3.4.1
APPENDIX C	Rinse Efficiency Test Protocol	None	ALL	Rinse Efficiency	3.4.2
NAVAIR 01-1A-503	Maintenance of Aeronautical Antifriction Bearing Cleaning for Organizational, Intermediate, and Depot Maintenance Levels	15 Feb 02	All		
MIL-PRF-680	Performance Specification, Degreasing Solvent	13 Dec 99	All		

Table 12. Reference Documents (continued)

Reference Document	Title	Date	Applicable Section(s) of Reference Document	JTP Test	JTP Section
Joint Test Protocol	Joint Test Protocol for Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning	October 2004	All	All	All
Demonstration Plan	Demonstration Plan for Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning	March 2005	All		
U.S Army Aberdeen Test Center Final Report	Final Report, Joint Test Protocol for Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning	July 2006	All	All	All
Naval Facilities Engineering Service Center Technical Memorandum (TM-2362-ENV)	Joint Service Solvent Substitution Methodology	May 2005	All		

APPENDIX A

Joint Test Protocol for
Validation of Alternatives to High Volatile Organic Compound
Solvents Used in Aeronautical Antifriction Bearing Cleaning

Environmental Security Technology Certification Program

Joint Test Protocol
for
Validation of Alternatives to
High Volatile Organic Compound Solvents
Used in Aeronautical Antifriction Bearing Cleaning

October 2004

PREFACE

This report was prepared by the Naval Facilities Engineering Service (NFESC) Center Pollution Prevention Technology Development Branch under Contract Number PP-0305 for the Environmental Security Technology Certification Program (ESTCP).

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U.S. Army Research Lab (ARL)
U.S. Army Tank Automotive Research, Development, and Engineering Center (TARDEC)
U.S. Army Aviation and Missile Command (AMCOM)
National Defense Center for Environmental Excellence (NDCEE)
Concurrent Technologies Corporation (CTC)
AG Environmental Products L.L.C.
United Soybean Board (USB)

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1 INTRODUCTION

1.1 ESTCP Background

The Environmental Security Technology Certification Program's (ESTCP) goal is to demonstrate and validate promising, innovative technologies that target the Department of Defense's (DoD's) most urgent environmental needs. These technologies provide a return on investment through cost savings and improved efficiency.

The ESTCP's strategy is to select lab-proven technologies with broad DoD and market application. These projects are aggressively moved to the field for rigorous trials that document their cost, performance, and market potential. Successful demonstration leads to acceptance of innovative technologies by DoD end-users and the regulatory community. To ensure that the demonstrated technologies have a real impact, ESTCP incorporates these players in the development and execution of each technology.

ESTCP demonstrations:

- Address real DoD environmental needs.
- Significantly reduce costs and risks and expedite implementation.
- Document and validate the cost and performance of new technologies for DoD end-users and the regulatory community.

This Joint Test Protocol (JTP) contains the critical requirements and tests necessary to validate potential alternatives to selected processes for a particular application. These tests were derived from engineering, performance, and operational impact requirements defined by a consensus of government and industry participants.

A final technical report will document the results of the testing as well as any modifications made to the JTP during testing execution. To minimize duplication of effort for future pollution prevention endeavors, the final technical report will be made available to DoD and commercial users.

1.2 DoD Solvent Background

Historically, vehicle, equipment, aircraft, and ship maintenance activities have typically used organic solvents to remove dirt, grease, soot, and burned-on carbon from various parts. Many of these solvents contain photo reactive volatile organic compounds (VOCs) which react with oxides of nitrogen to form ground-level ozone, the primary component of “smog”. Additionally, some solvents have been identified in the Clean Air Act as potentially toxic compounds and are listed as Hazardous Air Pollutants (HAPs). As new environmental regulations become stricter on the use of VOCs and HAPs, the use of many organic solvents becomes expensive due to the environmental controls and reporting requirements needed for compliance. In recent years, the DoD has increasingly relied on aqueous-alkaline cleaners to comply with new environmental regulations; however, they are not adequate for certain applications as they can cause corrosion of

some metal surfaces. Because of these limitations, the DoD continues to use large quantities of organic solvent cleaners at a great expense. Due to environmental concerns related to solvent-based cleaners and performance concerns of aqueous-alkaline cleaners, it is desirable to test and implement a new class of organic solvents. These environmentally friendly alternative solvents: (1) do not contribute to emission of VOCs, (2) contain no HAPs, and (3) meet DoD material compatibility and performance criteria.

1.3 JTP Objective

This ESTCP demonstration and validation project evaluates an alternative to high VOC containing solvents for the rinsing of aeronautical antifriction bearings (non-instrument) during DoD Depot level maintenance cleaning. This ESTCP demonstration and validation project is being performed at Naval Air Depot (NADEP), North Island, San Diego, California.

The information and instructions for the handling and maintenance of aeronautical antifriction bearings are contained in the tri-service technical manual *Maintenance of Aeronautical Antifriction Bearing Cleaning for Organizational, Intermediate, and Depot Maintenance Levels (NAVAIR 01-1A-503, TM55-1500-322-24, T.O. 44B-1-122).* Henceforth, this document will be referred to as the "bearing cleaning technical manual". Section V of the bearing cleaning technical manual, included in Appendix A of this JTP, prescribes recommended cleaning procedures and the equipment required to accomplish the cleaning process.

The cleaning of aeronautical antifriction bearings is a process. It involves a sequence of steps that ensures appropriate bearing cleanliness. A typical solvent based cleaning process involves the following steps: demagnetize, pre-clean, degrease, carbon removal, hot water rinse, water displacing oil, solvent rinse, dry, inspection, neutralize fingerprints, and preservation and packaging. Details of the bearing cleaning process can be found in Section 5-33 of the bearing cleaning technical manual included in Appendix A of this JTP.

This ESTCP demonstration and validation project objective is to evaluate an alternative solvent for the specific bearing cleaning sequence of solvent rinsing. According to the bearing cleaning technical manual, "Every soak or wash step shall be immediately followed by an appropriate filtered solvent rinse. This process is used to remove residual cleaning materials. Solvent, Federal Specification MIL-PRF-680, Type II, shall be used in all cleaning processes except the water detergent process." (Appendix A, Section 5-27)

It is important to note that this ESTCP demonstration is not to obtain a comprehensive DoD replacement for MIL-PRF-680; rather, it is an evaluation of an alternative solvent for the rinsing of aeronautical antifriction bearing during DoD Depot level maintenance cleaning. Since MIL-PRF-680, Type II is referenced in the bearing cleaning technical manual as the required rinsing agent, criteria from MIL-PRF-680, *Performance Specification, Degreasing Solvent* will be used throughout this JTP as a guidance for testing and for baseline and/or benchmark performance measures. This JTP will note

whenever criteria from MIL-PRF-680 is used as a reference. Table 1 summarizes the target solvents, process, materials, application, current specifications, affected programs, and candidate parts.

Table 1. Target Solvents Summary for Aeronautical Antifriction Bearing Cleaning

Target Solvents	Current Process	Applications	Guidance Documents	Affected Programs	Candidate Parts/ Substrates
High VOC containing solvents (Mineral Spirits, Stoddard Solvent, MIL-PRF-680, Type II)	Rinsing bearings in fluid agitated tanks	Aeronautical antifriction bearings (non-instrument bearings)	Maintenance of Aeronautical Antifriction Bearing Cleaning for Organizational, Intermediate, and Depot Maintenance Levels (NAVAIR 01-1A-503, TM55-1500-322-24, T.O. 44B-1-122)	Navy, Army, Air Force Depot level aeronautical antifriction bearing maintenance	Parts: Aeronautical antifriction bearings (non-instrument bearings) Substrates: Refer to Table 6 for a complete listing of aeronautical antifriction bearing substrate descriptions

1.4 Solvent Selection

The ESTCP's strategy is to select lab-proven technologies with broad DoD and market application. This ESTCP demonstration evaluates SoyGold® 1000 as a low VOC and no HAP organic (non-aqueous) solvent. SoyGold® 1000 is a soybean oil based methyl ester. The manufacturing process for soy methyl ester (or methyl soyate) is the simple transesterification of soybean oil and methanol with a sodium hydroxide catalyst.

Production of soy methyl esters began in the mid-1980s for biodiesel fuel development. SoyGold® 1000 is a commercially available product currently used in the private sector for petroleum degreasing, metal cutting applications, adhesive removal, and tool and equipment cleaning. SoyGold® 1000 is certified as a “Clean Air Solvent” by the California South Coast Air Quality Management District. APPENDIX B contains information on SoyGold® 1000 including MSDS, technical data sheets, and compatibility ratings.

Table 2 summarizes the demonstration solvent material evaluated for this JTP. Table 3 compares important solvent parameters of the demonstration solvent material to the solvent material currently used.

Table 2. Demonstration Solvent Material for Aeronautical Antifriction Bearing Cleaning

Solvent	Chemical Name	Manufacturer
SoyGold® 1000	Soy Methyl Ester (Methyl Soyate)	AG Environmental Products, LLC 12700 West Dodge Road Omaha, NE 68154 800-599-9209

Table 3. Solvent Properties for Demonstration Solvent Material

Solvent Parameters	SoyGold® 1000	MIL-PRF-680 Type II
ENVIRONMENTAL, OCCUPATIONAL SAFETY AND HEALTH PROPERTIES		
VOCs	South Coast Air Quality Management District Certified Clean Air Solvent	500-800 g/L
HAPs	None	Yes
Flash Point	425° F (Closed Cup)	141 - 198° F
Toxicity	Non-Toxic (LD_{50} - 17.4 g/kg body weight)	No adverse effects on health
CHEMICAL PROPERTIES		
Vapor Pressure	1.8 mm Hg @ 20° C	< 2.0 mm Hg @ 20° C
Kauri Butanol Value	61	27 - 45

2 ACCEPTANCE CRITERIA

2.1 Development

A joint group led by the Naval Facilities Engineering Service Center and consisting of technical representatives from Naval Facilities Engineering Command, Naval Air Systems Command, U.S. Army Aberdeen Test Center, U.S. Army Research Lab, U.S. Army Tank Automotive Research, Development, and Engineering Center, U.S. Army Aviation and Missile Command, Air Force Materiel Command, Air Force Warner Robins Air Logistics Center identified engineering performance and testing requirements for aeronautical antifriction bearing cleaning. This group reached consensus on the test conditions and acceptance criteria to qualify alternatives against these critical technical and performance requirements.

NAVAIR scientists and engineers provided the acceptance criteria requirements in this JTP. Furthermore, NAVAIR scientists and engineers provided technical expertise pertaining to aeronautical antifriction bearings.

Table 5 lists Environmental, Occupational Safety and Health criteria for validating alternatives used for rinsing aeronautical antifriction bearings during Depot level maintenance cleaning.

Tests in this JTP may involve the use of hazardous materials, operations, and equipment. This JTP does not address all safety issues associated with its use. *It is the responsibility of each user of this JTP to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to its use.*

2.2 Testing Sequence

Testing of the demonstration solvent material will be performed in phases to evaluate the product's potential throughout the evaluation. *Results from each phase must be acceptable to stakeholders before proceeding to the next phase.* The testing sequence phases are:

Phase I - Screening: The demonstration solvent material shall be screened against the solvent parameters listed in Table 4.

Table 4. Screening Criteria for Demonstration Solvent Material

Solvent Parameters	Criteria
ENVIRONMENTAL, OCCUPATIONAL SAFETY AND HEALTH PROPERTIES	
VOCs	Shall contain less than 50 g/L VOC, be VOC exempt, or a South Coast Air Quality Management District Certified Clean Air Solvent.
HAPs	None
Flash Point	< 212° F
Toxicity	Shall have no adverse effect on human health when used as intended and shall contain no chemicals listed as carcinogens.
CHEMICAL PROPERTIES	
Vapor Pressure	< 2.0 mm Hg @ 20° C
Kauri Butanol Value	27 - 45

Phase II - Testing: The demonstration solvent material must comply with the materials compatibility tests listed in Table 5.

Table 5. Performance and Testing Requirements

Engineering Requirement	Test Method*	JTP Section	Acceptance Criteria
ENVIRONMENTAL, OCCUPATIONAL SAFETY AND HEALTH RELATED TESTS			
Toxicity	N/A	3.1.1	The demonstration solvent material shall have no adverse effect on human health when used as intended and shall contain no chemicals listed as carcinogens.
Volatile Organic Compounds	EPA Method 24 Or SCAQMD Method 313	3.1.2	The demonstration solvent material shall contain less than 50 g/L VOC, be VOC exempt, or a South Coast Air Quality Management District Certified Clean Air Solvent.
Flash Point	ASTM D 93	3.1.3	The demonstration solvent material flash point shall be greater than 100° C (212° F).
CHEMICAL PROPERTIES RELATED TESTS			
Vapor Pressure	ASTM D 2879	3.2.1	The demonstration solvent material maximum vapor pressure is 2.0 mm Hg @ 20º C.
Acidity	ASTM D 847	3.2.2	The demonstration solvent material shall show no evidence of acidity.
Appearance	N/A	3.2.3	The demonstration solvent material shall be clear and free from suspended matter and undissolved water when observed at ambient conditions.
MATERIALS COMPATIBILITY RELATED TESTS			
Total Immersion Corrosion	ASTM F 483	3.3.1	The demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack; nor shall weight changes exceed allowable limits.
Titanium Stress Corrosion	ASTM F 945	3.3.2	The demonstration solvent material shall not cause any microscopic cracking when examined at 500X magnification.
Hydrogen Embrittlement	ASTM F 519	3.3.3	The demonstration solvent material shall not cause hydrogen embrittlement of cadmium plated AISI 4340 steel.
Stress Corrosion	ASTM G 44	3.3.4	The demonstration solvent material shall cause no evidence of cracking.

Table 5. Performance and Testing Requirements (continued)

Engineering Requirement	Test Method*	JTP Section	Acceptance Criteria
Nonvolatile Residue	ASTM D 1353	3.3.5	The demonstration solvent material shall not have a nonvolatile residue greater than 8 mg/100 mL.
Nonvolatile Residue with Isopropyl Alcohol Rinse	ASTM D 1353 (Modified)	3.3.6	The demonstration solvent material shall not have a nonvolatile residue greater than 8 mg/100 mL.
PERFORMANCE CRITERIA RELATED TESTS			
Storage Stability	ASTM F 1105	3.4.1	After 12 month storage, the demonstration solvent material should meet the acceptance criteria for: Rinsing Efficiency, Total Immersion Corrosion, Titanium Stress Corrosion, Hydrogen Embrittlement, Stress Corrosion, Acidity, and Appearance.
Rinse Efficiency	APPENDIX C	3.4.2	The rinse efficiency of the demonstration solvent material shall be equal to or better than MIL-PRF-680.
***Refer to most current version of test method**			

2.3 Vendor Supplied Information

In order to minimize the Government's cost of testing the demonstration solvent material, the vendor will be responsible to provide the following information on their product along with 3rd party analysis that would verify any of the vendor's claims, that;

1. Chloride is not a by-product during the processing or manufacture of the demonstration solvent material.
2. Aromatics are not a by-product during the processing or manufacture of the demonstration solvent material.
3. Phenol is not a by-product during the processing or manufacture of the demonstration solvent material.
4. The demonstration solvent material will not produce foam under high shear conditions.
5. The demonstration solvent material has a high boiling point, and the vendor will supply the ASTM test method used for this determination.

3 TEST DESCRIPTIONS

Tests identified in Table 5 are divided into four categories including; Environmental, Occupational Safety and Health, Chemical Properties, Materials Compatibility, and Performance related tests. Tests are further defined to include test description, rationale,

and methodology. Also identified, as needed, are any major or unique equipment, and data reporting and analysis procedures. Test methodology includes the definition of test parameters, test specimens, number of trials per specimen, any experimental control specimens required, and acceptance (pass/fail) criteria.

Table 6 is a listing of substrate test specimens representative of aeronautical antifriction bearing materials:

Table 6. Test Specimen Codes and Substrate Descriptions for Aeronautical Antifriction Bearing Cleaning

Code	Specimen	Stock	Test Method
AL-1a	Aluminum, QQ-A-250/4, T3 surface treatment accordance of AMS 2470	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
AL-1b	Aluminum, QQ-A250/4, Bare T3 Alloy	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
AL-1c	Aluminum, QQ-A-250/12, Bare T6 Alloy	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
AL-2a	Aluminum, QQ-A-250/4, T3 surface treatment accordance of AMS 2470	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
AL-2b	Aluminum, QQ-A250/4, Bare T3 Alloy	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
AL-2c	Aluminum, QQ-A-250/12, Bare T6 Alloy	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
BR-1	Brass, AMS 4616	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
BR-2	Brass, AMS 4616	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CG-1	Carburizing Grade CEVM Steel, AMS 6276 (SAE 8620)	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
CG-2	Carburizing Grade CEVM Steel, AMS 6276 (SAE 8620)	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CP-1a	Stainless Steel ASTM A240, Class 410 (Cd plated accordance with QQ-P-416 Type I)	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483

Table 6. Test Specimen Codes and Substrate Descriptions for Aeronautical Antifriction Bearing Cleaning (continued)

Code	Specimen	Stock	Test Method
CP-2a	Stainless Steel ASTM A240, Class 410 (Cd plated accordance with QQ-P-416 Type I)	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CP-2b	Cadmium Plated Steel, AISI 410	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CR-1	Cronidur 30	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
CR-2	Cronidur 30	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CS-1	Chrome Steel, AISI 52100	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
CS-2	Chrome Steel, AISI 52100	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
CU-1	Copper	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
CU-2	Copper	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
HT-1	High Temperature Tool Steel, M-50	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
HT-2	High Temperature Tool Steel, M-50	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
M-1	M-50 NiL (AMS 6278)	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
M-2	M-50 NiL (AMS 6278)	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
NB-1	Nickel Aluminum Bronze, AMS 4640	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
NB-2	Nickel Aluminum Bronze, AMS 4640	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44

Table 6. Test Specimen Codes and Substrate Descriptions for Aeronautical Antifriction Bearing Cleaning (continued)

Code	Specimen	Stock	Test Method
NI-1	Nickel AMS 5536	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
NI-2	Nickel AMS 5536	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
PH-1a	Precipitation Hardening Stainless Steel, 17-4PH	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
PH-1b	Precipitation Hardening Stainless Steel, 16-4PH	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
PH-1c	Precipitation Hardening Stainless Steel, 13-8PH	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
PH-2a	Precipitation Hardening Stainless Steel, 17-4PH	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
PH-2b	Precipitation Hardening Stainless Steel, 16-4PH	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
PH-2c	Precipitation Hardening Stainless Steel, 13-8PH	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
RS-1	Rivets, Steel, Corrosion Resistant, AMS 7228	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
RS-2	Rivets, Steel, Corrosion Resistant, AMS 7228	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
SS-1	Stainless Steel, AISI 440C	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
SS-2	Stainless Steel, AISI 440C	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
ST-1	Steel, SAE 4340	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
ST-2	Steel, SAE 4340	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44

Table 6. Test Specimen Codes and Substrate Descriptions for Aeronautical Antifriction Bearing Cleaning (continued)

Code	Specimen	Stock	Test Method
ST-3	Steel, AISI 4340	Notch round bar in tension per ASTM F 519, Type 1a	Hydrogen Embrittlement ASTM F 519
TI-1	Titanium, AMS 4911, 6AL-4V	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
TI-2	Titanium, AMS 4911, 6AL-4V	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44
TI-3	Titanium, AMS 4916	Same sheet stock, cut parallel to the rolling direction and dimensions 75x 19x1.25 mm, (3.0 x 0.75 x 0.050 in.), hole diameters 7 mm (0.28 in.), offset 13 mm (0.5 in.) from edge	Titanium Stress Corrosion ASTM F 945
TI-4	Titanium, AMS 4911	Same sheet stock, cut parallel to the rolling direction and dimensions 75x 19x1.25 mm, (3.0 x 0.75 x 0.050 in.), hole diameters 7 mm (0.28 in.), offset 13 mm (0.5 in.) from edge	Titanium Stress Corrosion ASTM F 945
VX-1	Vasco X-2	Same sheet stock, dimensions 50.8 x 25.4 x 1.6 mm (2 x 1 x 0.06 in.)	Total Immersion Corrosion ASTM F 483
VX-2	Vasco X-2	U-Bend from the same sheet stock and per ASTM G 30, type (a)	Stress Corrosion ASTM G 44

3.1 Environmental, Occupational Safety and Health Related Tests

3.1.1 Toxicity

Test Description

The test objective is to determine if a toxicity clearance can be given for the manufacturer's suggested working concentration of the demonstrated solvent material.

Toxicological Clearance for any potentially hazardous product to be used by the DoD is granted or denied independently by each service.

Army

The Army Center for Health Promotion and Preventative Medicine (CHPPM) performs a toxicity evaluation of materials prior to introduction into the Army supply system using the process in Army Regulation 40-5, *Preventative Medicine*. A toxicity evaluation is performed and clearances are conditionally approved based upon the solvent application or use condition.

CHPPM toxicity evaluations require the following:

(1) Final chemical formulation (handled as proprietary if required).
(2) Identity and application of new solvent; identity of solvent being replaced, if applicable.
(3) Reports from manufacturers pertaining to use of the solvent in the commercial market and material safety data sheets (MSDSs).
(4) Available human and animal toxicity studies and epidemiology information.

Navy

The Navy Environmental Health Center (NEHC) performs a toxicity evaluation of materials prior to introduction into the Navy supply system. A toxicity evaluation is performed and clearances are conditionally approved based upon the solvent application or use condition.

NEHC toxicity evaluations require the following:

(1) Complete description of the product, (i.e., part number/trade name), intended applications, together with technical specification sheet and sales literature.
(2) Name, address, telephone number, and technical point of contact at company supplying product.
(3) Material safety data sheet (MSDS) and label from product that complies with the OSHA hazard communication standard (29 CFR 1910.1200).
(4) Small sample of product, e.g. one ounce if a liquid. This is not required for all items. Consult with NEHC point of contact.
(5) Complete formula for the product, with ingredients totaling 100 percent, and CAS number provided for each ingredient. The use of generic ingredients, e.g. “pigments” is not permitted.
(6) Current MSDS for each ingredient identified in #5 above. These MSDS’s must have all the data elements required by the hazard communication standard. The vendor must contact each ingredient supplier within 30 days of documentation package submission, to verify that each MSDS is the most current available.
(7) The service temperatures to which the material will be subjected during typical as well as “worst case” conditions.
(8) Copies of any industrial hygiene survey reports, which addresses potential health hazards related to working with the material. Of particular concern is information

pertaining to any adverse health effects experienced by company plant workers during research, development, and manufacture of the product, and industrial experience of major commercial/government users.
(9) Copies of any toxicity study reports involving laboratory animals subjected to dusts/vapor from the product, its ingredients, or its pyrolysis products, when burned or severely heated.
(10) Copies of laboratory reports which address the composition and magnitude of pyrolysis products emitted from the product when it is involved in a fire or otherwise severely heated/allowed to contact molten metal, etc.
(11) Copies of all standard operating procedures, which relate to the application/use of the product, including time/temperature curing scenarios.
(12) Technical points of contact within the Navy and at major commercial users of product, should additional information pertaining to application/use experience be required.

Air Force

The Air Force Institute for Operational Heath (AFIOH) performs a toxicity evaluation of materials prior to introduction into the Air Force supply system. A toxicity evaluation is performed and clearances are conditionally approved based upon the solvent application or use condition.

Rationale

The toxicity of the manufacturer's suggested working concentration of the demonstrated solvent materials shall have no adverse effects on the health of personnel or the environment when used properly and with the appropriate personal protection equipment.

Test Methodology

Parameters	Toxicity
Number and Type of Specimens per Candidate Alternative	Not Applicable
Trials per Specimen (*if needed*)	Not Applicable
Experimental Control Specimens	None
Acceptance Criteria	The demonstration solvent material shall have no adverse effect on human health when used as intended and shall contain no chemicals listed as carcinogens.

Major or Unique Equipment

No special requirements

Data Reporting and Analysis

For each demonstration solvent material a toxicity or health hazard assessment clearance or approval from NEHC, CHPPM, and AFIOH is required.

3.1.2 Volatile Organic Compounds

Test Description

This test method determines the volatile matter content, water content, density, volume solids, and weight solids of paint, varnish, lacquer, or other related surface coatings per EPA Method 24, *Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings*, or South Coast Air Quality Management District (SCAQMD) Method 313, *Determination of Volatile Organic Compounds (VOC) by Gas Chromatography/Mass Spectrometry (GCMS).*

Rationale

VOC emissions from industrial cleaning operations are regulated by local air district regulations related to National Ambient Air Quality Standards (NAAQS) for ozone.

Test Methodology

Parameters	Volatile Organic Compounds
Number and Type of Specimens per Candidate Alternative	Not Applicable
Trials per Specimen (*if needed*)	Three (3) for repeatability
Experimental Control Specimens	None
Acceptance Criteria	The solvent material shall contain less than 50 g/L VOC.

Major or Unique Equipment

Refer to EPA Method 24 or SCAQMD Method 313 for equipment, supplies, and reagents.

Data Reporting and Analysis

For each demonstration solvent material, record its name, type, source, concentration, and total amount of VOC in mg/L. Also, for each demonstration solvent material, record the VOC compound name, reporting limit, and result (including non detected or less than the reporting limit) vapor pressure.

Summarize any deviations made from EPA Method 24 or SCAQMD Method 313 protocols.

3.1.3 Flash Point

Test Description

The flash point temperature is one measure of the tendency of a test specimen to form a flammable mixture with air under controlled laboratory conditions. It is only one of a number of properties which must be considered in assessing the overall flammability hazard of a material. This test determines the flash point temperature per ASTM D 93, *Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester*.

A brass test cup of specified dimensions, filled to the inside mark with test specimen and fitted with a cover of specified dimensions, is heated and the specimen stirred at specified rates. An ignition source is directed into the test cup at regular intervals with simultaneous interruption of the stirring, until a flash is detected.

Rationale

Flash point is used in shipping and safety regulations to define *flammable* and *combustible* materials. The U.S. Department of Transportation (DOT) and U.S. Department of Labor (OSHA) have established that liquids with a flash point under 37.8° C (100° F) are flammable, as determined by this test method.

Test Methodology

Parameters	Use ASTM D 93, Procedure A
Number and Type of Specimens per Candidate Alternative	Not Applicable
Trials per Specimen (*if needed*)	Not Applicable
Experimental Control Specimens	None
Acceptance Criteria	The demonstration solvent material flash point shall be greater than 100° C (212° F).

Major or Unique Equipment

Apparatus specified in ASTM D 93 include: a Pensky-Martens Closed Cup Apparatus (manual or automated); a temperature measuring device; and an ignition source.

Data Reporting and Analysis

For each demonstration solvent material, record its name, type, source, concentration, and the corrected flash point.

Summarize any deviations made from the ASTM D 93 protocol.

3.2 Chemical Properties Related Tests

3.2.1 Vapor Pressure

Test Description

This test method determines the vapor pressure of pure liquids per ASTM D 2879, *Standard Test Method for Vapor Pressure-Temperature Relationship and Initial Decomposition Temperature of Liquids by Isoteniscope*.

Dissolved and entrained fixed gases are removed from the sample in the isoteniscope by heating a thin layer of a sample at reduced pressure, removing in this process the minimum amount of volatile constituents from the sample. The vapor pressure of the sample at selected temperatures is determined by balancing the pressure due to the vapor of the sample against a known pressure of an inert gas. The manometer section of the isoteniscope is used to determine pressure equality.

Rationale

The vapor pressure of a substance as determined by isoteniscope reflects a property of the sample as received including most volatile components, but excluding dissolved fixed gases such as air. Vapor pressure, *per se*, is a thermodynamic property which is dependent only upon composition and temperature for stable systems. The isoteniscope method is designed to minimize composition changes which may occur during the course of measurement.

Test Methodology

Parameters	Temperature, Pressure
Number and Type of Specimens per Candidate Alternative	Not Applicable
Trials per Specimen (*if needed*)	Not Applicable
Experimental Control Specimens	None
Acceptance Criteria	The demonstration solvent material maximum vapor pressure is 2.0 mm Hg @ 20º C.

Major or Unique Equipment

Apparatus specified in ASTM D 2879 include: an Isoteniscope; a constant-temperature air bath; a temperature controller; a vacuum and gas handling system; a mercury manometer; a mechanical two-stage vacuum pump; a direct temperature readout; a thermocouple; pre-purified grade nitrogen; a nitrogen pressure regulator; an alcohol lamp.

Data Reporting and Analysis

For each demonstration solvent material, record the following:

(1) Identification of solution tested, concentration used, and diluent used.
(2) Test conditions; temperature, exposure time, and humidity.
(3) Identification of testing laboratory and responsible technical point of contact.
(4) Results of the vapor pressure.

Summarize any deviations made from the ASTM D 2879 protocol.

3.2.2 Acidity

Test Description

This test method determines the acidity of industrial aromatic hydrocarbons per ASTM D 847, *Standard Test Method for Acidity of Benzene, Toluene, Xylenes, Solvent Naphthas, and Similar Industrial Aromatic Hydrocarbons*.

The acidity of the demonstration solvent material is detected and determined quantitatively using a sodium hydroxide titration and a color change in a phenolphthalein indicator.

Rationale

This test method gives an indication of residual acidity and is a measure of the quality of the demonstration solvent material. It is an indication of the tendency of the demonstration solvent material to corrode equipment.

Test Methodology

Parameters	Dilution of Demonstration Solvent Material: Procedure requires demonstration solvent material be diluted 50%; 100 mL solvent with 100 mL neutral distilled water Temperature of Demonstration Solvent Material: between 15 and 18.5° C (60 and 65° F)
Number and Type of Specimens per Candidate Alternative	Not Applicable
Trials per Specimen (*if needed*)	Not Applicable
Experimental Control Specimens	None
Acceptance Criteria	The demonstration solvent material shall show no evidence of acidity.

Major or Unique Equipment

Apparatus specified in ASTM D 847 include: Graduate (100-mL); Bottle (500-mL glass - stoppered); and a Buret (10-mL, graduated in 0.05-mL subdivisions. Reagents specified in ASTM F 483 include: Phenolphthalein Indicator Solution; Sodium Hydroxide (0.1 N); Sodium Hydroxide (0.01 N); Sulfuric Acid (0.01 N); and Neutral Distilled Water.

Data Reporting and Analysis

For each demonstration solvent material, record its name, type, source, concentration, and acidity (if applicable) reported in terms of milligrams of NaOH required for 100 mL of specimen.
Summarize any deviations made from the ASTM D 847 protocol.

3.2.3 Appearance

Test Description

This test method determines the appearance of the manufacturer's suggested working concentration of the demonstration solvent material. The manufacturer's suggested working concentration of the cleaning compound is mixed, if not already supplied in this form, and observed for separations or colloidal dispersions. Perform the inspection as follows:

Take a uniform 1-liter sample of the demonstration solvent material and place it into a clean glass jar with a screw-type lid.

Allow the closed sample to sit undisturbed for 48 hours at ambient conditions.

With minimal disturbance, observe the sample for separations or colloidal dispersions. Appearance at this time should be photographically documented.

Rationale

To ensure quality, the demonstrated solvent materials must appear homogeneous.

Test Methodology

Parameters	Visual inspection
Number and Type of Specimens per Candidate Alternative	Not Applicable
Trials per Specimen (*if needed*)	Not Applicable
Experimental Control Specimens	None
Acceptance Criteria	The demonstration solvent material shall be clear and free from suspended matter and undissolved water when observed at ambient conditions.

Major or Unique Equipment

No special requirements

Data Reporting and Analysis

For each demonstration solvent material, record the following:

(1) Identification of solution tested, concentration used, and diluent used.
(2) Test conditions; temperature, exposure time, and humidity.
(3) Identification of testing laboratory and responsible technical point of contact.
(4) Results of visual inspections, observations, and discussion of specimen condition.
(5) Photographic documentation of specimen conditions.

3.3 Materials Compatibility Related Tests

3.3.1 Total Immersion Corrosion

Test Description

This test method determines the corrosiveness of aircraft maintenance chemicals on aircraft metals with time under conditions of total immersion by a combination of weight change measurements and visual qualitative determination of change per ASTM F 483, *Standard Test Method for Total Immersion Corrosion Test for Aircraft Maintenance Chemicals*.

Select four (4) test specimens of a given alloy and dimensions. Identify each test specimen with Numbers 1, 2, 3, or 4. Preclean, weigh, and immerse three test specimens in an undiluted solution of the demonstration solvent material for 24 hours. Rinse the immersed test specimens and examine for visible changes in comparison with the fourth virgin specimen of each alloy. Immerse the three specimens in the same solution for an additional 144 hours. Rinse the immersed test specimens and examine for visible changes in comparison with the fourth virgin specimen of each alloy. Reweigh the specimens to calculate weight loss or gain.

Rationale

Many aircraft maintenance chemicals may cause excessive dimensional change to aeronautical antifriction bearings which would adversely affect the bearing systems. This test method screens these chemicals to ensure compliance with specified weight change criteria.

Test Methodology

Parameters	Dilution of Demonstration Solvent Material: None Temperature of Demonstration Solvent Material: 38 ± 3° C (100 ± 5° F)
Number and Type of Specimens per Candidate Alternative	Four (4) each:
Trials per Specimen (*if needed*)	One (1)
Experimental Control Specimens	None
Acceptance Criteria	The demonstration solvent material shall not cause any indication of staining, etching, pitting, or localized attack; nor shall weight changes exceed allowable limits. Average of 3 Panels Weight Loss, Max (mg/cm^2/24-hr) AL-1a: 0.04 (168 hrs) AL-1b: 0.04 (168 hrs) AL-1c: 0.04 (168 hrs) BR-1: 0.04 (168 hrs) CG-1: 0.04 (168 hrs) CP-1a: 0.04 (168hrs) CR-1: 0.04 (168hrs) CS-1: 0.04 (168hrs) CU-1: 0.04 (168hrs) HT-1: 0.04 (168hrs) M-1: 0.04 (168hrs) NB-1: 0.04 (168hrs) NI-1: 0.04 (168hrs) PH-1a: 0.04 (168hrs) PH-1b: 0.04 (168hrs) PH-1c: 0.04 (168hrs) RS-1: 0.04 (168hrs) SS-1: 0.04 (168hrs) ST-1: 0.04 (168hrs) TI-1: 0.04 (168 hrs) VX-1: 0.04 (168hrs)

Major or Unique Equipment

Apparatus specified in ASTM F 483 include: Wide Mouth Sealable Glass Jar or Stoppered Flask of Suitable Size; Specimen-Supporting Device; Constant-Temperature Device, Thermometer, and an Oven. Reagents specified in ASTM F 483 include: Acetone; Methyl Ethyl Ketone; and Mineral Spirits, Type II.

Data Reporting and Analysis

For each demonstration solvent material, record on a form illustrated in ASTM F 483 Appendix X1 any changes in the three (3) immersed specimens in comparison with the fourth virgin specimen of each alloy any discoloration and dulling; etching; presence of accretions and relative amounts; pitting; presence of selective or localizes attack; and weight loss or gain.

Photograph documentation of specimen conditions (specifically any staining, evidence of general corrosion, etching, pitting, or localized attack).

Summarize any deviations made from the ASTM F 483 protocol.

3.3.2 Titanium Stress Corrosion

Test Description

This test method determines the propensity of aircraft turbine engine cleaning and maintenance materials for causing stress corrosion cracking of titanium alloy parts per ASTM F 945, *Standard Test Method for Stress-Corrosion of Titanium Alloys by Aircraft Engine Cleaning Materials*. The evaluation is conducted on representative titanium alloys by determining the effect of contact with cleaning and maintenance materials on tendency of prestressed titanium alloys to crack when subsequently heated to elevated temperatures.
Preclean and fabricate the specimens according to Section 7 of ASTM F 945. Test a minimum of nine (9) specimens of each alloy for each demonstration solvent material according to the procedures outlined in Section 8 of ASTM F 945. Heat the specimens per Method A, Section 8.2.1 of ASTM F 945. After heating, inspect the specimens for cracking.

Rationale

Because of the tendency of prestressed titanium alloy parts to crack if heated while in contact with certain chemical reagents, it is necessary to ensure that cleaning and maintenance materials will not initiate stress corrosion of titanium alloys under controlled conditions.

Test Methodology

Parameters	Heat: 480 ± 10° C (900 ± 20° F) for 8 ± 0.2 hours Visual inspection at 20X and 500X magnification
Number and Type of Specimens per Candidate Alternative	Nine (9) each: TI-3, TI-4
Trials per Specimen (*if needed*)	One (1)
Experimental Control Specimens	One (1) of each alloy for each actual test
Acceptance Criteria	The demonstration solvent material shall not cause any microscopic cracking when examined at 500X magnification.

Major or Unique Equipment

Apparatus specified in ASTM F 945 include: a linear measuring device; a press forming apparatus; beakers; a vice; an air circulation furnace; a magnifier (20X); a microscope

(500X); and a 6-mm (0.25-in.) stainless steel bolt, washers, and nut. Reagents specified in ASTM F 945 include: water; a cleaning solution of nitric acid, hydrofluoric acid, and reagent water; 3 percent (%) sodium chloride in distilled water; and toluene.

Data Reporting and Analysis

For each demonstration solvent material, record its name, type, source, and concentration; the heat treatment method applied; the acceptance or rejection of the demonstration solvent material; and a description of any observed corrosion phenomena.

Photograph documentation of specimen conditions (specifically any staining, evidence of general corrosion, etching, pitting, or localized attack) for each test and examination.

Summarize any deviations made from the ASTM F 945 protocol.

3.3.3 Hydrogen Embrittlement

Test Description

This test method establishes a means to determine the hydrogen embrittlement potential of chemicals that may contact plated steel parts during manufacturing, overhaul, and service life per ASTM F 519, *Standard Test Method for Mechanical Hydrogen Embrittlement Evaluation of Plating Processes and Service Environments, Annex 5, Service Environments*.

Test specimens are stressed and immersed in an undiluted solution of the demonstration solvent material for a specific amount of time. Specimens are then inspected for fracture.

Rationale

During the cleaning process, many aircraft maintenance chemicals may add hydrogen atoms that permeate into steel alloys atomic structure. This creates high internal residual stress in the alloy and if not removed could cause component failure.

Test Methodology

Parameters	Dilution of Demonstration Solvent Material: None Temperature of Demonstration Solvent Material: Ambient Classification of Demonstration Solvent Material: Passive Specimens: Type 1a standard (notch round bars),

	cadmium plated in accordance with ASTM F 519 Table 2, Treatment B (low embrittling cadmium) Stress: Load in tension at 75% of the notch fracture strength Time: 200 hours
Number and Type of Specimens per Candidate Alternative	Four (4) each: ST-3
Trials per Specimen (*if needed*)	One (1)
Experimental Control Specimens	None
Acceptance Criteria	The demonstration solvent material shall not cause hydrogen embrittlement of cadmium plated AISI 4340 steel.

Major or Unique Equipment

Apparatus specified in ASTM F 519 include: tensile test frame.

Data Reporting and Analysis

For each demonstration solvent material prepare a report certifying that the test has been run in accordance with this test method and listing the exact conditions of the test as performed. The test report shall include the following minimum information:

- a lot acceptance and sensitivity certification report; the type, dimensions, and number of specimens tested;
- identification of solution tested, concentration used, and diluent used;
- a description of the plating process and test environment (concentration, temperature, and so forth) if other than ambient air;
- the sustained or threshold load, or percent of notched fracture strength or notch bend strength of unplated specimens, or displacement as appropriate for the type of specimen tested;
- the time under load in the test environments; and
- results of visual inspections, observations, and discussion of specimen condition.

Photograph documentation of specimen conditions (specifically any staining, evidence of general corrosion, etching, pitting, or localized attack).

Summarize any deviations made from the ASTM F 519 protocol.

3.3.4 Stress Corrosion

Test Description

This test method determines the stress corrosion of aircraft maintenance chemicals per ASTM G 44, *Standard Practice for Exposure of Metals and Alloys by Alternate*

Immersion in Neutral 3.5 % Sodium Chloride Solutions, modified per ASTM D 6361, *Standard Guide for Selecting Cleaning Agents and Processes*, Appendix X2.

The modified alternate immersion test substitutes the following:

- The manufacturer's suggested working concentration of the demonstration solvent material for the 3.5 % sodium chloride solution;
- A 20 minute soak and 100 minute drying cycle for the 10 minute soak and 50 minute drying cycle. This 2 hour cycle is continued 24 hours/day for 90 days.; and
- A temperature between 40 and 50° C (100 and 120° F) instead of 27° C (80° F).

Use sufficient test solution to cover the stress portion of the test specimens throughout the 20 minute immersion period and maintain the level in the immersion baths by addition of the demonstration solvent material. On a 7-day interval, replace the immersion bath test solution with fresh test solution.

Rationale

Repeated cyclic exposure to solvents occurs at bearing maintenance facilities. This cyclic exposure can cause stress corrosion cracking damage. This test method screens these chemicals to ensure compliance.

Test Methodology

Parameters	Specimens: Stressed per ASTM G 30, type (a) Time: 20 minute soak/100 minute drying cycle Visual inspection at 20X/500X
Number and Type of Specimens per Candidate Alternative	Three (3) each: AL-2a, AL-2b, AL-2c, BR-2, CG-2, CP-2a, CP-2b, CR-2, CS-2, CU-2, HT-2, M-2, NB-2, NI-2, PH-2a, PH-2b, PH-2c, RS-2, SS-2, ST-2, TI-2, VX-2
Trials per Specimen (*if needed*)	One (1)
Experimental Control Specimens	One (1)
Acceptance Criteria	The demonstration solvent material shall cause no evidence of cracking.

Major or Unique Equipment

Apparatus specified in ASTM G 44 include: an immersion cycling apparatus; and specimen holders.

Specimens shall be stressed according to ASTM G 30, *Standard Practice for Making and Using U-Bend Stress-Corrosion Test Specimens*. Test specimens shall be type (a).

Data Reporting and Analysis

After exposure, specimens should be rinsed with water and then cleaned as soon as possible. It is important that the specimens be cleaned as thoroughly as possible by recommended methods of cleaning, such as ASTM G 1.

Test specimens that do not show obvious cracks should be examined at 20X. If the untreated (control) specimens are cracked the results of the stress corrosion test are invalid.

Metallographic examination may be required to verify freedom from cracking. Representative failed specimens should be examined metallographically to verify failure was caused by stress-corrosion cracking. Metallographic inspection shall be conducted as follows:

- Make a cross section of each specimen at the bend normal to the bend axis (parallel to the test panel long axis).
- Cut the specimens using a saw that produces a smooth cut with minimal disturbance of specimen edges. Make the cut approximately at the center axis in line with the holes. The metallographic section shall encompass material from the bend to a point approximately 13 mm (0.5 in.) from the bend.
- Examine the cut surface over the 13 mm (0.5 in.) distance on both sides of the bend zone at 500X.

Report the following information for each test performed:

(1) Summary of ASTM G 44 test method and any deviations from the protocol.
(2) Identification of sample material alloy(s), product temper, and selection of thickness of material tested including reference to product specification.
(3) Specimen details; type and dimensions of test specimen and number of replicates.
(4) Identification of solution tested, concentration used, and diluent used.
(5) Test conditions; temperature, exposure time, and humidity.
(6) Identification of testing laboratory and responsible technical point of contact.
(7) Individual and average test results.
(8) Results of visual inspections, observations, and discussion of specimen condition.
(9) Photographic documentation of specimen conditions (specifically any staining, evidence of general corrosion, etching, pitting, or localized attack).

3.3.5 Nonvolatile Residue

Test Description

This test method determines the nonvolatile matter in volatile solvents per ASTM D 1353, *Standard Test Method for Nonvolatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer, and Related Products*.

In an evaporating dish, dry a sample of the demonstration solvent material, cool in a desiccator, and weigh. Measure 100-mL of the demonstration solvent material into the evaporating dish, place on a steam bath and evaporate to dryness. Dry the outside of the dish, heat in an oven, cool in a desiccator, and weigh.

Rationale

The presence of any volatile solvent residue on aeronautical antifriction bearings may affect the inspection and performance of bearings.

Test Methodology

Parameters	Weight
Number and Type of Specimens per Candidate Alternative	Not Applicable
Trials per Specimen (*if needed*)	Not Applicable
Experimental Control Specimens	None
Acceptance Criteria	The demonstration solvent material shall not have a nonvolatile residue greater than 8 mg/100 mL.

Major or Unique Equipment

Apparatus specified in ASTM D 1353 include: a thermostatically controlled oven; a 125-mL platinum evaporating dish; a graduated cylinder (100-mL); and an analytical balance.

Data Reporting and Analysis

For each demonstration solvent material, record the following:
(1) Identification of solution tested, concentration used, and diluent used.
(2) Test conditions; temperature, exposure time, and humidity.
(3) Identification of testing laboratory and responsible technical point of contact.
(4) Results of the nonvolatile residue as milligrams/100 mL.
(5) Photographic documentation of nonvolatile residue conditions.

Summarize any deviations made from the ASTM D 1353 protocol.

3.3.6 Nonvolatile Residue with Isopropyl Alcohol Rinse

Test Description

This modified test method determines the nonvolatile matter in volatile solvents after rinsing with isopropyl alcohol. Modifications to ASTM D 1353, *Standard Test Method for Nonvolatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer, and Related Products*, are described below.

The following describes the modifications to Section 6 (Procedure) of ASTM D 1353. All other sections of ASTM D 1353 shall remain the same.

6. Procedure

6.1 Dry a 125-mL platinum evaporating dish in an oven at 105 ± 5°C and cool in a desiccator. Repeat until the weight is within 0.1 mg of the previous weighing.

6.2 With the graduated cylinder, measure 100 mL of the demonstration solvent material at room temperature into the conditioned platinum evaporating dish, place on a steam bath and evaporate the specimen to dryness. Rinse by adding 100 mL of isopropyl alcohol to the platinum evaporation and let stand for (4) minutes. Air dry the platinum evaporating dish for 20 minutes. Dry the outside of the dish with a clean, lint-free cloth and heat in an oven at 105 ± 5°C for approximately 1 hour. Cool in a desiccator and weigh the evaporating dish and contents to 0.1 mg.

6.3 Return the dish and contents to the oven for 15 to 30 minutes, cool, and reweigh. Repeat, if necessary, until the weight is constant to within 0.1 mg of the previous weighing.

Rationale

The presence of any volatile solvent residue on aeronautical antifriction bearings may affect the inspection and performance of bearings. Previous studies show the low evaporation rate of soy methyl esters result in nonvolatile residue amounts greater than 8 mg/100 mL. However, the bearing cleaning technical manual (NAVAIR 01-1A-503) Section 5-14i requires removal of the last solvent rinsate from the bearings using isopropyl alcohol vapor. Therefore, this additional isopropyl alcohol rinse step was added to the ASTM 135 test method procedure to replicate the actual aeronautical antifriction bearing cleaning process.

Test Methodology

Parameters	Weight
Number and Type of Specimens per Candidate Alternative	Not Applicable
Trials per Specimen (*if needed*)	Not Applicable
Experimental Control Specimens	None
Acceptance Criteria	The demonstration solvent material shall not have a nonvolatile residue greater than 8 mg/100 mL.

Major or Unique Equipment

Apparatus specified in ASTM D 1353 include: a thermostatically controlled oven; a 125-mL platinum evaporating dish; a graduated cylinder (100-mL); and an analytical balance. Reagents include: isopropyl alcohol.

Data Reporting and Analysis

For each demonstration solvent material, record the following:

(1) Identification of solution tested, concentration used, and diluent used.
(2) Test conditions; temperature, exposure time, and humidity.
(3) Identification of testing laboratory and responsible technical point of contact.
(4) Results of the nonvolatile residue as milligrams/100 mL before and after immersion in isopropyl alcohol.
(5) Photographic documentation of nonvolatile residue conditions before and after immersion in isopropyl alcohol.

Summarize any deviations made from the ASTM D 1353 protocol.

3.4 Performance Related Tests

3.4.1 Storage Stability

Test Description

This test method determines the storage stability of the manufacturer's suggested working concentration of the demonstration solvent material by evaluation the effect of time, temperature, and environmental conditions per ASTM F 1105, *Preparing Aircraft Cleaning Compounds, Liquid Type, Temperature-Sensitive, or Solvent-Based, for Storage Stability Testing*.

The demonstration solvent material is subjected to a specified storage environment for a period of 12 months. After this time, subsequent testing requirements are repeated for performance.

Rationale

This test method ensures the long-term storage stability of the demonstration solvent material and their ability to meet performance and shelf-life requirements.

Test Methodology

Parameters	Length of Storage: 12 Months Storage Environment: 10 to 27° C (50 to 80° F) Cold-Temperature Storage Environment: 15 day time interval at -8 ± 2° C (17 ± 3° F) Hot-Temperature Storage Environment: 15 day time interval at 32 ± 2° C (90 ± 5° F)
Number and Type of Specimens per Candidate Alternative	Not Applicable
Trials per Specimen (*if needed*)	Not Applicable
Experimental Control Specimens	None
Acceptance Criteria	After 12 month storage, the demonstration solvent material should meet the acceptance criteria for: Rinsing Efficiency, Total Immersion Corrosion, Titanium Stress Corrosion, Hydrogen Embrittlement, Stress Corrosion, Acidity, and Appearance.

Major or Unique Equipment

No special requirements

Data Reporting and Analysis

Report date arrived, dates stored at what temperature (conditions), location of storage, and storage container material and dimensions.

After 12 month storage, remove the top of the container and examine the internal surface for corrosion or sediment. Take samples of the demonstration solvent material and perform the following tests:

- Toxicity (Section 3.1.1)
- Acidity (Section 3.2.2)
- Appearance (Section 3.2.3)
- Total Immersion Corrosion (Section 3.3.1)
- Titanium Stress Corrosion (Section 3.3.2)
- Hydrogen Embrittlement (Section 3.3.3)
- Stress Corrosion (Section 3.3.4)

3.4.2 Rinse Efficiency

Test Description

The rinse efficiency test is a screening test designed to quickly determine the ability of the demonstration solvent to remove cleaning agents such as degreasers, water displacing oil, vibratory cleaner burnishing soap, and fingerprint neutralizer used during the bearing cleaning process. A successful outcome of the rinse efficiency screening test will indicate that the demonstration solvent should be considered for further testing outlined in the JTP.

Rationale

The demonstration solvent is being considered as a replacement in the rinse step of the bearing cleaning process. Laboratory tests outlined in this JTP are costly and time consuming to perform. It is prudent to perform a rinse efficiency screening test to provide a quick, low cost method to determine whether or not the demonstration solvent should be considered for further testing.

Test Methodology

Parameters	Coupon Preparation: Coupon Geometry – 2” x 1” x 1/16” Coupon Material – 316 Stainless Steel
Number and Type of Specimens per Candidate Alternative	Six (6)
Trials per Specimen (*if needed*)	One (1)
Experimental Control Specimens	One (1)
Acceptance Criteria	Equal to or better than MIL-PRF-680 performance.

Major or Unique Equipment

Spectrophotometer

Data Reporting and Analysis

See Appendix C

Summarize any deviations made from the above protocol.

4 REFERENCE DOCUMENTS

Documents referenced in the development of the JTP are listed in Table 7.

Table 7. References

Reference Document	Title	Date	Applicable Section(s) of Reference Document	JTP Test	JTP Section
Army Regulation 40-5	Preventative Medicine	15 Oct 90	Chapter 2, Section I, Paragraph 2-2.o	Toxicity	3.1.1
EPA Method 24	Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings		All	Volatile Organic Compound	3.1.2
SCAQMD Clean Air Solvent Certification Protocol Appendix I Method 313	Determination of Volatile Organic Compounds (VOC) by Gas Chromatography/Mass Spectrometry (GC/MS)			Volatile Organic Compound	3.1.2
ASTM D 93	Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester	10 Dec 02	All	Flash Point	3.1.3
ASTM D 2879	Standard Test Method for Vapor Pressure-Temperature Relationship and Initial Decomposition Temperature of Liquids by Isoteniscope	10 Apr 97	All	Vapor Pressure	3.2.1

Table 7. References (continued)

Reference Document	Title	Date	Applicable Section(s) of Reference Document	JTP Test	JTP Section
ASTM D 847	Standard Test Method for Acidity of Benzene, Toluene, Xylenes, Solvent Naphthas, and Similar Industrial Aromatic Hydrocarbons	10 Jun 96	All	Acidity	3.2.2
ASTM F 483	Standard Test Method for Total Immersion Corrosion Test for Aircraft Maintenance Chemicals	10 Oct 98	All	Total Immersion Corrosion	3.3.1
ASTM F 945	Standard Test Method for Stress-Corrosion of Titanium Alloys by Aircraft Engine Cleaning Materials	10 Nov 01	All	Titanium Stress Corrosion	3.3.2
ASTM F 519-97	Standard Test Method for Mechanical Hydrogen Embrittlement Evaluation of Plating Processes and Service Environments	10 May 97	All	Hydrogen Embrittle-ment	3.3.3
ASTM G 44	Standard Practice for Exposure of Metals and Alloys by Alternate Immersion in Neutral 3.5 % Sodium Chloride Solutions	10 Dec 99	All	Stress Corrosion	3.3.4
ASTM D 6361	Standard Guide for Selecting Cleaning Agents and Processes	10 Dec 98	Appendix X2	Stress Corrosion	3.3.4

Table 7. References (continued)

Reference Document	Title	Date	Applicable Section(s) of Reference Document	JTP Test	JTP Section
ASTM G 30	Standard Practice for Making and Using U-Bend Stress-Corrosion Test Specimens	10 Apr 97	All	Stress Corrosion	3.3.4
ASTM D 1353	Standard Test Method for Nonvolatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer, and Related Products	10 Dec 02	All	Nonvolatile Residue; Nonvolatile Residue with IPA Rinse	3.3.5; 3.3.6
ASTM F 1105	Preparing Aircraft Cleaning Compounds, Liquid Type, Temperature-Sensitive, or Solvent-Based, for Storage Stability Testing	10 Mar 03	All	Storage Stability	3.4.1
APPENDIX C	Rinse Efficiency Test Protocol	None	ALL	Rinse Efficiency	3.4.2
NAVAIR 01-1A-503	Maintenance of Aeronautical Antifriction Bearing Cleaning for Organizational, Intermediate, and Depot Maintenance Levels	15 Feb 02	All		
MIL-PRF-680	Performance Specification, Degreasing Solvent	13 Dec 99	All		

APPENDIX A

NAVAIR TECHNICAL MANUAL 01-1A-503
(TM55-1500-322-24, T.O. 44B-1-122)

MAINTENANCE OF AERONAUTICAL ANTIFRICTION BEARINGS FOR ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE LEVELS

SECTION V
CLEANING OF BEARINGS

SECTION V

CLEANING OF BEARINGS

5-1. **GENERAL.**

5-2. The success of any bearing processing program is dependent on the effectiveness of the cleaning processes. Bearings must be clean before they can be properly inspected. However, no standard cleaning process or single processing sequence will clean all bearings 100 percent of the time. Individual bearings vary in the type and amount of contamination that must be removed. Also, cleaning results for a given cleaning procedure will vary. Close control of the process and evaluation of cleaning results must be maintained. The selection of cleaning materials and the length of time the bearings are subjected to these materials are additional factors that must be considered.

5-3. **DEVIATIONS FROM SPECIFIED CLEANING PROCESS.** Depot level activities shall comply with the cleaning procedures specified in this section. Deviations and/or exceptions to basic procedures shall be handled in accordance with instructions contained in paragraph 1-35. However, local deviations to the cleaning process may be necessary to clean a limited number of bearings with difficult-to-remove soil contaminants. The local Materials Engineering Laboratory/Physical Science Laboratory shall be responsible for controlling all bearing cleaning processes and for developing limited cleaning processes that may be required at each facility.

NOTE

The cleaning processes and equipment specified in paragraph 5-11 are inter-dependent. The specified equipment is required to obtain the required level of cleanliness for aeronautical bearings.

5-4. **FACILITIES.**

5-5. The work area that is required at each activity to clean bearings will depend on production workload and the type of bearings being processed. The cleaning area shall be enclosed and separated from the rest of the bearing processing shop. Temperature and humidity control is not required. The presence of dust and dirt producing source, such as cartons, trash barrels and boxes shall be kept to a minimum. Dust and particle control shall be specified by the cognizant engineer at each depot or facility as specified in the latest revision of FED-STD-209 per MIL-STD-197.

5-6. **SAFETY AND GOOD HOUSEKEEPING.**

5-7. The cleaning area will require continuous housekeeping. A complete general cleaning is needed at least once a week. Tanks and equipment should be flush with the floor or should be supported above the deck in such a manner as to provide for easy and effective cleaning. Ventilation, as designated by the local OSH, is required for all heated tanks and for all tanks containing toxic or flammable materials. Fire protective devices shall be provided in sufficient quantities to ensure fire protection and shall be conveniently located for ready access. Tank thermostats and valves shall be checked monthly. Electric motors, wiring, and plug outlets shall comply with all local safety and fire requirements for materials used in bearing cleaning. Safety glasses, face shields, protective aprons, gloves and hand creams shall be available for use by the employee. Smoking, eating, or drinking shall not be permitted in the cleaning area.

5-8. **HAZARDOUS WASTE REDUCTION PROGRAM.**

5-9. Bearing processing facilities often utilize materials to clean bearings that have been classified as hazardous waste by the Environmental Protection Agency (EPA). A hazardous waste minimization (HAZMIN) program is currently being implemented by the Services that will establish waste reduction goals for specific materials and compounds. These materials have been classified by the EPA as hazardous to the environment and to humans. These HAZMIN efforts will directly impact the operation of the depot bearing facilities and will require the full cooperation of shop personnel in meeting these goals while still producing clean bearings.

5-10. The bearing processing facility shall comply with all applicable EPA, OSHA, state and local regulations involving air and water pollution, and solid waste disposal requirements during the operation of the shop. Solution levels may also be regulated by environmental agencies as well.

NOTE

Certain cleaning materials called out in this section may be restricted at a particular depot or intermediate level activity. Providing substitute solvents shall be the responsibility of the local Materials Engineering Laboratory/Physical Science Laboratory.

5-11. **EQUIPMENT.**

5-12. **GENERAL.** The cleaning equipment required by depot bearing shops will depend on the type of bearings being processed and the workload. In general, bearings of ABEC-5 precision or better and with an outer diameter of 1 inch or less, will require the same special cleaning procedures and equipment specified for instrument-type bearings in Section XIV.

5-13. **MINIMUM INTERMEDIATE MAINTENANCE LEVEL ACTIVITY (IMA) CLEANING EQUIPMENT.** Bearing cleaning equipment requirements for IMA level shops will be less than for depot level facilities. In general, the minimum equipment needed by the IMA bearing facilities will be agitated tanks that can be used either as a static soak and agitated rinse. A spray booth for solvent spray rinsing of the bearings may be used if the solvent and spray equipment is approved for local use by the facility's environmental compliance office.

5-14. **CLEANING EQUIPMENT.** The following equipment is required by depot level activities to clean the many different types of bearings that are used in aeronautical applications:

a. Static and Agitated Soak Tanks.

(1) Static soak tanks shall be equipped with a moveable supported platform, or be equipped with a false bottom or baffle. This prevents contamination of the bearings by the sludge and dirt that accumulated on the bottom of the tank.

(2) The tanks may be of the agitated-type equipped with additional controls to allow static positioning of the bearings in either the lowered or raised position.

(3) The tanks shall be constructed of stainless steel or other approved nonreactive material or coating in those areas in contact with the cleaning solutions.

(4) Heating shall be provided when required by the cleaning process.

(5) Continuous filtration will be required for certain solutions.

b Solvent Spray Booth. Local regulations may be imposed that will prohibit or restrict the use of pressurized air to spray organic solvents unless the spray booth is equipped with a high efficiency scrubber and/or carbon absorber system that will capture and recycle solvent mist vapors in the exhaust system. Direct impingement spraying may be allowed if the delivery pressure is very low and the solvent vapor pressure is below a published limit. Consult the cognizant facility environmental office for specific direction.

NOTE

The bearing can be cleaned in a self contained pressure spray cabinet using a perfluorinated as described in paragraph 14–82.

(1) The booth, piping, and other surfaces coming in contact with the solvent shall be constructed of stainless steel or other approved non-reactive material or coating.

(2) The interior of the spray booth shall not be painted or coated with any flaking or peeling material.

(3) Filtration of the air and solvent is required and the air shall be supplied from a dry air source. Ordinary shop air contains significant amounts of water/moisture and shall not be used to supply air to the booth.

(4) The booth shall be designed to provide one time use of the solvent prior to redistillation.

(5) The solvent spray booths shall meet all state and local environmental, safety, fire and hygienic requirements including all air pollution control requirements imposed by the EPA, state and/or local air pollution control boards.

c. Ultrasonic Cleaning Machine.

CAUTION

The use of an ultrasonic cleaning machine to clean bearings may cause internal damage to rolling elements, raceways and retainer pockets. Acoustic energy within the bearing can cause contacting parts to fret which can result in irreparable damage. The use of an ultrasonic cleaning machine must be approved by the local bearing engineering authority. Properly designed and powered machines will enhance cleaning of certain non-separable, instrument and thin section bearings.

(1) The ultrasonic cleaning tank shall be constructed of 300 series stainless steel. Tank size will depend on the size of bearings that are processed through the cleaning line.

(2) The unit must be adequately powered to clean non-separable, instrument, thin section and metallic spherical bearings. The rated power must compensate for the significant energy loss due to the cleaning solution, the holding baskets and the bearings.

(3) A maximum energy level of 5 watts average power per square inch, measured over the inside tank bottom surface, is recommended for bearing cleaning.

d. Demagnetizer. The throat of the demagnetizing coil should be large enough to accommodate the largest bearing that will be normally processed through the bearing shop. The width of the coil will normally be 15 to 18 inches. The height of the coil opening should be able to readily accommodate the basket/tray in which the individual bearings are placed during the demagnetizing process.

e. Gaussmeter. The gauss meter shall be capable of measuring residual magnetism from 0 to a minimum of 10 gauss.

f. Cleaning Baskets. The bearing handling baskets shall be made of 300 series stainless steel of expanded metal construction (figure 5-1). The expanded metal baskets can also be used in ultrasonic cleaning processes.

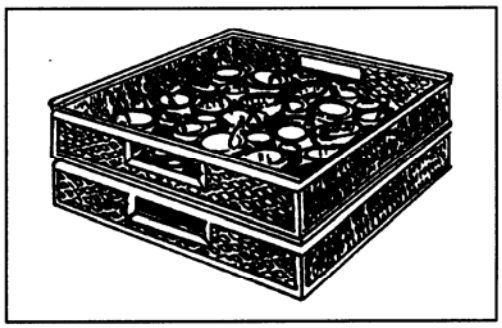

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Figure 5-1. Cleaning Baskets for Bearing Handling Throughout Process

g. Rough Spray Cleaning. A rough solvent spray cleaner should be developed at each facility to expedite the cleaning of heavily contaminated grease lubricated bearings. The cleaning machine should use a direct impingement spray from fixed or hand held nozzles to blast at least 75% of the grease from basketed bearings. The fixed nozzle machine should be conveyorized to allow proper exposure of the bearings to the spray. The glove box type of machine should be ergonomically designed to minimize operator fatigue. The machine should be self-contained and allow no solvent vapors to escape to the atmosphere. The machine must also be equipped to safely handle flammable solvents. The machine should be located at the beginning of the entire cleaning process line so that subsequent cleaning solutions are not subjected to gross contamination.

NOTE

Consult state and local air pollution control regulations for effect on the design and operation of pressurized solvent spray equipment.

h. Vibro-Tumbling Finishing Mills. Several sizes of finishing mills can be used in the bearing cleaning line to handle the bearing workload. Mills are available in 1.2, 3, 10 and 20 cubic feet capacity. The entire bowl assembly shall be mounted to the base by coil springs. The bowl shall have a vertical motor attached to the center post. Counter weights shall be adjustable to vary the vibrational energy to the media and parts. The bowl shall be of a toroidal design with an outside lip curving back toward the center post. The toroidal bowl shall be lined with an abrasion resistant polyurethane elastomer. Refer to figure 5-2 for design details.

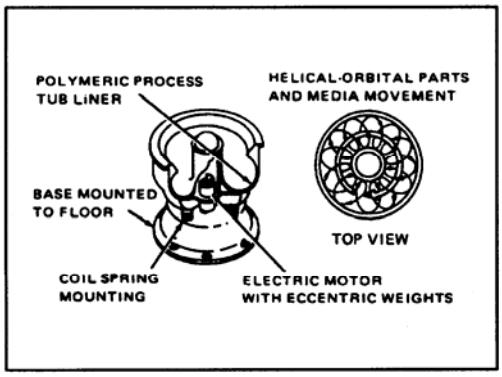

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Figure 5-2. Vibro-Tumbling Mill Schematic

i. Drying Methods. A method of removing the last solvent rinsate from the bearings is required. Bearings must be clean and dry in order to perform the subsequent visual and dimensional inspections. Some of the successful drying methods are listed below in order of preference:

(1) Isopropyl Alcohol (IPA) Vapor Degreaser/ Dryer. This method has been shown to be the most effective alternative to ODS (OLDS) based methods. It utilizes a sophisticated vapor degreaser that has been designed to handle the flammable alcohol and restrict vapor emissions. The vapor dryer shall be capable of drying baskets of bearings that are covered in the final rinsate. The bearings are immersed into the vapor zone and Isopropyl Alcohol (IPA) is allowed to condense on the cooler bearing surfaces. This action displaces the rinsate and continuously washes fresh IPA over the bearings until the temperature of the bearings and vapor equalize. The bearings are then slowly raised through the chilled zone of the dryer where the IPA flashes off, leaving warm, dry bearings. The bearings are clean and spot free and ready for inspection when they cool down to comfortable handling temperatures. All ABEC/RBEC classified bearings are authorized to be dried by this method. Some of the salient features of the unit are listed below (refer to figure 5-3.)

(a) The entire unit must be designed with all necessary electronic and mechanical fire sensing and fire suppression equipment. This equipment must be totally fire and explosion proof in order to conform to all fire and safety regulations.

(b) The equipment shall have provisions for nitrogen gas shrouding, CO_2 fire extinguishing, flame detection, fire alarm and automatic shut-down equipment.

(c) Thermocouples shall monitor the chiller coils, vapor zone height, the solvating sump and the electronic cabinetry. This temperature sensing system will shut down the unit if any preset levels are exceeded.

(d) The top of the tank shall have a low flow lip vent that captures any alcohol emissions. The vent system shall have a vapor monitor that shuts down the heating system if the alcohol concentration in the vent air exceeds 20 ppm.

(e) The vent system shall be attached to a vapor scrubber to remove and recover alcohol from the vent air.

(f) There shall be a mechanical parts handling mechanism that immerses and retracts the parts in a controlled rate so alcohol vapors are properly contained in the dryer. The mechanism shall be monitored with motion sensors (or equivalent) that can detect excessive feed rates and will shut down the system if so detected.

(g) There shall be an automatically controlled lid that opens only when the parts feed mechanism requires it to do so.

(h) The unit shall be provided with an automatic waste solvent removal and fresh solvent replenishment system. The waste solvent shall be captured in a sealed container that is easily accessible for periodic disposal.

(2) HFE Co-Solvent Vapor Degreaser. This method features the use of a hydrocarbon (HC) solvating agent and a Hydrofluoroether (HFE) liquid rinse and vapor drying solvent operating within a specially designed degreaser. This system is a more aggressive cleaner than the IPA degreaser/dryer system. It is an excellent final rinse and dryer combination and its use is encouraged. All ABEC/RBEC classified bearings are authorized to be dried by this method. Some of the salient features of this machine are listed below (refer to figure 5-4).

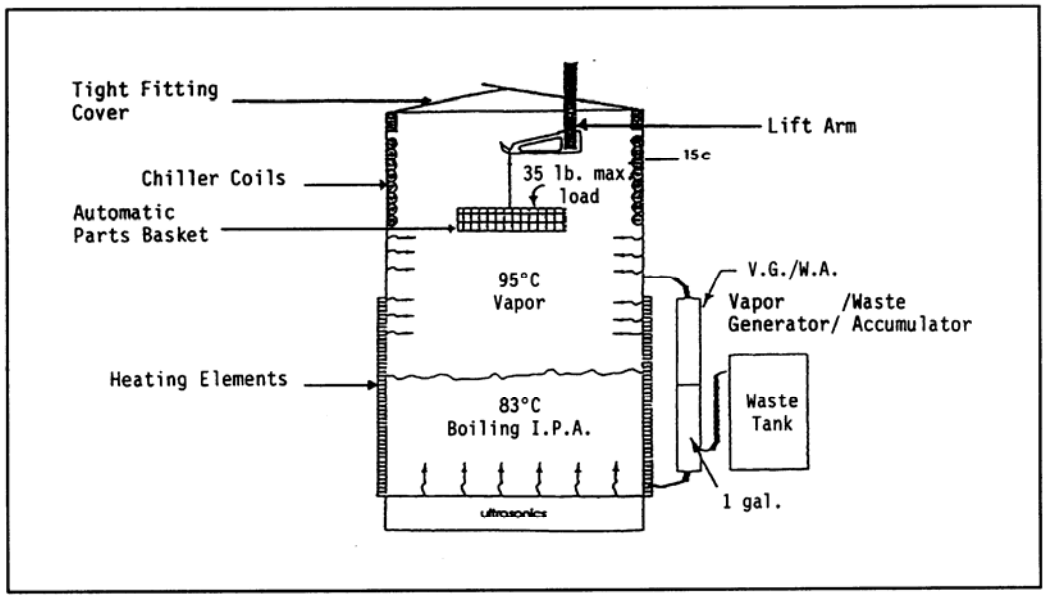

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Figure 5-3. Isopropyl Alcohol (IPA) Vapor Degreaser/Dryer

(a) Two sumps shall be provided at the bottom of the tank below the vapor zone. In one sump the solvating agent and HFE rinsate is heated and pump-agitated to degrease immersed bearings. The second sump is for immersion rinsing the bearings in the pure liquid HFE rinsate.

(b) Ultrasonic agitation shall be provided in the rinsate sump. The power of the ultrasonic energy measured at the bottom of the sump shall not exceed 5 watts per square inch.

(c) The HFE vapor zone shall have a 150% freeboard.

(d) There shall be one primary condenser coil and two chiller coils to contain the vapor zone. The primary coil shall be operated at 50°F and secondary coils shall be operated at -20°F.

(e) The tank shall have a tight fitting lid to minimize solvent vapor emissions.

(f) There shall be separation reservoirs attached to the unit in such a manner that the contaminated solvating agent is separated from the HFE rinse solvent and drained into a proper disposal vessel.

(g) There shall be provided an efficient method for the HFE rinse solvent to be filtered, distilled and returned to the rinse sump. These solvents are very expensive.

(h) The entire unit shall be constructed of corrosion resistant metals and solvent compatible polymers.

(3) Air Circulating Oven. This method dries bearings at a relatively low temperature (120° - 130°F) inside of an air circulating oven. All ABEC/RBEC classified bearings are authorized to be dried by this method.

(a) The solvent vapors shall be exhausted through a vapor recovery system that complies with local environmental regulations.

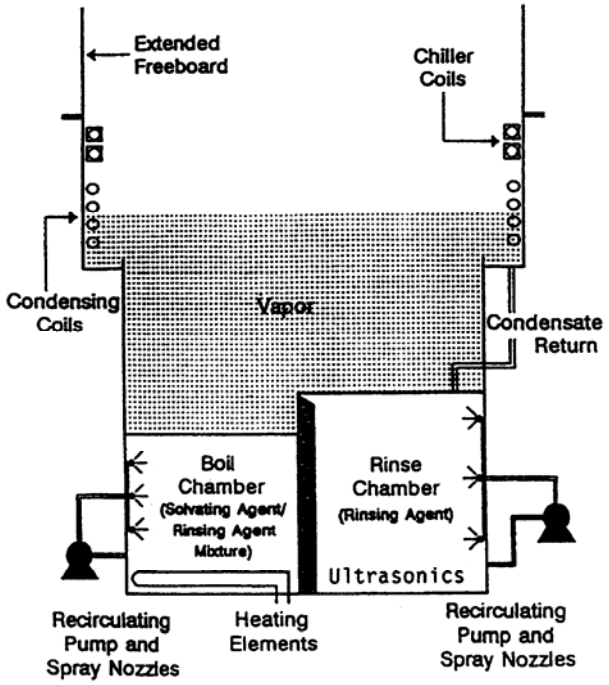

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Figure 5-4. HFE Co-Solvent Vapor Rinse System

(b) The oven must be designed so that the circulating air is prefiltered to preclude airborne contamination problems.

(c) The oven must be designed to accomodate flammable vapors and handle them safely.

(d) After oven drying, the bearings shall be left dry to the touch. Some residues from the final rinsate may still coat the surfaces. Typically, these films will not interfere with visual and dimensional testing.

(4) Air Blast. This is the least expensive and most common method of drying bearings. It is also the hardest to control and has the greatest potential to damage bearings.

(a) In general, compressed air (about 90 PSI) is directed to each bearing from a hand held nozzle. The bearings are held in a gloved hand as the air blast displaces the final rinsate from internal and external surfaces. The bearing rings and rolling elements are carefully and deliberately moved by the artisan while being air blasted. This will prevent the bearing from spinning and destroying internal surfaces.

(b) The air must be water, oil and particulate free.

(c) The spray booth must have a solvent vapor recovery system efficient enough to comply with local environmental and safety regulations.

CAUTION

This air blast method is authorized only for non-precision bearings of ABEC/RBEC 1 classification. Precision bearings of ABEC/RBEC 3, 5, 7 and 9 classifications shall not be dried by any air blast method.

(5) Air Blast Machines. This method is an automated version of the hand held method described in 5-14j(4).

(a) These machines have nozzles fixtured inside of a chamber that directs warm, dry air to an area where baskets of bearings are placed.

(b) The movement of the baskets through the chamber can be either by hand or by a conveyor system.

(c) A vapor recovery system must be designed to capture solvent vapors to comply with local environmental and safety regulations.

CAUTION

This method is authorized only for non-precision bearings of ABEC/RBEC 1 classification. Precision bearings of ABEC/RBEC 3, 5, 7 or 9 classifications shall not be dried by any air blast method.

5-15. **SEAL AND SHIELD REMOVAL.**

5-16. **REMOVABLE TYPES.** Removable-type seals and/or shields shall be removed prior to cleaning the bearings. This will allow a thorough cleaning and permit visual inspection of the internal bearing surfaces. Some types of seals and shields can be removed by using a slim blade that is inserted between the inner ring and the seal or shield. A light twisting force is exerted against the seal or shield as the blade is slid circumferentially around the bearing.

CAUTION

Do not pry from just one position on the ring as the seals and shield may be permanently distorted.

5-17. Special tools can be developed for each type of seal and shield so that they can be removed without damage and without damaging the bearing. Special holding blocks and holding tools are usually needed to facilitate seal and shield removal (figure 5-5). Bearing lots requiring seal or shield removal shall be marked with special tags at time of induction for processing. This special marking shall accompany the bearing lot all through processing to ensure that the proper type of seal or shield is reinstalled after lubrication.

5-18. **NONREMOVABLE TYPES.** Nonremovable-type seals and/or shields are not usually removed. However, when one seal or shield is to be removed, it can be done without damage to the bearing if reasonable care is taken.

CAUTION

When exerting pressure against a bearing ring to remove the seal or shield, always apply force to the ring in which the seal or shield is attached. Failure to observe this precaution can damage the bearing.

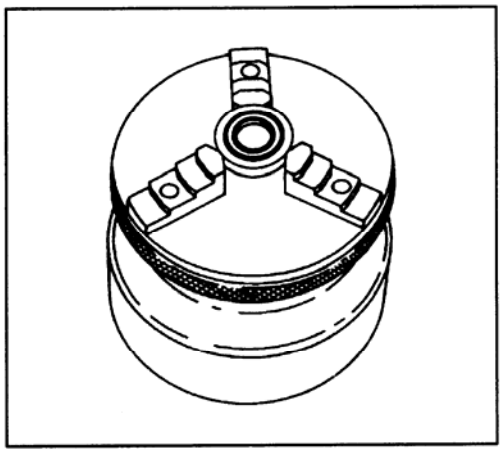

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Figure 5-5. Special Holding Device for Seal/Shield Removal and Installation

5-19. **DEMAGNETIZATION.**

5-20. **GENERAL.** Demagnetizing equipment is used to remove residual magnetism from bearings. Most bearings are made of steel alloys and accumulate a certain amount of residual magnetism during operation. A magnetized bearing will retain steel chips and particles inside the bearing all through the cleaning process. Therefore, it is very important that bearings be free of residual magnetism prior to cleaning. A demagnetizing coil with an appropriately sized throat is suitable for this purpose.

5-21. Conveyorized demagnetizing equipment can be used to expedite the process. However, magnetic materials should not be used within 3 feet of the magnetizing coil.

5-22. **PROCEDURE.** Demagnetize all bearings prior to cleaning, after buffing and at other times during the cleaning process as indicated by the gaussmeter. Bearings shall be demagnetized after each rework process. Bearings can be demagnetized while they are in the cleaning basket (figure 5-1) Facilities not having a heavy-duty demagnetizer shall use the hand method.

a. Basket Demagnetization.

NOTE

Demagnitize one basket at a time. Do not stack baskets.

(1) Pass the basket slowly through the demagnetizer coil.

(2) Rotate the basket 90 degrees and pass it again through the demagnetizer coil.

(3) Withdraw the basket a sufficient distance away from the coil before shutting-off the demagnetizer.

(4) Check bearings for residual magnetism. A maximum of five (5) gauss residual magnetism is acceptable for bearings 2 inches OD or greater. A two (2) gauss limit applies to precision bearings under 2 inches outer diameter.

(5) Repeat this procedure as many times as necessary to reduce the level of residual magnetism to acceptable limits.

b. Hand Method Demagnetization.

(1) Demagnetize large bearings individually. Airframe bearings and loose bearing components can be demagnetized as lots in baskets or as grouped on safety wire. Demagnetize all separable bearing components individually rather than as a unit.

(2) Hold the inner and outer rings of non-separable bearings so they will not vibrate and be damaged.

(3) Pass the bearing slowly through the demagnetizing coil. Rotate the bearing approximately 90 degrees during the pass.

(4) Rotate the bearing rings slowly as the bearing is returned through the demagnetizing field. Move the bearing or bearing components at a rate not to exceed 12 feet per minute.

(5) Slowly withdraw the bearing until some distance from the coil while the demagnetizer is still on and the current is flowing through the coil.

(6) Test the bearing or bearing parts for residual magnetism. A maximum of five (5) gauss residual magnetism is acceptable for large bearings and two (2) gauss for small precision bearings 2 inches outer diameter and smaller.

(7) Repeat this procedure as many times as necessary. The gaussmeter shall be used to check both the effectiveness of the demagnetizing procedure and the necessity for processing new bearings received from Supply.

c. Conveyorized Demagnetizers will require sufficient testing to determine proper operational speed for adequate demagnetization.

5-23. **CHECKING FOR MAGNETISM.** Use a magnetometer (gaussmeter) that reads directly in gauss to check the effectiveness of the demagnetizing procedure. The gaussmeter shall be permanently located in the cleaning area and shall be used to monitor baskets of bearings after demagnetization.

5-24. **GENERAL CLEANING PROCEDURES.**

5-25. **SOAK.** The purpose of the soak process is to soften greases, preservative compounds, carbon residues and adhering organic foreign matter for easier removal in subsequent washing operations. The need for controlled heating will depend on the cleaning solution that has been selected for the soak. Agitation will usually increase the efficiency of the

cleaning action of the soak. However, agitation will necessitate rough filtering. Agitation cannot be used with solutions that have a water seal on the surface due to solvent evaporation. Soak time will depend on the type and amount of contamination to be removed and the effectiveness of the cleaning compound. Ultrasonic cleaning tanks with adequate power levels will greatly facilitate the removal of difficult-to-remove residues from inside the bearings.

5-26. There are several different chemical solvents/ compounds that can be used in soak tank processes depending on the type and amount of contamination on the bearings.

a. Light greases, slush preservative coatings, or oils may be removed by an organic solvent, listed in Table 5-1. The advantage of a hydrocarbon solvent (i.e. Stoddard Solvent, MIL–PRF–680, Type II) is that it can be recycled. All solvents shall be continuously filtered through replaceable 10 micron filters.

b. Heavy greases and soft film hot dip preservatives can be removed by soaking in hot oil. Hot oil soak is effective in softening grease deposits prior to an agitated solvent rinse. The hot oil soak is required to help remove grease from miniature bearings and other bearings with small crevices or openings such as thin section and non-removable seal-type bearings.

c. Water based solutions are effective to remove oils, greases and preservatives from bearings and are listed in Table 5-1. These materials tend to be more effective cleaners than hydrocarbon solvents. The water based materials are usually heated and a hot water rinse is required, followed immediately by immersion in a water displacing oil. The solutions shall be continuously filtered through 10 micron filters.

NOTE

The major disadvantages to water based materials is that they produce waste streams that must be treated in an industrial waste treatment plant because they are not normally recycled. For each process tank a hot water rinse tank and a water displacing oil tank are also required.

d. Carbon or oxidized hydrocarbon greases are particularly difficult to remove. Most carbon removers are aqueous based; some contain sodium hydroxide, others contain monoethanolamine or N-methyl-2-Pyrrolidone (NMP). The recommended carbon removers are listed in Table 5-1.

5-27. **RINSE.** Every soak or wash step shall be immediately followed by an appropriate filtered solvent rinse. This process is used to remove residual cleaning materials. Solvent, Federal Specification MIL–PRF–680, Type II, shall be used in all cleaning processes except the water detergent process.

a. Filtration and agitation is required for all solvent rinse tanks. Filtration of solvents shall be in accordance with paragraph 5-52.

b. Rotate the bearing to dislodge internal contamination trapped in the ball/roller retainer pockets. This procedure should be accomplished during final rinsing.

c. Rinsing can be accomplished by the use of agitated tanks, or spray booths.

CAUTION

Do not spin the bearing at high speeds, even when solvent spraying. Raceways and rolling elements will be damaged from sliding and skidding.

5-28. **VAPOR DEGREASING.** Vapor degreasing used in bearing cleaning is intended to remove light oils and rinsates at the end of the process. The process requires the use of environmentally safe solvents and specialized equipment as described in paragraph 5-14j.

a. Isopropyl Alcohol (IPA) degreasing (figure 5-3) is used for final rinsing or drying bearings just prior to the preliminary inspection process. IPA degreasing machines are manufactured in sizes to accommodate large bearings as well as miniature instrument bearings.

b. Hydrofluoroether (HFE) degreasing (figure 5-4) is limited for use in the final processing of instrument bearings.

NOTE

The use of chlorinated and chlorofluorinated solvents (i.e. 1,1,1 trichloroethane (TCA) or "Freon" trichlortrifluoroethane) is no longer authorized for use. Trichloroethylene (TCE) and perchloroethylene are exempt from these restrictions in certain areas, but their use for cleaning bearings is not recommended.

5-29. **VIBRO-TUMBLING.** The vibro-tumbling process is effective in removing hardened deposits from bearing parts when chemical means are found to be ineffective. In general, rolling element bearings must be completely disassembled into basic unit parts (rings, retainers, balls/rollers) before being processed in the mill. Complete disassembly is authorized only if the bearing drawing or the component technical manual allows complete disassembly. Metal-to-metal plain or spherical bearings which cannot be disassembled can be processed in the mill as complete assemblies.

CAUTION

Assembled rolling element bearings may be processed in the mill when authorized by the cognizant depot bearing engineer. Assembled bearings with silver plated, one piece machined bronze/steel retainers, are particularly affected by entrapped abrasive in the ball/roller pockets and between the ring land guided surfaces. Figure C-30 in Appendix C illustrates the effects of abrasive contamination in silver plated retainers.

5-30. **Vibro-Tumbling Media.** The function of the media is to provide support and cushioning for the bearings during the tumbling operations. Ceramic media is hard, wear resistant, and sufficiently dense to provide support. The ceramic media is manufactured from clay materials which are extruded into various shapes and sizes and then kiln-fired to a hard finish. Most of the ceramic media that is produced contain abrasives (aluminum oxide, silicon carbide) of varying grit sizes and quantities. Do not use any media containing abrasives for bearing cleaning as it will damage the microfinished bearing surfaces. Ceramic media used for bearing cleaning and burnishing operations shall meet the following requirement:

a. Ceramic media shall be nonabrasive with no added abrasive materials. Specify this requirement when procuring the media.

b. The recommended media shape shall be triangles, cones or 22 degree angle-cut cylinders.

c. The media size is dependent on the size of the parts being tumbled. In general, the 3/8 x 5/8 inch cylinders, the 3/8 x 3/8 or the 3/8 x 5/8 inch triangles or the 3/8 x 1/2 cones are recommended for most bearings and bearing parts.

5-31. **Media Preparation.** De-glaze the media as follows:

a. Shut the mill drain.

b. Add 1/2 to 1 gallon water and one cup of burnishing compound to wet the media.

c. Run the mill for 100 hours.

d. Open the drain and flush the media with fresh water until it runs clear.

e. Media is now properly de-glazed and may be used for all finishing mill operations.

f. During use add more media to the mill as required to bring the volume back to proper limits. Further de-glazing is not required.

NOTE

Use only the volume of media specified for the particular model mill.

5-32. **Vibro-Tumbling Procedure.** The cleaning and burnishing operations of vibro-tumbling mills are as follows:

a. Prepare the mill.

(1) Close the drain, add just enough water to the mill to wet the media and add one or two cups (8 oz.) of powdered burnishing compound.

(2) Run the mill for about 20 minutes until the water and burnishing compound are thoroughly dispersed. A ring of suds will appear around the mill center post when the mixture is correct.

NOTE

Excessive compound will slow the tumbling action of the media and will prevent the parts from properly moving around the mill. Insufficient compound will not provide sufficient cushioning between the parts and may cause damage to the bearing.

(3) Adjust the water-to-compound ratio until the media action is proper.

NOTE

The balance between media, water, and compound is achieved through experience. Use rejected bearings to establish the vibrotumbling procedure.

b. Adding Bearings. Add the bearing parts to the mill one at a time to avoid nicking and denting. Process similar sized parts together (all inner rings or all outer rings).

NOTE

Load the mill with parts not to exceed one third (1/3) the rated volume of the mill. Some vibrotumblers are designed with divided compartments to allow different size parts to be run at the same time.

c. Running Bearings. Run the parts in the mill for two hours. Check the parts for condition. If needed, run the parts for two additional hours. Do not run the parts any longer than is necessary to clean the bearings or achieve the specified surface finish.

d. Rinsing Bearings. Remove the parts from the mill and rinse them in hot or cold water to thoroughly remove the burnishing soap compound.

e. Water Displacing Process. Immerse the parts immediately in water displacing oil to prevent corrosion.

f. Clean the bearings and bearing parts in the standard bearing cleaning line to remove the water displacing oil and burnishing compound.

NOTE

These procedures may be repeated and the amount of compound or water varied to achieve finer surface finishes. Experience will come with trial and error. Burnishing operations should not remove measurable metal.

5-33. **TYPICAL CLEANING SEQUENCES.**

5-34. **GENERAL.** The following cleaning processes shall be followed for the cleaning of new and used bearings. The local Materials Engineering Laboratory/Physical Science Laboratory shall be responsible for selecting and controlling the bearing cleaning processes at their respective activity. Activities below the depot level that use this manual and do not have a Materials Engineering Laboratory/Physical Science Laboratory at their disposal may contact the Materials Engineering Division at the Naval Air Depot, Naval Air Station, North Island for suggestions and recommendations on bearing cleaning procedures. Air Force activities should contact WR-ALC/MMI.

5-35. Flow charts and legends summarizing approved bearing cleaning processes are illustrated in figures 5-6 through 5-9. Indicated times are approximate and will vary according to the type and amount of contamination. The flow charts are organized into:

a. Figure 5-6: Used, solvent based.

b. Figure 5-7: Used, aqueous based.

c. Figure 5-8: New, solvent based.

d. Figure 5-9: New, aqueous based.

Refer to table 5-1 for the description of the cleaning material and the applicable government specification.

5-36. **SPECIAL PROCESSING LIMITATION.** New and used bearings should not be cleaned in the same cleaning solutions and/or cleaning tanks. New bearings are not contaminated with dirt, metal, carbon, and other abrasive particles, but are coated with oils, greases or preservatives. New bearings can be quickly contaminated and possibly damaged when cleaned with used bearings.

5-37. **LIGHT GREASE AND OIL REMOVAL (NEW OR USED).**

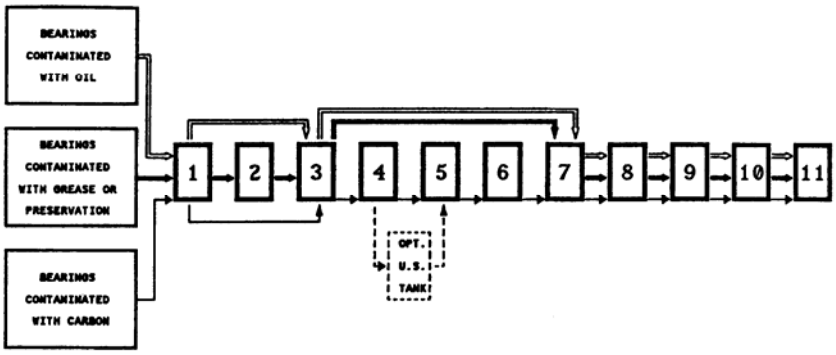
a. Demagnetize.

b. Static or agitated soak in hot (160°) oil for 30 minutes or until the grease or preservative is removed.

NOTE

Use either MIL–PRF–32033 or MIL-PRF–6081 (1010) oil.

c. Agitated rinse in solvent/degreaser at room temperature for 5 minutes.



NO.	FUNCTION	EQUIPMENT	MATERIAL	TIME REQ.
1	DEMAGNITIZE	DEMAGNETIZER	NONE	30 SECONDS
2	PRE-CLEAN	FLUID AGITATED TANK	MIL-PRF-32033(160°) OR MIL-PRF-6081(1010)	30 MIN
3	DEGREASER	FLUID AGITATED TANK	SEE NOTE[1]	5 MIN
4	CARBON REMOVER	FLUID AGITATED TANK	SEE NOTE[1]	SEE NOTE[1]
(OPT.)	(OPTIONAL PROCESS)	ULTRASONIC TANK	SEE NOTE[1]	SEE NOTE[1]
5	RINSE	FLUID AGITATED TANK	HOT R-O WATER (180°F) (RUST INHIBITED-SEE NOTE[1])	1 MIN
6	WATER DISP. OIL	FLUID AGITATED TANK	MIL-PRF-32033 AND NOTE[1]	3-5 MIN
7	RINSE	FLUID AGITATED TANK*	MIL-PRF-680	5 MIN
8	DRY	DRYER	SEE NOTE[2]	SEE NOTE[2]
9	PERFORMANCE INSPECTION	NONE	NONE	AS REQUIRED
10	NEUTRALIZE FINGERPRINTS	FLUID AGITATED TANK	MIL-C-15074	5 MIN
11	PRESERVE / PACKAGE	AS REQUIRED	AS REQUIRED	AS REQUIRED

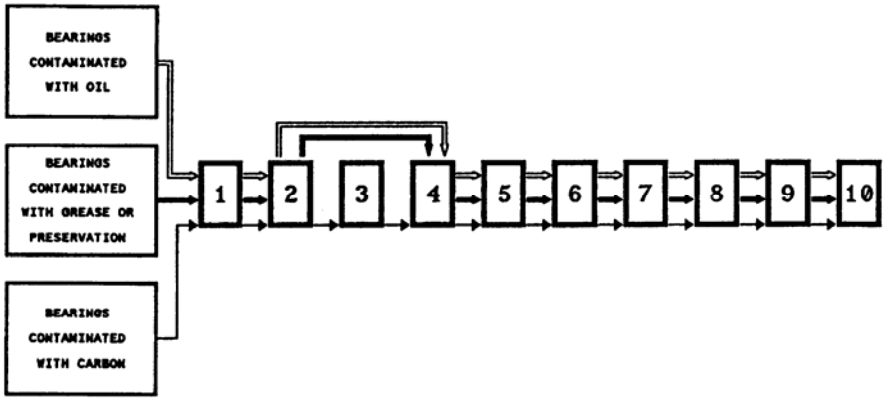
NOTE[1]: REFER TO TABLE 5-1 FOR APPROVED SOLUTIONS

* MIN. OF 3 CASCADING TANKS

NOTE[2]: REFER TO PARAGRAPH 5-14j FOR OPTIONS

005006

Figure 5-6. Solvent Based Cleaning Process for Used Bearings



NO.	FUNCTION	EQUIPMENT	MATERIAL	TIME REQ.
1	DEMAGNITIZE	DEMAGNETIZER	NONE	30 SECONDS
2	AQUEOUS CLEANER	FLUID AGITATED TANK	SEE NOTE[1]	SEE NOTE[1]
3	CARBON REMOVER	FLUID AGITATED TANK	SEE NOTE[1]	SEE NOTE[1]
4	RINSE	FLUID AGITATED TANK	HOT R-O WATER (180°F) (RUST INHIBITED SEE NOTE[1])	1 MIN
5	WATER DISP. OIL	FLUID AGITATED TANK	MIL-PRF-32033 AND NOTE[1]	3-5 MIN
6	RINSE	FLUID AGITATED TANK*	MIL-PRF-680, TYPE II	5 MIN
7	DRY	DRYER	SEE NOTE[2]	SEE NOTE[2]
8	PERFORMANCE INSPECTION	AS REQUIRED	NONE	AS REQUIRED
9	NEUTRALIZE FINGERPRINTS	FLUID AGITATED TANK	MIL-C-15074	5 MIN
10	PRESERVE / PACKAGE	NONE	AS REQUIRED	AS REQUIRED

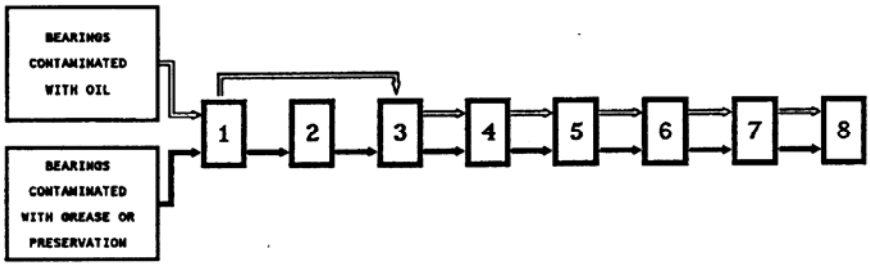
NOTE[1]: REFER TO TABLE 5-1 FOR APPROVED SOLUTIONS

* MIN. OF 3 CASCADING TANKS

NOTE[2]: REFER TO PARAGRAPH 5-14j FOR OPTIONS

005007

Figure 5-7. Aqueous Based Cleaning Process for Used Bearings



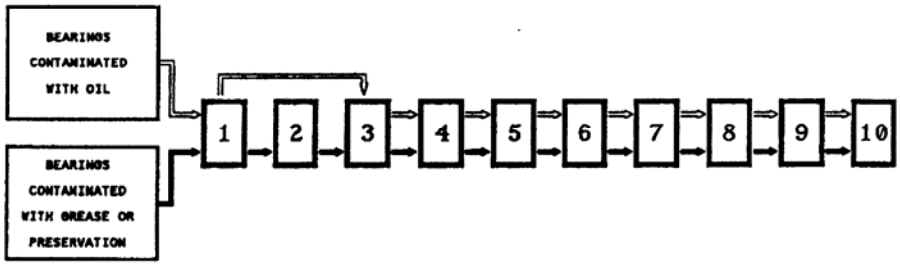
NO.	FUNCTION	EQUIPMENT	MATERIAL	TIME REQ.
1	DEMAGNITIZE	DEMAGNETIZER	NONE	30 SECONDS
2	PRE-CLEAN	FLUID AGITATED TANK	MIL-PRF-32033(160°) OR MIL-PRF-6081(1010)	30 MIN
3	DEGREASER	FLUID AGITATED TANK	MIL-PRF-680, OR NOTE[1]	5 MIN
4	RINSE	FLUID AGITATED TANK*	MIL-PRF-680, TYPE II	5 MIN
5	DRY	DRYER	SEE NOTE	SEE NOTE
6	PERFORMANCE INSPECTION	AS REQUIRED	NONE	AS REQUIRED
7	NEUTRALIZE FINGERPRINTS	FLUID AGITATED TANK	MIL-C-15074	5 MIN
8	PRESERVE / PACKAGE	AS REQUIRED	AS REQUIRED	AS REQUIRED

* MIN. OF 3 CASCADING TANKS

NOTE : REFER TO PARAGRAPH 5-14j FOR OPTIONS

005008

Figure 5-8. Solvent Based Cleaning Process for New Bearings



NO.	FUNCTION	EQUIPMENT	MATERIAL	TIME REQ.
1	DEMAGNITIZE	DEMAGNETIZER	NONE	30 SECONDS
2	PRE-CLEAN	FLUID AGITATED TANK	MIL-PRF-32033(160°) OR MIL-PRF-6081(1010)	30 MIN
3	AQUEOUS CLEANER	FLUID AGITATED TANK	SEE NOTE[1]	SEE NOTE[1]
4	RINSE	FLUID AGITATED TANK	NOT R-O WATER (180°F) (RUST INHIBITED-SEE NOTE[1])	1 MIN
5	WATER DISP. OIL	FLUID AGITATED TANK	MIL-PRF-32033	3-5 MIN
6	RINSE	FLUID AGITATED TANK*	MIL-PRF-680	5 MIN
7	DRY	DRYER	SEE NOTE[2]	SEE NOTE[2]
8	PERFORMANCE INSPECTION	AS REQUIRED	NONE	AS REQUIRED
9	NEUTRALIZE FINGERPRINTS	FLUID AGITATED TANK	MIL-C-15074	5 MIN
10	PRESERVE / PACKAGE	NONE	AS REQUIRED	AS REQUIRED

NOTE[1]: REFER TO TABLE 5-1 FOR APPROVED SOLUTIONS

* MIN. OF 3 CASCADING TANKS

NOTE[2]: REFER TO PARAGRAPH 5-14j FOR OPTIONS

005009

Figure 5-9. Aqueous Based Cleaning Process for New Bearings

d. Optional. Ultrasonic agitation may be locally authorized. Use a water based solvent mixture with corrosion inhibitors and operate the tank at room temperature. Bearings shall not be exposed to ultrasonic energy for more than 5 minutes. The ultrasonic power at the bottom of the tank must not exceed 5 watts per square inch (refer to paragraph 5-14d). After removal from the ultrasonic tank, rinse the bearings in hot water, followed by immersion in a water displacing oil.

e. Agitated rinse in solvent at room temperature for 5 minutes. This operation may be repeated in cleaner rinse tanks for several more cycles to achieve the cleanest possible bearings.

f. Dry the bearings using one of the optional methods described in paragraph 5-14j.

g. Place the clean and dry bearings in the inspection area for further processing.

NOTE

The bearing inspection area must be humidity and/or dew point controlled to prevent corrosion. Personnel must wear gloves or use an anti-perspirant cream on their hands when they handle clean bearings.

5-38. **HEAVY GREASE AND PRESERVATIVE REMOVAL.**

a. Demagnetize completely.

b. Static soak in hot oil for 30 minutes or until the grease or preservative is removed.

NOTE

Use either MIL–PRF–32033 or MIL-PRF-6081 (1010) oil.

c. Agitated rinse in solvent/degreaser at room temperature for 5 minutes.

d. Optional. Ultrasonic agitation may be locally authorized. Use a water based solvent mixture with corrosion inhibitors and operate the tank at room temperature. Bearings shall not be exposed to ultrasonic energy for more than 5 minutes. The ultrasonic power at the bottom of the tank must not exceed 5 watts per square inch (refer to paragraph 5-14d). After removal from the ultrasonic tank, rinse the bearings in hot water, followed by immersion in a water displacing oil.

e. Agitated rinse in solvent at room temperature for 5 minutes. This operation may be repeated in cleaner rinse tanks for several more cycles to achieve the cleanest possible bearings.

f. Dry the bearings using one of the optional methods described in paragraph 5-14j.

g. Place the clean and dry bearings in the inspection area for further processing.

NOTE

The bearing inspection area must be humidity and/or dew point controlled to prevent corrosion. Personnel must wear gloves or use an anti-perspirant cream on their hands when they handle clean bearings.

5-39. **CARBON REMOVAL.**

a. Demagnetize completely.

b. Agitated soak in solvent at room temperature for 5 minutes.

c. Agitated soak in carbon removing compound for the time designated in table 5-1. Note that the alkaline based carbon removers require no more than **15 SECONDS** because long exposure to hot alkaline cleaners will discolor or even etch the bearings as seen in Figure 5–10.

d. Optional Ultrasonic agitate in detergent and water per table 5-1.

e. Agitated rinse in hot deionized (DI) or reverse osmosis (RO) water.

f. Agitated oil rinse in water displacing oil at room temperature for 5 minutes.

g. Agitated rinse in solvent at room temperature for 5 minutes. This operation should be repeated in cleaner rinse tanks for several more cycles to achieve the cleanest possible bearings.

h. Dry the bearings using one of the optional methods described in paragraph 5-14j.

i. Place the clean and dry bearings in the inspection areas for further processing.

NOTE

The bearing inspection area must be humidity and/or dew point controlled to prevent corrosion. Personnel must wear gloves or use an anti-perspirant cream on their hands when they handle clean bearings.

5-40. **OXYGEN SYSTEM BEARINGS (NEW AND USED).**

a. Demagnetize completely.

b. Agitated soak in perfluorinated solvent per table 5-1 for 30 minutes.

c. Visually inspect the bearings for cleanliness and repeat the perfluorinated solvent immersion until visually clean. Brushing with a bristle brush may be required.

NOTE

The bearings can be cleaned in a self contained pressure spray cabinet using a perfluorinated solvent as described in paragraph 14-82.

d. Agitated rinse in a fluorocarbon solvent at room temperature for 5 minutes. This operation may be repeated in cleaner rinse tanks for several more cycles to achieve the cleanest possible bearings.

e. Dry the bearings using the HFE Co-Solvent vapor dryer/degreaser as described in paragraph 5-14j.

f. Place the clean and dry bearings in the inspection areas for further processing.

WARNING

Bearings that are used in gaseous or liquid oxygen systems shall be handled with clean nylon gloves that are free of petroleum hydrocarbons (mineral and synthetic greases and oils). Keep away from all non-authorized oils, greases, and solvents. Contamination with the hydrocarbon materials will cause a violent, explosion-like reaction with oxygen.

NOTE

The bearing inspection area must be humidity and/or dew point controlled to prevent corrosion. Personnel must wear gloves on their hands when they handle clean bearings.

5-41. **OIL-IMPREGNATED BEARINGS.** Lubricating oil was put into porous sintered bearings by a vacuum impregnation process. The oil cannot be easily removed by vapor degreasing or a quick dip in a solvent. Refer to Section X for detailed instructions for relubricating oil-impregnated bearings.

a. Demagnetize iron base-type sintered bearings.

b. Heat bearings in an oven at 200° ± 10°F.

c. Agitated soak in solvent at room temperature for 15 minutes.

d. Place in a vacuum chamber and evacuate to 2 inches of mercury (28 inches gage) for 15 minutes.

e. Repeat steps b, c, and d except time in vacuum chamber can be reduced to 5 minutes.

f. Dry in oven at 200° ± 10°F for 1 hour.

5-42. **BARRIER FILM COATED BEARINGS.** See paragraph 14-199 for details on barrier film coated bearings.

5-43. **DU Bearings.**

a. Agitated soak in solvent at room temperatures to remove exterior grime and dirt.

b. Agitated rinse in solvent at room temperature for 5 minutes. This operation may be repeated in cleaner rinse tanks for several more cycles to achieve the cleanest possible bearings.

CAUTION

Do not buff, polish, wire brush, vapor or grit blast the bearing surfaces.

5-44. **CERAMIC COATED, CARBON GRAPHITE LINED BEARINGS.**

a. Agitated soak in hot water at 180°F for 30 minutes.

b. Rinse in hot water at 180°F for 10 minutes.

c. Dry the bearings using one of the optional methods described in paragraph 5-14j.

5-45. **FABRIC-LINED BEARINGS.**

CAUTION

Do not remove the self-lubricating fiber material that adheres to the ball and raceway surfaces.

a. Agitated soak in solvent at room temperature to remove exterior grime and dirt.

NOTE

Clean bearings by wiping with a clean, dry, lint free cloth. No further cleaning will be necessary.

b. Agitated rinse in solvent at room temperature for 5 minutes. This operation may be repeated in cleaner rinse tanks for several more cycles to achieve the cleanest possible bearings.

c. Dry the bearings in an oven set between 150° and 180°F for one half hour.

5-46. **BUFFING COMPOUND REMOVAL.** Removing buffing compounds will require cleaning steps in addition to the processes specified in the typical cleaning sequences. After buffing in accordance with instructions contained in Section VI, clean the bearing as follows:

a. Demagnetize.

b. Agitated soak in solvent at room temperature for 15 minutes.

c. Agitated soak in carbon removing compound for the time designated in table 5-1.

d. Optional/recommended. Agitated rinse in hot deionized (DI) or reverse osmosis (RO) water.

e. Agitated rinse in water displacing oil at room temperature for 5 minutes.

f. Agitated rinse in solvent at room temperature for 5 minutes. This operation may be repeated in cleaner rinse tanks for several more cycles to achieve the cleanest possible bearings.

g. Dry the bearings using one of the optional methods described in paragraph 5-14j.

5-47. **CONTROL OF BEARING CLEANING PROCESSES.**

5-48. **GENERAL.** Control of materials used in bearing cleaning shall be the responsibility of the local Materials Engineering/Physical Science Laboratory. Laboratory personnel will analyze the solutions as required to ensure effective cleaning without damage to the bearings. All bearing facilities shall consult their local Materials Engineering/Physical Science Laboratory for recommended solution and filter changes since these changes are predicated by the volume of bearings being cleaned. Solutions that are out of control can easily damage bearings costing many thousands of dollars before being detected (figure 5-10). Continual surveillance of all processes is necessary to prevent occurrences similar to that seen in figure 5-11.

5-49. **SOLVENT.** Use new solvent for all solvent cleaning and rinsing of bearings unless otherwise specified. It will be the responsibility of the local Materials Engineering Laboratory/Physical Science Laboratory to monitor the quality of incoming shipments of new solvent. The laboratory will also conduct periodic checks on the bulk delivery tank cars, bulk storage tanks, and intrafacility delivery equipment, to ensure the use of uncontaminated solvent. Solid and liquid contamination of shipping and storage containers can cause irreparable bearing damage and cause severe work stoppages and material shortages.

NOTE

U. S. Army Tank–Automotive andArmaments Command, AMSTA–TR–E/EI is the certifying authority for products qualified to MIL–PRF–680. ILO identification of a particular manufacturer in a qualified producers list, a certification letter from the Army activity stating compliance of the companies product with MIL–PRF–680 is considered acceptable

NOTE

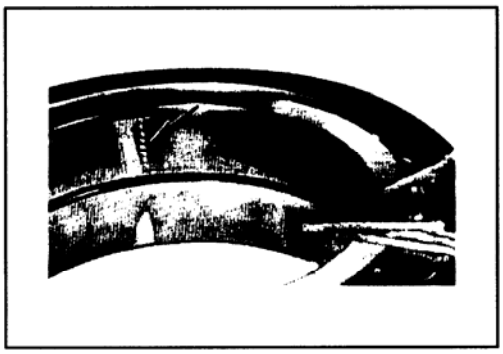
Fill the final rinse tank(s) with clean, fresh filtered solvent daily. Pump used solvent to the next dirtiest rinse tank(s). This will reduce solvent usage.

5-50. **DISTILLED SOLVENT.** Redistilled solvent shall not be used unless authorized and controlled

by the local Materials Engineering Laboratory/Physical Science Laboratory. When authorized, solvent shall be batched distilled and weekly tested for appearance, distillation range and residue content. Distilled solvent shall meet all specification requirements of the solvent. Solvent shall be clear, with no evidence of water droplets, cloudiness, and/or suspended matter when visually inspected.

005010

Figure 5-10. Galvanic Corrosion Resulting from Inadequate Controls on Carbon Remover



005011

Figure 5-11. Deplating During Fingerprint Neutralizing Due to Improper Selection of Materials

5-51. **STORAGE TANKS.** Tanks used for solvent storage and piping used to transport solvent shall be constructed of stainless steel or other noncorroding, noncontaminating material. Periodic inspections should be made for water contamination due to condensation and/or leakage. Tanks used for intrafacility transport of solvent shall not be used for carrying any other material.

5-52. **FILTRATION.** Solvent used for final rinsing and preservation processes shall be continuously filtered through 5- to 10-micron filters.

5-53. **CARBON REMOVER.** Maintenance of carbon removing solutions will vary with the type of material. Each local laboratory shall establish a monitoring program to periodically test the carbon remover. In general, these solutions will become contaminated with oil and soap residues from greases, and their cleaning effectiveness will decrease with use. Replace the solution when contamination level has built up so it is no longer effective.

5-54. **HOT OIL.** General purpose lubricating oil, MIL–PRF–32033, is used as a preservative, soak solution, softening media and flush solution.

a. Provide continuous filtration for all hot oil tanks.

b. Maintain temperature of the oil at 160° ± 10°F.

c. Change unfiltered oil on a daily basis.

5-55. **CONTROL OF BEARING CLEANING WORKLOAD.**

5-56. **PROTECTING CLEANED BEARINGS.**

a. Bearings shall not remain unprotected between cleaning processes for periods in excess of 2 hours in an uncontrolled environment.

b. Bearings requiring rework shall be given temporary protection immediately following cleaning.

c. Clean only those bearings that can be inspected and preserved within a work shift.

d. Protect bearings awaiting processing until the next shift by storing them in a temperature and humidity controlled room (70° ± 5°F and 35 to 45% relative humidity). If a controlled environment room is not available, protect the bearings with a locally approved preservative compound (e.g. MIL–PRF–32033).

NOTE

Do not use the solvent rinse tanks for over night or weekend bearing storage.

5-57. **HANDLING CLEANED BEARINGS.** Do not handle bearings with bare hands after they have been cleaned unless specifically permitted by special instructions. Use clean nonabsorbent gloves or special handling devices when handling bearings. Hand creams are not adequate as an antiperspirant for many people and there is also the problem of leaving cream residues on the clean bearing surfaces.

5-58. **SAFETY INSTRUCTIONS.**

NOTE

Materials specified or recommended in this manual are subject to all applicable federal, state, and local regulations. Local modification to these processes and procedures, and material substitutions may be necessary to ensure compliance with these regulations.

5-59. **HANDLING CHEMICALS.** Many of the chemicals specified in this section of the manual are toxic and corrosive to the skin and mucous membranes. Always observe the safety precautions and fire regulations for the use and handling of all chemical materials. Use protective equipment when working with or near these materials. Always use approved rubber gloves, aprons, face shields, and other appropriate clothing specified by local Safety and Industrial Hygienic personnel. Protective hand creams shall be utilized to prevent defatting and cracking of the skin.

5-60. **ENVIRONMENTAL CONTROLS.** The cleaning area shall be well ventilated and the use of required cleaning solvents shall be restricted to specially designated areas. Avoid prolonged or repeated breathing of vapors or physical contact with the skin. Contact local medical personnel if chlorinated solvents, carbon removers, or other chemicals come in contact with the skin and/or eyes. Wash thoroughly with water and report immediately to cognizant medical personnel.

5-61. The vapor concentrations of solvents in the working area shall not exceed maximum limits specified by the ACGIH.

Table 5-1. List of Cleaning Materials

Fig. No.	Item	Function	Material	Mfg. and/or Specification	Temp. °C (°F)	Concentration	Process Time
5-6	3	Degreaser	Lower VOC Solvent	Xxcel XLS–52	Room	As Rec'vd	As needed
5-6	4	Carbon Remover[1]	Monoethanolamine + glycol	Envirosolv 654CR	60° (140°)	Use as Rec'vd	20-30 minutes
5-6	4	Carbon Remover[1]	NMP based	Turco 5668	60° (140°)	Use as Rec'vd	20-30 minutes
5-6	4	Carbon Remover[1]	Monoethanolamine + glycol	P-C-111, Type II	Room	Use as Rec'vd	20-30 minutes
5-6	4	Carbon Remover[1]	Sodium hydrox. + chelaters	MIL-C-14460, Type I	80° (176°)	20 oz/g 150 g/l	**!15 SEC! MAXIMUM**
5–6	4	Carbon Remover[1]	Sodium hydrox. + chelaters	Turco 4181L	80° (176°)	24 oz/g	**!15 SEC! MAXIMUM**
5-6	4	Carbon Remover[1]	NMP based		60° (140°)	Use as Rec'vd	20-30 minutes
5-6	Opt.	Ultrasonics	Ultrasonic Detergent [1]	Turco Caviclean	Room		5 minutes
5-6	Opt.	Ultrasonics	Ultrasonic Detergent [1]	Fisher Brand Versa Clean	Room	2-3% by volume	5 minutes

Table 5-1. List of Cleaning Materials (Continued)

Fig. No.	Item	Function	Material	Mfg. and/or Specification	Temp. °C (°F)	Concentration	Process Time
5-6	Opt.	Ultrasonics	Ultrasonic Detergent [1]	EZE Products Intex 8125	Room	2-3% by volume	5 minutes
5-6	5	Hot water rinse	DI or RO water + inhibitor	Turco Rust Bloc	80° (176°)	0.7% by volume	1 minute
5–6	6	Water Displacement	Water Displacing Oil	Turco Aquasorb	Room	Use as Rec'd	3–5 min
5-7	2	Aqueous Cleaner [1]	Non-alkaline Detergent	Almco #150	60° (140°)	5-7% by volume	3 minutes
5-7	2	Aqueous Cleaner [1]	Non-alkaline Detergent	Branson MC-3	60° (140°)	8.5% by volume	3 minutes
5-7	2	Aqueous Cleaner [1]	Non-alkaline Detergent	Turco 6751L	60° (140°)	5-7% by volume	5 minutes
5-7	2	Aqueous Cleaner [1]	Non-alkaline Detergent	Allied Kelite Isoprep 44	60° (140°) 82° (180°)	8-10 oz./gal	3 minutes
5-7	3	Carbon Remover[1]	Monoethanolamine + glycol	Envirosolv 654CR	60° (140°)	Use as Rec'vd	20-30 minutes
5-7	3	Carbon Remover[1]	NMP based	Turco 5668	60° (140°)	Use as Rec'vd	20-30 minutes
5-7	3	Carbon Remover[1]	Monoethanolamine + glycol	P-C-111, Type II	Room	Use as Rec'vd	20-30 minutes
5-7	3	Carbon Remover[1]	Sodium hydrox. + chelaters	MIL-C-14460, Type I	80° (176°)	24 oz/g 150 g/l	**!15 SEC! MAXIMUM**
5–7	3	Carbon Remover	Sodium hydrox. + chelaters	Turco 4181L	80° (176°)	24oz/g	**!15 SEC! MAXIMUM**
5-7	3	Carbon Remover[1]	NMP based		60° (140°)	Use as Rec'vd	20-30 minutes
5-7	4	Hot water rinse	DI or RO water + inhibitor	Turco Rust Bloc	80° (176°)	0.7% by volume	1 minute
5–8	3	Degreaser	Lower VOC Solvent	Xxcel XLS–52	Room	Use as Rec'd	As needed
5-9	3	Aqueous Cleaner [1]	Non-alkaline Detergent	Almco #150	60° (140°)	5-7% by volume	3 minutes
5-9	3	Aqueous Cleaner [1]	Non-alkaline Detergent	Branson MC-3	60° (140°)	8.5% by volume	3 minutes
5-9	3	Aqueous Cleaner [1]	Non-alkaline Detergent	Turco 6751L	60° (140°)	5-7% by volume	5 minutes

Table 5-1. List of Cleaning Materials (Continued)

Fig. No.	Item	Function	Material	Mfg. and/or Specification	Temp. °C (°F)	Concentration	Process Time
5-9	3	Aqueous Cleaner [1]	Non-alkaline Detergent	Allied Kelite Isoprep 44	60° (140°) 82° (180°)	8-10 oz./gal	3 minutes
5-9	4	Hot water rinse	DI or RO water + inhibitor	Turco Rust Bloc	80° (176°)	0.7% by volume	1 minute
N/A	N/A	Fluorinated grease remover	FC-77 or PF 5070	Minnesota Mining & Manufacturing (3M)	Room	Use as Rec'vd	30 minutes

Note[1]: The solutions identified in this table have been used successfully but they are by no means the only products that will perform adequately. New materials are continually being developed and they should be evaluated for this application.

APPENDIX B

SOYGOLD® 1000 TECHNICAL DATA

SOYGOLD®

1000

INDUSTRIAL SOLVENT

A multi-use solvent that addresses the environmental, regulatory, and safety issues facing solvent users today and in the future.

Technical Data Sheet

VOCs: (Volatile Organic Compounds)
LOW VOCs: 7.29% (64 g/L) - As tested by EPA Method Number 24

ULTRA LOW EVAPORATIVE EMISSIONS:
Less than 0.005 @ 76° Fahrenheit relative to n-butyl acetate (NBAC) = 1

KAURI BUTANOL VALUE: 61
(d'Limonene – KB - 56) – (Mineral Spirits – KB - 35)

SPECIFIC GRAVITY:
0.882 g/mL @ 25° C

DIELECTRIC STRENGTH: 42.2

BOILING POINT: 632° F

VAPOR PRESSURE:
1.8 mm Hg @ 68° F

HIGH FLASH POINT:
Above 300° Fahrenheit

NON - TOXIC:
Oral toxicity/Rats: LD_{50}-17.4 g/kg body weight
(Table Salt at 1.75 g/kg is ten (10) times more toxic)

READILY BIODEGRADABLE:
95% degraded in soil in 28 days

http://www.soygold.com/solvent1000.htm

REPLACE D'LIMONENE:
In most applications with no harsh or strong odor

HIGHLY COMPATIBLE:
With many other solvents in formulations or microemulsions containing d'Limonene, NMP, mineral spirits and alcohols

SARA: *(Superfund Amendments and Reauthorization Act)*
TITLE III 313 – Not Reportable

TSCA: *(Toxic Substance Control Act)*
Listed in Inventory

SNAP: *(Significant New Alternative Policy)*
EPA listed as approved replacement chemical for solvent usage

HAPS: *(Hazardous Air Pollutants)*
Not Listed

HMIS: *(Hazardous Materials Information System)*
Health 0, Flammability 1, Reactivity 0

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Hansen Solubility

Replacing Regulated Solvents

Using Hansen Solubility Parameters

Solubility Parameters

CGS Units

Solvent	SP_h	SP_p	SP_d
Propylene Carbonate	2.0	8.8	9.8
PM	8.0	4.6	7.8
NMP	3.5	6.0	8.8
DPM	6.3	2.4	7.4
$MeCl_2$	3.0	3.1	8.9
Acetone	3.4	5.1	7.6
PtB	6.0	2.1	7.3
PM Acetate	3.0	1.8	8.8
TPM	5.7	2.0	7.4
DPtB	5.4	1.8	7.3
Aromatic 150	1.5	0.5	8.9

http://www.soygold.com/solvent1000-hansen-solubility.htm

Soygold 1000 Industrial Solvent -Hansen Solubility

DPM Acetate	4.0	1.9	7.4
1,1,1 Trichloroethane	1.0	2.1	8.3
d' limonene	0.0	0.3	8.1
SoyGold 1000	**2.9**	**2.4**	**7.9**
Exxate 1000	1.5	2.8	7.3
CFC-113	0.0	1.0	7.5
Isopar L	0.0	0.0	7.3

SP_h = Hydrogen Bonding SP_d = Dispersion

SP_p = Polarity

http://www.soygold.com/solvent1000-hansen-solubility.htm

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INDUSTRIAL SOLVENT

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Rubber Compatibility

RATING	RECOMMENDED AND APPROVED
*A	Fluoroelastomer (FKM) - Viton
A	Epichlorohydrin (ECO/CO) - Hydrin
*AA	Fluoro Ethylene Propylene (FEP) - Teflon
A	Isobutylene Isoprene (IIR) - Butyl
A	Perfluorinated Elastomer (FFKM) - Chemraz
A	Perfluorinated Copolymer Elastomer (FFKM) - Kalraz
A	Fluorinated Copolymer (FXM) - Fluoraz
*A	Gylon - 3504, 3540, 3545, 3510 - Garlock Gylon

*Best for Service

	NOT RECOMMENDED AND NOT APPROVED
NR	Nitrile (NBR) - Buna-N
NR	Nitrile (NBR) - Buna-N Blends
NR	Hydrogenated Nitrile (HNBR)
NR	Ethylene Acrylic (EAM) - (EA) - Vamac
NR	Chlorinated Polyethylene (CPE) (CM)
NR	Chlorosulfanated Polyethylene (CSM) - Hypalon
NR	Silicone (VMQ)
NR	Chloroprene or Polychloroprene (CR) - Neoprene
NR	Nitrile - Black (NBR)
NR	Nitrile - White (NBR)
NR	Styrene Butadiene (SBR) - Buna-S
NR	Polyacrylate (ACM)
NR	Polyurethane (AU) (EU)

http://www.soygold.com/solvent1000-rubber-compatibility.htm

Soygold 1000 Industrial Solvent -Rubber Compatibility

NR	Polybutadiene or Butadiene (BR)
NR	Modified Polyethylene (AQP) - Aero Quip
NR	Synthetic Isoprene (IR) - Synthetic Rubber
	NOT RECOMMENDED BUT MARGINAL
B	X-Link Polyethylene (XLPE)
B	Ethylene Propylene (EPDM)
B	Ethylene Propylene (EP)

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http://www.soygold.com/solvent1000-rubber-compatibility.htm

SOYGOLD

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Carbon Chain Length Distribution and Percent Oxygen

Produced from Typical Soybean Oil

COMPONENT	CAS#	BONDING	% of compound	% O2
Methyl Palmitate	112-39-0	C-16	10.0	11.8
Methyl Stearate	112-61-8	C-18	04.0	10.7
SATURATED %			14.0	
Methyl Oleate	112-62-9	C-18=1	25.0	10.8
Methyl Linoleate	112-63-0	C-18=2	53.0	10.9
Methyl Linolenate	301-00-8	C-18=3	08.0	10.9
UNSATURATED%			86.0	
TOTAL AVG. % O2				11.0

http://www.soygold.com/solvent1000-chemical-breakdown.htm

Soygold 1000 Industrial Solvent -Carbon Distribution

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http://www.soygold.com/solvent1000-chemical-breakdown.htm

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Solvents

ACTS# (5100)	SoyGold 1000	SoyGOLD 1100
Total Plate Count	est.<10 cfu/g	est.<10cfu/g
Yeast Count	<10 cfu/g	<10 cfu/g
Mold Count	<10 cfu/g	<10 cfu/g
E. coli	Negative	Negative
Salmonella species	Negative	Negative
Staphylococcus aureus	Negative	Negative
Pseudomonas aeruginosa	Negative	Negative

ACTS# (5100)	SoyClear 1500	CanolaGold 110
Total Plate Count	est.<10 cfu/g	est.<10 cfu/g
Yeast Count	<10 cfu/g	<10 cfu/g
Mold Count	<10 cfu/g	<10 cfu/g
E. coli	Negative	Negative
Salmonella species	Negative	Negative
Staphylococcus aureus	Negative	Negative
Pseudomonas aeruginosa	Negative	Negative

ACTS# (5100)	SoyGold 2000
Total Plate Count	est.<10 cfu/g
Yeast Count	<10 cfu/g
Mold Count	<10 cfu/g

http://www.soygold.com/solvent1000-microbial-limits.htm

E. coli	Negative
Salmonella species	Negative
Staphylococcus aureus	Negative
Pseudomonas aeruginosa	Negative

est. refers to actual plate counts not within the range of 25 to 250 colony forming units
g = grams
< = less than

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Soygold 1000 Industrial Solvent -Comparison Chart

SOYGOLD®

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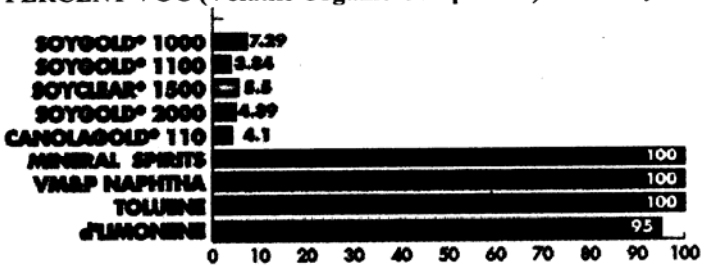
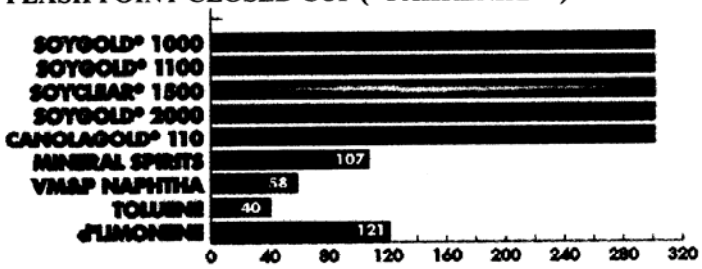
INDUSTRIAL SOLVENT

A multi-use solvent that addresses the environmental, regulatory, and safety issues facing solvent users today and in the future.

PERCENT VOC (Volatile Organic Compounds) As tested by EPA Method number 24



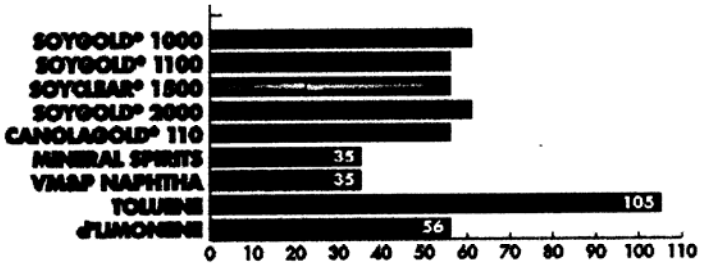
FLASH POINT CLOSED CUP (° FAHRENHEIT)



KAURI-BUTANOL VALUES

http://www.soygold.com/solvent1000-comparison-chart.htm

Soygold 1000 Industrial Solvent -Comparison Chart



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http://www.soygold.com/solvent1000-comparison-chart.htm

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A multi-use solvent that addresses the environmental, regulatory, and safety issues facing solvent users today and in the future.

Comparison With Common Solvents

Solvent	Health (1)	Flammability (2)	Reactivity (3)
SOYGOLD 1000	0	1	0
SOYGOLD 1100	0	1	0
SOYGOLD 1500	0	1	0
SOYGOLD 2000	0	1	0
CANOLAGOLD 110	0	1	0
Mineral Spirits	0	2	0
VM&P Naphtha	1	3	0
Toluene	2	3	0
d'limonene	0	2	0

(1) Health as per HMIS regulation - 0 = Normal, 1 = Slightly Hazardous, 2 = Hazardous, 3 = Extreme Danger, 4 = Deadly.

(2) Flammability (Flash Point °F) as per HMIS regulation - 0 = Will not burn, 1 = Above 200°F, 2 = Above 100°F not exceeding 200°F, 3 = Below 73°F (Boiling Point at/above 100°F) and/or above 73°F not exceeding 100°F, 4 = Below 73°F (Boiling Point below 100°F).

(3) Reactivity as per HMIS regulation - 0 = Stable, 1 = Unstable if heated, 2 = Violent chemical change, 3 = Shock/heat may detonate, 4 = May detonate

Solvent	Flash Closed Cup(°F)	Boiling Point(°F) @760mm HG	Evaporation Rate @ 25°C (NBAC=1.00)
SOYGOLD 1000	>300	632	<0.006
SOYGOLD 1100	>300	638	<0.005
SOYGOLD 1500	>300	634	<0.005

http://www.soygold.com/solvent1000-comparson.htm

Comparison of Solvent Properties

SOYGOLD 2000	>300	634	<0.005
CANOLAGOLD 110	>300	640	<0.002
Mineral Spirits	107	160-187	0.16
VM&P Naphtha	58	124-142	1.81
Toluene	40	110.6	2.00
d'limonene	121	175-176	0.005

Solvent	Specific Gravity g/mL @ 25°C	Viscosity @ 25°C
SOYGOLD 1000	0.882	4.50
SOYGOLD 1100	0.880	4.50
SOYGOLD 1500	0.876	4.50
SOYGOLD 2000	0.882	4.72
CANOLAGOLD 110	0.876	4.50
Mineral Spirits	0.775	0.88
VM&P Naphtha	0.748	0.62
Toluene	0.863	0.57
d'limonene	0.843	3.50

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SOYGOLD 1000 SOLVENT

MATERIAL SAFETY DATA SHEET

EMERGENCY PHONE: 913-599-6911 CHEMTREC: 800-424-9300

SECTION I-IDENTIFICATION

PRODUCT: SOYGOLD® 1000
CAS No.: 67784-80-9
CHEMICAL: Fatty acid methyl esters
SYNONYMS: Methyl esters of soybean oil

SECTION II-INGREDIENTS AND HAZARD CLASSIFICATION

TYPICAL COMPOSITION

Alkyl C_{16}-C_{18}-Methyl Esters
This product contains no hazardous material.
SARA HAZARD: TITLE III SECTION 313-Not listed FIRE (Section 311/312): None noted

SECTION III-HEALTH INFORMATION

EFFECTS OF OVEREXPOSURE
INHALATION: No known problems
INGESTION: LD_{50}:>50ml/kg (albino rats)(similar products)
EYE CONTACT: Not classified as eye irritants
SKIN CONTACT: Not classified as a skin irritant or corrosive material

SECTION IV-OCCUPATIONAL EXPOSURE LIMITS

PEL: NO OSHA PEL TLV: NO ACGIH TLV

SECTION V-EMERGENCY FIRST AID PROCEDURE

FOLLOW STANDARD FIRST AID PROCEDURES
SWALLOWING: Call physician or poison control center.
SKIN CONTACT: Wash affected area.
EYE CONTACT: Flush eyes with cool water for at least 15 minutes. Do not let victim rub eyes.
INHALATION: Immediately remove victim to fresh air. Get medical attention immediately.

SECTION VI-PHYSICAL DATA

BOILING POINT: Over 600° F (315° C) at 760 mm Hg pressure
MELTING POINT: -1° C
VAPOR PRESSURE: 1.8 mm Hg at 68° F
SPECIFIC GRAVITY: 0.882 g/ml at 25° C
DIELECTRIC STRENGTH: 42.4
SOLUBILITY IN WATER: Negligible at room temperature
APPEARANCE AND COLOR: Light yellow and liquid at room temperature
ODOR: Light vegetable oil odor

SECTION VII-FIRE AND EXPLOSION HAZARDS

FLASH POINT & METHOD USED: 425° F (218° C)(PMCC)
FLAMMABLE LIMITS: Not applicable
NFPA RATING: No NFPA rating

HMIS RATING: HEALTH: 0 FIRE: 1 REACTIVITY: 0

SPECIAL FIRE FIGHTING PROCEDURES & PRECAUTIONS
Treat as oil fire. Use water spray, dry chemical, foam or carbon dioxide.

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UNUSUAL FIRE & EXPLOSION HAZARDS
Rags soaked with any solvent present a fire hazard and should always be stored in UL listed or Factory Mutual approved, covered containers. Improperly stored rags can create conditions that lead to oxidation. Oxidation, under certain conditions can lead to spontaneous combustion. This product contains antioxidants to retard oxidation.

SECTION VIII-REACTIVITY

STABILITY:	Stable
HAZARDOUS POLYMERIZATION:	None likely
MATERIALS TO AVOID:	Strong oxidizing agents
HAZARDOUS DECOMPOSITION PRODUCTS:	CO_2, CO
CONDITIONS TO AVOID:	None known

SECTION IX-EMPLOYEE PROTECTION

CONTROL MEASURES:	Adequate ventilation
RESPIRATORY PROTECTION:	None required
PROTECTIVE CLOTHING:	No need anticipated
EYE PROTECTION:	None required

SECTION X-ENVIRONMENTAL PROTECTION

ENVIRONMENTAL PRECAUTIONS:	Avoid uncontrolled releases of this material into environment.
SPILL OR LEAK PRECAUTIONS:	Contain spilled material. Transfer to secure containers. Where necessary, collect using absorbent media.
WASTE DISPOSAL:	Dispose of according to federal, state and/or local requirements.

SECTION XI-REGULATORY CONTROLS

DOT CLASSIFICATION:	Class 55
DOT PROPER SHIPPING NAME:	Cleaning Compound, N.O.S.
OTHER REGULATORY REQUIREMENTS:	Listed in TSCA inventory

SECTION XII-PRECAUTIONS: HANDLING, STORAGE AND USAGE

No special precautions necessary.

SECTION XIII-DATE AND SIGNATURE

This information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any other process. The stated MSDS is reliable to the best of the company's knowledge and believed accurate as of the date indicated. However, no representation, warranty or guarantee of any kind, expressed or implied, is made as to its accuracy, reliability or completeness and we assume no responsibility for any loss, damage or expense, direct or consequential, arising out of use. It is the user's responsibility to satisfy himself as to the suitableness and completeness of such information for his own particular use.

AG ENVIRONMENTAL PRODUCTS, L.L.C.
9804 PFLUMM
LENEXA, KS 66215

SIGNATURE: William A. Ayres

PREPARED BY: WILLIAM A. AYRES REVISION DATE: 5-01-01

APPENDIX C

ALTERNATIVE SOLVENTS RINSE EFFICIENCY SCREENING TEST FOR THE AERONAUTICAL ANTIFRICTION BEARING CLEANING PROCESS

Alternative Solvents Rinse Efficiency Screening Test
For the Aeronautical Antifriction Bearing Cleaning Process

Introduction

MIL-PRF-680 is used as a rinsing agent in the aeronautical antifriction bearing cleaning process. In order to identify potential solvents that may be used as an alternative in this process, they must first be lab tested against MIL-PRF-680.

The rinse efficiency test described in this protocol is a quick and inexpensive method to determine the ability of alternative solvents to remove cleaning agents such as degreasers, water displacing oil, vibratory cleaner burnishing soap, and fingerprint neutralizer that are used during the bearing cleaning process.

A successful result of this preliminary test will indicate that the alternative solvents should be considered for further testing. The discussion that follows describes the test rationale and procedure used to determine rinse efficiency.

Test Rationale

A spectrophotometer will be used to compare the rinse efficiency of potential alternative solvents to the rinse agent that is currently used in the bearing cleaning process.

A test coupon of known mass, contaminated with a known quantity of cleaning agent, will be immersed into a known volume of an alternative solvent for a prescribed length of time, and then removed. All, or a portion of the cleaning agent will be removed from the test coupon and be contained in the known volume of alternative solvent.

A spectrophotometer will be used to determine the peak absorbance of the resultant solution of alternative rinse agent and cleaner. The absorbance value will be compared to a reference curve generated from a series of know concentrations of the same alternative rinse agent and cleaner. By locating the peak absorbance on a reference curve of peak absorbance vs. concentration, the rinse efficiency can be determined.

The same procedure will be performed using the same cleaner and MIL-PRF-680 to determine rinse efficiency. The rinse efficiencies of the alternative solvent and MIL-PRF-680 will then be compared to determine if further testing of the alternative solvent is warranted.

Experimental Approach

The rinse efficiency test is divided into three parts. In Part 1, test coupons are prepared and weighed. In Part 2, reference curves relating peak absorbance to cleaner (contaminant) concentration in the rinse agent solution are prepared for both MIL-PRF-680 and the alternative solvent. In Part 3, a spectrophotometer is used to determine the rinse efficiencies of MIL-PRF-

680 and the alternative solvent. The following sections provide detailed procedures for Parts 1, 2, and 3 of the rinse efficiency test.

PART 1: Coupon Preparation

Prepare a total of six coupons to determine the rinse efficiency for each alternative solvent.

1. Shape each coupon to 2” x 1” x 1/16” 316 Stainless Steel and drill a 1/16 inch diameter hole at one end for attachment of a handling wire. Drill the hole 3/16 inch from the edge at the mid point of the 1-inch long side.

2. The test coupons do not require any specialized surface preparation (i.e. no sanding or polishing).

3. Label each of the six coupons with an alphanumeric code. Designate the labels as follows: each coupon receives the letters “MP” (MIL-PRF-680) or “AS” (Alternative Solvent) and a number 1, 2 or 3, resulting, MP1, MP2, MP3, AS1, AS2, and AS3.

4. Clean and dry each coupon to remove residual oils and surface contaminants. Weigh each coupon to the nearest 0.01mg and record the results in Table 1 as WMP1, WMP2, WMP3, WAS1, WAS2, and WAS3. Store all test coupons in a desiccator until needed. After cleaning, handle the test coupons only with laboratory tongs or tweezers by a handling wire attached to the coupon.

Table 1: TEST COUPON DATA

Coupon Label	Coupon Weight (g)	Weight of Contaminated Coupon (g)	Weight of Contaminant Applied (g)	Peak Absorbance
MP1	WMP1	WCMP1	WCAMP1	PAMP1
MP2	WMP2	WCMP2	WCAMP2	PAMP2
MP3	WMP3	WCMP3	WCAMP3	PAMP3
AS1	WAS1	WCAS1	WCAAS1	PAAS1
AS2	WAS2	WCAS2	WCAAS2	PAAS2
AS3	WAS3	WCAS3	WCAAS3	PAAS3

PART 2: Preparation of Reference Curves

The rationale behind preparing reference curves for MIL-PRF-680 and the alternative solvent is that contaminants present in a solvent will change the absorbtivity of the solvent. Also, a solvent with varying amounts of contaminant will yield a series of peak absorbance values that will vary with concentration.

Preparation of accurate reference curves for MIL-PRF-680 and the alternative solvent is key to determining the rinse efficiency using this protocol. This section provides detailed instruction for preparing these curves.

MIL-PRF-680 Reference Curve

1. Select the cleaning agent to be used as the contaminant in the rinse efficiency test. The bearing cleaning process currently uses agents such as degreasers, water displacing oil, vibratory cleaner burnishing soap, and fingerprint neutralizer. As only a small amount of cleaner (contaminant) will likely adhere to the sample surface, use an organic dye to color the cleaner. The amount of dye necessary depends on the specific cleaner (in some cases, no dye will be necessary). However, as only one solution of cleaner and dye will be used to compare any two rinsing agents, the quantity does not need to be specified. The amount of dye used should produce a measurable peak absorbency shift of varying concentrations of rinsing agent and contaminant.

2. Place 250ml of MIL-PRF-680 into three separate 250ml beakers. Place 250ml of the selected contaminant into a separate 250ml beaker. Label each beaker as to contents (MIL-PRF-680 or contaminant) and set aside.

3. Retrieve the three test coupons labeled MP1, MP2, and MP3 from the desiccator. Using a handling wire, hook test coupon MP1 through the hole in the coupon and fully immerse into the 250ml beaker containing the selected contaminant. Allow the coupon to remain fully immersed in the solution for approximately 15 seconds then remove the coupon and allow it to hang above the beaker until all the excess solution drips off the panel. Repeat this process with test coupons labeled MP2 and MP3.

4. Weigh each contaminated coupon to the nearest 0.01mg and record the results in Table 1 as WCMP1, WCMP2, and WCMP3. Using the initial weight of each panel, calculate the weight of contaminant applied (WCAMP1, WCAMP2, and WCAMP3) to each test coupon (WCAMP1=WCMP1-WMP1). Record the weight of contaminants applied for each of the three coupons in Table 1 as WCAMP1, WCAMP2, and WCAMP3.

At this point in the procedure, reference solutions with known concentrations of cleaner (contaminant) must be prepared. A series of solutions will be prepared for each of the three contaminated coupons labeled MP1, MP2, and MP3. We will assume that a 100% efficient rinsing agent (solvent) will remove 100% of the contaminant (cleaner). Therefore, using the mass of contaminant as a theoretical maximum, we will create a set of dilutions of the rinse agent, under investigation, with fractions of this maximum mass of contaminant in order to

generate a reference curve. We will assume that the contaminant will be completely removed from the coupon by the solvent and that the weight of contaminant in solution will be the weight of contaminant applied that was recorded earlier as WCAMP1, WCAMP2, and WCAMP3. The rinse efficiency of the particular solvent will be determined by comparing the experimentally diluted solution to the known reference solutions. The following procedure will be performed for each of the three contaminant weights.

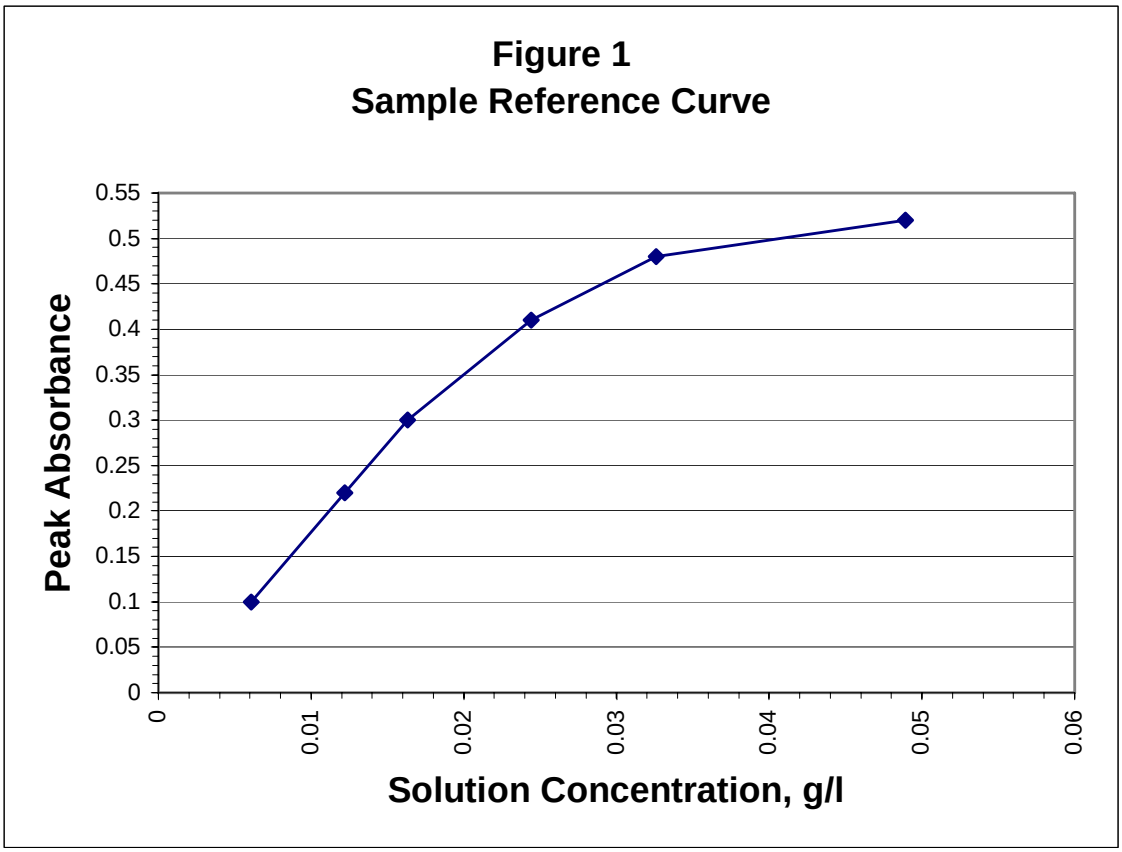
5. Place 4 times the calculated weight of WCAMP1 contaminant into a 1000ml beaker. Add 1000ml of MIL-PRF-680 to the beaker and mix thoroughly. From this solution, decant two 250ml samples and place each into 250ml beakers labeled "A1" and "B1". Place the remaining 500ml into a 500ml beaker and set aside.

6. Knowing the weight of contaminant recorded as WCAMP1 from step 4, prepare additional reference solutions A2, A3, A4, B2, and B3 using the equations shown in Table 2. Use a spectrophotometer to measure the peak absorbance for each solution concentration (A1, A2, A3, A4, B1, B2, and B3) and record the values in Table 2. Prepare an X-Y plot of peak absorbance as a function of solution concentration as illustrated in Figure 1.

7. Prepare similar reference curves for WCAMP2 and WCAMP3 using the same procedure.

8. Retrieve one of the three 250ml beakers of MIL-PRF-680 that were prepared in Step 2. Place a magnetic stirring rod into the beaker and place the beaker onto a magnetic stirrer. Turn the stirrer on and adjust the stirring speed to approximately 60 revolutions per minute. Turn the stirrer off. Using a handling wire, totally immerse the contaminated test coupon labeled MP1 into the beaker and turn the stirrer on. Allow the coupon to soak for approximately 15 seconds. Remove the coupon and allow it to drip-dry over the beaker. When fluid no longer drips from the coupon, set the coupon aside and allow the solution to mix thoroughly. Turn the stirrer off. Remove a sample of the solution and determine the peak absorbance using the spectrophotometer. Record the results as PAMP1 in Table 1. Repeat the process for contaminated test coupons labeled MP2 and MP3. Record the peak absorbances as PAMP2 and PAMP3 in Table 1.

Table 2: MIL-PRF-680 REFERENCE SOLUTIONS			
Beaker	**Dilution**	**Solution Concentration**	**Peak Absorbance**
A1	250ml solution of MIL-PRF-680 and Contaminant (250ml of MIL-PRF-680 + WCAMP1)	WCAMP1mg/250ml	PAA1
A2	Decant 125ml from A1 into a 250ml beaker and add 125ml of MIL-PRF-680 and label A2	(WCAMP1mg/250ml)/2	PAA2
A3	Decant 125ml from A2 into a 250ml beaker and add 125ml of MIL-PRF-680 and label A3	(WCAMP1mg/250ml)/4	PAA3
A4	Decant 125ml from A3 into a 250ml beaker and add 125ml of MIL-PRF-680 and label A4	(WCAMP1mg/250ml)/8	PAA4
B1	250ml solution of MIL-PRF-680 and contaminant (250ml of MIL-PRF-680 + WCAMP1)	WCAMP1mg/250ml	PAB1
B2	Decant 166.7ml from A1 into a 250ml beaker and add 83.3ml of MIL-PRF-680 and label B2	(2/3)(WCAMP1mg/250ml)	PAB2
B3	Decant 125ml from A2 into a 250ml beaker and add 125ml of MIL-PRF-680 and label B3	(1/3)(WCAMP1mg/250ml)	PAB3



Alternative Cleaner Reference Curve

1. Select the cleaning agent to be used as the contaminant in the rinse efficiency test.

2. Place 250ml of the alternative solvent into three separate 250ml beakers. Place 250ml of the selected contaminant into a separate 250ml beaker. Label each beaker as to contents (Alternative solvent or contaminant) and set aside.

3. Retrieve the three test coupons labeled AS1, AS2, and AS3 from the desiccator. Using a handling wire, hook test coupon AS1 through the hole in the coupon and fully immerse into the 250ml beaker containing the selected contaminant. Allow the coupon to remain fully immersed in the solution for approximately 15 seconds then remove the coupon and allow it to hang above the beaker until all the excess solution drips off the panel. Repeat this process with test coupons labeled AS2 and AS3.

4. Weigh each contaminated coupon to the nearest 0.01mg and record the results in Table 1 as WCAS1, WCAS2, and WCAS3. Using the initial weight of each panel, calculate the weight of contaminant applied (WCAAS1, WCAAS2, and WCAAS3) to each test coupon

(WCAAS1=WCAS1-WAS1). Record the weight of contaminants applied for each of the three coupons in Table 1 as WCAAS1, WCAAS2, and WCAAS3.

5. Place 4 times the calculated weight of WCAAS1 contaminant into a 1000ml of beaker. Add 1000ml of the alternative solvent to the beaker and mix thoroughly. From this solution, decant two, 250ml samples and place each into 250ml beakers labeled "C1" and "D1". Place the remaining 500ml into a 500ml beaker and set aside. Prepare additional reference solutions using the equations shown in Table 3.

6. Knowing the weight of contaminant recorded as WCAAS1 from step 4, prepare additional reference solutions C2, C3, C4, D2, and D3 using the equations shown in Table 3. Use a spectrophotometer to determine the peak absorbance for each solution concentration (C1, C2, C3, C4, D1, D2, and D3) and record the values in Table 3. Prepare an X-Y plot of peak absorbance as a function of solution concentration as illustrated in Figure 1.

7. Prepare similar reference curves for WCAAS2 and WCAAS3 using the same procedure.

8. Retrieve one of the three 250ml beakers of alternative solvent that were prepared in Step 2. Place a magnetic stirring rod into the beaker and place the beaker onto a magnetic stirrer. Turn the stirrer on and adjust the stirring speed to approximately 60 revolutions per minute. Turn the stirrer off. Using a handling wire, totally immerse the contaminated test coupon labeled AS1 into the beaker and turn the stirrer on. Allow the coupon to soak for approximately 15 seconds. Remove the coupon and allow it to drip-dry over the beaker. When fluid no longer drips from the coupon set the coupon aside and allow the solution to mix thoroughly. Turn the magnetic stirrer off. Remove a sample of the solution and determine the peak absorbance using the spectrophotometer. Record the results as PAAS1 in Table 1. Repeat the process for contaminated test coupons labeled AS2 and AS3. Record the peak absorbances as PAAS2 and PAAS3 in Table 1.

Table 3: ALTERNATIVE SOLVENT REFERENCE SOLUTIONS			
Beaker	**Dilution**	**Solution Concentration**	**Peak Absorbance**
C1	250ml solution of Alternative solvent and Contaminant (250ml of Alternative solvent + WCAAS1)	WCAAS1mg/250ml	PAC1
C2	Decant 125ml from C1 into a 250ml beaker and add 125ml of Alternative solvent and label C2	(WCAAS1mg/250ml)/2	PAC2
C3	Decant 125ml from C2 into a 250ml beaker and add 125ml of Alternative solvent and label C3	(WCAAS1mg/250ml)/4	PAC3
C4	Decant 125ml from C3 into a 250ml beaker and add 125ml of Alternative solvent and label C4	(WCAAS1mg/250ml)/8	PAC4
D1	250ml solution of Alternative solvent and Contaminant (250ml of Alternative solvent + WCAAS1)	WCAAS1mg/250ml	PAD1
D2	Decant 166.7ml from D1 into a 250ml beaker and add 83.3ml of Alternative solvent and label D2	(2/3)(WCAAS1mg/250ml)	PAD2
D3	Decant 125ml from D2 into a 250ml beaker and add 125ml of Alternative solvent and label D3	(1/3)(WCAAS1mg/250ml)	PAD3

PART 3: Rinse Efficiency Determination

In Part 3, rinse efficiencies are determined for both MIL-PRF-680 and the Alternative solvent using the coupons prepared in Part 1 and the reference curves developed in Part 2.

Determine MIL-PRF-680 Rinse Efficiency

Using the WCAMP1, WCAMP2, and WCAMP3 reference curves developed in Part 2, locate the corresponding solution concentrations for the peak absorbance values PAMP1, PAMP2, and PAMP3 that were recorded in Table 1.

Knowing the corresponding solution concentrations in g/l, the amount of contaminant removed from the coupons can be determined.

Recall in Part 1, that the contaminated coupon was immersed in a 250ml beaker of MIL-PRF-680 to remove a portion, or all, of the contaminant. The amount of contaminant removed from

the coupon is therefore the solution concentration in g/1000ml times 250ml. Or, one quarter of the corresponding amount identified in Figure 1. Record the weight of contaminant removed as WCRMP1 in Table 4. Repeat for WCRMP2 and WCRMP3.

The rinse efficiency of MIL-PRF-680 is calculated to be the amount of contaminant removed from the coupon divided by the weight of contaminant applied to the coupon in Part 1 times 100. This value represents the percent of contaminant removed by the MIL-PRF-680. Record this value in Table 4 as rinse efficiency as REMP1. Repeat for REMP2 and REMP3.

Determine Alternative Solvent Rinse Efficiency

The alternative solvent rinse efficiency is determined using the same method as previously described for MIL-PRF-680. Using the WCAAS1, WCAAS2, and WCAAS3 reference curves, find the corresponding solution concentration for the measured peak absorbance for samples AS1, AS2 and AS3 that were recorded in Table 1.

Knowing the corresponding solution concentrations in g/l, the amount of contaminant removed from the coupons can be determined.

Recall in Part 1, that the contaminated coupon was immersed in a 250ml beaker containing the alternative solvent to remove a portion, or all, of the contaminant. The amount of contaminant removed from the coupon is therefore the solution concentration in g/1000ml times 250ml. Or, one quarter of the corresponding amount identified in Figure 1. Record the weight of contaminant removed as WCRAS1 in Table 4. Repeat for WCRAS2 and WCRAS3.

The rinse efficiency of the alternative solvent is calculated to be the amount of contaminant removed from the coupon divided by the weight of contaminant applied to the coupon in Part 1 times 100. This value represents the percent of contaminant removed by the alternative solvent. Record this value in Table 4 as rinse efficiency as REAS1. Repeat for REAS2 and REAS3.

Table 4: RINSE EFFICIENCY

Coupon Label	Weight of Contaminant Applied	Weight of Contaminant Removed	Rinse Efficiency
MP1	WCAMP1	WCRMP1	REMP1
MP2	WCAMP2	WCRMP2	REMP2
MP3	WCAMP3	WCRMP3	REMP3
AS1	WCAAS1	WCRAS1	REAS1
AS2	WCASC2	WCRAS2	REAS2
AS3	WCASC3	WCRAS3	REAS3

Comparison of MIL-PRF-680 and Alternative Cleaner Rinse Efficiencies

As a screening test, the rinse efficiencies of the alternative cleaner and MIL-PRF-680 are to be compared. If the rinse efficiency of the alternative solvent is found to be equal to or better than the MIL-PRF-680 rinse agent, compatibility testing will be considered. If the rinse efficiency is found to be less that that of the MIL-PRF-680 rinse agent compatibility testing will not be performed.

APPENDIX B

U.S. Army Aberdeen Test Center
Final Analytical Test Report
No. ATC-9192

U.S. ARMY ABERDEEN TEST CENTER

REPORT NO. ATC-9192

Final Report

Joint Test Protocol for Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning

August 2006

William Taylor

Warfighter Directorate, Applied Sciences Test Division
Materials and Standards Testing Team

Prepared for:
U.S. Naval Facilities Engineering
Service Center
Port Hueneme, CA 93043-4370

U.S. Army Developmental Test Command
Aberdeen Proving Ground, MD 21005-5055

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ABERDEEN PROVING GROUND, MARYLAND 21005-5059

REPLY TO
ATTENTION OF

CSTE-DTC-AT-WF-A

MEMORANDUM FOR Naval Facilities Engineering Services Center, (Brad Hollan) Code 421, 1100 23rd Avenue, Port Hueneme, CA 93043-4370

SUBJECT: Joint Test Protocol for Validation of Alternatives to High Volatile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning Report

1. Subject report is forwarded for release.

2. The point of contact of this at this activity is William H. Taylor and he may be reached at 410-278-4461 or email William.Taylor@atc.army.mil.

Encl

JOHN B. RUHL
Director, Warfighter Directorate

Printed on Recycled Paper

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1.1 SUMMARY

a. The U.S. Naval Facilities Engineering Service Center (NFESC) requested that the U.S. Army Aberdeen Test Center (ATC) provide assistance in resolving an issue with a soybean oil-based methyl ester product manufactured by Ag Environmental Products, L.L.C., called SoyGold 1000. The Navy is considering the use of SoyGold 1000 as a replacement for hydrocarbon-based solvents during the rinsing of aeronautical antifriction bearings during Department of Defense (DoD) depot-level maintenance cleaning. Testing had not been performed to determine the effects that SoyGold 1000 may have on parts, equipment, the environment, or worker safety. A group led by NFESC, consisting of technical representatives from ATC, U.S. Naval Facilities Engineering Command, U.S. Naval Air Systems Command, U.S. Army Research Laboratory (ARL), U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC), U.S. Army Aviation and Missile Command (AAMCOM), U.S. Air Force Material Command, and U.S. Air Force Warner Robins Air Logistics Center, developed a protocol to address the issues about this cleaner.

b. The protocol was developed to test SoyGold 1000 using established and recognized test methods endorsed by the American Society for Testing and Materials (ASTM) and the Society of Automotive Engineers (SAE). For unique situations, military test specifications were used to meet mission-critical criteria.

c. Testing was divided into two phases. Phase I was screening criteria of Environmental and Occupational Safety and Health Properties. Phase II was Materials Compatibility.

d. For phase I testing, a toxicity clearance was requested and granted by the U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM), Aberdeen Proving Ground (APG), Maryland, for SoyGold 1000. At the detection limits identified by CHPPM, there was a trace of one volatile organic compound (VOC) found. Flash point and vapor pressure values were within the stated criteria. Appearance of the new and 12-month-old products was within the stated criterion. The product was slightly acidic for both new and old products with the criterion not allowing any evidence of acidity. The two nonvolatile residue results were not within the criterion limits because of the product's inability to evaporate as a result of low volatile content. The kauri-butanol value was above the limits set in the criterion and did not meet that requirement.

e. Phase II, materials compatibility testing for total immersion and stress corrosion for both the new and 12-month-old products, met the criterion. The product met the criterion for titanium stress corrosion but not hydrogen embrittlement.

f. The performance tests of water break and soil cleaning were not met by SoyGold 1000.

1.2 TEST OBJECTIVE

The test objective was to provide technical data to NFESC to enable them to determine if SoyGold 1000 is a safe, materially compatible, and viable alternative replacement for MIL-PRF-680 solvents for rinsing aeronautical bearings during maintenance.

1.3 TESTING AUTHORITY

In November 2004, the U.S. Army Aberdeen Test Center (ATC) was authorized to conduct testing on 17 alternative cleaners for use during hand-wipe operations. This program, called the Sustained Painting Operations for the Total Army (SPOTA), included the testing of the SoyGold 1000 product. The testing required by NFESC for SoyGold 1000 was included in the SPOTA program.

1.4 SYSTEM DESCRIPTION

The SoyGold 1000 product is a soybean oil-based methyl ester. It is used commercially as a petroleum degreaser and adhesive removal for metal-cutting applications and tool and equipment cleaning.

1.5 TESTING ENVIRONMENT

a. SoyGold 1000 was tested as received at ambient temperature for the majority of the materials compatibility tests. One of the requirements of the testing was to determine the effects that long-term storage had on SoyGold 1000. It was required that several tests be conducted using new product and product after a minimum 12-month storage period. The data will be displayed as “new” and “old.” Virgin product was used for each test. After the solution was used for any testing, it was disposed of properly.

b. In the test protocol, the required test materials for each test were described. Two of those materials, M-50 NiL and Vasco X-2, were unavailable. Telephone calls were made to five production mills and more than a dozen metal suppliers, but these materials have not been made for several years. The material Cronidur 30 could not be made in coupons suitable for stress corrosion testing. The material is extremely hard and would shatter if bent. The material can be formed for the total immersion corrosion test coupons.

1.6 CONCLUSIONS

a. Environmental, Occupational Safety, and Health.

(1) SoyGold 1000 was granted a toxicity clearance by CHPPM.

(2) The amount of VOCs for all compounds except naphthalene was under the detection limits of the equipment and therefore considered to have met the criterion as a low VOC product. Naphthalene was detected in trace amounts.

(3) The flash point of SoyGold 1000 for the new and old products was within the criterion.

b. Chemical Properties.

(1) The vapor pressure value met the criterion.

(2) SoyGold 1000 had a slight amount of acidity and did not meet the criterion.

(3) SoyGold 1000 met the criterion for appearance for both the old and new products.

(4) Since SoyGold 1000 did not evaporate, the nonvolatile residue of the product was determined to be 105,000 times over the stated criterion. The nonvolatile residue with isopropyl rinse could not be accomplished because of the evaporating issue. An explanation of this test and results are in the body of the report.

c. Materials Compatibility.

(1) SoyGold 1000 performed well during the total immersion corrosion testing for both the old and new products. There was minimal weight change for all materials tested. Some test coupons developed very slight stains that could be attributed to the washing and drying sequence.

(2) The stress corrosion testing was met using the stated criteria for both the new and old products. There was no evidence of cracking on any coupon.

(3) The hydrogen embrittlement testing was not met for either the old or new products.

(4) The titanium stress corrosion testing was met for both the new and old products for both materials, 4911 and 4916.

d. Performance.

(1) SoyGold 1000 did not meet the criterion for soil cleaning. The requirement in the MIL-PRF-680 for types I, II, and III solvents is 85 percent solvency and 88 percent for type IV solvents. The efficiency of SoyGold 1000 averaged 30 percent.

(2) The product developed an immediate discontinuous film of water during the water-break test and did not meet the criterion.

(3) SoyGold 1000 met the criterion for storage stability.

1.7 RECOMMENDATIONS

a. SoyGold 1000 should not be used for applications where the possibility of hydrogen embrittlement exists.

b. SoyGold 1000 is safe to use from a health and safety standpoint.

c. SoyGold 1000 can be used in applications where nonplated parts are under stress or extended periods of immersion using the tested materials.

d. The performance of SoyGold 1000 as a cleaner seems to be questionable considering the performance tests for soil cleaning, water break, and nonvolatile residue.

e. SoyGold 1000 can be stored in hot or cold conditions.

(Page 1-4 Blank)

3.1 ENVIRONMENTAL-, OCCUPATIONAL SAFETY-, AND HEALTH-RELATED TESTS

3.1.1 TOXICITY

3.1.1.1 Objective

The objective of this test was to determine whether a toxicity clearance can be given for the manufacturer's suggested working concentration of the cleaning compound.

3.1.1.2 Criterion

The toxicity of the manufacturer's suggested working concentration of the cleaning compound shall conform to AR 40-5 and shall have no adverse effects on the health of personnel or the environment when used properly and with the appropriate personal protection equipment (PPE).

3.1.1.3 Test Procedures

a. A toxicity clearance for any potentially hazardous product to be used by U.S. Army military personnel is granted or denied by CHPPM using the process in Army Regulation (AR) 40-5 (app H, ref 3.1-1). A toxicity evaluation is performed and clearances are conditionally approved based on the solvent application or use condition. A toxicity clearance involves a toxicological evaluation of materials prior to introduction into the Army supply system. The program manager is responsible for identifying technically feasible materials and requesting a toxicity clearance for use of those materials.

b. CHPPM toxicity evaluations require the following:

(1) Final chemical formulation (handled as proprietary, if required).

(2) Identity and application of new solvent; identity of solvent being replaced, if applicable.

(3) Reports from manufacturers pertaining to use of the solvent in the commercial market and material safety data sheets (MSDSs).

(4) Available human and animal toxicity studies and epidemiology information.

3.1.1.4 Test Findings

a. The protocol was not deviated from during testing.

b. A toxicological evaluation of SoyGold 1000 was conducted and a toxicity clearance granted on 23 February 2005 (app A) by CHPPM, APG, Maryland, approving SoyGold 1000 as a degreaser. An additional toxicity clearance was granted on 31 January 2006 (app A), approving SoyGold 1000 as a cleaner.

3.1.1.5 Technical Analysis

SoyGold 1000 met the criterion for a toxicity clearance to be granted within the recommendations set forth in the clearance.

3.1.2 VOLATILE ORGANIC COMPOUNDS (VOCs)

3.1.2.1 Objective

The objective of this test was to determine the VOC content of the manufacturer's suggested working concentration of the cleaning compound.

3.1.2.2 Criterion

The manufacturer's suggested working concentration of the cleaning compound shall contain less than 50 g/l VOC, be VOC exempt, or a South Coast Air Quality Management District, Certified Clean Air Solvent.

3.1.2.3 Test Procedures

a. The test method, Environmental Protection Agency (EPA) Method 24 (ref 3.1-2), outlined in the test protocol, references ASTM D2369, Standard Test Method for Volatile Content of Coatings (ref 3.1.3), as the test method to follow for the determination of VOCs.

b. A more appropriate method for the determination of VOCs is EPA Method 5030B/8260B, Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS): Capillary Column Technique (ref 3.1-4). EPA Method 5030B/8260B is a more accurate laboratory method that determines amounts of each particular VOC and was also used in the conduct of this test.

3.1.2.4 Test Findings

a. An analysis pertaining to VOCs can be found in Appendix B.

b. Testing by EPA Method 5030B/8260B was performed by CHPPM, Directorate of Laboratory Sciences, APG, Maryland.

c. According to the CHPPM report (app C), all listed VOCs were undetected except for naphthalene, which was found in trace amounts. The listed VOCs are those related to clean air compliance and are the VOCs of concern.

d. Testing by ASTM Method D2369 was performed by the Chemical Sampling and Analysis Team, Warfighter Directorate, ATC, APG, Maryland.

e. Total VOCs as calculated by ASTM D2369 determined the new SoyGold 1000 product as having 5.8% by weight total VOCs and the old product as having 6.7% by weight total VOCs. The criterion of 50 g/L equates to 5% by total weight.

3.1.2.5 Technical Analysis

a. SoyGold 1000 did not meet the criterion of less than 50 g/L VOCs for either the old or new product.

b. SoyGold 1000 should be considered VOC free because it does not contain detectable amounts of listed VOCs in EPA Method 5030B/8260B, except for trace amounts of naphthalene.

c. ASTM Method D2369 is followed when testing coatings that are expected to cure within 60 min. SoyGold 1000 is not a coating and does not dry as evidenced by the results of the nonvolatile residue (NVR) test, during which SoyGold 1000 did not evaporate.

d. When testing by ASTM Method D2369, VOCs, water, or any compound that could evaporate in the 60-min period cannot be distinguished. This method associates weight loss with VOCs, although the weight loss may or may not be a VOC. Because of proprietary information, it is not known what compound could be contributing to the difference in the VOC value during testing by ASTM Method D2369 and the fact that there were undetectable amounts of the listed VOCs in the CHPPM report.

3.1.3 FLASH POINT

3.1.3.1 Objective

The objective of this test was to determine the flash point characteristics of the manufacturer's suggested working concentration of the cleaning compound.

3.1.3.2 Criterion

The flash point of the manufacturer's suggested working concentration of the cleaning compound shall be greater than 212 ^{o}F (100 ^{o}C).

3.1.3.3 Test Procedures

a. The flash point of the manufacturer's suggested working concentration of the cleaning compound was determined using the method outlined in ASTM D93 (ref 3.1-5), Standard Test Methods for Flash-Point by Pensky-Martens Closed Cup Tester.

b. The test apparatus was prepared, the samples were taken, and all cautionary statements in ASTM D93 were applied.

c. Testing was performed using a GT Instruments D93 tester.

d. The following information was reported for each test performed:

(1) Summary of test methods and any deviations from the protocol.

(2) Identification of solution tested, concentration used, and diluent used.

(3) Test conditions: temperature, exposure time, and humidity.

(4) Identification of testing laboratory and responsible technical point of contact.

(5) Individual and averaged test results.

3.1.3.4 Test Findings

a. Results pertaining to flash point can be found in the Chemistry Laboratory Report (app B).

b. The protocol was not deviated from during testing.

c. The flash point of SoyGold 1000 was determined to be 156 ^{o}C (313 ^{o}F) for the older product and 166 ^{o}C (331 ^{o}F) for the new product.

3.1.3.5 Technical Analysis

SoyGold 1000 met the criterion for flash point for both the old and new products.

3.2 CHEMICAL PROPERTIES-RELATED TESTS

3.2.1 VAPOR PRESSURE

3.2.1.1 Objective

The objective of this test was to determine the vapor pressure of the manufacturer's suggested working concentration of the cleaning compound.

3.2.1.2 Criterion

The vapor pressure of the manufacturer's suggested working concentration of the cleaning compound shall have a maximum vapor pressure of 2.0 mm Hg at 20 ^{o}C.

3.2.1.3 Test Procedures

a. The vapor pressure of the manufacturer's suggested working concentration of the cleaning compound was determined using the method outlined in ASTM D2879 (ref 3.2-1), Standard Test Method for Vapor Pressure-Temperature Relationship and Initial Decomposition Temperature of Liquids by Isoteniscope.

b. The test apparatus was prepared, the samples were taken, and all cautionary statements in ASTM D2879 were applied.

c. Testing was performed by the Chemical Sampling and Analysis Team, ATC, APG, Maryland.

d. The following information was reported for each test performed:

(1) Summary of test methods and any deviations from the protocol.

(2) Identification of solution tested, concentration used, and diluent used.

(3) Test conditions: temperature, exposure time, and humidity.

(4) Identification of testing laboratory and responsible technical point of contact.

(5) Individual and averaged test results.

3.2.1.4 Test Findings

a. Results pertaining to vapor pressure can be found in the Chemistry Laboratory Report (app B).

b. The protocol was not deviated from during testing.

c. The vapor pressure of the SoyGold 1000 was determined to be less than 2.00 mm Hg.

3.2.1.5 Technical Analysis

The SoyGold 1000 met the criterion for vapor pressure.

(Page 3.2.1-2 Blank)

3.2.2 ACIDITY

3.2.2.1 Objective

The objective of this test was to determine the acidity of the manufacturer's suggested working concentration of the cleaning compound.

3.2.2.2 Criterion

The manufacturer's suggested working concentration of the product shall show no evidence of acidity.

3.2.2.3 Test Procedures

a. The acidity of the manufacturer's suggested working concentration of the cleaning compound was determined using the method outlined in ASTM D847 (ref 3.2-2), Standard Test Method for Acidity of Benzene, Toluene, Xylenes, Solvent Naphthas, and Similar Industrial Aromatic Hydrocarbons.

b. Testing was performed by the Chemical Sampling and Analysis Team, ATC, APG, Maryland.

c. The testing was conducted on product that had been stored for longer than 12 mo (old) and product that had recently arrived at the test laboratory (new).

d. The following information was reported for each test performed:

(1) Summary of test methods and any deviations from the protocol.

(2) Identification of solution tested, concentration used, and diluent used.

(3) Test conditions: temperature, exposure time, and humidity.

(4) Identification of testing laboratory and responsible technical point of contact.

(5) Individual and averaged test results.

3.2.2.4 Test Findings

a. Results pertaining to acidity can be found in the Chemistry Laboratory Report (app B).

b. The protocol was not deviated from during testing.

c. The acidity of SoyGold 1000 was determined to be 0.680 mg KOH/L for the older product and 1.47 mg KOH/L for the new product.

3.2.2.5 Technical Analysis

SoyGold 1000 did not meet the criterion for acidity for both the old and new products.

(Page 3.2.2-2 Blank)

3.2.3 APPEARANCE

3.2.3.1 Objective

The objective of this test was to determine the appearance characteristics of the manufacturer's suggested working concentration of the cleaning compound.

3.2.3.2 Criterion

The appearance of the manufacturer's suggested working concentration of the cleaning compound shall be clear and free from suspended matter and undisclosed water when observed at ambient conditions.

3.2.3.3 Test Procedures

a. The appearance of the manufacturer's suggested working concentration of the cleaning compound was determined using the method outlined in the test protocol.

b. A 1-L sample of the product was drawn and placed into a clear glass container with a screw-type lid.

c. The container was closed and allowed to sit undisturbed for 48 hr.

d. With minimal disturbance, the container was observed for separations or colloidal dispersions.

e. The testing was conducted on product that had been stored for longer than 12 mo (old) and product that had recently arrived at the test laboratory (new).

f. The following information was reported for each test performed:

(1) Summary of test methods and any deviations from the protocol.

(2) Identification of solution tested, concentration used, and diluent used.

(3) Test conditions: temperature, exposure time, and humidity.

(4) Identification of testing laboratory and responsible technical point of contact.

(5) Individual and averaged test results.

3.2.3.4 Test Findings

a. Data sheets pertaining to appearance can be found in Appendix D.

b. The protocol was not deviated from during testing.

c. The appearance of SoyGold 1000 was determined to be clear for both the old and new products.

3.2.3.5 Technical Analysis

SoyGold 1000 met the criterion for appearance for both the old and new products.

3.2.4 KAURI BUTANOL

3.2.4.1 Objective

The objective of this test was to determine the kauri-butanol (Kb) value of the manufacturer's suggested working concentration of the cleaning compound.

3.2.4.2 Criterion

The kauri butanol value of the manufacturer's suggested working concentration of the cleaning compound shall be 27-45 (Test Matrix).

3.2.4.3 Test Procedures

a. The Kb value of the manufacturer's suggested working concentration of the cleaning compound was determined using the method outlined in ASTM D1133, Standard Test Method for Kauri-Butanol Value of Hydrocarbon Solvents (ref 3.2-3).

b. The test apparatus was prepared, the samples were taken, and all cautionary statements in ASTM D1133-04 were applied.

c. The following information was reported for each test performed:

(1) Summary of test methods and any deviations from the protocol.

(2) Identification of solution tested, concentration used, and diluent used.

(3) Test conditions: temperature, exposure time, and humidity.

(4) Identification of testing laboratory and responsible technical point of contact.

(5) Individual and averaged test results.

3.2.4.4 Test Findings

a. Results pertaining to Kb values can be found in the Chemistry Laboratory Report (app B).

b. The protocol was not deviated from during testing.

c. The Kb value of SoyGold 1000 was determined to be 58.5 for old product and 58.6 for new product.

3.2.4.5 Technical Analysis

a. SoyGold 1000 did not meet the criterion for Kb value for both the old and new products.

b. The Kb value is a measure of the solvent power of hydrocarbon solvents. The higher the number, the better the cleaning ability of the solvent. As a reference, naphtha usually has a Kb value of approximately 30 whereas toluene is approximately 105. It is generally accepted that if a solvent has a high Kb value, it may be harmful to plastic and rubber. Other testing performed on this product showed that SoyGold 1000 had an effect on most rubbers by decreasing hardness and tensile strength.

3.2.5 ANALYSIS OF SOYGOLD 1000 VAPOR

3.2.5.1 Objective

Although not required by the Test Matrix, an analysis of the vapor for two samples of SoyGold 1000, old and new, was performed as a means to develop an operating procedure. This product was used because it was convenient at the time for the laboratory technician.

3.2.5.2 Criterion

Informational Only. The report (app E) is included as additional information to this testing effort and does not have criterion associated with it.

3.2.5.3 Test Procedures

The procedure is described in the laboratory report.

3.2.5.4 Test Findings

According to the laboratory report, the absorbance for methanol of the new SoyGold 1000 product was 0.21 and the old product was 0.35. The absorbance of the old product was approximately 50 percent higher than the new product.

3.2.5.5 Technical Analysis

The testing confirmed that as SoyGold 1000 ages, it releases methanol vapor, and the levels of methanol production increase as SoyGold 1000 ages. The generation rate could not be determined from this experiment, nor was it in the scope of this testing. Further analysis should be performed to determine if a significant problem exists that will affect the storage methods and shelf life for this product.

(Page 3.2.5-2 Blank)

3.3 MATERIALS COMPATIBILITY-RELATED TESTS

3.3.1 TOTAL IMMERSION CORROSION

3.3.1.1 Objective

The objective of this test was to determine the total immersion characteristics of the manufacturer's suggested working concentration of the cleaning compound.

3.3.1.2 Criterion

The manufacturer's suggested working concentration of the cleaning compound shall not show any indication of staining, etching, pitting, or localized attack on the test panels. The product shall not cause weight change to an average of three (3) test panels, of the same material, of more than .04 mg/cm^2 over a 168 hr period.

3.3.1.3 Test Procedures

a. The total immersion corrosion caused by the manufacturer's suggested working concentration of the cleaning compound was determined using ASTM F483, Standard Test Method for Total Immersion Corrosion Test for Aircraft Maintenance Chemicals (ref 3.3-1).

b. The testing was conducted on product that had been stored for longer than 12 months (old) and product that had recently arrived at the test laboratory (new).

c. Four test specimens, 50.8 by 25.4 by 1.6 mm (2 by 1 by 0.06 in.) with a 3.2-mm- (0.125 in.-) diameter mounting hole suitably located at one end of the specimen, were prepared from the same sheet stock of the materials required in the test protocol.

d. The test specimens were immersed in a beaker of acetone, type II, in accordance with ASTM D235, Standard Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent) (ref 3.3-2), at room temperature. The surface of the individual specimens was swabbed thoroughly using clean forceps to hold the test specimen and a cotton swab.

e. The excess solvent was shaken off. The test specimens were transferred and immersed separately several times in a beaker of methyl ethyl ketone (MEK). The excess MEK was shaken off and specimens were dried in a low-temperature oven at 120 $\pm$ 5 ^{o}C (248 $\pm$ 5 ^{o}F) for 15 min. The test specimens were removed and placed in a desiccator for cooling to room temperature.

f. Each panel was identified by numbers 1, 2, 3, or 4. Each test specimen was weighed to the nearest 0.1 mg.

g. A container of the manufacturer's suggested maximum use concentration of the cleaning compound was prepared for immersing the test specimens. The volume of the cleaner solution is related to the area of the test specimen immersed by 8 mL of cleaner per 1 cm^2 of test specimen. The total area of the specimens was considered to be 28.2 cm^2 (4.4 in.^{2}).

h. Separate containers were used for each of the materials with new manufacturer's suggested working concentrations of the cleaning compound to prevent any contamination. Fresh solution was used for each set of replicates.

i. Testing was conducted at 38 $\pm$ 3 ^{o}C (100 $\pm$ 5 ^{o}F).

j. Three test specimens of each material type were immersed into the manufacturer's maximum recommended use concentration of the cleaning compound, allowed to soak for 24 hr, and maintained at the required temperature for the prescribed exposure period. The fourth test specimen was stored in a desiccator and was used as the control specimen for the test.

k. After 24 hr, the test specimens were removed from the manufacturer's maximum recommended use concentration of the cleaning compound.

l. The test specimens were rinsed under hot tap water (49 to 60 ^{o}C (120 to 140 ^{o}F)).

m. The test specimens were rinsed in deionized water in accordance with ASTM D1193, Standard Specification for Reagent Water (ref 3.3-3), type IV, at ambient (room) temperature.

n. The test specimens were rinsed with a stream of acetone, in accordance with ASTM D329, Standard Specification for Acetone (ref 3.3-4), from a wash bottle and oven-dried at 120 ^{o}C (248 ^{o}F).

o. After drying, the test specimens were placed in a container with desiccant until cooled to ambient (room) temperature.

p. The test specimens were individually weighed to the nearest 0.1 mg.

q. The following visual observations were conducted on each test specimen in comparison to the unexposed, control specimen:

(1) Discoloration and dulling.

(2) Etching.

(3) Presence of accretions and relative amounts.

(4) Pitting.

(5) Presence of selective or localized attack.

r. The three test specimens were immersed in the same manufacturer's suggested working concentration of the cleaning compound for an additional 144 hr.

s. The steps in paragraphs k through q were repeated.

t. The following information was reported for each test performed:

(1) Summary of test methods and any deviations from the protocol.

(2) Identification of sample material alloy(s), product temper, and selection of thickness of material tested including reference to product specification.

(3) Specimen details: type and dimensions of test specimen and number of replicates.

(4) Identification of solution tested, concentration used, and diluent used.

(5) Test conditions: temperature, exposure time, and humidity.

(6) Identification of testing laboratory and responsible technical point of contact.

(7) Individual and averaged test results.

(8) Results of visual inspections, observations, and discussion of specimen condition.

(9) Photographic documentation of specimen conditions (specifically any staining, evidence of general corrosion, etching, pitting, or localized attack).

3.3.1.4 <u>Test Findings</u>

a. Data sheets pertaining to total immersion corrosion can be found in Appendix D.

b. The results of the total immersion corrosion testing for new and old products are provided below:

(1) Aluminum 2024 with AMS 2470 (AL-1a).

(a) New. At the end of 24 and 168 hr, the samples had no discoloration or staining (fig. F-3.3.1-1 and F-3.3.1-2). The average weight change of the three samples was 0.009 mg/cm^2.

(b) Old. At the end of 24 and 168 hr, the samples had no discoloration or staining (fig. F-3.3.1-3 and F-3.3.1-4). The average weight change of the three samples was 0.02 mg/cm^2.

(2) Aluminum 2024 Bare (AL-1b).

(a) New. At the end of 24 and 168 hr, the samples had no discoloration or staining (fig. F-3.3.1-5 and F-3.3.1-6). The average weight change of the three samples was -0.002 mg/cm^2.

(b) Old. At the end of 24 and 168 hr, the samples had no discoloration or staining (fig. F-3.3.1-7 and F-3.3.1-8). The average weight change of the three samples was 0.01 mg/cm^2.

(3) Aluminum 7075-T6 (AL-1c).

(a) New. At the end of 24 and 168 hr, the samples had no discoloration or staining (fig. F-3.3.1-9 and F-3.3.1-10). The average weight change at the end of the 168-hr inspection was -0.016 mg/cm^2.

(b) Old. At the end of 24 and 168 hr, the samples had no discoloration or staining (fig. F-3.3.1-11 and F-3.3.1-12). The average weight change at the end of the 168-hr inspection was -0.01 mg/cm^2.

(4) Brass (BR-1).

(a) New. At the end of 24 and 168 hr, the samples had no discoloration or staining (fig. F-3.3.1-13 and F-3.3.1-14). The average weight change at the end of the 168-hr inspection was -0.006 mg/cm^2.

(b) Old. There was no change in the appearance of the samples during the 24-and 168-hr test (fig. F-3.3.1-15 and F-3.3.1-16). There was no weight change at the end of the 168-hr inspection.

(5) CEVM Steel (CG-1).

(a) New. At the end of 24 and 168 hr, all coupons had slight stains along the top and bottom edges on both sides (fig. F-3.3.1-17 and F-3.3.1-18). The average weight change at the end of the 168-hr inspection was 0.007 mg/cm^2.

(b) Old. At the end of 24 and 168 hr, the samples had no discoloration or staining (fig. F-3.3.1-19 and F-3.3.1-20). The average weight change at the end of the 168-hr inspection was 0.040 mg/cm^2.

(6) Stainless Steel Cad Plated (CP-1a).

(a) New. At the end of 24 hr, the samples had no discoloration or staining (fig. F-3.3.1-21). After 168 hr, the test coupons appeared brighter than the control (fig. F-3.3.1-22). The average weight change of the three samples was -0.020 mg/cm^2.

(b) Old. At the end of 24 hr, the coupons had no discoloration or staining (fig. F-3.3.1-23). All coupons had light stains on the bottom edges after 168 hr (fig. F-3.3.1-24). The average weight change of the three samples was -0.01 mg/cm2.

(7) Cronidur 30 (CR-1).

(a) New. At the end of 24 and 168 hr, the samples had no discoloration or staining (fig. F-3.3.1-25 and F-3.3.1-26). The average weight change of the three samples was -0.031 mg/cm^2.

(b) Old. There was no change in the appearance of the samples during the 24- and 168-hr test (fig. F-3.3.1-27 and F-3.3.1-28). The average weight change at the end of the 168-hr inspection was -0.030 mg/cm^2.

(8) Chrome Steel AISI 52100 (CS-1).

(a) New. At the end of 24 and 168 hr, all coupons had slight stains over all surfaces (fig. F-3.3.1-29 and F-3.3.1-30). The average weight change at the end of the 168-hr inspection was 0.025 mg/cm^2.

(b) Old. At the end of 24 and 168 hr, coupons No. 1 and 2 had light stains on the back (fig. F-3.3.1-31 and F-3.3.1-32). The average weight change at the end of the 168-hr inspection was 0.02 mg/cm^2.

(9) Copper (CU-1).

(a) New. At the end of 24 and 168 hr, the samples had no discoloration or staining (fig. F-3.3.1-33 and F-3.3.1-34). The average weight change of the three samples was -0.012 mg/cm^2.

(b) Old. At the end of 24 and 168 hr, the samples had no discoloration or staining (fig. F-3.3.1-35 and F-3.3.1-36). The average weight change of the three samples was -0.01 mg/cm^2.

(10) High-Temperature Tool Steel M-50 (HT-1).

(a) New. The 24-hr inspection showed light stains along the top and bottom edges of all coupons (fig. F-3.3.1-37). At the end of 168 hr, all coupons had slight stains over all surfaces (fig. F-3.3.1-38). The average weight change at the end of the 168-hr inspection was 0.041 mg/cm^2.

(b) Old. There was no change in the appearance of the samples during the 24- and 168-hr test (fig. F-3.3.1-39 and F-3.3.1-40). The average weight change at the end of the 168-hr inspection was 0.04 mg/cm^2.

(11) Nickel, Aluminum, Bronze (NB-1).

(a) New. At the end of 24 and 168 hr, the samples had no discoloration or staining (fig. F-3.3.1-41 and F-3.3.1-42). The average weight change of the three samples was -0.016 mg/cm^2.

(b) Old. At the end of 24 and 168 hr (fig. F-3.3.1-43 and F-3.3.1-44), the samples had no discoloration or staining. The average weight change of the three samples was -0.01 mg/cm^2.

(12) Nickel AMS 5536 (NI-1).

(a) New. At the end of 24 and 168 hr, the samples had no discoloration or staining (fig. F-3.3.1-45 and F-3.3.1-46). The average weight change of the three samples was 0.001 mg/cm^2.

(b) Old. At the end of the 24-hr inspection, there was no discoloration or staining (fig. F-3.3.1-47). The 168-hr inspection showed slight staining on coupons No. 2 and 3 (fig. F-3.3.1-48). The average weight change of the three samples was 0.02 mg/cm^2.

(13) PH 17-4 (PH-1a).

(a) New. There were slight stains along the top and bottom edges of both the 24- and 168-hr coupons (fig. F-3.3.1-49 and F-3.3.1-50). The average weight change of the three samples was 0.005 mg/cm^2.

(b) Old. There was no change in the appearance of the samples during the 24- and 168-hr test (fig. F-3.3.1-51 and F-3.3.1-52). The average weight change of the three samples was 0.02 mg/cm^2.

(14) PH 15-5 (PH-1b).

(a) New. At the end of 24 and 168 hr, the samples had no discoloration or staining (fig. F-3.3.1-53 and F-3.3.1-54). The average weight change of the three samples was 0.048 mg/cm^2.

(b) Old. There was no change in the appearance of the samples during the 24- and 168-hr test (fig. F-3.3.1-55 and F-3.3.1-56). There was no weight change at the end of the 168-hr inspection.

(15) PH 13-8 Steel (PH-1c).

(a) New. At the end of 24 and 168 hr, the samples had no discoloration or staining (fig. F-3.3.1-57 and F-3.3.1-58). The average weight change at the end of the 168-hr inspection was -0.031 mg/cm^2.

(b) Old. At the end of 24 and 168 hr (fig. F-3.3.1-59 and F-3.3.1-60), the samples had no discoloration or staining. The average weight change at the end of the 168-hr inspection was -0.01 mg/cm^2.

(16) Rivet Steel AMS 7228 (RS-1).

(a) New. At the end of 24 and 168 hr, the samples had no discoloration or staining (fig. F-3.3.1-61 and F-3.3.1-62). The average weight change of the three samples was 0.004 mg/cm^2.

(b) Old. At the end of 24 and 168 hr, the samples had no discoloration or staining (fig. F-3.3.1-63 and F-3.3.1-64). The average weight change of the three samples was 0.02 mg/cm^2.

(17) Stainless Steel AISI 440C (SS-1).

(a) New. At the end of 24 hr, the samples had no discoloration or staining (fig. F-3.3.1-65). The 168-hr coupons had light stains on both sides (fig. F-3.3.1-66). The average weight change of the three samples was -0.047 mg/cm^2.

(b) Old. At the end of 24 hr, the No. 2 coupon had light stains on both sides and coupons No. 1 and 3 had no discoloration or staining (fig. F-3.3.1-67). All coupons had light stains after 168 hr (fig. F-3.3.1-68). The average weight change of the three samples was 0.03 mg/cm^2.

(18) Steel 4340 (ST-1).

(a) New. There were slight stains along the top and bottom edges of both the 24- and 168-hr coupons (fig. F-3.3.1-69 and F-3.3.1-70). The average weight change of the three samples was 0.060 mg/cm^2.

(b) Old. There was no change in the appearance of the samples during the 24- and 168-hr test (fig. F-3.3.1-71 and F-3.3.1-72). The average weight change of the three samples was -0.02 mg/cm^2.

(19) Titanium 4911 (TI-1).

(a) New. There was no change in the appearance of the samples during the 24- and 168-hr test (fig. F-3.3.1-73 and F-3.3.1-74). The average weight change of the three samples was -0.004 mg/cm^2.

(b) Old. There was no change in the appearance of the samples during the 24- and 168-hr test (fig. F-3.3.1-75 and F-3.3.1-76). There was no weight change at the end of the 168-hr inspection.

3.3.1.5 Technical Analysis

a. The following materials did not meet the criteria for total immersion for the following reasons:

(1) New Product.

(a) CG-1 - stains along top and bottom edges on both sides.

(b) CS-1 - light stains on all coupons.

(c) HT-1 - light stains on all coupons.

(d) PH-1b - excessive weight gain (0.048 mg/cm^2).

(e) SS-1 - excessive weight loss (-0.047 mg/cm^2); light stains.

(f) ST-1 - exceeded weight gain (0.060 mg/cm^2); light stains on top and bottom edges.

(2) Old Product.

(a) CP-1a - light stains along bottom edges.

(b) CS-1 - light stains on two of the three coupons.

(c) NI-1 - light stains on two of the three coupons.

(d) SS-1 - very light stains.

b. The following materials met the criterion for total immersion:

(1) New Product.

(a) AL-1a.	(e) CP-1a.	(h) NB-1.	(k) PH-1c.
(b) AL-1b.	(f) CR-1.	(i) NI-1a.	(l) RS-1.
(c) AL-1c.	(g) CU-1.	(j) PH-1a.	(m) TI-1.
(d) BR-1.			

(2) Old Product.

(a) AL-1a.	(e) CG-1.	(i) NB-1.	(m) RS-1.
(b) AL-1b.	(f) CR-1.	(j) PH-1a.	(n) ST-1.
(c) AL-1c.	(g) CU-1.	(k) PH-1b.	(o) TI-1.
(d) BR-1.	(h) HT-1.	(l) PH-1c.	

c. The excessive weight gains could be attributed to the method of rinsing before weighing. The SoyGold 1000 product is a medium weight, oily product that does not wash off easily with water and does not evaporate. The test procedure did not permit the coupons to be brushed, only washed with water and rinsed with a stream of acetone.

d. It is interesting to note that the materials tested with the old product did not have excessive weight changes.

e. Most materials that had stains were highly polished and stains were easily seen. Acetone that dried on a clean, bright coupon produced a light stain. If all of the product was not removed with the hot water rinse or the acetone, the residual product remaining after the acetone evaporated left a more pronounced stain.

3.3.2 TITANIUM STRESS CORROSION

3.3.2.1 Objective

The objective of this test was to determine the titanium stress corrosion characteristics caused by the manufacturer's suggested working concentration of the cleaning compound.

3.3.2.2 Criterion

The manufacturer's suggested working concentration of the cleaning compound shall not cause titanium stress corrosion (Test Protocol).

3.3.2.3 Test Procedures

a. The titanium stress corrosion caused by the manufacturer's suggested working concentration of the cleaning compound was determined using ASTM F945 (ref 3.3-5), Standard Test Method for Stress-Corrosion of Titanium Alloys by Aircraft Engine Cleaning Materials.

b. The titanium stress corrosion testing was conducted by Scientific Material International (SMI), Inc., 12219 SW 131 Avenue, Miami, FL 33186-6401.

c. Testing was conducted in accordance with ASTM F945 with all necessary reporting and documentation included in the test report by SMI (app G).

3.3.2.4 Test Findings

As reported by SMI, both old and new SoyGold 1000 met the criterion for titanium stress corrosion.

3.3.2.5 Technical Analysis

The SoyGold 1000 can be used to clean parts under stress made of titanium 4916 and 4911.

(Page 3.3.2-2 Blank)

3.3.3 HYDROGEN EMBRITTLEMENT

3.3.3.1 Objective

The objective of this test was to determine whether the manufacturer's suggested working concentration of the cleaning compound causes hydrogen embrittlement failure.

3.3.3.2 Criterion

The manufacturer's suggested working concentration of the cleaning compound shall not cause hydrogen embrittlement of cadmium plated ANSI 4340 steel (Test Matrix).

3.3.3.3 Test Procedures

a. The hydrogen embrittlement effect that the manufacturer's suggested working concentration of the cleaning compound has on materials was determined using ASTM F519 (ref 3.3-6), Standard Test Method for Mechanical Hydrogen Embrittlement Evaluation of Plating Processes and Service Environments.

b. Test specimens, type 1a, standard round notch bars, were prepared according to the requirements of ASTM F519.

c. All specimens were taken from a single lot.

(1) A lot consisted of only those specimens cut from the same heat of steel in the same orientation, heat-treated together in the same furnace, quenched and tempered together, and subjected to the same manufacturing processes.

(2) All notched specimens were suitable for test purposes if the sampling and inspection results conformed to the requirements of the lot acceptance criteria for type 1a notched specimens, as stated in Table 1 of ASTM F519.

d. The sensitivity to hydrogen embrittlement was demonstrated for each heat of AISI 4340 steel by exposing six trial specimens to two different embrittling environments after manufacture and inspection in accordance with the test procedures.

(1) Three specimens were electroplated under the highly embrittling conditions produced in a cadmium cyanide bath by Treatment A (Table 2), ASTM F519.

(2) Each heat of steel was of suitable sensitivity only if all three specimens plated by treatment A fractured within 24 hr and none of the three specimens plated by treatment B fractured within 200 hr after applying the sustained load of 75 percent of the bend notch fracture strength.

(3) To verify further the quality of the manufactured lot of specimens, a minimum of five specimens plated by treatment B were tensile-tested per Test Method E8 as in Table 1 of ASTM F519. All of the tensile test results were within $\pm$10 ksi of the mean of the ten unplated specimens. The diameter or dimensions of the bare metal specimen were used in the stress calculations.

e. Certification of lot conformance to the above requirements was included in the data package for the results of the hydrogen embrittlement test.

f. Four test specimens manufactured and plated in accordance with Treatment B of ASTM F519 were tested to determine the hydrogen embrittling effect of the test cleaner.

g. The test was conducted in air or any other controlled environment using an appropriate inert container and fixture that was suitably electrically isolated from the specimen or compensated to prevent a galvanic coupling. The cleaner was tested at the maximum specified dilution to determine the full embrittling effect of exposure in service. All tests were conducted at the operating service temperature of the test cleaner.

h. The test specimens were loaded by a means that sustained the load for the described periods of time.

i. Each type 1a specimen was tested separately with sufficient quantity of the test cleaner solution to completely cover the specimen notch.

j. The test cleaner was considered nonembrittling if none of the immersed specimens failed within 200 hr after immersion into the chemical. The time-to-failure was recorded if less than 200 hr. The test was discontinued after 200 hr.

k. If only one of the four specimens fractured within the exposure time, step loading was continued on the remaining specimens, every hour in 5-percent increments to 90 percent of the fracture tensile/bend load after completion of a 200-hr sustained load. After 1 hr at 90 percent, the cleaner was considered nonembrittling if no fracture occurred.

l. The following information was reported for each test performed:

(1) Summary of test methods and any deviations from the protocol.

(2) Identification of sample material alloy-tested including reference to product specification.

(3) Specimen details: type and dimensions of test specimen and number of replicates.

(4) Identification of solution tested, concentration used, and diluent used.

(5) Test conditions: temperature, exposure time, and humidity.

(6) Identification of testing laboratory and responsible technical point of contact.

(7) Individual and averaged test results.

(8) Results of visual inspections, observations, and discussion of specimen condition.

3.3.3.4 Test Findings

a. Data sheets pertaining to hydrogen embrittlement can be found in Appendix D.

b. There was no deviation in testing from ASTM F519.

c. Ten baseline specimens that were not plated were placed in an Instron tensile testing machine model 1125 and tensile-tested to develop load values to failure. The average of the loads to failure of the ten unplated specimens was 7991.64 lbf.

d. Included in the lot of specimens were three treatment A specimens that were plated but not baked to relieve the hydrogen embrittling condition. These three treatment A specimens were individually loaded to 75 percent of the lot acceptance value for the ten unplated specimens or 5994 lbf. The three treatment A specimens broke after 2.0, 2.7, and 1.8 hr.

e. Three specimens that were plated by treatment B method were loaded to 75 percent of the lot acceptance value of 5994 lbf. These specimens did not break within 200 hr.

f. Five specimens plated by treatment B were tensile-tested to failure and found to be within ±10 ksi of the average of the ten baseline unplated specimens.

g. Eight treatment B specimens were individually loaded to 75 percent of the lot acceptance value of 5994 lbf. They were placed in a fixture that allowed the product to surround and touch only the specimen while maintaining the required load. Four of the specimens were tested with the SoyGold 1000 new product and the remaining tested with the SoyGold 1000 old product.

h. All specimens tested with both old and new products fractured to failure within 200 hr.

3.3.3.5 Technical Analysis

a. The lot of specimens used met the sensitivity testing required by ASTM F519.

b. SoyGold 1000 did not meet the criterion for hydrogen embrittlement for either the old or new products.

(Page 3.3.3-4 Blank)

3.3.4 STRESS CORROSION

3.3.4.1 Objective

The objective of this test was to determine the stress corrosion characteristics of the manufacturer's suggested working concentration of the cleaning compound.

3.3.4.2 Criterion

The manufacturer's suggested working concentration of the cleaning compound shall not cause stress corrosion cracking.

3.3.4.3 Test Procedures

a. The stress corrosion caused by the manufacturer's suggested working concentration of the cleaning compound was determined using ASTM G30 (ref 3.3-7), type (a) test specimens, Standard Practice for Making and Using U-Bend Stress-Corrosion Test Specimens and ASTM G44 (ref 3.3-8) test method, Standard Practice for Exposure of Metals and Alloys by Alternate Immersion in Neutral 3.5 % Sodium Chloride Solution, modified in the following manner. The manufacturer's suggested working concentration of the cleaning compound was substituted for the 3.5-percent sodium chloride solution; a 10-min soak and 50-min drying cycle were substituted for a 20-min soak and 100-min drying cycle; and the temperature was ambient instead of 27 ^{o}C (80 ^{o}F) at 45 $\pm$ 10-percent relative humidity. These modifications were specified in ASTM D6361, Standard Guide for Selecting Cleaning Agents and Processes, Appendix X2, Modification of Practice G44 (ref 3.3-9).

b. Nine specimens (three test coupons for new product, three test coupons for old product, and three control) were fabricated in accordance with ASTM G30, type (a) U-bend from each of the following materials stated in the test protocol.

c. The three control specimens were stressed but not tested to establish validity of the sheet material.

d. All of the precautions were followed as outlined in ASTM G44.

e. The entire cycling mechanism, the test solution, and the drying environment were maintained at 23 $\pm$ 2 ^{o}C (73 $\pm$ 3 ^{o}F).

f. Sufficient test solution to cover the stress portion of the test specimens was used throughout the 20-min immersion period.

g. The level in the immersion baths was maintained by the addition of virgin product. On a 7-day interval, the immersion bath test solution was replaced with fresh test solution.

h. This cycle was continued for 24 hr per day for 90 days.

i. After exposure, specimens were rinsed with water and cleaned as soon as possible. It is important to note that the specimens were cleaned as thoroughly as possible by recommended methods of cleaning, such as outlined in ASTM G1, Standard Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens (ref 3.3-10).

j. Test specimens that did not show obvious cracks were examined at 20x magnification. If the untreated (control) specimens were cracked, the results of the stress corrosion test were invalid. Metallographic examination was required to verify freedom from cracking.

k. Representative failed specimens were examined metallographically to verify that failure was caused by stress-corrosion cracking.

l. Metallographic inspection was conducted. A cross section of each specimen at the bend normal to the bend axis (parallel to the test panel long axis) was made. The specimens were cut using a saw that produced a smooth cut with minimal disturbance of specimen edges. The cut was made approximately at the center axis in line with the holes. The metallographic section encompassed material from the bend to a point approximately 0.5 in. (13 mm) from the bend. The cut surface was examined over the 0.5-in. (13-mm) distance on both sides of the bend zone at 500x magnification.

m. The following information was reported for each test performed:

(1) Summary of test methods and any deviations from the protocol.

(2) Identification of sample material alloy(s), product temper, and selection of thickness of material tested including reference to product specification.

(3) Specimen details: type and dimensions of test specimen and number of replicates.

(4) Identification of solution tested, concentration used, and diluent used.

(5) Test conditions: temperature, exposure time, and humidity.

(6) Identification of testing laboratory and responsible technical point of contact.

(7) Individual and averaged test results.

(8) Results of visual inspections, observations, and discussion of specimen condition.

(9) Photographic documentation, if needed, of specimen conditions (specifically any staining, evidence of general corrosion, etching, pitting, or localized attack).

3.3.4.4 Test Findings

a. Data sheets pertaining to stress corrosion can be found in Appendix D.

b. The protocol was deviated from in that three of the required test materials were not tested: M-50 NiL, Vasco X-2, and Cronidur 30. An explanation is given in the summary under the Test Environment paragraph.

c. After the 90-day exposure, there was no evidence of cracking on any of the materials tested for either the old or new products.

d. There were no signs of corrosion on any coupon tested.

3.3.4.5 Technical Analysis

The SoyGold 1000 met the criterion for stress corrosion for both the old and new products.

(Page 3.3.4-4 Blank)

3.3.5 NONVOLATILE RESIDUE AND NONVOLATILE RESIDUE WITH ISOPROPYL ALCOHOL RINSE

3.3.5.1 Objective

The objective of this test was to determine the nonvolatile residue (NVR) characteristics of the manufacturer's suggested working concentration of the cleaning compound using the standard and modified methods.

3.3.5.2 Criterion

The nonvolatile residue of the manufacturer's suggested working concentration of the cleaning compound shall not be greater than 8 mg of residue per 100 ml of solution.

3.3.5.3 Test Procedures

a. The NVR characteristics of the manufacturer's suggested working concentration of the cleaning compound was determined according to ASTM D1353, Standard Test Method for Nonvolatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer, and Related Products (ref 3.3-11). An additional test was performed using a modified method of ASTM D1353.

b. SoyGold 1000 was tested as written in ASTM D1353.

c. One hundred milliliters of the product was measured and placed in an evaporating dish, placed on a steam bath, and evaporated to dryness.

d. The residue remaining in the dish was weighed.

e. NVR determinations were made on three samples and the average was reported. If the two weights differed by more than 0.5 percent (absolute), the drying procedure was repeated.

f. The test was repeated with the following modifications to Section 6 of ASTM D1353.

g. A 125-mL platinum evaporating dish was dried in an oven at 105 $\pm$ 5 ^{o}C (221 $\pm$ 5 F) and cooled in a desiccator. The procedure was repeated until the weight was within 0.1 mg of the previous weighing.

h. With a graduated cylinder, 100 mL of the demonstrated solvent was measured at room temperature into the conditioned platinum evaporating dish, placed on a steam bath, and evaporated to dryness. The specimen was rinsed by adding 100 mL of isopropyl alcohol to the dish and was left to stand for 4 min. The dish was air-dried for 20 min. The outside of the dish was dried and heated in an oven at 105 $\pm$ 5 ^{o}C for approximately 1 hour. The specimen was cooled in a desiccator, and the dish and contents were weighed to 0.1 mg.

i. The dish was returned to the oven for an additional 15 to 30 min, cooled, and reweighed. If necessary, the procedure was repeated until the weights were within 0.1 mg of the previous weighing.

j. The following information was reported for each test performed:

(1) Summary of test methods and any deviations from the protocol.

(2) Identification of the solution tested, concentration used, and diluent used.

(3) Test conditions: temperature, exposure time, and humidity.

(4) Identification of testing laboratory and responsible technical point of contact.

(5) Individual and averaged test results.

(6) Results of visual inspections, observations, and discussion of specimen condition.

3.3.5.4 <u>Test Findings</u>

a. Results pertaining to NVRs can be found in the Chemistry Laboratory Report (app B).

b. The ASTM method was not deviated from during initial testing.

c. The second test, with the alcohol rinse, was deviated from as described in the test procedures, paragraphs f, g, and h.

d. The makeup of the SoyGold 1000 product is such that it does not evaporate.

e. After several attempts to evaporate this product, it was concluded that the NVRs for SoyGold 1000 could not be determined.

3.3.5.5 <u>Technical Analysis</u>

a. SoyGold 1000 did not meet the criterion for NVR.

b. SoyGold 1000 did not meet the criterion for NVR with an isopropyl alcohol rinse.

3.4 PERFORMANCE CRITERIA-RELATED TESTS

3.4.1 STORAGE STABILITY

3.4.1.1 Objective

The objective of this test was to determine the storage stability of the manufacturer's suggested working concentration of the cleaning compound.

3.4.1.2 Criterion

After a minimum of 12 month storage, the manufacturer's suggested working concentration of the product shall meet the acceptance criterion for: Rinsing Efficiency, Total Immersion Corrosion, Titanium Stress Corrosion, Hydrogen Embrittlement, Stress Corrosion, Acidity and Appearance. The product shall not cause corrosion to the internal surface of the metal storage container or allow sediment to form on the container bottom.

3.4.1.3 Test Procedures

a. The storage stability of the manufacturer's suggested working concentration of the cleaning compound was determined using the method outlined in the test protocol.

b. Testing for rinsing efficiency, total immersion corrosion, titanium stress corrosion, hydrogen embrittlement, stress corrosion, acidity, and appearance was conducted as stated in the relevant sections using product that was stored for more than 12 mo.

c. The results of testing the product that was stored were reported in the section as well as the new product. The results were reported as "old" and "new."

d. The lid or plug of the container used to store the product was removed without disturbing the contents. The inside walls of the container were examined for corrosion and the bottom for sediment.

3.4.1.4 Test Findings

a. The protocol was not deviated from during testing.

b. The product was stored in a steel 55-gal drum for approximately 14 mo when the observations were made.

c. There was no corrosion or sediment found on the inside of the drum.

3.4.1.5 Technical Analysis

a. SoyGold 1000 met the criterion for storage stability pertaining to the corrosion of the inside of the container.

b. Results of testing the stored product for the materials compatibility tests are found in the respective sections.

(Page 3.4.1-2 Blank)

3.4.2 SOIL CLEANING

3.4.2.1 Objective

The objective of this test was to determine the soil cleaning characteristics of the manufacturer's suggested working concentration of the cleaner.

3.4.2.2 Criterion

The manufacturer's suggested working concentration of the cleaning compound shall not have a cleaning power of less than 85 percent (MIL-PRF-680A).

3.4.2.3 Test Procedures

a. The soil cleaning of the manufacturer's suggested working concentration of the cleaning compound was determined by test method MIL-PRF-680A, Performance Specification for Degreasing Solvent (ref 3.4-1).

b. Three test specimens, 25 by 25 by 1 mm (1 by 1 by 0.04 in.), are made from steel, carbon, mild (ASTM A366, class 1, commercial bright finish (ref 3.4-2)).

c. The metal specimens were washed in toluene until free of any soils and greases.

d. The test specimens were dried with dry, clean air.

e. The test specimens were weighed to the nearest 0.1 g.

f. Approximately 0.4 g of MIL-G-10924F grease (ref 3.4-3) was applied to the test specimens, covering both sides uniformly.

g. The test specimens were hung individually inside separate beakers by two hooks to prevent contact with the sides or bottom of the beaker.

h. The manufacturer's suggested working concentration of the cleaning compound was added to the beakers until the test coupons were completely immersed.

i. The beakers with the test specimens were immersed in an ultrasonic cleaner in such a manner that there was no mixing of the test cleaner and the water in the ultrasonic cleaner. The water in the ultrasonic cleaner was maintained at a water temperature of 50 ^{o}C (122 ^{o}F).

j. The test specimens were observed until all of the grease was removed, and the time was recorded.

k. If grease remained on the test specimens after 100 min, testing was terminated and the cleaning time was recorded as 100 min.

l. The test specimens were dried using dry, clean air and weighed to the nearest 0.1 g.

m. The cleaning power was calculated as follows:

Solvent cleaning power, % = ((100-A)/100) x 100.

Where A is the average time of three runs obtained from testing.

n. The following information was reported for each test performed:

(1) A summary of test methods and any deviations from the protocol.

(2) Identification of the solution tested, concentration used, and diluent used.

(3) Test conditions: temperature, exposure time, and humidity.

(4) Identification of testing laboratory and responsible technical point of contact.

(5) Individual and averaged test results.

(6) Results of visual inspections, observations, and discussion of specimen condition if necessary.

(7) Photographic documentation, if needed, of specimen conditions (specifically any staining, evidence of general corrosion, etching, pitting, or localized attack).

3.4.2.4 <u>Test Findings</u>

a. Data sheets pertaining to soil cleaning can be found in Appendix D.

b. Additional tests were conducted using toluene and Safety Kleen solvent as a control cleaner.

c. The three coupons were tested as instructed in MIL-PRF-680A with cleaning times of 60, 73, and 76 min. The averaged solvent cleaning power of the SoyGold 1000 was 30 percent.

d. Toluene was used as a control for the ultrasonic bath. The cleaning times for the three specimens were 6, 7, and 6 min for a 94-percent solvent cleaning power.

e. Safety Kleen solvent, part No. 6638, which qualifies for the MIL-PRF-680A specification, was tested for general information. The cleaning times for the three specimens were 19, 21, and 28 minutes for a 77-percent cleaning power.

3.4.2.5 <u>Technical Analysis</u>

a. SoyGold 1000 did not meet the criterion for soil cleaning.

b. The Safety Kleen solvent, part No. 6638, did not meet the criterion for relative solvency.

c. Toluene, the control cleaner, met the relative solvency criterion.

3.4.3 WATER BREAK

3.4.3.1 Objective

The objective of this test was to determine the rinse efficiency or water break free of the manufacturer's suggested working concentration of the cleaning compound.

3.4.3.2 Criterion

The water break free for any surface cleaned with the manufacturer's suggested working concentration of the cleaning compound shall be greater than one (1) minute.

3.4.3.3 Test Procedures

a. The water break free of the manufacturer's suggested working concentration of the cleaning compound was to be determined using the method outlined in ASTM F22, Standard Test Method for Hydrophobic Surface Films by the Water-Break Test (ref 3.4-4).

b. A 10- by 10- by 1.0-cm (4- by 4- by 0.25-in.) test coupon of aluminum 7075-T6 was abraded and cleaned with a Scotch-Brite pad.

c. The test coupon was placed into a container of distilled water.

d. The test coupon was removed vertically from the water.

e. The time it takes for the draining water layer to become a discontinuous film was determined.

f. The steps in paragraphs a through d were repeated until the time exceeded 1 min.

g. The test coupon was dried.

h. A standard contaminant mixture was made by combining two parts (by weight) of hydraulic fluid (MIL-H-83282 (ref 3.4-5)) and one part (by weight) of lubricating grease (MIL-G-81322 (ref 3.4-6)).

i. The standardized mixture was applied to the test coupon and baked for 2 hr in an air-circulating oven at 54 ^{o}C (129 ^{o}F). The test coupon was allowed to cool to ambient (room) temperature.

j. The test coupon was cleaned with the manufacturer's suggested working concentration of the cleaning compound and allowed to air-dry. The cleaning was accomplished by soaking a cleaning towel with the product and wiping it across the panel four times. With each wipe, the towel was folded to expose a clean section. Wiping was performed by trying to be consistent with the amount of pressure and speed and wiping the entire surface with one stroke.

k. The test coupon was tested again for water break using the steps in paragraphs b through d.

3.4.3.4 Test Findings

a. Data sheets pertaining to water break free can be found in Appendix D.

b. The protocol was deviated from during testing in that aluminum 7075-T6 coupons were used instead of mica blanks.

c. The specimen cleaned with SoyGold 1000 had an immediate discontinuous film of water.

3.4.3.5 Technical Analysis

SoyGold 1000 did not meet the criterion for water break.

APPENDIX A. TOXICITY CLEARANCES

(Page A-2 Blank)

DEPARTMENT OF THE ARMY
US ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND MD 21010-5403

MCHB-TS-TTE 23 February 2005

MEMORANDUM Applied Science Test Team, U.S. Army Aberdeen Test Center (CSTE-DTC-WC-AS-M/Mr. William Taylor), 400 Colleran Road, Aberdeen Proving Ground, MD 21005-5059

SUBJECT: Toxicity Clearance for Soy Gold 1000 Solvent

1. References:

a. Memorandum, your Command, (CSTE-DTC-WC-AS-M), Mr. William Newton, 6 January 2005, subject: Request for Toxicity Clearance for Soy Gold 1000 Solvent.

b. Phone conversation, between Ms. Jamie G. Suski, this Center, and Ms. Kathy Radachi, AG Environmental Products L.L.C., 21 January 2005, subject: Information on Soy Gold 1000 Solvent.

c. Fax, between Ms. Jamie G. Suski, this Center, and Ms. Kathy Radachi, AG Environmental Products L.L.C., 21 January 2005, subject: Information on Soy Gold 1000 Solvent.

d. Material Safety Data Sheet, Soy Gold 1000 Solvent, 22 March 2004, subject: Soy Gold 1000.

e. Fax, between Ms. Jamie G. Suski, this Center, and Ag Environmental Products L.L.C., 21 January 2005, subject: Technical Information on Biodegradability and Toxicity of Soy Gold.

f. Technical Data Sheet-Soy Gold, 14 September 2001, Available online at www.Soy Gold.com/solvent1000.htm accessed on 21 January 2005.

g. Industrial Solvent-Soy Gold 1000, 14 September 2001, Available online at www.Soy Gold.com/solvent1000-comparison-chart.htm

h. Joint Test Protocol for Validation of Alternatives to High Volitile Organic Compound Solvents Used in Aeronautical Antifriction Bearing Cleaning. Environmental Security Technology Certification Program, Department of Defense, October 2004.

2. Background.

a. The U.S. Army Aberdeen Test Center (CSTE-DTC-WC-AS-M) has requested that a Toxicity Clearance be performed by U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) for Soy Gold 1000 solvent. Soy Gold 1000 solvent is a candidate for possible integration into the supply system for use in degreasing (reference 1a). The ultimate goal is to replace PD680 solvent which is the currently used degreasing agent. Soy Gold 1000 is a multiuse solvent that focuses on the safety of the solvent user and the environment (reference 1g).

b. Soy Gold 1000 is distributed by Ag Environmental Products L.L.C., 12700 West Dodge Road, Omaha, NE 68154. This product is commercially available to the public in bulk orders (reference 1b). It is used for petroleum degreasing, metal cutting applications, adhesive removal, and tool and equipment cleaning. Soy Gold is a soybean oil based methyl-ester. The manufacturing process entails transesterification of soybean oil and methanol with sodium hydroxide catalyst (reference 1h). Many solvents release a substantial amount of Volitile Organic Compounds (VOCs) and Hazardous Air Pollutants (HAPs). The VOCs create air pollution by contributing to smog and ultimately lead to dangerous ozone (O_3). The HAPs may cause a variety of serious health effects, including neurological changes. Soy Gold 1000 releases only 7 percent VOCs compared to other solvents where routinely 95-100 percent VOC is emitted. Additionally, Soy Gold 1000 does not contain HAPs. Thus, providing a safer working-environment for the solvent user and secondarily protecting the integrity of the natural-environment. Ag Environmental has had no reports of any adverse health effects from using this product (reference 1a).

c. Toxicological investigations have been conducted by Ag Environmental using this product. See table below:

Study Animal	**Study Type**	**Experimental Results**
Rat	Acute (LD50)- oral	>17.4 g/kg body weight
Rabbit	Acute exposure- ocular (undiluted)	Mild irritation- eye returned to normal following with in 24 hrs
Human	Acute – dermal (undiluted)	Very mild irritation
Bluegill- Aquatic	96hr- LC50	>1000mg/L

For comparative purposes, the LD50 for rats exposed orally to table salt (NaCl) is 1.75 g/ kg, this is 10 times more toxic than Soy Gold 1000 in an acute experiment. Additionally, humans

exposed to 4 percent aqueous soap solution in a patch test experienced a more severe reaction than did the humans exposed to Soy Gold 1000 (reference 1e). No inhalation investigations were found. Furthermore, Soy Gold 1000 will biodegrade to less than 95 percent in soil within 28 days. The flashpoint is above 300°F, thus, low flammability (reference 1f).

d. A listing of Soy Gold 1000 components, along with their associated Material Safety Data Sheet (MSDS), are on file at the USACHPPM, Directorate of Toxicology (DTOX). The list of the product components was reviewed by the Toxicity Evaluation Program. According to the MSDS few potential health hazards could occur with skin, eyes, and ingestion (reference 1c). Only mild irritations via dermal and ocular exposures to Soy Gold 1000 are expected. No significant adverse health effects are expected via oral and inhalation exposure.

3. Recommendations.

a. When handling Soy Gold 1000 impervious gloves and goggles should be worn; additionally, Soy Gold 1000 should be used in an adequately ventilated environment.

b. Handling instructions found in the MSDS and technical packages should be followed.

c. As with all chemicals, unnecessary exposure should be avoided.

4. Conclusions. Soy Gold 1000 must be used in accordance with the manufacturer's suggested procedures and intended usages. It must be disposed of properly to prevent unnecessary environmental exposures. Based on a review of the MSDS and data package provided by the manufacturer and extensive searches of toxicological databases, a Toxicity Clearance is granted for the addition of Soy Gold 1000 to the Army supply system as a degreaser. A new Toxicity Clearance must be performed if there are any changes in the components of Soy Gold 1000.

5. Questions regarding this reply may be directed to Jamie Suski, DSN 584-8303, commercial (410) 436-8303, or e-mail: Jamie.suski@us.army.mil.

FOR THE COMMANDER:

JAMES W. BOLES
LTC, VC
Director, Toxicology

DEPARTMENT OF THE ARMY
US ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND MD 21010-5403

MCHB-TS-TTE 31 January 2006

MEMORANDUM FOR Warfighter Directorate (CSTE-DTC-AT-WF-A/Mr. William Taylor), U.S. Army Aberdeen Test Center, Aberdeen Proving Ground, MD 21005-5059

SUBJECT: Toxicity Clearance for Soygold 1000 Solvent

1. References:

a. Memorandum, U.S. Army Aberdeen Test Center, CSTE-DTC-AT-WF-A, undated, subject: Request for Toxicity Clearance for Various Cleaners.

b. Memorandum, USACHPPM, MCHB-TS-TTE, 23 February 2005, subject: Soygold 1000 Solvent.

c. Web page, Occupational Safety and Health Administration (OSHA), Guideline for Vegetable Oil Mist, http://osha.gov/SLTC/healthguidelines/vegetableoilmist/recognition.html, 17 January 2006.

d. E-mail, U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) (MCHB-TS-TTE), Mr. John Houpt, 25 August 2005, subject: FW: cleaners.

2. Background.

a. The U.S. Army Aberdeen Test Center, Warfighter Directorate has requested Toxicity Clearances be performed by USACHPPM for 17 cleaning products where the ultimate goal is to replace the standard PD-680 hydrocarbon solvent. Currently, PD-680 is used as a cleaner in painting and paint removal operations which is the intended use of the proposed cleaning products. Soygold 1000 has already been approved to be added to the Army's supply system as a degreaser (reference 1b). Therefore, this Toxicity Clearance will address concerns associated with new use.

b. Soygold 1000 is distributed by Ag Environmental Products L.L.C., 12700 West Dodge Road, Omaha, NE 68154. This product is commercially available to the public in bulk orders (reference 1b). Soygold is a multipurpose cleaner, appropriate applications include, petroleum degreasing, metal cutting applications, adhesive/paint removal, and tool and equipment cleaning. Soygold 1000 is a soybean oil based methyl-ester. The manufacturing process entails transesterification of soybean oil and methanol with sodium hydroxide catalyst (reference 1b). Many solvents release a substantial amount of Volatile Organic Compounds (VOCs) and

Hazardous Air Pollutants (HAPs). Volatile Organic Compounds create air pollution by contributing to smog and ultimately lead to dangerous ozone (O_3). Hazardous Air Pollutants may cause a variety of serious health effects, including neurological changes. Soygold 1000 releases only 7 percent VOCs compared to other solvents where routinely 95-100 percent VOC is emitted. Additionally, Soygold 1000 does not contain HAPs. Thus, providing a safer working-environment for the solvent user and secondarily protecting the integrity of the natural-environment. Ag Environmental has had no reports of any adverse health effects from using this product (reference 1b).

c. Toxicological investigations have been conducted by Ag Environmental using this product. See table below:

Study Animal	**Study Type**	**Experimental Results**
Rat	Acute (LD50)- oral	>17.4 g/kg body weight
Rabbit	Acute exposure- ocular (undiluted)	Mild irritation- eye returned to normal following with in 24hrs
Human	Acute – dermal (undiluted)	Very mild irritation
Bluegill- Aquatic	96hr- LC50	>1000mg/L

For comparative purposes, the LD50 for rats exposed orally to table salt (NaCl) is 1.75 g/kg, this is 10 times more toxic than Soygold 1000 in an acute experiment. Additionally, humans exposed to 4 percent aqueous soap solution in a patch test experienced a more severe reaction than did the humans exposed to Soygold 1000 (reference 1b). No inhalation investigations were found. Furthermore, Soygold 1000 will biodegrade to less than 95 percent in soil within 28 days. The flashpoint is above 300°F, thus, low flammability (reference 1b).

d. Soygold is intended to be used in painting and paint removal operations. The cleaner will be sprayed onto a hand cloth then used to wipe the item being prepped for paint or paint removal clean (reference 1d). Aerating the product in mist form may be cause for inhalation concerns. As there are no inhalation data available nor have guidelines been established for soybean oil (methyl soyate) it may be appropriate to advise OSHA's Permissible Exposure Limit (PEL) of 5 $mg/m^{(3)}$; which is the limit established for the respirable fraction of vegetable oil based on an 8-hour time-weighted average (reference 1c).

e. A listing of Soygold 1000 components, along with their associated Material Safety Data Sheet (MSDS), are on file at the USACHPPM, Directorate of Toxicology (DTOX). The list of the product components was reviewed by the Toxicity Evaluation Program, DTOX. According

to the MSDS few potential health hazards could occur with skin, eyes, and ingestion (reference 1b). Only mild irritations via dermal and ocular exposures to Soygold 1000 are expected. No significant adverse health effects are expected via oral and inhalation exposure.

3. Recommendations.

a. When handling Soygold 1000 impervious gloves and goggles should be worn; additionally, Soygold 1000 should be used in an adequately ventilated environment.

b. Handling instructions found in the MSDS and technical packages should be followed.

c. As there is an increasing trend to replace harsh solvents with soy based products all routes of exposure should be evaluated for toxic effects. Specifically, there are no inhalation data for Soygold; therefore, it is recommended that methyl soyate be evaluated for toxic effects in an acute and sub-chronic study via inhalation exposure route.

d. As with all chemicals, unnecessary exposure should be avoided.

4. Conclusions. Soygold 1000 must be used in accordance with the manufacturer's suggested procedures and intended usages. It must be disposed of properly to prevent unnecessary environmental exposures. Based on literature reviews and the previously granted Toxicity Clearance for Soygold 1000 a new Toxicity Clearance is granted for the addition of Soygold 1000 to the Army supply system as a cleaner, including use in painting and paint removal operations. A new Toxicity Clearance must be performed if there are any changes in the components of Soygold 1000.

5. Point of contact for this action is Ms. Jamie Suski, DSN 584-8303, commercial (410) 436-8303 or via e-mail at Jamie.gail.suski@us.army.mil.

FOR THE COMMANDER:

for STEPHEN L. KISTNER
Deputy for Technical Services

APPENDIX B. CHEMISTRY LABORATORY REPORT

(Page B-2 Blank)

U.S. Army Aberdeen Test Center

400 Colleran Road
Aberdeen Proving Ground, MD 21005-5059

CHEMICAL SAMPLING AND ANALYSIS TEAM
APPLIED SCIENCES TEST DIVISION
WARFIGHTER DIRECTORATE
Petroleum Oil Lubricants & Fuels Report
SUPPLEMENT TO TEST REPORT 2005-CC-154

Taylor, William
CSTE-DTC-WC-AS
PHYSICAL TEST UNIT
APG, MD 21005

Project Number: C7867

Gwen McKinney
Quality Manager

Report Number: 0412016.23-Jan-06 15:59 **(05CC154A)**

This report shall not be reproduced except in its entirety without the written approval of the Chemical Sampling and Analysis Team. The results relate only to the specific samples/test item/test scenario identified within the report.

Authorized for Release:

Signature: William W Newton Date: 25 January 2006

William W. Newton
Chief, Applied Science Test Division

January 23, 2006

Taylor, William
CSTE-DTC-WC-AS
APPLIED SCIENCE TEST DIVISION / PHYSICAL TEST UNIT
APG, MD 21005

RE: **SOY GOLD 1000 TEST**
Project **#C7867**

Two samples identified as Soy Gold 1000 old and new received 9 Dec 2004 were assigned laboratory numbers: 0412016-01 and 0412016-02, respectively. The following analyses were requested:

Test Name	**Units**	**Specification for Soy Gold 1000**
Acidity	mgNaOH/100ml	0
Flash Point (min)	°C	> 100
Kauri Butanol	KB	27 – 45
VOC	g/L	<50 (or 5% by weight)
Vapor Pressure	mmHg	<2.0
Non-volatiles	mg/L	

All results for the above tests were reported 9 March 2005 with the exception of the Non Volatiles. Analysis was performed in accordance to ASTM method D1353. Due to the chemical makeup of the sample, little or no signs of evaporation were observed. After several attempts of obtaining results for non-volatiles, it was concluded that the non-volatiles in Soy Gold was greater than 84%.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Engineering Technician

CSTE-DTC-WC-AS PHYSICAL TEST UNIT APG, MD 21005	Project: Project Number: Project Manager:	SOY GOLD 1000 TEST C7867 Taylor, William	Reported: 1/23/2006

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received	Notes
SOY GOLD 1000 OLD	0412016-01	Fuel	08-Dec-04 00:00	09-Dec-04 15:24	12 MONTHS OLD
SOY GOLD 1000 NEW	0412016-02	Fuel	08-Dec-03 00:00	09-Dec-04 15:24	

Data Assessment:

The Soy Gold 1000 samples did not meet the specifications listed in Table 1:

0412016-01 (**OLD**) – Acidity was above specification @ 0.68
Kauri Butanol was outside the limits @ 58.5

0412016-02 (**NEW**) – Acidity was above specification @ 1.70
Kauri Butanol was outside the limits @ 58.6

Table 1: Performance and Testing Requirements

Test Name	Units	Specification for Soy Gold 1000
Acidity	mgNaOH/100ml	0
Flash Point (min)	°C	> 100
Kauri Butanol	KB	27 – 45
VOC	g/L	<50 (or 5% by weight)
Vapor Pressure	mmHg	<2.0
Non-volatiles	mg/L	

CSTE-DTC-WC-AS	Project:	SOY GOLD 1000 TEST	
PHYSICAL TEST UNIT	Project Number:	C7867	Reported:
APG, MD 21005	Project Manager:	Taylor, William	3/9/2005

Surveillance of Fuel Sample

Chemical Sampling & Analysis Team

Analyte	Result	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
SOY GOLD 1000 OLD (0412016-01)								
Acidity	**0.680**	mgNaOH /100ml	1	B502009	15-Feb-05	15-Feb-05	ASTM D847	
Flashpoint	**156**	°C	"	"	"	15-Feb-05	ASTM D93	
Kauri Butanol	**58.5**	KB	"	"	"	15-Feb-05	ASTM D1133	A-01
VOC	**6.7**	% by weight	"	"	"	15-Feb-05	ASTM D2369	
SOY GOLD 1000 NEW (0412016-02)								
Acidity	**1.70**	mgNaOH/ 100ml	1	B502009	15-Feb-05	15-Feb-05	ASTM D847	
Flashpoint	**166**	°C	"	"	"	15-Feb-05	ASTM D93	
Kauri Butanol	**58.6**	KB	"	"	"	15-Feb-05	ASTM D1133	A-01
Vapor Pressure	**<2.00**	mm Hg	"	"	"	15-Feb-05	ASTM D2879	
VOC	**5.8**	% by weight	"	"	"	15-Feb-05	ASTM D2369	

Notes and Definitions

A-01 Averaged Result

APPENDIX C. VOLATILE ORGANIC COMPOUNDS REPORT

(Page C-2 Blank)

U.S. Army Center for Health Promotion and Preventive Medicine

DIRECTORATE OF LABORATORY SCIENCES (DLS)
FINAL ANALYTICAL REPORT

PROFILE NUMBER: 29127-03NK
REPORT SERIAL NUMBER: A050224-1
WORKORDER: 15100
PROJECT SITE: ATC-APG
CLIENT: WILLIAM TAYLOR
METHOD NUMBER: EPA 5030B/8260B (ASD SOP # 46.10)
REPORT DATE: 24 FEBRUARY 2005

Readiness Thru Health

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DEPARTMENT OF THE ARMY
U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO
ATTENTION OF

MCHB-TS-LAD (40-5F)

DIRECTORATE OF LABORATORY SCIENCES (DLS)
ANALYTICAL SPECTROMETRY DIVISION
FINAL ANALYTICAL REPORT

PROFILE NUMBER: 29127-03NK
REPORT SERIAL NUMBER: A050224-1
WORKORDER: 15100
PROJECT SITE: ATC-APG
CLIENT: WILLIAM TAYLOR
METHOD NUMBER: EPA 5030B/8260B (ASD SOP # 46.10)
REPORT DATE: 24 FEBRUARY 2005

This report shall not be reproduced except in full without the written approval of DLS. The results relate only to the specific samples identified within the report. This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government.

REPORT RELEASE AUTHORIZATION:

Signature: _____ Date: 8 May 06
for Geraldine Miles
Chief, Analytical Spectrometry Division

AIHA
Industrial Hygiene
ACCREDITED
LABORATORY

CERTIFICATE # 28.02

DLS holds accreditation from AIHA, A2LA, NLLAP and COLA
Readiness Thru Health

CASE NARRATIVE

PROFILE NUMBER: 29127-03NK
REPORT SERIAL NUMBER: A050224-1
WORKORDER: 15100
PROJECT SITE: ATC-APG
CLIENT: WILLIAM TAYLOR
METHOD NUMBER: EPA 5030B/8260B (ASD SOP # 46.10)
REPORT DATE: 24 FEBRUARY 2005

Provided are the results of two soybean oil samples submitted from ATC-APG for volatiles analysis. The samples were collected on 24 January 2005, and received in DLS on 24 January 2005. The samples were received without refrigeration, which is not within the acceptable temperature range of 2-6°C. This deviation adds some analytical uncertainty to the quantitative results reported.

Sample Analysis:

The samples were analyzed for volatiles by EPA Method 5030B/8260B on 7 February 2005. All analytical holding times were met for the samples. Target compound hexachlorobutadiene was detected at trace levels in the laboratory blank. The presence of this compound should be attributed to laboratory contamination. Due to the nature of the oil matrix, the sample could not be analyzed neat therefore a 1:250 dilution of the sample in methanol was performed. Target compound naphthalene was detected in the samples at a trace/low concentration. The duplicate sample failed to meet the acceptance criteria for the last internal standard (1,4-dichlorobenzene-d4) and, as such, the result for naphthalene is biased high in the sample and an additional amount of analytical uncertainty should be associated with the result.

Quality Control:

Most internal standard area counts and retention times complied with method QC requirements, except as discussed above in the Sample Analysis section above. Most surrogate recoveries met method requirements as noted on Form 2. A second source Laboratory Control Spike (LCS) was prepared and analyzed with acceptable recoveries for most compounds, except as noted on the LCS Report form. These deviations are minor and not thought to have an adverse effect on the quality of the data. Additionally, due to the difficulty of the matrix a matrix spike (MS) and matrix spike duplicate (MSD) was not performed.

Project Analyst: _____ Date: _____

Technical Reviewer: _____ Date: _____

Administrative Reviewer: _____ Date: _____

Report POC: Jennifer Seeger, GC/MS Team Leader (410) 436-8280

Listing of Report Contents:

Section	Beginning Page	Section	Beginning Page
Cover Sheet	1	Results of Analysis (Form 1's)	5
Cover Letter	2	Quality Control Report	11
Case Narrative	3	Terminology/Abbreviations/Codes	29
Sample Summary	4	Total Number of Pages in Report	29

SAMPLE SUMMARY

Field Number	Date Collected	LISMD Number	Data File Number	Matrix
Soy Gold 1000	1/24/2005	15100001 (1:250 dil)	D7W82072.D	Soybean Oil
Soy Gold 1000 - Dup	1/24/2005	15100002 (1:250 dil)	D7W82073.D	Soybean Oil

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

Sample Number: **Soy Gold 1000 1:250 DIL**

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03NK Site: ATC-APG Code: E8260 Units: ug/L

Matrix: (soil/water) WATER Lab Sample ID: 15100001

Sample wt/vol: 5.0 (g/ml) ML Lab File ID: D7W82072.D

Level: (low/med) LOW Date Collected: 01/24/05

% Moisture: not dec. _____ Date Analyzed: 02/07/05

GC Column: DB-624 ID: 0.18 (mm) Dilution Factor: 250.0

Soil Extract Volume _____ (uL) Soil Aliquot Volume: _____ (uL)

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND		Q
75-71-8	dichlorodifluoromethane	500	U
74-87-3	chloromethane	500	U
75-01-4	vinyl chloride	500	U
74-83-9	bromomethane	500	U
75-00-3	chloroethane	500	U
75-69-4	trichlorofluoromethane	500	U
60-29-7	ethyl ether	5000	U
74-88-4	iodomethane	5000	U
75-15-0	carbon disulfide	5000	U
67-64-1	acetone	5000	U
75-35-4	1,1-dichloroethene	500	U
107-05-1	allyl chloride	5000	U
75-09-2	methylene chloride	500	U
107-13-1	acrylonitrile	5000	U
1634-04-4	methyl-t-butyl ether	5000	U
156-60-5	trans-1,2-dichloroethene	500	U
75-34-3	1,1-dichloroethane	500	U
594-20-7	2,2-dichloropropane	500	U
156-59-2	cis-1,2-dichloroethene	500	U
78-93-3	2-butanone	5000	U
107-12-0	propionitrile	5000	U
96-33-3	methyl acrylate	5000	U
126-98-7	methacrylonitrile	5000	U
109-99-9	tetrahydrofuran	5000	U
74-97-5	bromochloromethane	500	U
67-66-3	chloroform	500	U
71-55-6	1,1,1-trichloroethane	500	U
56-23-5	carbon tetrachloride	500	U
563-58-6	1,1-dichloropropene	500	U
109-69-3	1-chlorobutane	5000	U
71-43-2	benzene	500	U
107-06-2	1,2-dichloroethane	500	U
79-01-6	trichloroethene	500	U
78-87-5	1,2-dichloropropane	500	U
74-95-3	dibromomethane	500	U
80-62-6	methyl methacrylate	5000	U
75-27-4	bromodichloromethane	500	U
79-46-9	2-nitropropane	5000	U
107-14-2	chloroacetonitrile	5000	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

Sample Number: **Soy Gold 1000 1:250 DIL**

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03NK Site: ATC-APG Code: E8260 Units: ug/L

Matrix: (soil/water) WATER Lab Sample ID: 15100001

Sample wt/vol: 5.0 (g/ml) ML Lab File ID: D7W82072.D

Level: (low/med) LOW Date Collected: 01/24/05

% Moisture: not dec. _____ Date Analyzed: 02/07/05

GC Column: DB-624 ID: 0.18 (mm) Dilution Factor: 250.0

Soil Extract Volume _____ (uL) Soil Aliquot Volume: _____ (uL)

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND		Q
10061-01-5	cis-1,3-dichloropropene	500	U
108-10-1	4-methyl-2-pentanone	5000	U
108-88-3	toluene	500	U
10061-02-6	trans-1,3-dichloropropene	500	U
79-00-5	1,1,2-trichloroethane	500	U
97-63-2	ethyl methacrylate	5000	U
127-18-4	tetrachloroethene	500	U
142-28-9	1,3-dichloropropane	500	U
591-78-6	2-hexanone	5000	U
124-48-1	dibromochloromethane	500	U
106-93-4	1,2-dibromoethane	500	U
108-90-7	chlorobenzene	500	U
630-20-6	1,1,1,2-tetrachloroethane	500	U
100-41-4	ethylbenzene	500	U
108-38-3;10	m/p-xylene	500	U
95-47-6	o-xylene	500	U
100-42-5	styrene	500	U
75-25-2	bromoform	500	U
98-82-8	isopropylbenzene	500	U
108-86-1	bromobenzene	500	U
79-34-5	1,1,2,2-tetrachloroethane	500	U
96-18-4	1,2,3-trichloropropane	500	U
110-57-6	trans-1,4-dichloro-2-butene	5000	U
103-65-1	n-propylbenzene	500	U
95-49-8	2-chlorotoluene	500	U
106-43-4	4-chlorotoluene	500	U
108-67-8	1,3,5-trimethylbenzene	500	U
98-06-6	tert-butylbenzene	500	U
76-01-7	pentachloroethane	5000	U
95-63-6	1,2,4-trimethylbenzene	500	U
135-98-8	sec-butylbenzene	500	U
541-73-1	1,3-dichlorobenzene	500	U
99-87-6	4-isopropyltoluene	500	U
106-46-7	1,4-dichlorobenzene	500	U
95-50-1	1,2-dichlorobenzene	500	U
104-51-8	n-butylbenzene	500	U
67-72-1	hexachloroethane	5000	U
96-12-8	1,2-dibromo-3-chloropropane	500	U
120-82-1	1,2,4-trichlorobenzene	500	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

Sample Number:

Soy Gold 1000 1:250 DIL

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03NK Site: ATC-APG Code: E8260 Units: ug/L

Matrix: (soil/water) WATER Lab Sample ID: 15100001

Sample wt/vol: 5.0 (g/ml) ML Lab File ID: D7W82072.D

Level: (low/med) LOW Date Collected: 01/24/05

% Moisture: not dec. Date Analyzed: 02/07/05

GC Column: DB-624 ID: 0.18 (mm) Dilution Factor: 250.0

Soil Extract Volume (uL) Soil Aliquot Volume: (uL)

CONCENTRATION UNITS:

CAS NO.	COMPOUND	(ug/L or ug/Kg) UG/L	Q
87-68-3	hexachlorobutadiene	500	U
91-20-3	naphthalene	350	JD
87-61-6	1,2,3-trichlorobenzene	500	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

Sample Number:

Soy Gold 1000 - Dup 1:250 DIL

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03NK Site: ATC-APG Code: E8260 Units: ug/L

Matrix: (soil/water) WATER Lab Sample ID: 15100002

Sample wt/vol: 5.0 (g/ml) ML Lab File ID: D7W82073.D

Level: (low/med) LOW Date Collected: 01/24/05

% Moisture: not dec. Date Analyzed: 02/07/05

GC Column: DB-624 ID: 0.18 (mm) Dilution Factor: 250.0

Soil Extract Volume (uL) Soil Aliquot Volume: (uL)

CONCENTRATION UNITS:

CAS NO.	COMPOUND	(ug/L or ug/Kg) UG/L	Q
75-71-8	dichlorodifluoromethane	500	U
74-87-3	chloromethane	500	U
75-01-4	vinyl chloride	500	U
74-83-9	bromomethane	500	U
75-00-3	chloroethane	500	U
75-69-4	trichlorofluoromethane	500	U
60-29-7	ethyl ether	5000	U
74-88-4	iodomethane	5000	U
75-15-0	carbon disulfide	5000	U
67-64-1	acetone	5000	U
75-35-4	1,1-dichloroethene	500	U
107-05-1	allyl chloride	5000	U
75-09-2	methylene chloride	500	U
107-13-1	acrylonitrile	5000	U
1634-04-4	methyl-t-butyl ether	5000	U
156-60-5	trans-1,2-dichloroethene	500	U
75-34-3	1,1-dichloroethane	500	U
594-20-7	2,2-dichloropropane	500	U
156-59-2	cis-1,2-dichloroethene	500	U
78-93-3	2-butanone	5000	U
107-12-0	propionitrile	5000	U
96-33-3	methyl acrylate	5000	U
126-98-7	methacrylonitrile	5000	U
109-99-9	tetrahydrofuran	5000	U
74-97-5	bromochloromethane	500	U
67-66-3	chloroform	500	U
71-55-6	1,1,1-trichloroethane	500	U
56-23-5	carbon tetrachloride	500	U
563-58-6	1,1-dichloropropene	500	U
109-69-3	1-chlorobutane	5000	U
71-43-2	benzene	500	U
107-06-2	1,2-dichloroethane	500	U
79-01-6	trichloroethene	500	U
78-87-5	1,2-dichloropropane	500	U
74-95-3	dibromomethane	500	U
80-62-6	methyl methacrylate	5000	U
75-27-4	bromodichloromethane	500	U
79-46-9	2-nitropropane	5000	U
107-14-2	chloroacetonitrile	5000	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

Sample Number:

Soy Gold 1000 - Dup 1:250 DIL

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03NK Site: ATC-APG Code: E8260 Units: ug/L

Matrix: (soil/water) WATER Lab Sample ID: 15100002

Sample wt/vol: 5.0 (g/ml) ML Lab File ID: D7W82073.D

Level: (low/med) LOW Date Collected: 01/24/05

% Moisture: not dec. Date Analyzed: 02/07/05

GC Column: DB-624 ID: 0.18 (mm) Dilution Factor: 250.0

Soil Extract Volume (uL) Soil Aliquot Volume: (uL)

CONCENTRATION UNITS:

CAS NO.	COMPOUND	(ug/L or ug/Kg) UG/L	Q
10061-01-5	cis-1,3-dichloropropene	500	U
108-10-1	4-methyl-2-pentanone	5000	U
108-88-3	toluene	500	U
10061-02-6	trans-1,3-dichloropropene	500	U
79-00-5	1,1,2-trichloroethane	500	U
97-63-2	ethyl methacrylate	5000	U
127-18-4	tetrachloroethene	500	U
142-28-9	1,3-dichloropropane	500	U
591-78-6	2-hexanone	5000	U
124-48-1	dibromochloromethane	500	U
106-93-4	1,2-dibromoethane	500	U
108-90-7	chlorobenzene	500	U
630-20-6	1,1,1,2-tetrachloroethane	500	U
100-41-4	ethylbenzene	500	U
108-38-3;10	m/p-xylene	500	U
95-47-6	o-xylene	500	U
100-42-5	styrene	500	U
75-25-2	bromoform	500	U
98-82-8	isopropylbenzene	500	U
108-86-1	bromobenzene	500	U
79-34-5	1,1,2,2-tetrachloroethane	500	U
96-18-4	1,2,3-trichloropropane	500	U
110-57-6	trans-1,4-dichloro-2-butene	5000	U
103-65-1	n-propylbenzene	500	U
95-49-8	2-chlorotoluene	500	U
106-43-4	4-chlorotoluene	500	U
108-67-8	1,3,5-trimethylbenzene	500	U
98-06-6	tert-butylbenzene	500	U
76-01-7	pentachloroethane	5000	U
95-63-6	1,2,4-trimethylbenzene	500	U
135-98-8	sec-butylbenzene	500	U
541-73-1	1,3-dichlorobenzene	500	U
99-87-6	4-isopropyltoluene	500	U
106-46-7	1,4-dichlorobenzene	500	U
95-50-1	1,2-dichlorobenzene	500	U
104-51-8	n-butylbenzene	500	U
67-72-1	hexachloroethane	5000	U
96-12-8	1,2-dibromo-3-chloropropane	500	U
120-82-1	1,2,4-trichlorobenzene	500	U

FORM I VOA 3/90

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

Sample Number:

Soy Gold 1000 - Dup 1:250 DIL

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03NK Site: ATC-APG Code: E8260 Units: ug/L

Matrix: (soil/water) WATER Lab Sample ID: 15100002

Sample wt/vol: 5.0 (g/ml) ML Lab File ID: D7W82073.D

Level: (low/med) LOW Date Collected: 01/24/05

% Moisture: not dec. Date Analyzed: 02/07/05

GC Column: DB-624 ID: 0.18 (mm) Dilution Factor: 250.0

Soil Extract Volume (uL) Soil Aliquot Volume: (uL)

CONCENTRATION UNITS:

CAS NO.	COMPOUND (ug/L or ug/Kg)	UG/L	Q
87-68-3	hexachlorobutadiene	500	U
91-20-3	naphthalene	1500	D
87-61-6	1,2,3-trichlorobenzene	500	U

FORM I VOA 3/90

QUALITY CONTROL REPORT

Contains:

1. Data Analysis Sheets (Form 1's) for method blanks, spiked blanks, and/or spiked samples.

2. Matrix Spike / Matrix Spike Duplicate Recovery Report(s) (Form 3) and Recovery Report(s) for spiked blanks

3. Surrogate Recovery Report(s) (Form 2)

4. Blank Report(s) (Form 4)

5. Tune Check Report(s) (Form 5)

6. Initial Calibration Report(s) (Form 6)

7. Continuing Calibration Report(s) (Form 7)

8. Internal Standard Response and Retention Time Report(s) (Form 8)

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

Sample Number: **Lab Blank 0207**

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03NK Site: ATC-APG Code: E8260 Units: ug/L

Matrix: (soil/water) WATER Lab Sample ID: LAB BLANK 0207-

Sample wt/vol: 5.0 (g/ml) ML Lab File ID: B7W82071.D

Level: (low/med) LOW Date Collected: 02/07/05

% Moisture: not dec. Date Analyzed: 02/07/05

GC Column: DB-624 ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume (uL) Soil Aliquot Volume: (uL)

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND		Q
75-71-8	dichlorodifluoromethane	2.0	U
74-87-3	chloromethane	2.0	U
75-01-4	vinyl chloride	2.0	U
74-83-9	bromomethane	2.0	U
75-00-3	chloroethane	2.0	U
75-69-4	trichlorofluoromethane	2.0	U
60-29-7	ethyl ether	20	U
74-88-4	iodomethane	20	U
75-15-0	carbon disulfide	20	U
67-64-1	acetone	20	U
75-35-4	1,1-dichloroethene	2.0	U
107-05-1	allyl chloride	20	U
75-09-2	methylene chloride	2.0	U
107-13-1	acrylonitrile	20	U
1634-04-4	methyl-t-butyl ether	20	U
156-60-5	trans-1,2-dichloroethene	2.0	U
75-34-3	1,1-dichloroethane	2.0	U
594-20-7	2,2-dichloropropane	2.0	U
156-59-2	cis-1,2-dichloroethene	2.0	U
78-93-3	2-butanone	20	U
107-12-0	propionitrile	20	U
96-33-3	methyl acrylate	20	U
126-98-7	methacrylonitrile	20	U
109-99-9	tetrahydrofuran	20	U
74-97-5	bromochloromethane	2.0	U
67-66-3	chloroform	2.0	U
71-55-6	1,1,1-trichloroethane	2.0	U
56-23-5	carbon tetrachloride	2.0	U
563-58-6	1,1-dichloropropene	2.0	U
109-69-3	1-chlorobutane	20	U
71-43-2	benzene	2.0	U
107-06-2	1,2-dichloroethane	2.0	U
79-01-6	trichloroethene	2.0	U
78-87-5	1,2-dichloropropane	2.0	U
74-95-3	dibromomethane	2.0	U
80-62-6	methyl methacrylate	20	U
75-27-4	bromodichloromethane	2.0	U
79-46-9	2-nitropropane	20	U
107-14-2	chloroacetonitrile	20	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

Sample Number: **Lab Blank 0207**

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03NK Site: ATC-APG Code: E8260 Units: ug/L

Matrix: (soil/water) WATER Lab Sample ID: LAB BLANK 0207-

Sample wt/vol: 5.0 (g/ml) ML Lab File ID: B7W82071.D

Level: (low/med) LOW Date Collected: 02/07/05

% Moisture: not dec. _____ Date Analyzed: 02/07/05

GC Column: DB-624 ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume _____ (uL) Soil Aliquot Volume: _____ (uL)

CONCENTRATION UNITS:

CAS NO.	COMPOUND (ug/L or ug/Kg) UG/L		Q
10061-01-5	cis-1,3-dichloropropene	2.0	U
108-10-1	4-methyl-2-pentanone	20	U
108-88-3	toluene	2.0	U
10061-02-6	trans-1,3-dichloropropene	2.0	U
79-00-5	1,1,2-trichloroethane	2.0	U
97-63-2	ethyl methacrylate	20	U
127-18-4	tetrachloroethene	2.0	U
142-28-9	1,3-dichloropropane	2.0	U
591-78-6	2-hexanone	20	U
124-48-1	dibromochloromethane	2.0	U
106-93-4	1,2-dibromoethane	2.0	U
108-90-7	chlorobenzene	2.0	U
630-20-6	1,1,1,2-tetrachloroethane	2.0	U
100-41-4	ethylbenzene	2.0	U
108-38-3;10	m/p-xylene	2.0	U
95-47-6	o-xylene	2.0	U
100-42-5	styrene	2.0	U
75-25-2	bromoform	2.0	U
98-82-8	isopropylbenzene	2.0	U
108-86-1	bromobenzene	2.0	U
79-34-5	1,1,2,2-tetrachloroethane	2.0	U
96-18-4	1,2,3-trichloropropane	2.0	U
110-57-6	trans-1,4-dichloro-2-butene	20	U
103-65-1	n-propylbenzene	2.0	U
95-49-8	2-chlorotoluene	2.0	U
106-43-4	4-chlorotoluene	2.0	U
108-67-8	1,3,5-trimethylbenzene	2.0	U
98-06-6	tert-butylbenzene	2.0	U
76-01-7	pentachloroethane	20	U
95-63-6	1,2,4-trimethylbenzene	2.0	U
135-98-8	sec-butylbenzene	2.0	U
541-73-1	1,3-dichlorobenzene	2.0	U
99-87-6	4-isopropyltoluene	2.0	U
106-46-7	1,4-dichlorobenzene	2.0	U
95-50-1	1,2-dichlorobenzene	2.0	U
104-51-8	n-butylbenzene	2.0	U
67-72-1	hexachloroethane	20	U
96-12-8	1,2-dibromo-3-chloropropane	2.0	U
120-82-1	1,2,4-trichlorobenzene	2.0	U

FORM I VOA 3/90

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

Sample Number: **Lab Blank 0207**

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03NK Site: ATC-APG Code: E8260 Units: ug/L

Matrix: (soil/water) WATER Lab Sample ID: LAB BLANK 0207-

Sample wt/vol: 5.0 (g/ml) ML Lab File ID: B7W82071.D

Level: (low/med) LOW Date Collected: 02/07/05

% Moisture: not dec. _____ Date Analyzed: 02/07/05

GC Column: DB-624 ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume _____ (uL) Soil Aliquot Volume: _____ (uL)

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND		Q
87-68-3	hexachlorobutadiene	1.7	J
91-20-3	naphthalene	2.0	U
87-61-6	1,2,3-trichlorobenzene	2.0	U

FORM I VOA 3/90

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

Sample Number: **LCS 0207**

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03NK Site: ATC-APG Code: E8260 Units: ug/L

Matrix: (soil/water) WATER Lab Sample ID: 20 PPB LCS

Sample wt/vol: 5.0 (g/ml) ML Lab File ID: L7W82067.D

Level: (low/med) LOW Date Collected: 02/07/05

% Moisture: not dec. _____ Date Analyzed: 02/07/05

GC Column: DB-624 ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume _____ (uL) Soil Aliquot Volume: _____ (uL)

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND		Q
75-71-8	dichlorodifluoromethane	24	
74-87-3	chloromethane	17	
75-01-4	vinyl chloride	19	
74-83-9	bromomethane	29	
75-00-3	chloroethane	19	
75-69-4	trichlorofluoromethane	19	
60-29-7	ethyl ether	85	
74-88-4	iodomethane	92	
75-15-0	carbon disulfide	89	
67-64-1	acetone	86	
75-35-4	1,1-dichloroethene	14	
107-05-1	allyl chloride	87	
75-09-2	methylene chloride	16	
107-13-1	acrylonitrile	80	
1634-04-4	methyl-t-butyl ether	92	
156-60-5	trans-1,2-dichloroethene	17	
75-34-3	1,1-dichloroethane	18	
594-20-7	2,2-dichloropropane	21	
156-59-2	cis-1,2-dichloroethene	18	
78-93-3	2-butanone	84	
107-12-0	propionitrile	81	
96-33-3	methyl acrylate	82	
126-98-7	methacrylonitrile	83	
109-99-9	tetrahydrofuran	80	
74-97-5	bromochloromethane	18	
67-66-3	chloroform	17	
71-55-6	1,1,1-trichloroethane	19	
56-23-5	carbon tetrachloride	21	
563-58-6	1,1-dichloropropene	17	
109-69-3	1-chlorobutane	93	
71-43-2	benzene	18	
107-06-2	1,2-dichloroethane	19	
79-01-6	trichloroethene	19	
78-87-5	1,2-dichloropropane	18	
74-95-3	dibromomethane	18	
80-62-6	methyl methacrylate	87	
75-27-4	bromodichloromethane	20	
79-46-9	2-nitropropane	92	
107-14-2	chloroacetonitrile	96	

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

Sample Number: **LCS 0207**

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03NK Site: ATC-APG Code: E8260 Units: ug/L

Matrix: (soil/water) WATER Lab Sample ID: 20 PPB LCS

Sample wt/vol: 5.0 (g/ml) ML Lab File ID: L7W82067.D

Level: (low/med) LOW Date Collected: 02/07/05

% Moisture: not dec. _____ Date Analyzed: 02/07/05

GC Column: DB-624 ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume _____ (uL) Soil Aliquot Volume: _____ (uL)

CONCENTRATION UNITS:

CAS NO.	COMPOUND	(ug/L or ug/Kg) UG/L	Q
10061-01-5	cis-1,3-dichloropropene	19	
108-10-1	4-methyl-2-pentanone	89	
108-88-3	toluene	18	
10061-02-6	trans-1,3-dichloropropene	17	
79-00-5	1,1,2-trichloroethane	18	
97-63-2	ethyl methacrylate	90	
127-18-4	tetrachloroethene	6.8	
142-28-9	1,3-dichloropropane	17	
591-78-6	2-hexanone	86	
124-48-1	dibromochloromethane	17	
106-93-4	1,2-dibromoethane	17	
108-90-7	chlorobenzene	19	
630-20-6	1,1,1,2-tetrachloroethane	18	
100-41-4	ethylbenzene	20	
108-38-3;10	m/p-xylene	39	
95-47-6	o-xylene	19	
100-42-5	styrene	19	
75-25-2	bromoform	16	
98-82-8	isopropylbenzene	24	
108-86-1	bromobenzene	19	
79-34-5	1,1,2,2-tetrachloroethane	19	
96-18-4	1,2,3-trichloropropane	18	
110-57-6	trans-1,4-dichloro-2-butene	96	
103-65-1	n-propylbenzene	22	
95-49-8	2-chlorotoluene	20	
106-43-4	4-chlorotoluene	22	
108-67-8	1,3,5-trimethylbenzene	20	
98-06-6	tert-butylbenzene	20	
76-01-7	pentachloroethane	280	
95-63-6	1,2,4-trimethylbenzene	20	
135-98-8	sec-butylbenzene	19	
541-73-1	1,3-dichlorobenzene	19	
99-87-6	4-isopropyltoluene	19	
106-46-7	1,4-dichlorobenzene	18	
95-50-1	1,2-dichlorobenzene	18	
104-51-8	n-butylbenzene	19	
67-72-1	hexachloroethane	91	
96-12-8	1,2-dibromo-3-chloropropane	24	
120-82-1	1,2,4-trichlorobenzene	25	

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

Sample Number: **LCS 0207**

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03NK Site: ATC-APG Code: E8260 Units: ug/L

Matrix: (soil/water) WATER Lab Sample ID: 20 PPB LCS

Sample wt/vol: 5.0 (g/ml) ML Lab File ID: L7W82067.D

Level: (low/med) LOW Date Collected: 02/07/05

% Moisture: not dec. _____ Date Analyzed: 02/07/05

GC Column: DB-624 ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume _____ (uL) Soil Aliquot Volume: _____ (uL)

CONCENTRATION UNITS:

CAS NO.	COMPOUND	(ug/L or ug/Kg) UG/L	Q
87-68-3	hexachlorobutadiene	23	B
91-20-3	naphthalene	28	
87-61-6	1,2,3-trichlorobenzene	25	

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8260B WATER LABORATORY CONTROL SPIKE REPORT

File Number: L7W82067.D Data File Path: G:\VOC7\DATA\02_07_05\
Sample Name: 20 PPB LCS Operator: 0196LISA
Date Acquired: 7 Feb 2005 11:20 Method File: 826WADD1
Misc. Information: G:A,B3040352,L:S,LB18338,A:A,B4030141

COMPOUND NAME	CONC (ug/L)	PERCENT RECOVERY (%)	RANGE LOWER	RANGE UPPER	IN SPEC (YES/NO)
dichlorodifluoromethane	24	119	32	191	YES
chloromethane	17	87	59	144	YES
vinyl chloride	19	96	68	126	YES
bromomethane	29	147	54	180	YES
chloroethane	19	96	66	132	YES
trichlorofluoromethane	19	93	34	141	YES
ethyl ether	85	85	79	111	YES
iodomethane	92	92	41	122	YES
carbon disulfide	89	89	39	125	YES
acetone	86	86	78	148	YES
1,1-dichloroethene	14	69	35	125	YES
allyl chloride	87	87	71	140	YES
methylene chloride	16	79	72	118	YES
acrylonitrile	80	80	83	118	NO
methyl-t-butyl ether	92	92	79	126	YES
trans-1,2-dichloroethene	17	83	68	118	YES
1,1-dichloroethane	18	88	75	116	YES
2,2-dichloropropane	21	104	63	125	YES
cis-1,2-dichloroethene	18	88	81	121	YES
2-butanone	84	84	83	128	YES
propionitrile	81	81	78	127	YES
methyl acrylate	82	82	89	117	NO
methacrylonitrile	83	83	86	117	NO
tetrahydrofuran	80	80	86	113	NO
bromochloromethane	18	89	86	117	YES
chloroform	17	87	82	108	YES
1,1,1-trichloroethane	19	97	73	117	YES
carbon tetrachloride	21	106	64	121	YES
1,1-dichloropropene	17	85	66	109	YES
1-chlorobutane	93	93	67	122	YES
benzene	18	89	85	105	YES
1,2-dichloroethane	19	93	84	110	YES
trichloroethene	19	93	86	112	YES
1,2-dichloropropane	18	90	87	109	YES
dibromomethane	18	88	90	107	NO
methyl methacrylate	87	87	91	115	NO
bromodichloromethane	20	98	86	109	YES
2-nitropropane	92	92	64	136	YES
chloroacetonitrile	96	96	77	140	YES
cis-1,3-dichloropropene	19	97	86	113	YES
4-methyl-2-pentanone	89	89	87	122	YES
toluene	18	91	88	105	YES
trans-1,3-dichloropropene	17	84	70	126	YES
1,1,2-trichloroethane	18	88	90	103	NO
ethyl methacrylate	90	90	93	117	NO
tetrachloroethene	7	34	50	250	NO
1,3-dichloropropane	17	85	87	106	NO
2-hexanone	86	86	85	126	YES
dibromochloromethane	17	86	67	127	YES
1,2-dibromoethane	17	86	90	106	NO
chlorobenzene	19	93	92	105	YES
1,1,1,2-tetrachloroethane	18	91	92	122	NO
ethylbenzene	20	99	87	105	YES
m/p-xylene	39	96	88	108	YES
o-xylene	19	97	92	110	YES
styrene	19	94	91	109	YES
bromoform	16	78	50	140	YES
isopropylbenzene	24	122	93	120	NO
bromobenzene	19	97	84	112	YES
1,1,2,2-tetrachloroethane	19	94	86	112	YES
1,2,3-trichloropropane	18	90	78	117	YES
trans-1,4-dichloro-2-butene	96	96	72	135	YES
n-propylbenzene	22	109	82	107	NO
2-chlorotoluene	20	102	86	107	YES
4-chlorotoluene	22	109	91	107	NO
1,3,5-trimethylbenzene	20	102	88	107	YES
tert-butylbenzene	20	99	84	110	YES
pentachloroethane	275	275	50	250	NO
1,2,4-trimethylbenzene	20	100	88	103	YES
sec-butylbenzene	19	94	76	108	YES
1,3-dichlorobenzene	19	94	93	106	YES
4-isopropyltoluene	19	97	84	112	YES
1,4-dichlorobenzene	18	90	89	105	YES
1,2-dichlorobenzene	18	91	94	108	NO
n-butylbenzene	19	97	77	112	YES
hexachloroethane	91	91	79	122	YES
1,2-dibromo-3-chloropropane	24	118	70	116	NO
1,2,4-trichlorobenzene	25	123	85	111	NO
hexachlorobutadiene	23	114	69	111	NO
naphthalene	27	137	71	115	NO
1,2,3-trichlorobenzene	25	123	84	112	NO

Comments:

2A
WATER VOLATILE SYSTEM MONITORING COMPOUND RECOVERY

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03N Site: ATC-AP Code: E8260 Units: ug/L

	Sample Number:	SMC1 DBF #	SMC2 DCE #	SMC3 TOL #	SMC4 BFB #	TOT OUT
01	LCS 0207	101	101	100	105	0
02	LAB BLANK 0207	96	101	97	100	0
03	SOY GOLD 1000	98	96	95	172 *	1
04	SOY GOLD 1000 -	95	91	96	177 *	1

QC LIMITS

SMC1	DBF	=	DIBROMOFLUOROMETHANE	(80-114)
SMC2	DCE	=	1,2-DICHLOROETHANE-D4	(85-112)
SMC3	TOL	=	TOLUENE-D8	(90-110)
SMC4	BFB	=	4-BROMOFLUOROBENZENE	(92-107)

Column to be used to flag recovery values

* Values outside of contract required QC limits

D System Monitoring Compound diluted out

4A
VOLATILE METHOD BLANK SUMMARY

Sample Number: **Lab Blank 0207**

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03N Site: ATC-AP Code: E8260 Units: ug/L

Lab File ID: B7W82071.D Lab Sample ID: LAB BLANK 0207-

Date Analyzed: 02/07/05 Time Analyzed: 14:15

GC Column: DB-624 ID: 0.18 (mm) Heated Purge: (Y/N) N

Instrument ID: VOC7

THIS METHOD BLANK APPLIES TO THE FOLLOWING SAMPLES, MS AND MSD:

	Sample Number:	LAB SAMPLE ID	LAB FILE ID	TIME ANALYZED
01	LCS 0207	20 PPB LCS	L7W82067.D	11:20
02	SOY GOLD 1000 1:250	15100001	D7W82072.D	15:05
03	SOY GOLD 1000 - DU	15100002	D7W82073.D	15:52

COMMENTS

5A

VOLATILE ORGANIC INSTRUMENT PERFORMANCE CHECK

BROMOFLUOROBENZENE (BFB)

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03N Site: ATC-AP Code: E8260 Units: ug/L

Lab File ID: T7W82035.D BFB Injection Date: 02/03/05

Instrument ID: VOC7 BFB Injection Time: 13:20

GC Column: DB-624 ID: 0.18 (mm) Heated Purge: (Y/N) N

m/e	ION ABUNDANCE CRITERIA	% RELATIVE ABUNDANCE
50	15.0 - 40.0% of mass 95	20.0
75	30.0 - 60.0% of mass 95**	45.5
95	Base peak, 100% relative abundance	100.0
96	5.0 - 9.0% of mass 95	6.6
173	Less than 2.0% of mass 174	0.5 (0.8)1
174	50.0 - 100.0% of mass 95	63.3
175	5.0 - 9.0% of mass 174	4.1 (6.4)1
176	95.0 - 101.0% of mass 174	63.6 (100.4)1
177	5.0 - 9.0% of mass 176	4.5 (7.1)2

** 30-80% for 524.2 1-Value is % mass 174 2-Value is % mass 176

THIS CHECK APPLIES TO THE FOLLOWING SAMPLES, MS, MSD, BLANKS, AND STANDARDS:

	Sample Number:	LAB SAMPLE ID	LAB FILE ID	DATE ANALYZED	TIME ANALYZED
01	VSTD 2	2 PPB STD	C7W82038.D	02/03/05	14:50
02	VSTD 4	4 PPB STD	C7W82040.D	02/03/05	15:55
03	VSTD 10	10 PPB STD	C7W82042.D	02/03/05	16:59
04	VSTD 20	20 PPB STD	C7W82044.D	02/03/05	18:04
05	VSTD 50	50 PPB STD	C7W82046.D	02/03/05	19:08
06	VSTD 100	100 PPB STD	C7W82048.D	02/03/05	20:13

5A

VOLATILE ORGANIC INSTRUMENT PERFORMANCE CHECK

BROMOFLUOROBENZENE (BFB)

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03N Site: ATC-AP Code: E8260 Units: ug/L

Lab File ID: T7W82063.D BFB Injection Date: 02/07/05

Instrument ID: VOC7 BFB Injection Time: 08:46

GC Column: DB-624 ID: 0.18 (mm) Heated Purge: (Y/N) N

m/e	ION ABUNDANCE CRITERIA	% RELATIVE ABUNDANCE
50	15.0 - 40.0% of mass 95	23.9
75	30.0 - 60.0% of mass 95**	49.1
95	Base peak, 100% relative abundance	100.0
96	5.0 - 9.0% of mass 95	6.6
173	Less than 2.0% of mass 174	0.3 (0.5)1
174	50.0 - 100.0% of mass 95	59.3
175	5.0 - 9.0% of mass 174	5.2 (8.7)1
176	95.0 - 101.0% of mass 174	57.1 (96.3)1
177	5.0 - 9.0% of mass 176	4.0 (7.0)2

** 30-80% for 524.2 1-Value is % mass 174 2-Value is % mass 176

THIS CHECK APPLIES TO THE FOLLOWING SAMPLES, MS, MSD, BLANKS, AND STANDARDS:

	Sample Number:	LAB SAMPLE ID	LAB FILE ID	DATE ANALYZED	TIME ANALYZED
01	VSTD 0207	20 PPB CHK STD	K7W82065.D	02/07/05	09:38
02	LCS 0207	20 PPB LCS	L7W82067.D	02/07/05	11:20
03	LAB BLANK 0207	LAB BLANK 0207-4	B7W82071.D	02/07/05	14:15
04	SOY GOLD 1000 1:250	15100001	D7W82072.D	02/07/05	15:05
05	SOY GOLD 1000 - DU	15100002	D7W82073.D	02/07/05	15:52

Response Factor Report VOC7

Method Path : G:\VOC7\OLDCURVES\8260_WATER\02_03_05\
Method File : 826WADD1.M
Title : METHOD 8260 WATER - W/ ADDINS
Last Update : Fri Feb 04 08:30:29 2005
Response Via : Initial Calibration

Calibration Files
2 =C7W82038.D 10 =C7W82042.D 20 =C7W82044.D
50 =C7W82046.D 100 =C7W82048.D 4 =C7W82040.D

		Compound	2	10	20	50	100	4	Avg	%RSD
1)	I	PENTAFLUOROBENZENE	----------ISTD----------							
2)	M	dichlorodifluorom	0.672	0.621	0.559	0.594	0.723	0.585	0.625	9.76
3)	MP	chloromethane	1.340	0.980	0.846	0.928	1.084	1.107	1.047	16.54
4)	MC	vinyl chloride	0.697	0.646	0.601	0.668	0.802	0.618	0.672	10.74
5)	M	bromomethane	0.662	0.259	0.229	0.254	0.222	0.489	0.352	51.64
6)	M	chloroethane	0.393	0.368	0.324	0.341	0.366	0.350	0.357	6.69
7)	M	trichlorofluorome	0.860	0.807	0.720	0.793	0.976	0.736	0.815	11.50
8)	MA	ethyl ether	0.543	0.526	0.441	0.519	0.444	0.503	0.496	8.78
9)	MA	iodomethane	0.441	0.540	0.477	0.579	0.568	0.434	0.506	12.66
10)	MA	carbon disulfide	1.587	1.579	1.343	1.226		1.465	1.440	10.79
11)	MA	acetone	0.244	0.219	0.192	0.213	0.220	0.216	0.217	7.62
12)	MC	1,1-dichloroethen	0.452	0.447	0.406	0.462	0.547	0.432	0.458	10.47
13)	MA	allyl chloride	0.308	0.292	0.250	0.303	0.327	0.287	0.294	8.75
14)	M	methylene chlorid	0.677	0.587	0.505	0.579	0.661	0.576	0.598	10.54
15)	MA	acrylonitrile	0.268	0.267	0.232	0.264	0.262	0.255	0.258	5.29
16)	MA	methyl-t-butyl et	1.713	1.702	1.458	1.432		1.599	1.581	8.34
17)	M	trans-1,2-dichlor	0.531	0.508	0.451	0.516	0.581	0.502	0.515	8.23
18)	MP	1,1-dichloroethan	1.094	1.063	0.951	1.107	1.288	1.031	1.089	10.29
19)	M	2,2-dichloropropa	0.776	0.734	0.654	0.748	0.887	0.727	0.754	10.17
20)	M	cis-1,2-dichloroe	0.618	0.590	0.512	0.594	0.678	0.574	0.594	9.15
21)	MA	2-butanone	0.321	0.309	0.277	0.322	0.331	0.301	0.310	6.29
22)	MA	propionitrile	0.091	0.094	0.079	0.096	0.095	0.091	0.091	6.60
23)	MA	methyl acrylate	0.631	0.612	0.541	0.649	0.666	0.610	0.618	7.01
24)	MA	methacrylonitrile	0.255	0.249	0.223	0.259	0.254	0.245	0.247	5.30
25)	MA	tetrahydrofuran	0.068	0.065	0.059	0.068	0.068	0.064	0.065	5.61
26)	M	bromochloromethan	0.275	0.250	0.220	0.244	0.259	0.253	0.250	7.26
27)	MC	chloroform	1.093	1.077	0.948	1.116	1.277	1.045	1.093	9.87
28)	M	1,1,1-trichloroet	0.797	0.800	0.710	0.848	1.024	0.760	0.823	13.20
29)	S	DIBROMOFLUOROMETH	0.496	0.510	0.488	0.515	0.535	0.504	0.508	3.25
30)	I	1,4-DIFLUOROBENZENE	----------ISTD----------							
31)	M	carbon tetrachlor	0.266	0.236	0.231	0.259	0.312	0.226	0.255	12.61
32)	M	1,1-dichloroprope	0.135	0.119	0.109	0.118	0.130	0.119	0.122	7.66
33)	MA	1-chlorobutane	0.607	0.601	0.515	0.562		0.542	0.565	6.88
34)	S	1,2-DICHLOROETHAN	0.059	0.065	0.061	0.057	0.058	0.059	0.060	4.76
35)	M	benzene	1.201	1.313	0.992	1.092	1.206	1.003	1.135	11.23
36)	M	1,2-dichloroethan	0.456	0.475	0.411	0.459	0.499	0.435	0.456	6.69
37)	M	trichloroethene	0.330	0.314	0.292	0.324	0.359	0.284	0.317	8.67
38)	MC	1,2-dichloropropa	0.360	0.353	0.315	0.349	0.376	0.330	0.347	6.33#
39)	M	dibromomethane	0.189	0.192	0.172	0.192	0.203	0.187	0.189	5.28
40)	MA	methyl methacryla	0.261	0.252	0.228	0.255	0.227	0.244	0.244	5.84
41)	M	bromodichlorometh	0.353	0.356	0.330	0.393	0.446	0.326	0.367	12.39
42)	MA	2-nitropropane	0.035	0.043	0.044	0.068	0.077	0.038	0.051	34.31
43)	MA	chloroacetonitril	0.012	0.012	0.010	0.012	0.012	0.011	0.012	6.81
44)	M	cis-1,3-dichlorop	0.423	0.448	0.427	0.504	0.567	0.403	0.462	13.42
45)	MA	4-methyl-2-pentan	0.133	0.139	0.128	0.142	0.135	0.131	0.135	3.79
46)	S	TOLUENE-D8	1.139	1.163	1.140	1.161	1.149	1.141	1.149	0.93
47)	MC	toluene	0.838	0.804	0.740	0.807	0.889	0.752	0.805	6.86
48)	M	trans-1,3-dichlor	0.330	0.371	0.355	0.442	0.497	0.326	0.387	17.70
49)	M	1,1,2-trichloroet	0.260	0.260	0.233	0.249	0.250	0.254	0.251	4.00
50)	I	CHLOROBENZENE-D5	----------ISTD----------							
51)	MA	ethyl methacrylat	0.607	0.558	0.506	0.481		0.540	0.538	9.04
52)	M	tetrachloroethene	1.135	1.113	1.131	1.306	1.255	1.136	1.179	6.83
53)	M	1,3-dichloropropa	0.658	0.642	0.599	0.642	0.687	0.620	0.641	4.73
54)	MA	2-hexanone	0.157	0.158	0.149	0.167	0.160	0.151	0.157	4.12
55)	M	dibromochlorometh	0.217	0.230	0.239	0.292	0.340	0.209	0.255	20.06

Response Factor Report VOC7

Method Path : G:\VOC7\OLDCURVES\8260_WATER\02_03_05\
Method File : 826WADD1.M
Title : METHOD 8260 WATER - W/ ADDINS
Last Update : Fri Feb 04 08:30:29 2005
Response Via : Initial Calibration

Calibration Files
2 =C7W82038.D 10 =C7W82042.D 20 =C7W82044.D
50 =C7W82046.D 100 =C7W82048.D 4 =C7W82040.D

		Compound	2	10	20	50	100	4	Avg	%RSD
56)	M	1,2-dibromoethane	0.340	0.340	0.319	0.349	0.376	0.328	0.342	5.73
57)	MP	chlorobenzene	1.099	1.024	0.949	1.030	1.083	1.011	1.033	5.23
58)	M	1,1,1,2-tetrachlo	0.230	0.243	0.237	0.287	0.334	0.220	0.258	16.87
59)	MC	ethylbenzene	1.746	1.763	1.679	1.866	1.444	1.654	1.692	8.42
60)	M	m/p-xylene	0.685	0.680	0.623	0.671	0.678	0.637	0.662	3.89
61)	M	o-xylene	0.624	0.637	0.610	0.658	0.704	0.613	0.641	5.54
62)	M	styrene	1.102	1.187	1.112	1.206	1.176	1.089	1.145	4.38
63)	MP	bromoform	0.109	0.116	0.124	0.161	0.194	0.102	0.135	26.53
64)	I	1,4-DICHLOROBENZENE-D	----------ISTD----------							
65)	M	isopropylbenzene	2.993	3.038	2.776	3.126	2.840	2.636	2.902	6.30
66)	S	4-BROMOFLUOROBENZ	1.213	1.213	1.174	1.218	1.263	1.195	1.213	2.44
67)	M	bromobenzene	0.858	0.822	0.730	0.804	0.894	0.787	0.816	7.00
68)	MP	1,1,2,2-tetrachlo	0.822	0.836	0.778	0.837	0.893	0.805	0.829	4.66
69)	M	1,2,3-trichloropr	0.282	0.270	0.249	0.277	0.296	0.260	0.272	6.15
70)	MA	trans-1,4-dichlor	0.080	0.106	0.110	0.159	0.166	0.089	0.118	30.44
71)	M	n-propylbenzene	5.241	4.551	4.130	4.536	3.265	4.336	4.343	14.90
72)	M	2-chlorotoluene	2.907	2.683	2.415	2.633	2.635	2.467	2.623	6.64
73)	M	4-chlorotoluene	3.180	3.056	2.761	3.059	2.770	2.812	2.940	6.13
74)	M	1,3,5-trimethylbe	3.232	2.965	2.659	2.906	2.714	2.728	2.867	7.49
75)	M	tert-butylbenzene	1.926	1.625	1.481	1.630	1.879	1.511	1.675	11.13
76)	MA	pentachloroethane	0.247	0.108	0.071	0.061	0.062	0.173	0.120	62.62
77)	M	1,2,4-trimethylbe	3.273	2.959	2.735	3.037	2.762	2.765	2.922	7.23
78)	M	sec-butylbenzene	4.569	3.595	3.257	3.606		3.473	3.700	13.67
79)	M	1,3-dichlorobenze	1.712	1.512	1.366	1.510	1.694	1.471	1.544	8.69
80)	M	4-isopropyltoluen	3.598	2.803	2.472	2.730	2.522	2.704	2.805	14.58
81)	M	1,4-dichlorobenze	1.768	1.547	1.421	1.539	1.670	1.502	1.575	7.91
82)	M	1,2-dichlorobenze	1.394	1.378	1.243	1.385	1.521	1.275	1.366	7.22
83)	M	n-butylbenzene	4.062	2.841	2.533	2.806	2.584	2.834	2.943	19.16
84)	MA	hexachloroethane	0.177	0.180	0.172	0.242	0.267	0.161	0.200	21.81
85)	M	1,2-dibromo-3-chl	0.050	0.052	0.058	0.072	0.081	0.052	0.061	20.73
86)	M	1,2,4-trichlorobe	0.729	0.301	0.320	0.340	0.373	0.379	0.407	39.43
87)	M	hexachlorobutadie	0.477	0.205	0.197	0.199	0.213	0.279	0.262	42.04
88)	M	naphthalene	0.978	0.551	0.650	0.722	0.816	0.608	0.721	21.67
89)	M	1,2,3-trichlorobe	0.729	0.301	0.320	0.340	0.373	0.379	0.407	39.43

(#) = Out of Range ### Number of calibration levels exceeded format ###

Evaluate Continuing Calibration Report

Data Path : G:\VOC7\data\year2005\02_07_05\
Data File : K7W82065.D
Acq On : 7 Feb 2005 9:38 am
Operator : 0196LISA
Sample : 20 PPB CHK STD
Misc : G:S,LB20096,L:A,B4050069,A:R,A027713,15,8749
ALS Vial : 1 Sample Multiplier: 1

Quant Time: May 08 14:10:32 2006
Quant Method : G:\VOC7\METHODS\826WADD1.M
Quant Title : METHOD 8260 WATER - W/ ADDINS
QLast Update : Fri Feb 04 08:30:29 2005
Response via : Initial Calibration

Min. RRF : 0.000 Min. Rel. Area : 50% Max. R.T. Dev 0.50min
Max. RRF Dev : 30% Max. Rel. Area : 200%

		Compound	AvgRF	CCRF	%Dev	Area%	Dev(min)
1	I	PENTAFLUOROBENZENE	1.000	1.000	0.0	101	0.00
2	M	dichlorodifluoromethane	0.625	0.547	12.5	98	0.00
3	MP	chloromethane	1.047	0.863	17.6	103	0.00
4	MC	vinyl chloride	0.672	0.592	11.9	99	0.00
5	M	bromomethane	0.352	0.344	2.3	151	0.00
6	M	chloroethane	0.357	0.326	8.7	101	0.00
7	M	trichlorofluoromethane	0.815	0.744	8.7	104	0.00
8	MA	ethyl ether	0.496	0.432	12.9	98	0.00
9	MA	iodomethane	0.506	0.420	17.0	88	0.00
10	MA	carbon disulfide	1.440	1.363	5.3	102	0.00
11	MA	acetone	0.217	0.165	24.0	87	0.00
12	MC	1,1-dichloroethene	0.458	0.416	9.2	103	0.00
13	MA	allyl chloride	0.294	0.248	15.6	100	0.00
14	M	methylene chloride	0.598	0.502	16.1	100	0.00
15	MA	acrylonitrile	0.258	0.197	23.6	85	0.00
16	MA	methyl-t-butyl ether	1.581	1.421	10.1	98	0.00
17	M	trans-1,2-dichloroethene	0.515	0.463	10.1	103	0.00
18	MP	1,1-dichloroethane	1.089	0.954	12.4	101	0.00
19	M	2,2-dichloropropane	0.754	0.793	-5.2	122	0.00
20	M	cis-1,2-dichloroethene	0.594	0.507	14.6	100	0.00
21	MA	2-butanone	0.310	0.236	23.9	86	0.00
22	MA	propionitrile	0.091	0.069	24.2	88	0.00
23	MA	methyl acrylate	0.618	0.477	22.8	89	0.00
24	MA	methacrylonitrile	0.247	0.191	22.7	86	0.00
25	MA	tetrahydrofuran	0.065	0.050	23.1	85	0.00
26	M	bromochloromethane	0.250	0.224	10.4	102	0.00
27	MC	chloroform	1.093	0.939	14.1	100	0.00
28	M	1,1,1-trichloroethane	0.823	0.803	2.4	114	0.00
29	S	DIBROMOFLUOROMETHANE	0.508	0.505	0.6	104	0.00
30	I	1,4-DIFLUOROBENZENE	1.000	1.000	0.0	102	0.00
31	M	carbon tetrachloride	0.255	0.279	-9.4	123	0.00
32	M	1,1-dichloropropene	0.122	0.112	8.2	104	0.00
33	MA	1-chlorobutane	0.565	0.526	6.9	104	0.00
34	S	1,2-DICHLOROETHANE-D4	0.060	0.057	5.0	95	0.00
35	M	benzene	1.135	0.976	14.0	100	0.00
36	M	1,2-dichloroethane	0.456	0.408	10.5	101	0.00
37	M	trichloroethene	0.317	0.284	10.4	99	0.00
38	MC	1,2-dichloropropane	0.347	0.310	10.7	100	0.00
39	M	dibromomethane	0.189	0.166	12.2	98	0.00
40	MA	methyl methacrylate	0.244	0.201	17.6	89	0.00
41	M	bromodichloromethane	0.367	0.372	-1.4	115	0.00
42	MA	2-nitropropane	0.051	0.062	-21.6	144	0.00
43	MA	chloroacetonitrile	0.012	0.010	16.7	101	0.00
44	M	cis-1,3-dichloropropene	0.462	0.445	3.7	106	0.00
45	MA	4-methyl-2-pentanone	0.135	0.106	21.5	83	0.00
46	S	TOLUENE-D8	1.149	1.149	0.0	102	0.00
47	MC	toluene	0.805	0.723	10.2	99	0.00
48	M	trans-1,3-dichloropropene	0.387	0.376	2.8	107	0.00
49	M	1,1,2-trichloroethane	0.251	0.212	15.5	93	0.00

Evaluate Continuing Calibration Report

Data Path : G:\VOC7\data\year2005\02_07_05\
Data File : K7W82065.D
Acq On : 7 Feb 2005 9:38 am
Operator : 0196LISA
Sample : 20 PPB CHK STD
Misc : G:S,LB20096,L:A,B4050069,A:R,A027713,15,8749
ALS Vial : 1 Sample Multiplier: 1

Quant Time: May 08 14:10:32 2006
Quant Method : G:\VOC7\METHODS\826WADD1.M
Quant Title : METHOD 8260 WATER - W/ ADDINS
QLast Update : Fri Feb 04 08:30:29 2005
Response via : Initial Calibration

Min. RRF : 0.000 Min. Rel. Area : 50% Max. R.T. Dev 0.50min
Max. RRF Dev : 30% Max. Rel. Area : 200%

		Compound	AvgRF	CCRF	%Dev	Area%	Dev(min)
50	I	CHLOROBENZENE-D5	1.000	1.000	0.0	102	0.00
51	MA	ethyl methacrylate	0.538	0.458	14.9	93	0.00
52	M	tetrachloroethene	1.179	0.431	63.4#	39#	0.00
53	M	1,3-dichloropropane	0.641	0.542	15.4	93	0.00
54	MA	2-hexanone	0.157	0.123	21.7	85	0.00
55	M	dibromochloromethane	0.255	0.263	-3.1	112	0.00
56	M	1,2-dibromoethane	0.342	0.290	15.2	93	0.00
57	MP	chlorobenzene	1.033	0.928	10.2	100	0.00
58	M	1,1,1,2-tetrachloroethane	0.258	0.267	-3.5	116	0.00
59	MC	ethylbenzene	1.692	1.677	0.9	102	0.00
60	M	m/p-xylene	0.662	0.618	6.6	101	0.00
61	M	o-xylene	0.641	0.591	7.8	99	0.00
62	M	styrene	1.145	1.048	8.5	96	0.00
63	MP	bromoform	0.135	0.136	-0.7	112	0.00
64	I	1,4-DICHLOROBENZENE-D4	1.000	1.000	0.0	87	0.00
65	M	isopropylbenzene	2.902	3.164	-9.0	99	0.00
66	S	4-BROMOFLUOROBENZENE	1.213	1.309	-7.9	97	0.00
67	M	bromobenzene	0.816	0.789	3.3	94	0.00
68	MP	1,1,2,2-tetrachloroethane	0.829	0.730	11.9	81	0.00
69	M	1,2,3-trichloropropane	0.272	0.236	13.2	82	0.00
70	MA	trans-1,4-dichloro-2-butene	0.118	0.143	-21.2	113	0.00
71	M	n-propylbenzene	4.343	4.707	-8.4	99	0.00
72	M	2-chlorotoluene	2.623	2.655	-1.2	95	0.00
73	M	4-chlorotoluene	2.940	3.019	-2.7	95	0.00
74	M	1,3,5-trimethylbenzene	2.867	2.881	-0.5	94	0.00
75	M	tert-butylbenzene	1.675	1.582	5.6	93	0.00
76	MA	pentachloroethane	0.120	0.301	-150.8#	369#	0.00
77	M	1,2,4-trimethylbenzene	2.922	2.893	1.0	92	0.00
78	M	sec-butylbenzene	3.700	3.460	6.5	92	0.00
79	M	1,3-dichlorobenzene	1.544	1.366	11.5	87	0.00
80	M	4-isopropyltoluene	2.805	2.616	6.7	92	0.00
81	M	1,4-dichlorobenzene	1.575	1.366	13.3	83	0.00
82	M	1,2-dichlorobenzene	1.366	1.149	15.9	80	0.00
83	M	n-butylbenzene	2.943	2.598	11.7	89	0.00
84	MA	hexachloroethane	0.200	0.248	-24.0	125	0.00
85	M	1,2-dibromo-3-chloropropane	0.061	0.097	-59.0#	145	0.00
86	M	1,2,4-trichlorobenzene	0.407	0.327	19.7	89	0.00
87	M	hexachlorobutadiene	0.262	0.216	17.6	95	0.00
88	M	naphthalene	0.721	0.800	-11.0	107	0.00
89	M	1,2,3-trichlorobenzene	0.407	0.327	19.7	89	0.00

(#) = Out of Range SPCC's out = 0 CCC's out = 0

8A

VOLATILE INTERNAL STANDARD AREA AND RT SUMMARY

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03N Site: ATC-AP Code: E8260 Units: ug/L

Lab File ID (Standard): K7W82065.D Date Analyzed: 02/07/05

Instrument ID: VOC7 Time Analyzed: 09:38

GC Column: DB-624 ID: 0.18 (mm) Heated Purge (Y/N): N

		IS1PFB AREA #	RT #	IS2DFB AREA #	RT #	IS3CBZ AREA #	RT #
	12 HOUR STD	1776298	4.80	3674920	5.68	3119803	8.77
	UPPER LIMIT	3552596	4.30	7349840	5.18	6239606	8.27
	LOWER LIMIT	888149	5.30	1837460	6.18	1559902	9.27
	Sample Number:						
01	LCS 0207	1727837	4.79	3620644	5.68	3117154	8.77
02	LAB BLANK 0207	1679707	4.80	3408799	5.68	2926552	8.77
03	SOY GOLD 1000	1885791	4.80	3893772	5.68	3245625	8.77
04	SOY GOLD 1000 -	1832736	4.79	3716595	5.68	2901993	8.77

IS1 PFB = PENTAFLUOROBENZE
IS2 DFB = 1,4-DIFLUOROBENZEN
IS3 CBZ = CHLOROBENZENE-D5
IS4 DCB = 1,4-DICHLOROBENZEN

AREA UPPER LIMIT = +100% of internal standard area
AREA LOWER LIMIT = - 50% of internal standard area
RT UPPER LIMIT = +0.50 minutes of internal standard RT
RT LOWER LIMIT = -0.50 minutes of internal standard RT

Column to be used to flag values outside QC limit with an asterisk.
* Values outside of contract required QC limits

8A

VOLATILE INTERNAL STANDARD AREA AND RT SUMMARY

Lab Name: USACHPPM/DLS/ASD/GCMS POC: Taylor

Profile: 29127-03N Site: ATC-AP Code: E8260 Units: ug/L

Lab File ID (Standard): K7W82065.D Date Analyzed: 02/07/05

Instrument ID: VOC7 Time Analyzed: 09:38

GC Column: DB-624 ID: 0.18 (mm) Heated Purge (Y/N): Y

		IS4DCB AREA #	RT #	AREA #	RT #	AREA #	RT #
	12 HOUR STD	1288626	11.09				
	UPPER LIMIT	2577252	10.59				
	LOWER LIMIT	644313	11.59				
	EPA SAMPLE NO.						
01	LCS 0207	1375419	11.09				
02	LAB BLANK 0	1314125	11.09				
03	SOY GOLD 1	697012	11.09				
04	SOY GOLD 1	467422 *	11.09				

IS1 PFB = PENTAFLUOROBENZE
IS2 DFB = 1,4-DIFLUOROBENZEN
IS3 CBZ = CHLOROBENZENE-D5
IS4 DCB = 1,4-DICHLOROBENZEN

AREA UPPER LIMIT = +100% of internal standard area
AREA LOWER LIMIT = - 50% of internal standard area
RT UPPER LIMIT = +0.50 minutes of internal standard RT
RT LOWER LIMIT = -0.50 minutes of internal standard RT

Column to be used to flag values outside QC limit with an asterisk.
* Values outside of contract required QC limits

TERMINOLOGY/ABBREVIATIONS/CODES

Terminology/Abbreviations:

A2LA or AALA - American Association for Laboratory Accreditation

AIHA - American Industrial Hygiene Association

ASD - Analytical Spectrometry Division

COLA - Commission on Office Laboratory Accreditation

EPA - U. S. Environmental Protection Agency

GC/MS - Gas Chromatography/Mass Spectrometry

ISO - International Organization for Standardization

NLLAP - National Laboratory Lead Accreditation Program

NVLAP - National Voluntary Laboratory Accreditation Program

Analysis Data Sheet Qualifier Codes:

B - Indicates analyte was found in the associated blank as well as in the sample

D - Indicates Sample was diluted.

E - Indicates reported value exceeds the upper limit of the quantitation curve.

J - Indicates reported value is an estimate.

U - Indicates compound was analyzed for but not detected.

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APPENDIX D. DATA SHEETS

(Page D-2 Blank)

APPEARANCE

(3.2.3)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature

Test Condition:

Exposure:
Date/Time In: Date/Time Out:
POC for Testing: Mr. William Taylor Test Instrumentation:

OBSERVATIONS:

There was no suspended matter, separations, or water in the 1-liter sample. The sample is considered clear.

APPEARANCE

(3.2.3)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature

Test Condition:

Exposure:
Date/Time In: Date/Time Out:
POC for Testing: Mr. William Taylor Test Instrumentation:

OBSERVATIONS:

There was no suspended matter, separations, or water in the 1-liter sample. The sample is considered clear.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

		TESTING LABORATORY	
Client Name	NFESC	Name	ATC Materials Laboratory
POC	Mr. Brad Hollan	POC	Mr. William Taylor
Address	1100 23rd Avenue	Address	ATTN: CSTE-DTC-AT-WF-A
	Port Hueneme, CA 93043-4370		APG, MD 21005-5059
Telephone	805-982-1320	Telephone	(410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:		**Solution Conditions:**	
Alloy Type	AL-1a AL 2024 T3 W/AMS 2470	Concentration	As Received
Surface Treatment		Diluent Used	None
Condition/Humidity		Temperature	100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 1 Aug 05, 0730 — Date/Time Out 24 hr Insp: 2 Aug 05, 0730
POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 8 Aug 05, 0930

ALLOY TYPE: AL-1a AL 2024 T3 W/AMS 2470

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	5.6372	5.6377	5.6378	0.500	0.600	0.021
1	5.6362	5.6365	5.6364	0.300	0.200	0.007
2	5.6124	5.6125	5.6124	0.100	0.000	0.000
3	5.6305	5.6312	5.6311	0.700	0.600	0.021
AVG	5.6264	5.6267	5.6266	0.367	0.267	0.009

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type AL-1a AL 2024 T3 W/AMS 2470	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 1 Aug 05, 0730 — Date/Time Out 24 hr Insp: 2 Aug 05, 0730
POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 8 Aug 05, 0930

ALLOY TYPE: AL-1a AL 2024 T3 W/AMS 2470

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	5.6372	5.6379	5.6377	0.7	0.5	0.02
1	5.6274	5.6280	5.6281	0.6	0.7	0.02
2	5.6352	5.6356	5.6357	0.4	0.5	0.02
3	5.6246	5.6251	5.6255	0.5	0.9	0.03
AVG	5.6291	5.6296	5.6298	0.5	0.7	0.02

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

		TESTING LABORATORY	
Client Name	NFESC	Name	ATC Materials Laboratory
POC	Mr. Brad Hollan	POC	Mr. William Taylor
Address	1100 23rd Avenue	Address	ATTN: CSTE-DTC-AT-WF-A
	Port Hueneme, CA 93043-4370		APG, MD 21005-5059
Telephone	805-982-1320	Telephone	(410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:		**Solution Conditions:**	
Alloy Type	AL-1b AL 2024 T3 BARE	Concentration	As Received
Surface Treatment		Diluent Used	None
Condition/Humidity		Temperature	100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In:	1 Aug 05, 0730	Date/Time Out 24 hr Insp:	2 Aug 05, 0730
POC for Testing:	Mr. William Taylor	Date/Time Out 168 hr Insp:	8 Aug 05, 0930

ALLOY TYPE: AL-1b AL 2024 T3 BARE

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	5.5826	5.5826	5.5826	0.000	0.000	0.000
1	5.5659	5.5658	5.5659	-0.100	0.000	0.000
2	5.6224	5.6222	5.6223	-0.200	-0.100	-0.004
3	5.5816	5.5814	5.5815	-0.200	-0.100	-0.004
AVG	5.5900	5.5898	5.5899	-0.167	-0.067	-0.002

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

		TESTING LABORATORY	
Client Name	NFESC	Name	ATC Materials Laboratory
POC	Mr. Brad Hollan	POC	Mr. William Taylor
Address	1100 23rd Avenue	Address	ATTN: CSTE-DTC-AT-WF-A
	Port Hueneme, CA 93043-4370		APG, MD 21005-5059
Telephone	805-982-1320	Telephone	(410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:		**Solution Conditions:**	
Alloy Type	AL-1b AL 2024 T3 BARE	Concentration	As Received
Surface Treatment		Diluent Used	None
Condition/Humidity		Temperature	100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 1 Aug 05, 0730 — Date/Time Out 24 hr Insp: 2 Aug 05, 0730
POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 8 Aug 05, 0930

ALLOY TYPE: AL-1b AL 2024 T3 BARE

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	5.5826	5.5827	5.5832	0.1	0.6	0.02
1	5.5673	5.5672	5.5673	-0.1	0.0	0.00
2	5.5718	5.5718	5.5724	0.0	0.6	0.02
3	5.5844	5.5841	5.5845	-0.3	0.1	0.00
AVG	5.5745	5.5744	5.5747	-0.1	0.2	0.01

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type AL-1c AL 7075 T6 BARE	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In: 28 Jul 05, 0730 — Date/Time Out 24 hr Insp: 29 Jul 05, 0730

POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 4 Aug 05, 0930

ALLOY TYPE: AL-1c AL 7075 T6 BARE

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	5.5276	5.5275	5.5275	-0.100	-0.100	-0.004
1	5.5225	5.5221	5.5217	-0.400	-0.800	-0.028
2	5.4606	5.4603	5.4603	-0.300	-0.300	-0.011
3	5.5286	5.5284	5.5283	-0.200	-0.300	-0.011
AVG	5.5039	5.5036	5.5034	-0.300	-0.467	-0.016

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type AL-1c AL 7075 T6 BARE	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In: 28 Jul 05, 0730 — Date/Time Out 24 hr Insp: 29 Jul 05, 0730

POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 4 Aug 05, 0930

ALLOY TYPE: AL-1c AL 7075 T6 BARE

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	5.5276	5.5276	5.5272	0.0	-0.4	-0.01
1	5.5069	5.5067	5.5066	-0.2	-0.3	-0.01
2	5.4448	5.4445	5.4447	-0.3	-0.1	0.00
3	5.5325	5.5322	5.5324	-0.3	-0.1	0.00
AVG	5.4947	5.4945	5.4946	-0.3	-0.2	-0.01

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

		TESTING LABORATORY	
Client Name	NFESC	Name	ATC Materials Laboratory
POC	Mr. Brad Hollan	POC	Mr. William Taylor
Address	1100 23rd Avenue	Address	ATTN: CSTE-DTC-AT-WF-A
	Port Hueneme, CA 93043-4370		APG, MD 21005-5059
Telephone	805-982-1320	Telephone	(410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:		**Solution Conditions:**	
Alloy Type	BR-1 BRASS, AMS 4616	Concentration	As Received
Surface Treatment		Diluent Used	None
Condition/Humidity		Temperature	100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In:	26 Aug 05, 0730	Date/Time Out 24 hr Insp:	27 Aug 05, 0730
POC for Testing:	Mr. William Taylor	Date/Time Out 168 hr Insp:	3 Aug 05, 0930

ALLOY TYPE: BR-1 BRASS, AMS 4616

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	17.3577	17.5830	17.5830	225.300	225.300	7.933
1	17.2305	17.2307	17.2304	0.200	-0.100	-0.004
2	17.5527	17.5530	17.5525	0.300	-0.200	-0.007
3	17.4754	17.4758	17.4752	0.400	-0.200	-0.007
AVG	17.4195	17.4198	17.4194	0.300	-0.167	-0.006

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type BR-1 BRASS, AMS 4616	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In: 26 Aug 05, 0730 — Date/Time Out 24 hr Insp: 27 Aug 05, 0730

POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 3 Aug 05, 0930

ALLOY TYPE: BR-1 BRASS, AMS 4616

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	17.3577	17.3578	17.3578	0.1	0.1	0.00
1	17.1994	17.1995	17.1994	0.1	0.0	0.00
2	17.7186	17.7189	17.7186	0.3	0.0	0.00
3	18.4024	18.4026	18.4024	0.2	0.0	0.00
AVG	17.7735	17.7737	17.7735	0.2	0.0	0.00

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type CG-1 CARBURIZING GRADE CEVM STEEL	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In: 20 Jul 05, 0730	Date/Time Out 24 hr Insp: 21 Jul 05, 0730
POC for Testing: Mr. William Taylor	Date/Time Out 168 hr Insp: 27 Aug 05, 0930

ALLOY TYPE: CG-1 CARBURIZING GRADE CEVM STEEL

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	15.9731	15.9727	15.9727	-0.400	-0.400	-0.014
1	16.0347	16.0347	16.0349	0.000	0.200	0.007
2	16.0235	16.0235	16.0236	0.000	0.100	0.004
3	15.9630	15.9630	15.9633	0.000	0.300	0.011
AVG	16.0071	16.0071	16.0073	0.000	0.200	0.007

REMARKS:

24 Hours: Stains particularly along top and bottom edges on both sides.

144 Hours: Stains particularly along top and bottom edges on both sides.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type CG-1 CARBURIZING GRADE CEVM STEEL	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In: 20 Jul 05, 0730 — Date/Time Out 24 hr Insp: 21 Jul 05, 0730

POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 27 Aug 05, 0930

ALLOY TYPE: CG-1 CARBURIZING GRADE CEVM STEEL

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	15.9731	15.9730	15.9728	-0.1	-0.3	-0.01
1	16.1158	16.1169	16.1171	1.1	1.3	0.05
2	15.8671	15.8681	15.8681	1.0	1.0	0.04
3	15.6196	15.6210	15.6210	1.4	1.4	0.05
AVG	15.8675	15.8687	15.8687	1.2	1.2	0.04

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type CP-1A STAINLESS STEEL ASTM A240 CAD PLATED	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In: 26 Jul 05, 0730	Date/Time Out 24 hr Insp: 27 Jul 05, 0730
POC for Testing: Mr. William Taylor	Date/Time Out 168 hr Insp: 2 Aug 05, 0930

ALLOY TYPE: CP-1A STAINLESS STEEL ASTM A240 CAD PLATED

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	15.4223	15.4217	15.4223	-0.600	0.000	0.000
1	15.4016	15.4016	15.4011	0.000	-0.500	-0.018
2	15.3668	15.3663	15.3661	-0.500	-0.700	-0.025
3	15.3001	15.2003	15.2996	-99.800	-0.500	-0.018
AVG	15.3562	15.3227	15.3556	-33.433	-0.567	-0.020

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects. Coupons are slightly brighter than the control specimen.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

Client Name NFESC	TESTING LABORATORY Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue Port Hueneme, CA 93043-4370	Address ATTN: CSTE-DTC-AT-WF-A APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type CP-1A STAINLESS STEEL ASTM A240 CAD PLATED	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In: 26 Jul 05, 0730	Date/Time Out 24 hr Insp: 27 Jul 05, 0730
POC for Testing: Mr. William Taylor	Date/Time Out 168 hr Insp: 2 Aug 05, 0930

ALLOY TYPE: CP-1A STAINLESS STEEL ASTM A240 CAD PLATED

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	15.4223	15.4226	15.4219	0.3	-0.4	-0.01
1	15.3411	15.3405	15.3408	-0.6	-0.3	-0.01
2	15.3360	15.3356	15.3359	-0.4	-0.1	0.00
3	15.3878	15.3874	15.3875	-0.4	-0.3	-0.01
AVG	15.3550	15.3545	15.3547	-0.5	-0.2	-0.01

REMARKS:

24 Hours: No Effects.

144 Hours: Light stains along bottom edge of coupons.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type CR-1 Cronidur 30	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In: 5 Jun 06, 0800 — Date/Time Out 24 hr Insp: 6 Jun 06, 0800

POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 12 Jun 06, 1000

ALLOY TYPE: CR-1 Cronidur 30

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	62.5878	62.5878	62.5878	0.000	0.000	0.000
1	62.6110	62.6086	62.6111	-2.400	0.100	0.004
2	62.6481	62.6465	62.6463	-1.600	-1.800	-0.063
3	62.6711	62.6690	62.6702	-2.100	-0.900	-0.032
AVG	62.6434	62.6414	62.6425	-2.033	-0.867	-0.031

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type CR-1 Cronidur 30	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In: 5 Jun 06, 0800 — Date/Time Out 24 hr Insp: 6 Jun 06, 0800

POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 12 Jun 06, 1000

ALLOY TYPE: CR-1 Cronidur 30

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	62.5878	62.5878	62.5878	0.0	0.0	0.00
1	62.6157	62.6160	62.6181	0.3	2.4	0.08
2	62.6237	62.6231	62.6211	-0.6	-2.6	-0.09
3	62.6242	62.6217	62.6222	-2.5	-2.0	-0.07
AVG	62.6212	62.6203	62.6205	-0.9	-0.7	-0.03

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

		TESTING LABORATORY	
Client Name	NFESC	Name	ATC Materials Laboratory
POC	Mr. Brad Hollan	POC	Mr. William Taylor
Address	1100 23rd Avenue	Address	ATTN: CSTE-DTC-AT-WF-A
	Port Hueneme, CA 93043-4370		APG, MD 21005-5059
Telephone	805-982-1320	Telephone	(410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:		**Solution Conditions:**	
Alloy Type	CS-1 CHROME STEEL AISI 52100	Concentration	As Received
Surface Treatment		Diluent Used	None
Condition/Humidity		Temperature	100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In: 1 Aug 05, 0730 — Date/Time Out 24 hr Insp: 2 Aug 05, 0730

POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 8 Aug 05, 0930

ALLOY TYPE: CS-1 CHROME STEEL AISI 52100

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	17.2143	17.2146	17.2154	0.300	1.100	0.039
1	16.0453	16.0453	16.0457	0.000	0.400	0.014
2	16.8705	16.8712	16.8715	0.700	1.000	0.035
3	15.7814	15.7818	15.7821	0.400	0.700	0.025
AVG	16.2324	16.2328	16.2331	0.367	0.700	0.025

REMARKS:

24 Hours: Light stains on all over.

144 Hours: Light stains on all over.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

		TESTING LABORATORY	
Client Name	NFESC	Name	ATC Materials Laboratory
POC	Mr. Brad Hollan	POC	Mr. William Taylor
Address	1100 23rd Avenue	Address	ATTN: CSTE-DTC-AT-WF-A
	Port Hueneme, CA 93043-4370		APG, MD 21005-5059
Telephone	805-982-1320	Telephone	(410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:		**Solution Conditions:**	
Alloy Type	CS-1 CHROME STEEL AISI 52100	Concentration	As Received
Surface Treatment		Diluent Used	None
Condition/Humidity		Temperature	100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 1 Aug 05, 0730 — Date/Time Out 24 hr Insp: 2 Aug 05, 0730
POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 8 Aug 05, 0930

ALLOY TYPE: CS-1 CHROME STEEL AISI 52100

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	17.2143	17.2152	17.2159	0.9	1.6	0.06
1	17.0329	17.0329	17.0341	0.0	1.2	0.04
2	15.3962	15.3956	15.3968	-0.6	0.6	0.02
3	17.2595	17.2594	17.2598	-0.1	0.3	0.01
AVG	16.5629	16.5626	16.5636	-0.2	0.7	0.02

REMARKS:

24 Hours: Light stains on back of coupons 1 and 2. No effect on coupon 3.

144 Hours: Light stains on back of coupons 1 and 2. No effect on coupon 3.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type CU-1 COPPER	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 18 Jul 05, 0730 — Date/Time Out 24 hr Insp: 19 Jul 05, 0730
POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 25 Jul 05, 0930

ALLOY TYPE: CU-1 COPPER

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	17.5553	17.5055	17.5055	-49.800	-49.800	-1.754
1	17.5572	17.5573	17.5571	0.100	-0.100	-0.004
2	17.4931	17.4928	17.4926	-0.300	-0.500	-0.018
3	17.5046	17.5049	17.5042	0.300	-0.400	-0.014
AVG	17.5183	17.5183	17.5180	0.033	-0.333	-0.012

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

Client Name NFESC	TESTING LABORATORY Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue Port Hueneme, CA 93043-4370	Address ATTN: CSTE-DTC-AT-WF-A APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type CU-1 COPPER	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In: 26 Jul 05, 0730 — Date/Time Out 24 hr Insp: 27 Jul 05, 0730

POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 2 Aug 05, 0930

ALLOY TYPE: CU-1 COPPER

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	17.5553	17.5054	17.5557	-49.9	0.4	0.01
1	17.4604	17.4598	17.4601	-0.6	-0.3	-0.01
2	17.4822	17.4818	17.4819	-0.4	-0.3	-0.01
3	17.5312	17.5207	17.5306	-10.5	-0.6	-0.02
AVG	17.4913	17.4874	17.4909	-3.8	-0.4	-0.01

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type HT-1 HIGH TEMPERATURE TOOL STEEL, M50	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In: 1 Aug 05, 0730	Date/Time Out 24 hr Insp: 2 Aug 05, 0730
POC for Testing: Mr. William Taylor	Date/Time Out 168 hr Insp: 8 Aug 05, 0930

ALLOY TYPE: HT-1 HIGH TEMPERATURE TOOL STEEL, M50

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	9.7045	9.7066	9.7062	2.100	1.700	0.060
1	9.8039	9.8050	9.8057	1.100	1.800	0.063
2	9.7420	9.7431	9.7432	1.100	1.200	0.042
3	9.7320	9.7327	9.7325	0.700	0.500	0.018
AVG	9.7593	9.7603	9.7605	0.967	1.167	0.041

REMARKS:

24 Hours: Light stain top and bottom edges.

144 Hours: Light stains all over.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

Client Name NFESC	TESTING LABORATORY Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue Port Hueneme, CA 93043-4370	Address ATTN: CSTE-DTC-AT-WF-A APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type HT-1 HIGH TEMPERATURE TOOL STEEL, M50	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In: 1 Aug 05, 0730	Date/Time Out 24 hr Insp: 2 Aug 05, 0730
POC for Testing: Mr. William Taylor	Date/Time Out 168 hr Insp: 8 Aug 05, 0930

ALLOY TYPE: HT-1 HIGH TEMPERATURE TOOL STEEL, M50

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	9.7045	9.7062	9.7068	1.7	2.3	0.08
1	9.8654	9.8655	9.8666	0.1	1.2	0.04
2	9.9415	9.9412	9.9424	-0.3	0.9	0.03
3	9.4979	9.4977	9.4992	-0.2	1.3	0.05
AVG	9.7683	9.7681	9.7694	-0.1	1.1	0.04

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209
POC:

Specimen Information:

Alloy Type NB-1 NICKEL ALUMINUM BRONZE AMS 4640
Surface Treatment
Condition/Humidity

Solution Conditions:

Concentration As Received
Diluent Used None
Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 26 Jul 05, 0730
Date/Time Out 24 hr Insp: 27 Jul 05, 0730
POC for Testing: Mr. William Taylor
Date/Time Out 168 hr Insp: 1 Aug 05, 0930

ALLOY TYPE: NB-1 NICKEL ALUMINUM BRONZE AMS 4640

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	16.3331	16.2288	16.2290	-104.300	-104.100	-3.665
1	15.7593	15.7592	15.7589	-0.100	-0.400	-0.014
2	16.0906	16.0910	16.0901	0.400	-0.500	-0.018
3	15.9155	15.9155	15.9150	0.000	-0.500	-0.018
AVG	15.9218	15.9219	15.9213	0.100	-0.467	-0.016

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:

Alloy Type NB-1 NICKEL ALUMINUM BRONZE AMS 4640
Surface Treatment
Condition/Humidity

Solution Conditions:

Concentration As Received
Diluent Used None
Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 26 Jul 05, 0730
Date/Time Out 24 hr Insp: 27 Jul 05, 0730
POC for Testing: Mr. William Taylor
Date/Time Out 168 hr Insp: 1 Aug 05, 0930

ALLOY TYPE: NB-1 NICKEL ALUMINUM BRONZE AMS 4640

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	16.3331	16.2290	16.3330	-104.1	-0.1	0.00
1	15.9619	15.9616	15.9616	-0.3	-0.3	-0.01
2	16.0855	16.0854	16.0851	-0.1	-0.4	-0.01
3	16.1837	16.1836	16.1833	-0.1	-0.4	-0.01
AVG	16.0770	16.0769	16.0767	-0.2	-0.4	-0.01

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

Client Name NFESC	TESTING LABORATORY Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue Port Hueneme, CA 93043-4370	Address ATTN: CSTE-DTC-AT-WF-A APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type NI-1 NICKEL AMS 5536	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In: 1 Aug 05, 0730 — Date/Time Out 24 hr Insp: 2 Aug 05, 0730

POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 8 Aug 05, 0930

ALLOY TYPE: NI-1 NICKEL AMS 5536

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	16.3098	16.3098	16.3097	0.000	-0.100	-0.004
1	16.4917	16.4923	16.4920	0.600	0.300	0.011
2	16.2194	16.2195	16.2191	0.100	-0.300	-0.011
3	16.2035	16.2040	16.2036	0.500	0.100	0.004
AVG	16.3049	16.3053	16.3049	0.400	0.033	0.001

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

		TESTING LABORATORY	
Client Name	NFESC	Name	ATC Materials Laboratory
POC	Mr. Brad Hollan	POC	Mr. William Taylor
Address	1100 23rd Avenue	Address	ATTN: CSTE-DTC-AT-WF-A
	Port Hueneme, CA 93043-4370		APG, MD 21005-5059
Telephone	805-982-1320	Telephone	(410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:		**Solution Conditions:**	
Alloy Type	NI-1 NICKEL AMS 5536	Concentration	As Received
Surface Treatment		Diluent Used	None
Condition/Humidity		Temperature	100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In:	1 Aug 05, 0730	Date/Time Out 24 hr Insp:	2 Aug 05, 0730
POC for Testing:	Mr. William Taylor	Date/Time Out 168 hr Insp:	8 Aug 05, 0930

ALLOY TYPE: NI-1 NICKEL AMS 5536

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	16.3098	16.3096	16.3101	-0.2	0.3	0.01
1	16.4282	16.4271	16.4280	-1.1	-0.2	-0.01
2	16.4730	16.4724	16.4736	-0.6	0.6	0.02
3	16.4334	16.4322	16.4345	-1.2	1.1	0.04
AVG	16.4449	16.4439	16.4454	-1.0	0.5	0.02

REMARKS:

24 Hours: No Effects.

144 Hours: Slight stain on coupons 2 and 3, front and back.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type PH-1a 17-4 PH	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 3 Aug 05, 0730 — Date/Time Out 24 hr Insp: 4 Aug 05, 0730
POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 10 Aug 05, 0930

ALLOY TYPE: PH-1a 17-4 PH

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	15.7187	15.7187	15.7187	0.000	0.000	0.000
1	15.6404	15.6412	15.6408	0.800	0.400	0.014
2	15.5874	15.5878	15.5877	0.400	0.300	0.011
3	15.6819	15.6811	15.6816	-0.800	-0.300	-0.011
AVG	15.6366	15.6367	15.6367	0.133	0.133	0.005

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type PH-1a 17-4 PH	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 3 Aug 05, 0730 — Date/Time Out 24 hr Insp: 4 Aug 05, 0730
POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 10 Aug 05, 0930

ALLOY TYPE: PH-1a 17-4 PH

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	15.7187	15.7188	15.7183	0.1	-0.4	-0.01
1	15.6489	15.6492	15.6492	0.3	0.3	0.01
2	15.6236	15.6241	15.6241	0.5	0.5	0.02
3	15.7193	15.7201	15.7205	0.8	1.2	0.04
AVG	15.6639	15.6645	15.6646	0.5	0.7	0.02

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type PH-1b 15-5 PH	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 3 Aug 05, 0730 — Date/Time Out 24 hr Insp: 4 Aug 05, 0730
POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 10 Aug 05, 0930

ALLOY TYPE: PH-1b 15-5 PH

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	11.0018	11.0016	11.0017	-0.200	-0.100	-0.004
1	12.9122	12.9116	12.9094	-0.600	-2.800	-0.099
2	12.8908	12.8902	12.8892	-0.600	-1.600	-0.056
3	13.1884	13.1877	13.1887	-0.700	0.300	0.011
AVG	12.9971	12.9965	12.9958	-0.633	-1.367	-0.048

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:

Alloy Type PH-1b 15-5 PH
Surface Treatment
Condition/Humidity

Solution Conditions:

Concentration As Received
Diluent Used None
Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 3 Aug 05, 0730
Date/Time Out 24 hr Insp: 4 Aug 05, 0730
POC for Testing: Mr. William Taylor
Date/Time Out 168 hr Insp: 10 Aug 05, 0930

ALLOY TYPE: PH-1b 15-5 PH

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	11.0018	11.0014	11.0007	-0.4	-1.1	-0.04
1	13.0350	13.0349	13.0351	-0.1	0.1	0.00
2	13.0570	13.0569	13.0565	-0.1	-0.5	-0.02
3	12.9537	12.9533	12.9543	-0.4	0.6	0.02
AVG	13.0152	13.0150	13.0153	-0.2	0.1	0.00

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type PH-1c 13-8 PH	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 3 Aug 05, 0730 — Date/Time Out 24 hr Insp: 4 Aug 05, 0730
POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 10 Aug 05, 0930

ALLOY TYPE: PH-1c 13-8 PH

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	15.9006	15.9004	15.9005	-0.200	-0.100	-0.004
1	16.2741	16.2741	16.2735	0.000	-0.600	-0.021
2	13.9238	13.9231	13.9230	-0.700	-0.800	-0.028
3	16.3889	16.3882	16.3877	-0.700	-1.200	-0.042
AVG	15.5289	15.5285	15.5281	-0.467	-0.867	-0.031

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type PH-1c 13-8 PH	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 3 Aug 05, 0730 — Date/Time Out 24 hr Insp: 4 Aug 05, 0730
POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 10 Aug 05, 0930

ALLOY TYPE: PH-1c 13-8 PH

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	5.5276	5.5276	5.5272	0.0	-0.4	-0.01
1	5.5069	5.5067	5.5066	-0.2	-0.3	-0.01
2	5.4448	5.4445	5.4447	-0.3	-0.1	0.00
3	5.5325	5.5322	5.5324	-0.3	-0.1	0.00
AVG	5.4947	5.4945	5.4946	-0.3	-0.2	-0.01

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type RS-1 RIVET STEEL AMS 7228	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 1 Aug 05, 0730 — Date/Time Out 24 hr Insp: 2 Aug 05, 0730
POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 8 Aug 05, 0930

ALLOY TYPE: RS-1 RIVET STEEL AMS 7228

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	14.6777	14.6782	14.6782	0.500	0.500	0.018
1	14.7159	14.7153	14.7160	-0.600	0.100	0.004
2	14.6960	14.6957	14.6961	-0.300	0.100	0.004
3	14.6936	14.6929	14.6937	-0.700	0.100	0.004
AVG	14.7018	14.7013	14.7019	-0.533	0.100	0.004

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

		TESTING LABORATORY	
Client Name	NFESC	Name	ATC Materials Laboratory
POC	Mr. Brad Hollan	POC	Mr. William Taylor
Address	1100 23rd Avenue	Address	ATTN: CSTE-DTC-AT-WF-A
	Port Hueneme, CA 93043-4370		APG, MD 21005-5059
Telephone	805-982-1320	Telephone	(410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:		**Solution Conditions:**	
Alloy Type	RS-1 RIVET STEEL AMS 7228	Concentration	As Received
Surface Treatment		Diluent Used	None
Condition/Humidity		Temperature	100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 1 Aug 05, 0730 — Date/Time Out 24 hr Insp: 2 Aug 05, 0730
POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 8 Aug 05, 0930

ALLOY TYPE: RS-1 RIVET STEEL AMS 7228

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	14.6777	14.6782	14.6782	0.5	0.5	0.02
1	14.6539	14.6542	14.6548	0.3	0.9	0.03
2	14.7058	14.7062	14.7062	0.4	0.4	0.01
3	14.7106	14.7106	14.7108	0.0	0.2	0.01
AVG	14.6901	14.6903	14.6906	0.2	0.5	0.02

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

		TESTING LABORATORY	
Client Name	NFESC	Name	ATC Materials Laboratory
POC	Mr. Brad Hollan	POC	Mr. William Taylor
Address	1100 23rd Avenue	Address	ATTN: CSTE-DTC-AT-WF-A
	Port Hueneme, CA 93043-4370		APG, MD 21005-5059
Telephone	805-982-1320	Telephone	(410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:		**Solution Conditions:**	
Alloy Type	SS-1 STAINLESS STEEL AISI 440c	Concentration	As Received
Surface Treatment		Diluent Used	None
Condition/Humidity		Temperature	100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 1 Aug 05, 0730 Date/Time Out 24 hr Insp: 2 Aug 05, 0730
POC for Testing: Mr. William Taylor Date/Time Out 168 hr Insp: 8 Aug 05, 0930

ALLOY TYPE: SS-1 STAINLESS STEEL AISI SS-1 STAINLESS STEEL AISI 440c

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	15.3098	15.3104	15.3112	0.600	1.400	0.049
1	15.4513	15.4515	15.4481	0.200	-3.200	-0.113
2	15.6549	15.6553	15.6548	0.400	-0.100	-0.004
3	15.1251	15.1255	15.1244	0.400	-0.700	-0.025
AVG	15.4104	15.4108	15.4091	0.333	-1.333	-0.047

REMARKS:

24 Hours: No change.

144 Hours: Light stains, both sides.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

Client Name NFESC	TESTING LABORATORY Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue Port Hueneme, CA 93043-4370	Address ATTN: CSTE-DTC-AT-WF-A APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:

Alloy Type SS-1 STAINLESS STEEL AISI 440c
Surface Treatment
Condition/Humidity

Solution Conditions:

Concentration As Received
Diluent Used None
Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 1 Aug 05, 0730
Date/Time Out 24 hr Insp: 2 Aug 05, 0730
POC for Testing: Mr. William Taylor
Date/Time Out 168 hr Insp: 8 Aug 05, 0930

ALLOY TYPE: SS-1 STAINLESS STEEL AISI 440c

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	15.3098	15.3109	15.3102	1.1	0.4	0.01
1	16.0269	16.0275	16.0284	0.6	1.5	0.05
2	15.7333	15.7334	15.4724	0.1	-260.9	-9.19
3	15.4714	15.4715	15.7334	0.1	262.0	9.23
AVG	15.7439	15.7441	15.7447	0.3	0.9	0.03

REMARKS:

24 Hours: Light stains on coupon 2, both sides. No Effects on coupons 1 and 3.

144 Hours: Very light stains on all coupons except control.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

Client Name NFESC	TESTING LABORATORY Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue Port Hueneme, CA 93043-4370	Address ATTN: CSTE-DTC-AT-WF-A APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type ST-1 STEEL, SAE 4340	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In: 28 Jul 05, 0730	Date/Time Out 24 hr Insp: 29 Jul 05, 0730
POC for Testing: Mr. William Taylor	Date/Time Out 168 hr Insp: 3 Aug 05, 0930

ALLOY TYPE: ST-1 STEEL, SAE 4340

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	14.9244	14.9255	14.9258	1.100	1.400	0.049
1	15.0700	15.0708	15.0711	0.800	1.100	0.039
2	14.9205	14.9231	14.9230	2.600	2.500	0.088
3	14.7822	14.7838	14.7837	1.600	1.500	0.053
AVG	14.9242	14.9259	14.9259	1.667	1.700	0.060

REMARKS:

24 Hours: Light stains top and bottom edges.

144 Hours: Light stains top and bottom edges.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type ST-1 STEEL, SAE 4340	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr

Date/Time In: 28 Jul 05, 0730 — Date/Time Out 24 hr Insp: 29 Jul 05, 0730

POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 3 Aug 05, 0930

ALLOY TYPE: ST-1 STEEL, SAE 4340

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	14.9244	14.9259	14.9257	1.5	1.3	0.05
1	15.0746	15.0743	15.0743	-0.3	-0.3	-0.01
2	15.0782	15.0779	15.0778	-0.3	-0.4	-0.01
3	14.9296	14.9291	14.9289	-0.5	-0.7	-0.02
AVG	15.0275	15.0271	15.0270	-0.4	-0.5	-0.02

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:

Alloy Type TI-1 TITANIUM, AMS 4911
Surface Treatment
Condition/Humidity

Solution Conditions:

Concentration As Received
Diluent Used None
Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 8 Aug 05, 0730
Date/Time Out 24 hr Insp: 9 Aug 05, 0730
POC for Testing: Mr. William Taylor
Date/Time Out 168 hr Insp: 15 Aug 05, 0930

ALLOY TYPE: TI-1 TITANIUM, AMS 4911

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	9.4929	9.4928	9.4928	-0.100	-0.100	-0.004
1	9.2685	9.2688	9.2686	0.300	0.100	0.004
2	9.5415	9.5415	9.5413	0.000	-0.200	-0.007
3	9.5075	9.5075	9.5073	0.000	-0.200	-0.007
AVG	9.4392	9.4393	9.4391	0.100	-0.100	-0.004

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

TOTAL IMMERSION CORROSION

(3.3.1)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type TI-1 TITANIUM, AMS 4911	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature 100°F

Test Condition:

Exposure: 24 hr + 144 hr
Date/Time In: 8 Aug 05, 0730 — Date/Time Out 24 hr Insp: 9 Aug 05, 0730
POC for Testing: Mr. William Taylor — Date/Time Out 168 hr Insp: 15 Aug 05, 0930

ALLOY TYPE: TI-1 TITANIUM, AMS 4911

	WEIGHTS					
		AFTER		Weight Loss/Gain, mg		Total
SPECIMEN	ORIGINAL	24 Hr	+144 Hr	24 Hr	+144 Hr	mg / cm^2
Control	9.4929	9.4928	9.4928	-0.1	-0.1	0.00
1	9.4863	9.4860	9.4860	-0.3	-0.3	-0.01
2	9.5215	9.5216	9.5215	0.1	0.0	0.00
3	9.5682	9.5682	9.5681	0.0	-0.1	0.00
AVG	9.5253	9.5253	9.5252	-0.1	-0.1	0.00

REMARKS:

24 Hours: No Effects.

144 Hours: No Effects.

HYDROGEN EMBRITTLEMENT

ATC MATERIALS LABORATORY

Client Name NFESC
POC Mr. Brad Hollan
Address 1100 23rd Avenue
Port Hueneme, CA 93043-4370
Telephone 805-982-1320

Name ATC Materials Laboratory
POC Mr. William Taylor
Address ATTN: CSTE-DTC-AT-WF-A
APG, MD 21005-5059
Telephone (410) 278-4461

Cleaner Tested
Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:
Type 1A
Surface Treatment
Condition/Humidity

Solution Conditions:
Concentration As Received
Diluent Used None
Temperature

Test Condition:
Exposure: Exposure is as required by ASTM
Date/Time In:
Date/Time Out:
POC for Testing: Mr. William Taylor
Test Instrumentation: INSTRON 1125

Determination of Average Load Failure of Unplated Specimens
(needed to determine force applied to sensitivity and test coupons)

Unplated Specimen No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average**
Load to Failure, lbf	7860	7434	8238	8060	7968	7905	8105	8577	7449	8320	**7992**

Treatment A Sensitivity Test (must fail before 200 hr) (PASSED)

Treatment A	Load, lbf (75% of 7992 lbf)	Time to Failure, hr
1	5994	2.0
2	5994	2.69
3	5994	1.82

Five Treatment B Sensitivity Test Specimens (must not fail before 200 hr loaded to 5994 lbf)
Specimens did not fracture within 200 hr **(PASSED)**

Test Specimens exposed to Solution
(must not fail before 200 hr)

Specimen	Load, lbf (75% of 7992 lbf)	Time to Failure, hr
1	5994	69.38 (failed)
2	5994	4.05 (failed)
3	5994	111.57 (failed)
4	5994	88.50 (failed)

HYDROGEN EMBRITTLEMENT

ATC MATERIALS LABORATORY

Client Name NFESC
POC Mr. Brad Hollan
Address 1100 23rd Avenue
Port Hueneme, CA 93043-4370
Telephone 805-982-1320

Name ATC Materials Laboratory
POC Mr. William Taylor
Address ATTN: CSTE-DTC-AT-WF-A
APG, MD 21005-5059
Telephone (410) 278-4461

Cleaner Tested
Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:
Type 1A
Surface Treatment
Condition/Humidity

Solution Conditions:
Concentration As Received
Diluent Used None
Temperature

Test Condition:
Exposure: Exposure is as required by ASTM
Date/Time In:
Date/Time Out:
POC for Testing: Mr. William Taylor
Test Instrumentation: INSTRON 1125

Determination of Average Load Failure of Unplated Specimens
(needed to determine force applied to sensitivity and test coupons)

Unplated Specimen No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average**
Load to Failure, lbf	7860	7434	8238	8060	7968	7905	8105	8577	7449	8320	**7992**

Treatment A Sensitivity Test (must fail before 200 hr) (PASSED)

Treatment A	Load, lbf (75% of 7992 lbf)	Time to Failure, hr
1	5994	2.0
2	5994	2.69
3	5994	1.82

Five Treatment B Sensitivity Test Specimens (must not fail before 200 hr loaded to 5994 lbf)
Specimens did not fracture within 200 hr **(PASSED)**

Test Specimens Exposed to Solution
(must not fail before 200 hr)

Specimen	Load, lbf (75% of 7992 lbf)	Time to Failure, hr
1	5994	19.17 (failed)
2	5994	10.49 (failed)
3	5994	81.88 (failed)
4	5994	50.20 (failed)

STRESS CORROSION

(3.3.4)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type	Concentration As Received
Surface Treatment	Diluent Used None
Condition/Humidity	Temperature Ambient

Test Condition:

Exposure: 90 days, 2-hr cycle – 20 min in solution, 100 min out
Date/Time In: Date/Time Out:
POC for Testing: Mr. William Taylor Test Instrumentation:

Specimen	Cracking	AL-2a AL 2024 W/AMS 2470
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	AL-2b AL 2024 T3 BARE
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	AL-2c AL 7075 T6 BARE
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	BR-2 BRASS AMS 4616
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

STRESS CORROSION

(3.3.4)
ATC MATERIALS LABORATORY
(Continued)

Specimen	Cracking	CG-2 CARBURIZING GRADE CEVM STEEL
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	CP-2a STAINLESS STEEL ASTM A240 CAD PLATED
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	CS-2 CHROME STEEL AISI 52100
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	CU-2 COPPER
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	HT-2 HIGH TEMPERATURE TOOL STEEL M-50
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	NB-2 NICKEL ALUMINUM BRONZE AMS 4640
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	NI-2 NICKEL AMS 5536
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	PH-2a 17-4PH
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	PH-2b 15-5PH
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

STRESS CORROSION

(3.3.4)
ATC MATERIALS LABORATORY
(Continued)

Specimen	Cracking	PH-2c 13-8PH
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	RS-2 RIVET STEEL AMS 7228
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	SS-2 STAINLESS STEEL AISI 440c
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	ST-2 STEEL SAE 4340
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	TI-2 TITANIUM AMS 4911
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

STRESS CORROSION

(3.3.4)

ATC MATERIALS LABORATORY

Client Name NFESC
POC Mr. Brad Hollan
Address 1100 23rd Avenue
Port Hueneme, CA 93043-4370
Telephone 805-982-1320

TESTING LABORATORY
Name ATC Materials Laboratory
POC Mr. William Taylor
Address ATTN: CSTE-DTC-AT-WF-A
APG, MD 21005-5059
Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:

Alloy Type
Surface Treatment
Condition/Humidity

Solution Conditions:

Concentration As Received
Diluent Used None
Temperature Ambient

Test Condition:

Exposure: 90 days, 2-hr cycle – 20 min in solution, 100 min out
Date/Time In: Date/Time Out:
POC for Testing: Mr. William Taylor Test Instrumentation:

Specimen	Cracking	AL-2a AL 2024 W/AMS 2470
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	AL-2b AL 2024 T3 BARE
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	AL-2c AL 7075 T6 BARE
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	BR-2 BRASS AMS 4616
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

STRESS CORROSION

(3.3.4)
ATC MATERIALS LABORATORY
(Continued)

Specimen	Cracking	CG-2 CARBURIZING GRADE CEVM STEEL
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	CP-2a STAINLESS STEEL ASTM A240 CAD PLATED
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	CS-2 CHROME STEEL AISI 52100
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	CU-2 COPPER
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	HT-2 HIGH TEMPERATURE TOOL STEEL M-50
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	NB-2 NICKEL ALUMINUM BRONZE AMS 4640
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	NI-2 NICKEL AMS 5536
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	PH-2a 17-4PH
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	PH-2b 15-5PH
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

STRESS CORROSION

(3.3.4)
ATC MATERIALS LABORATORY
(Continued)

Specimen	Cracking	PH-2c 13-8PH
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	RS-2 RIVET STEEL AMS 7228
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	SS-2 STAINLESS STEEL AISI 440c
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	ST-2 STEEL SAE 4340
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

Specimen	Cracking	TI-2 TITANIUM AMS 4911
1	No	No Effects.
2	No	No Effects.
3	No	No Effects.

SOIL CLEANING

(3.4.2)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (Old)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:

Alloy Type
Surface Treatment
Condition/Humidity

Solution Conditions:

Concentration Standard
Diluent Used
Temperature

Test Condition:

Exposure: Maximum 100 min
Date/Time In:
Date/Time Out:
POC for Testing: Mr. William Taylor
Test Instrumentation: Branson 8510 Ultrasonic Cleaner

CONTROL SAMPLE: TOLUENE

SAMPLE TYPE	SAMPLE NUMBER	WEIGHT, g ORIGINAL	WEIGHT, g CLEANED	CLEANING TIME, MIN	SOLVENT CLEANING POWER, %
STEEL, CARBON,	1	3.519	3.519	6	94
MILD (ASTM-A-366)	2	3.546	3.546	7	93
	3	3.372	3.372	6	94
	AVG	3.479	3.479	6	94

CONTROL SAMPLE: SAFETY KLEEN

SAMPLE TYPE	SAMPLE NUMBER	WEIGHT, g ORIGINAL	WEIGHT, g CLEANED	CLEANING TIME, MIN	SOLVENT CLEANING POWER, %
STEEL, CARBON,	1	3.410	3.410	19	81
MILD (ASTM-A-366)	2	3.403	3.402	21	79
	3	3.445	3.444	28	72
	AVG	3.419	3.419	23	77

TEST SAMPLE: SOY GOLD 1000

SAMPLE TYPE	SAMPLE NUMBER	WEIGHT, g ORIGINAL	WEIGHT, g CLEANED	CLEANING TIME, MIN	SOLVENT CLEANING POWER, %
STEEL, CARBON,	1	3.546	3.547	60	40
MILD (ASTM-A-366)	2	3.519	3.521	73	27
	3	3.372	3.372	76	24
	AVG	3.479	3.480	70	30

SOIL CLEANING

(3.4.2)

ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000 (New)
Company Name: AG Environmental
Company Address: 12700 W. Dodge Road
POC: Omaha, NE 68154
PHONE: 1-800-599-9209

Specimen Information:

Alloy Type
Surface Treatment
Condition/Humidity

Solution Conditions:

Concentration Standard
Diluent Used
Temperature

Test Condition:

Exposure: Maximum 100 min
Date/Time In:
Date/Time Out:
POC for Testing: Mr. William Taylor
Test Instrumentation: Branson 8510 Ultrasonic Cleaner

CONTROL SAMPLE: TOLUENE

SAMPLE	SAMPLE	WEIGHT, g		CLEANING	SOLVENT CLEANING
TYPE	NUMBER	ORIGINAL	CLEANED	TIME, MIN	POWER, %
STEEL, CARBON,	1	3.519	3.519	6	94
MILD (ASTM-A-366)	2	3.546	3.546	7	93
	3	3.372	3.372	6	94
	AVG	3.479	3.479	6	94

CONTROL SAMPLE: SAFETY KLEEN

SAMPLE	SAMPLE	WEIGHT, g		CLEANING	SOLVENT CLEANING
TYPE	NUMBER	ORIGINAL	CLEANED	TIME, MIN	POWER, %
STEEL, CARBON,	1	3.410	3.410	19	81
MILD (ASTM-A-366)	2	3.403	3.402	21	79
	3	3.445	3.444	28	72
	AVG	3.419	3.419	23	77

TEST SAMPLE: SOY GOLD 1000

SAMPLE	SAMPLE	WEIGHT, g		CLEANING	SOLVENT CLEANING
TYPE	NUMBER	ORIGINAL	CLEANED	TIME, MIN	POWER, %
STEEL, CARBON,	1	3.382	3.382	56	44
MILD (ASTM-A-366)	2	3.519	3.520	68	32
	3	3.483	3.483	85	15
	AVG	3.461	3.462	70	30

WATER BREAK FREE

(3.4.3)
ATC MATERIALS LABORATORY

	TESTING LABORATORY
Client Name NFESC	Name ATC Materials Laboratory
POC Mr. Brad Hollan	POC Mr. William Taylor
Address 1100 23rd Avenue	Address ATTN: CSTE-DTC-AT-WF-A
Port Hueneme, CA 93043-4370	APG, MD 21005-5059
Telephone 805-982-1320	Telephone (410) 278-4461

Cleaner Tested

Product Name: SoyGold 1000
Company Name: AG Environmental Products LLC
Company Address: 12700 W. Dodge Road, Omaha, NE 68154
Phone: 1-800-599-9209

Specimen Information:	**Solution Conditions:**
Alloy Type	Concentration Standard
Surface Treatment	Diluent Used
Condition/Humidity	Temperature Ambient

Test Condition:

Exposure: Maximum 100 min
Date/Time In: Date/Time Out:
POC for Testing: Mr. William Taylor
Test Instrumentation: Branson 8510 Ultrasonic Cleaner

OBSERVATIONS/DISCUSSION OF TEST RESULTS:

Water break was immediate.

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APPENDIX E. METHANOL REPORT

(Page E-2 Blank)

U.S. Army Aberdeen Test Center

Aberdeen Proving Ground, MD 21005-5059

CHEMISTRY SAMPLING AND ANALYSIS TEAM
APPLIED SCIENCE TEST DIVISION
WARFIGHTER DIRECTORATE

Test Director: Mr. Bill Taylor

Materials And Standards Testing Team
CSTE-DTC-AT-WF-A
400 Colleran Road, Bldg 359
Aberdeen Proving Ground, MD 21005

Project Number: None

Report Number: 2005-CC-123

This report shall not be reproduced except in its entirety without the written approval of the Chemistry Unit. The results relate only to the specific samples/test item/test scenario identified within this report.

Authorized for Release:

Signature Date: 11 February 2005

Judith D. Galloway
Technical Lead, Chemical Sampling and Analysis Team

CSTE-DTC-AT-WF-A (70-10r) 11 February 2005

MEMORANDUM FOR ATC, Materials And Standards Testing Team
ATTN: Mr. Bill Taylor

SUBJECT: Analysis of Vapor Over Stored Soy Gold Cleaner, Laboratory Report Number 2005-CC-123

1. During the course of preparing an operating procedure for a gas cell used with the Fourier transform Infrared spectrometer (FTIR) samples were taken from the vapor over Soy Gold cleaner. There were two jars of cleaner, one relatively new (Sample 0412016-02) and the second over a year old (Sample 0412016-01).

2. Figure 1 shows the infrared spectrum of vapor over the new Soy gold solvent. This spectrum was searched against a library of vapor phase compounds the results of the search are shown in Figure 2. The best library match was methanol vapor. The same search was performed on the infrared spectrum from the old Soy gold solvent. Again the best library match was methanol vapor (see Figure 3).

3. Figure 4 shows the infrared spectrum with expanded x scale of vapor over old (red) and new (blue) Soy gold solvents in glass bottles. The level of methanol detected in this qualitative analysis is much higher in the older Soy Gold.

4. The source of this methanol vapor has not been determined.

5. Any questions concerning this information can be directed to Paul Marsh, 410-278-3024.

Paul E. Marsh

Paul E. Marsh
Senior Analytical Chemist
ATC Chemical Analysis and Sampling Team

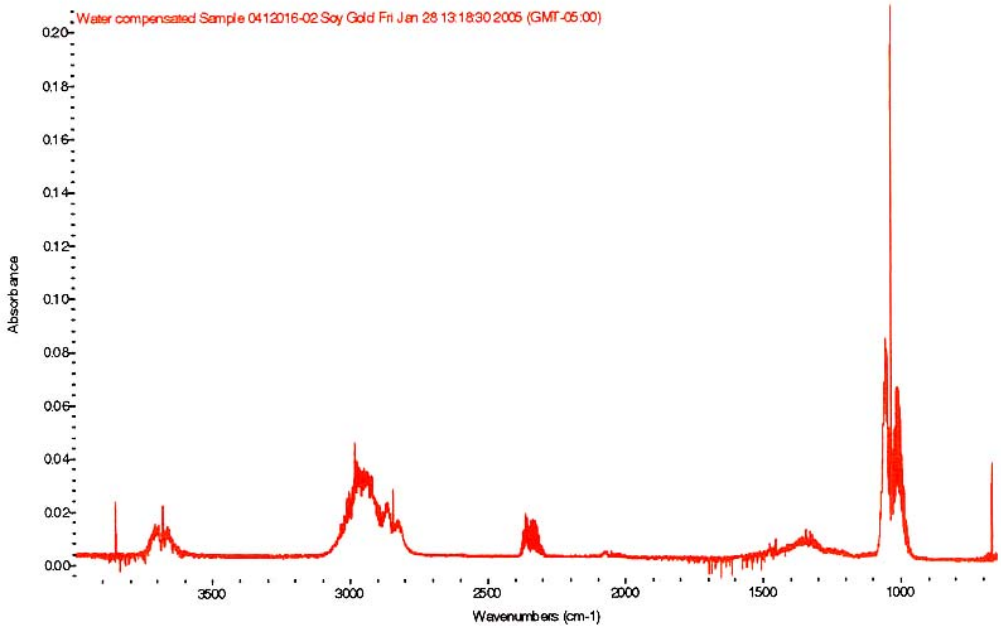

Figure 1. Infrared spectrum of vapor over new Soy gold solvent.

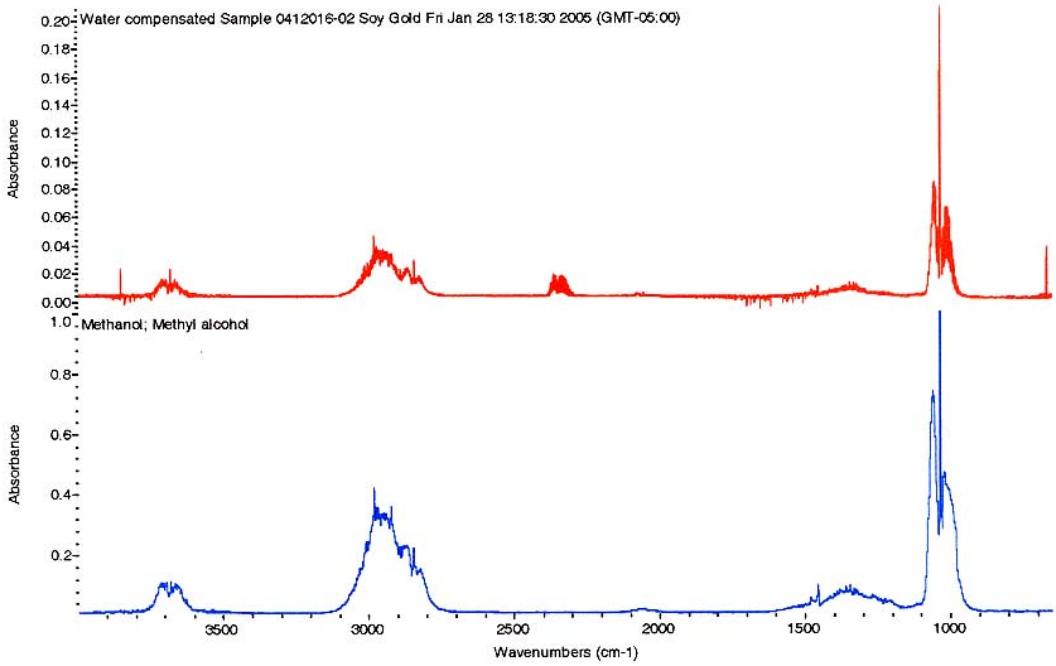

Figure 2. Infrared spectrum of vapor over new Soy gold solvent in glass bottle (top), best library match methanol (bottom).

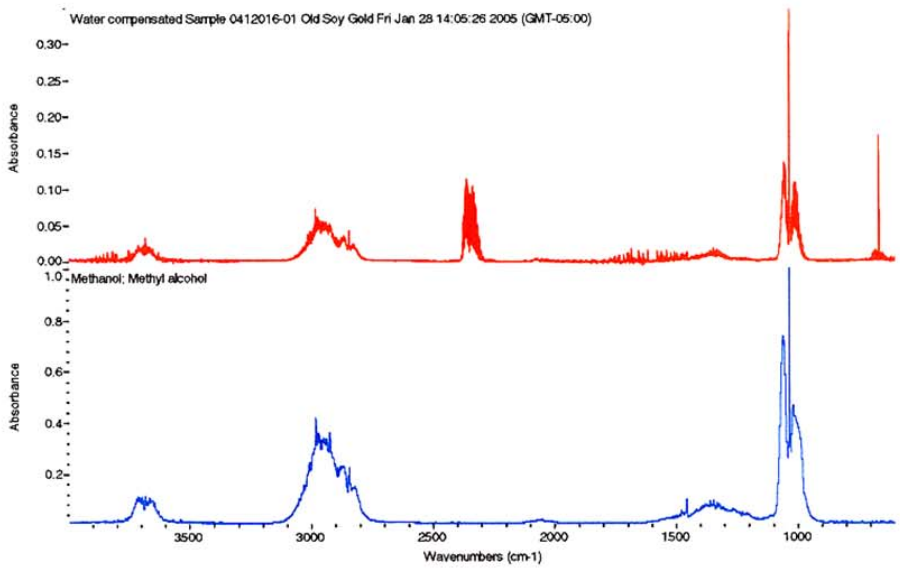

Figure 3. Infrared spectrum of vapor over old Soy gold solvent in glass bottle (top), best library match methanol (bottom).

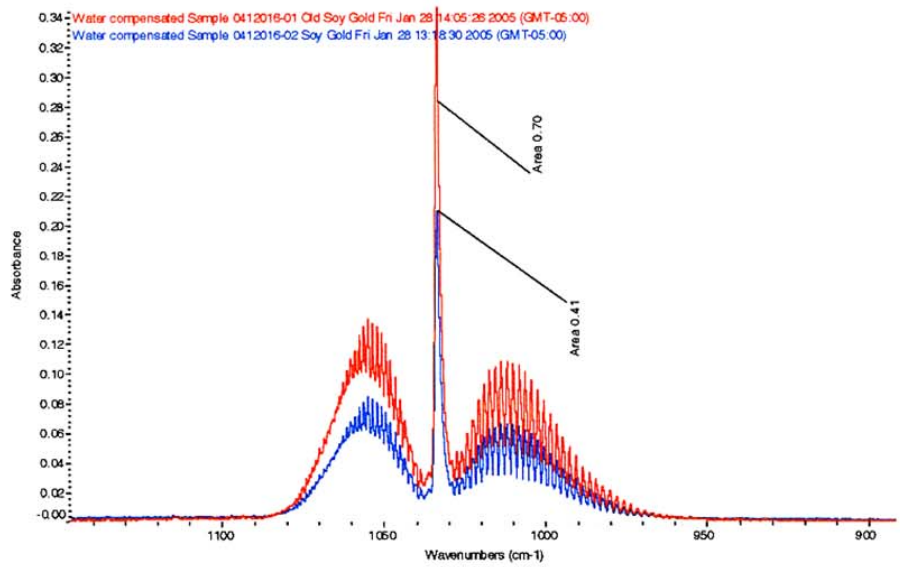

Figure 4. Infrared spectrum with expanded x scale of vapor over old (red) and new (blue) Soy gold solvents in glass bottles. The level of methanol detected is much higher in the older Soy Gold.

APPENDIX F. TOTAL IMMERSION PHOTOGRAPHS

(Page F-2 Blank)

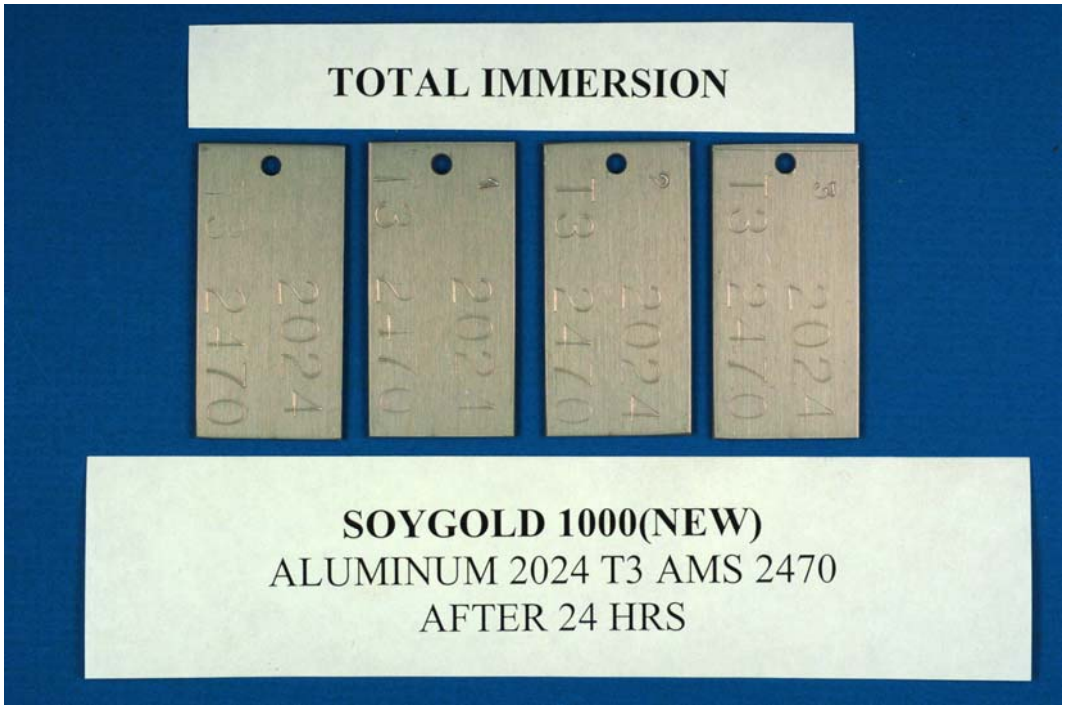

Figure F-3.3.1-1. AL-1a, New, 24 hr.

Figure F-3.3.1-2. AL-1a, New, 168 hr.

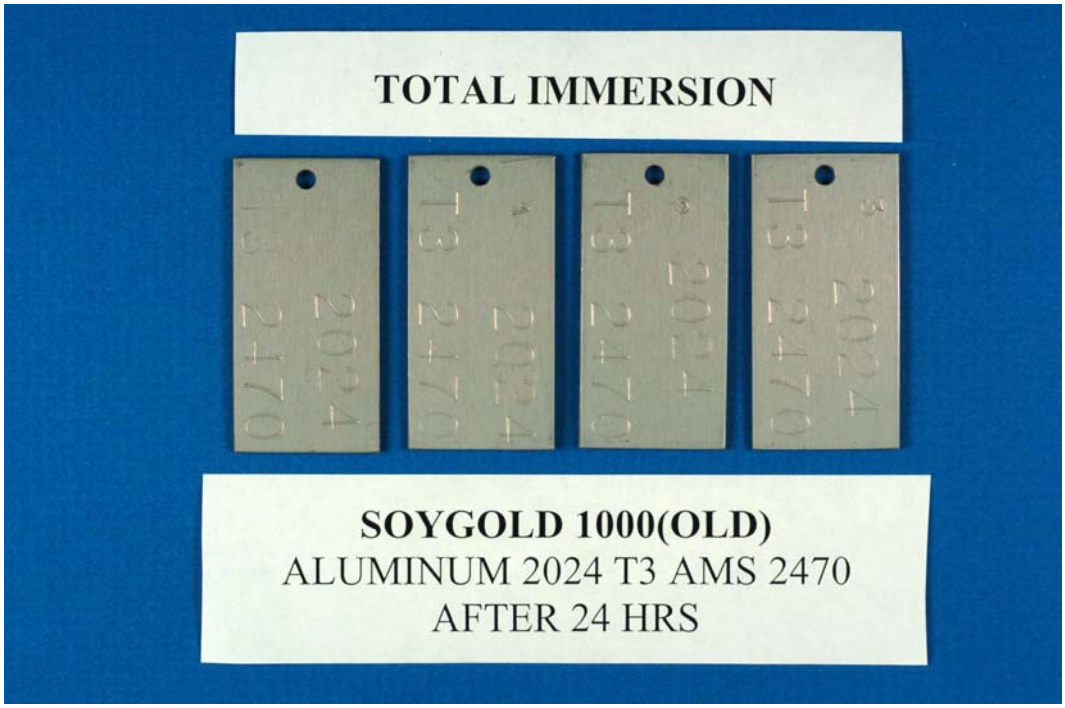

Figure F-3.3.1-3. AL-1a, Old, 24 hr.

Figure F-3.3.1-4. AL-1a, Old, 168 hr.

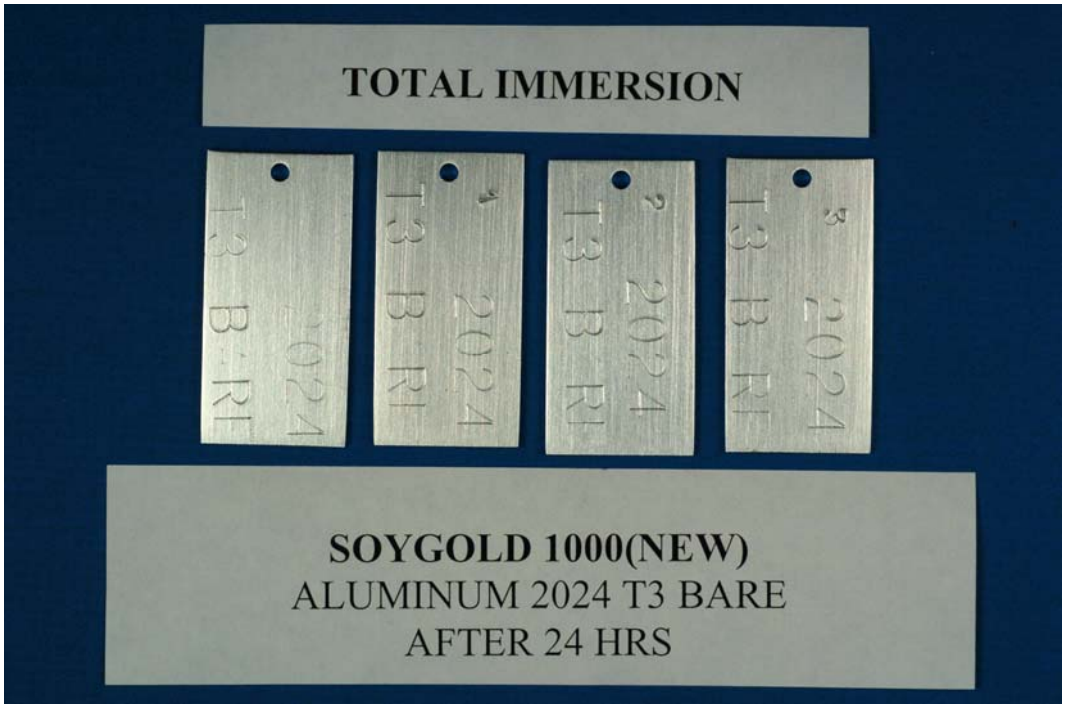

Figure F-3.3.1-5. AL-1b, New, 24 hr.

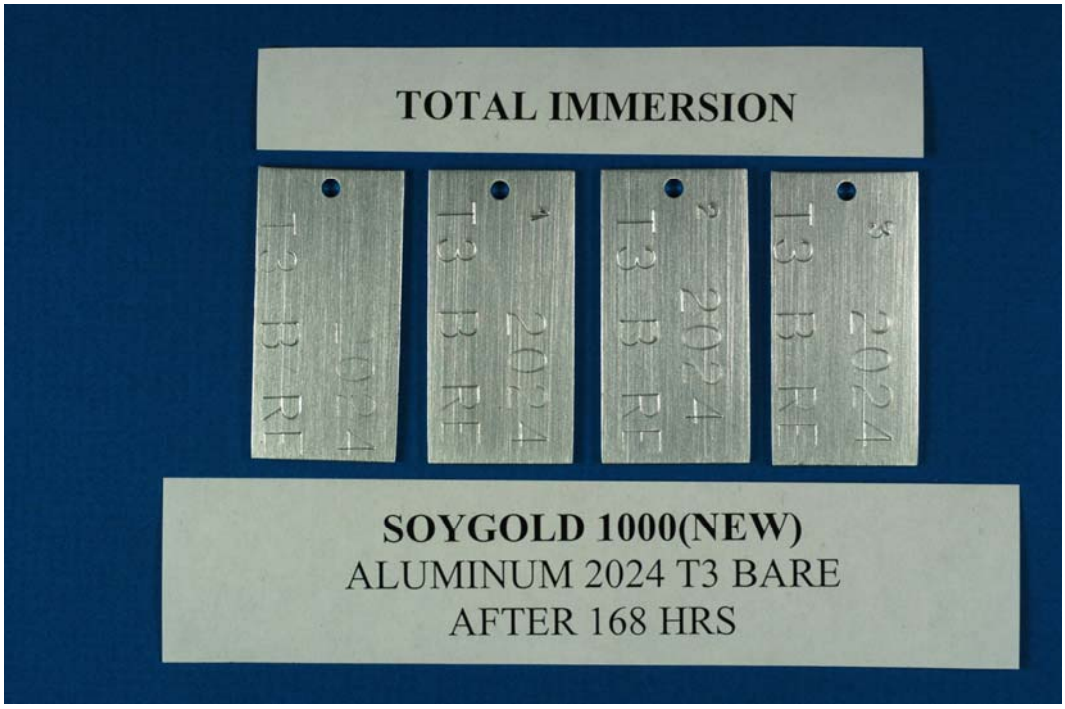

Figure F-3.3.1-6. AL-1b, New, 168 hr.

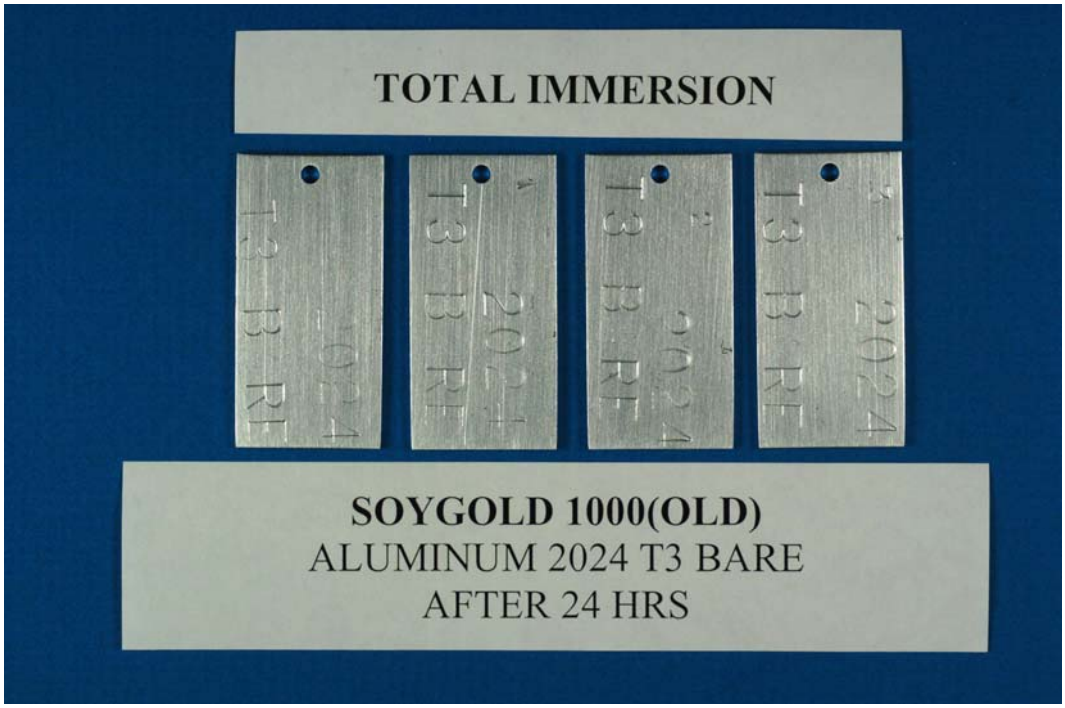

Figure F-3.3.1-7. AL-1b, Old, 24 hr.

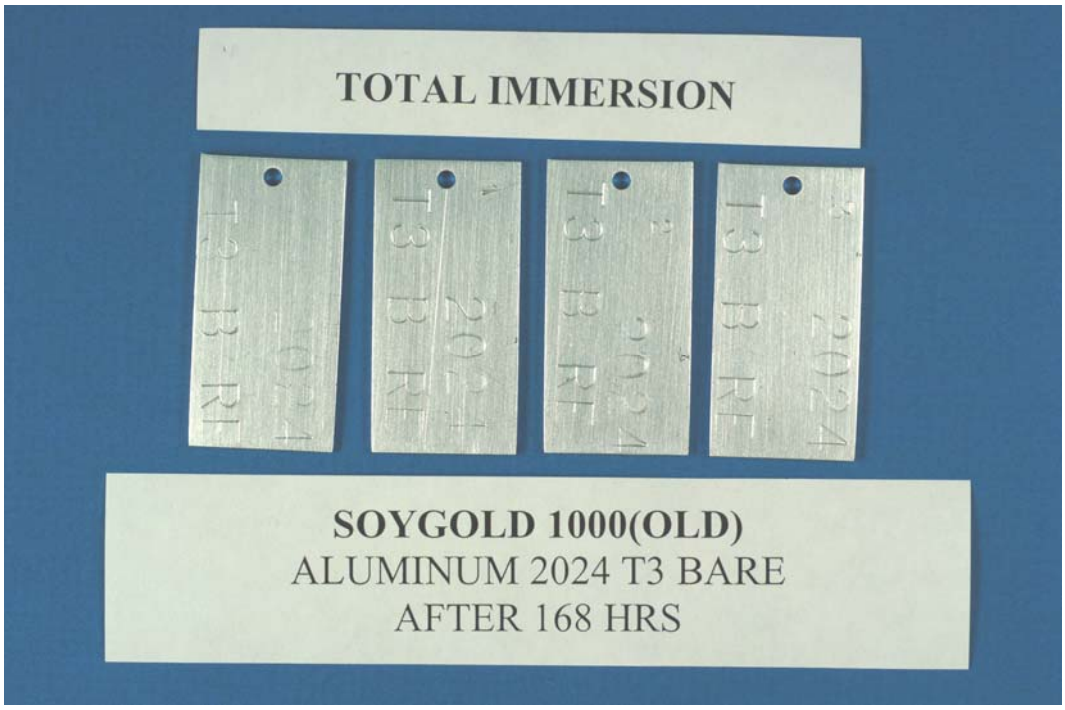

Figure F-3.3.1-8. AL-1b, Old, 168 hr.

Figure F-3.3.1-9. AL-1c, New, 24 hr.

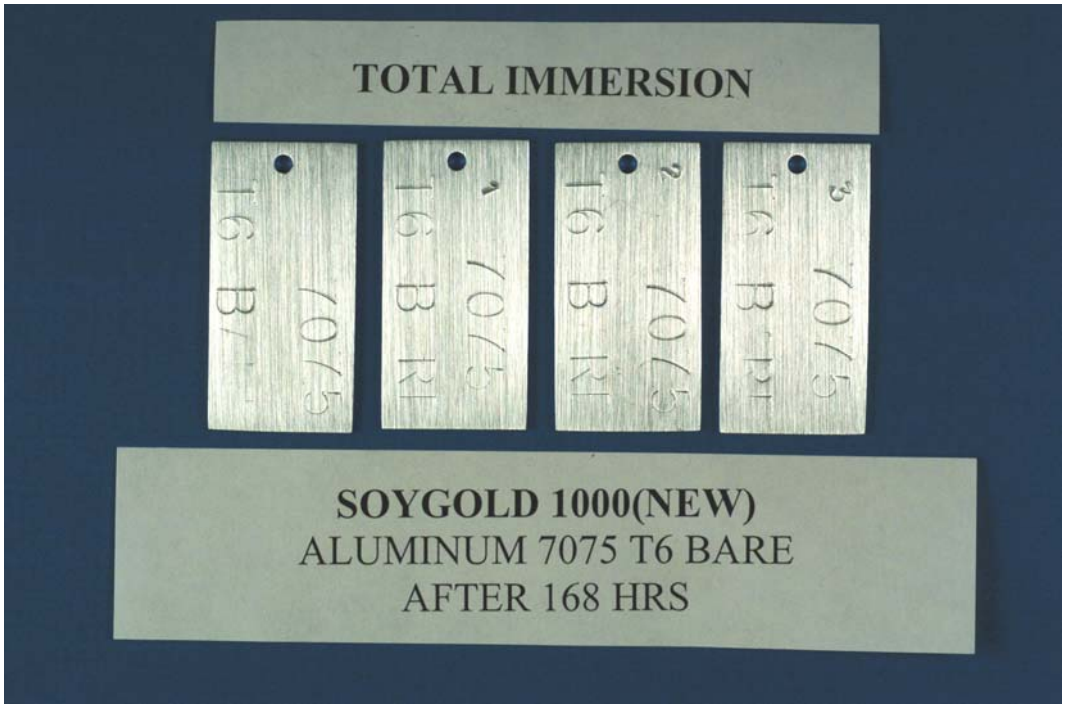

Figure F-3.3.1-10. AL-1c, New, 168 hr.

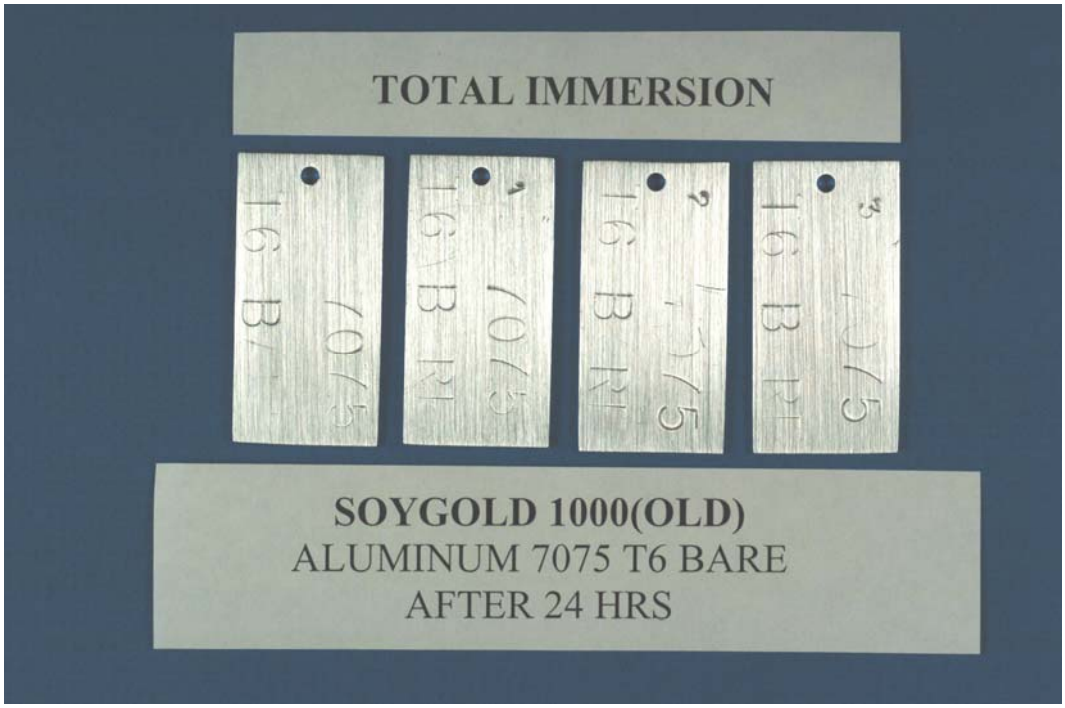

Figure F-3.3.1-11. AL-1c, Old, 24 hr.

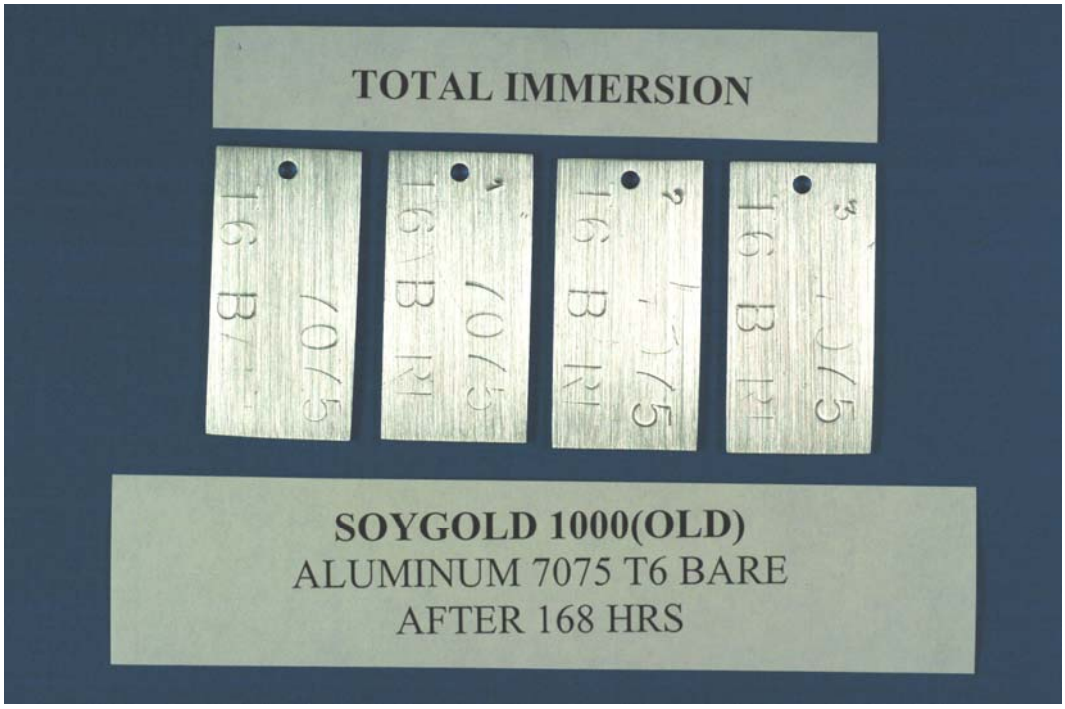

Figure F-3.3.1-12. AL-1c, Old, 168 hr.

Figure F-3.3.1-13. BR-1, New, 24 hr.

Figure F-3.3.1-14. BR-1, New, 168 hr.

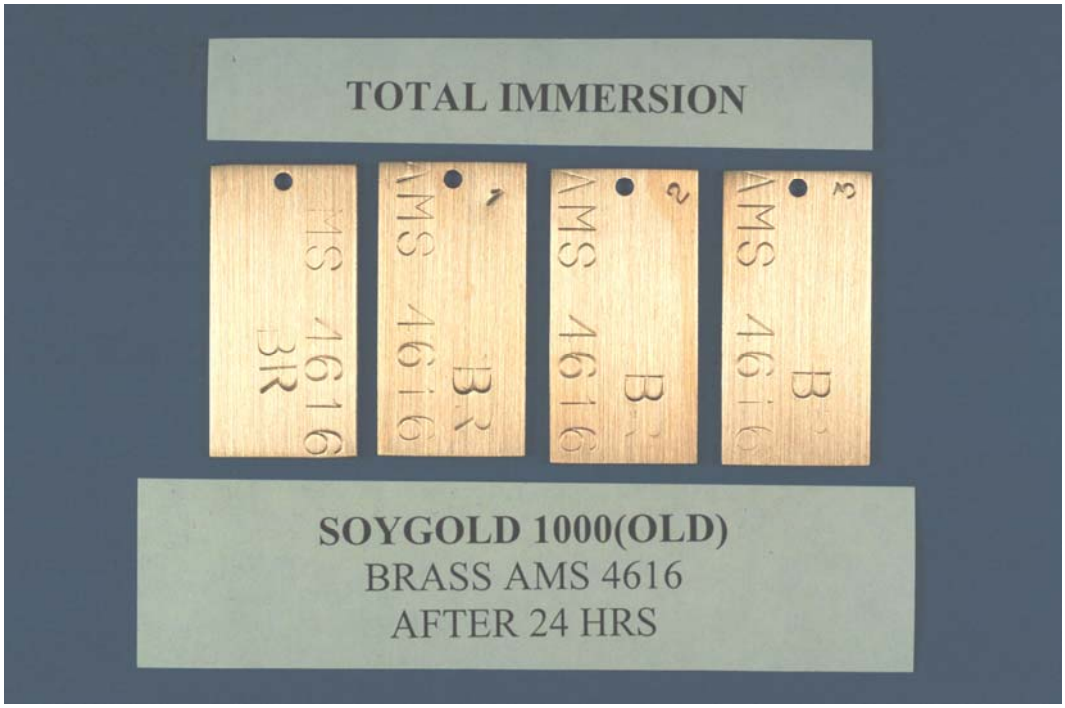

Figure F-3.3.1-15. BR-1, Old, 24 hr.

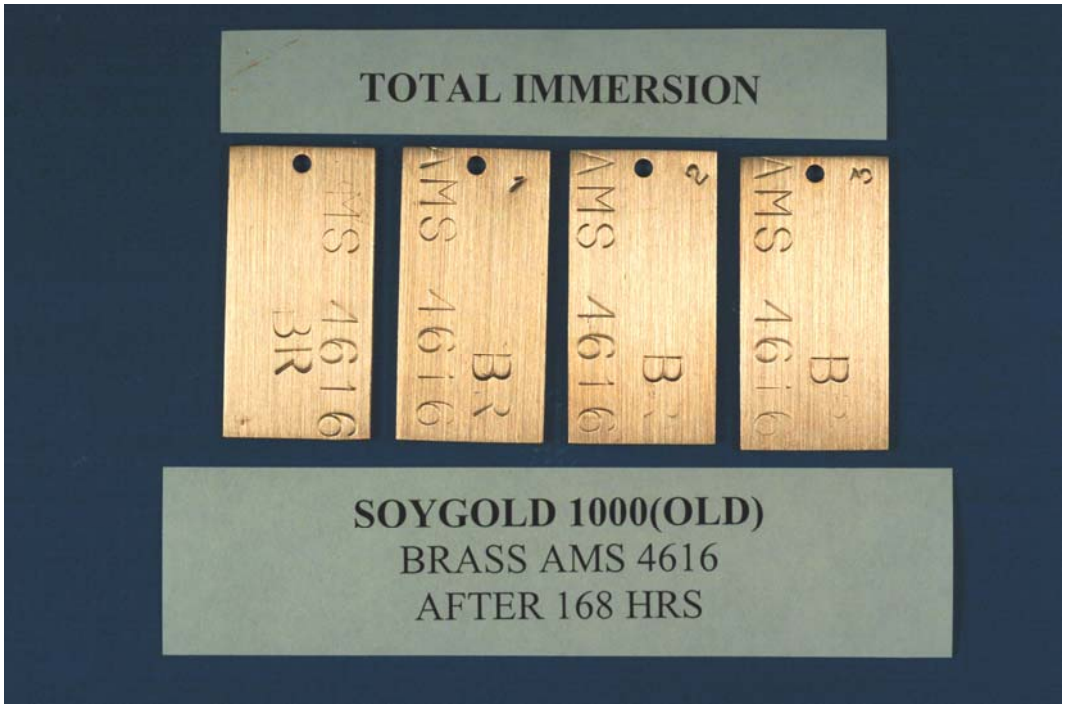

Figure F-3.3.1-16. BR-1, Old, 168 hr.

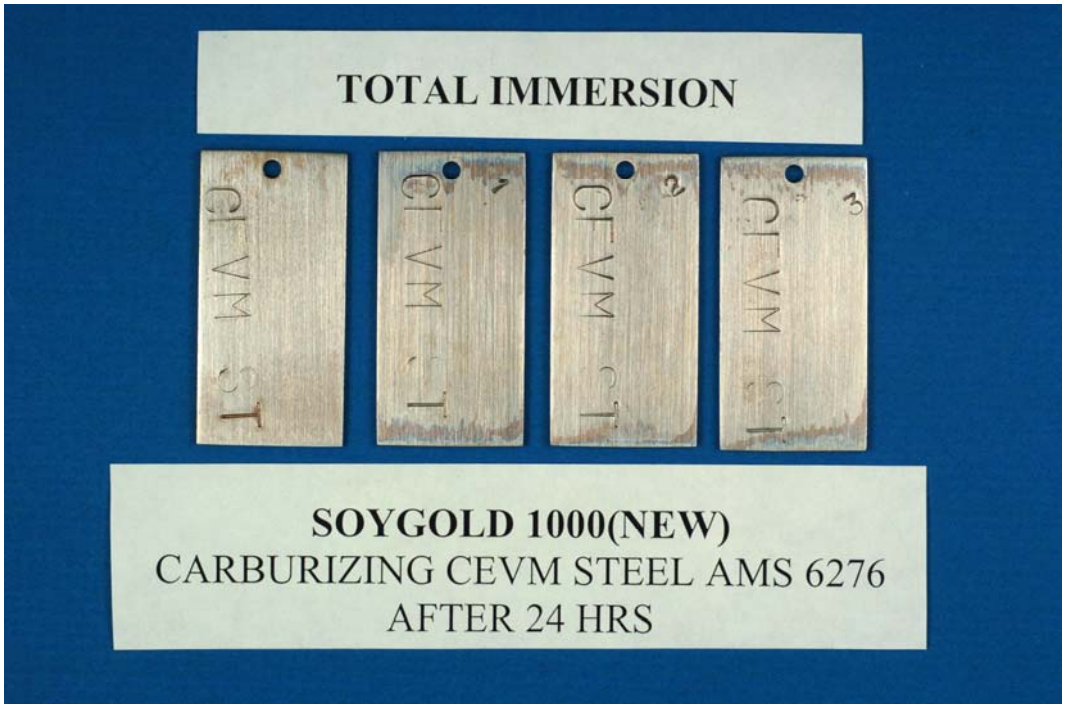

Figure F-3.3.1-17. CG-1, New, 24 hr.

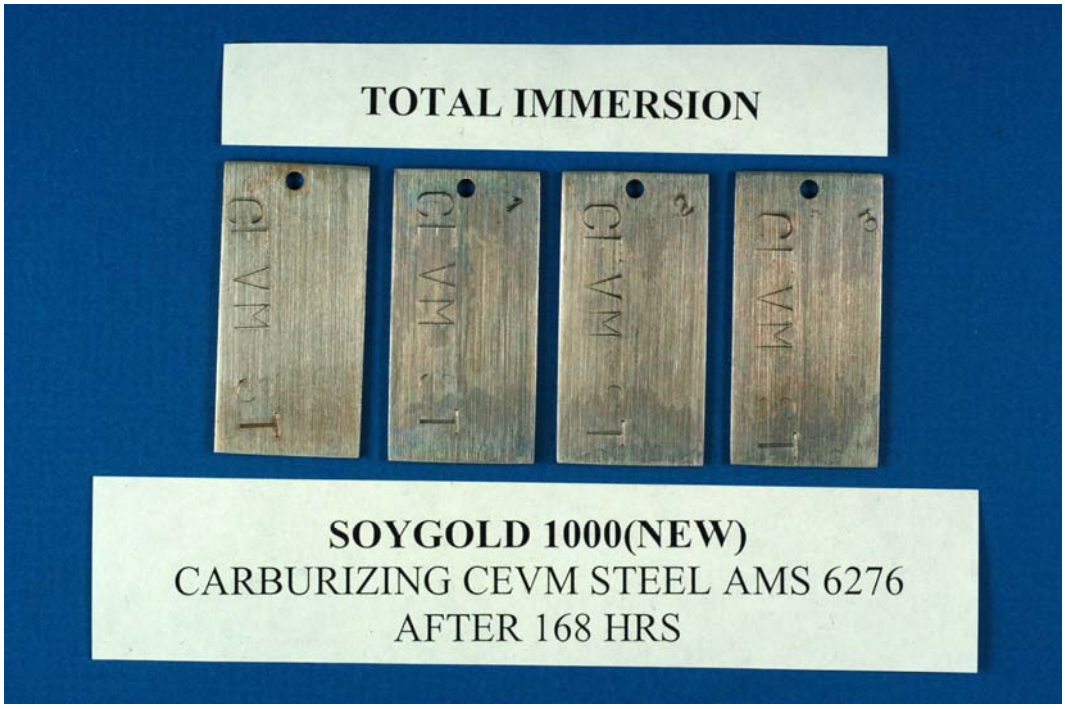

Figure F-3.3.1-18. CG-1, New, 168 hr.

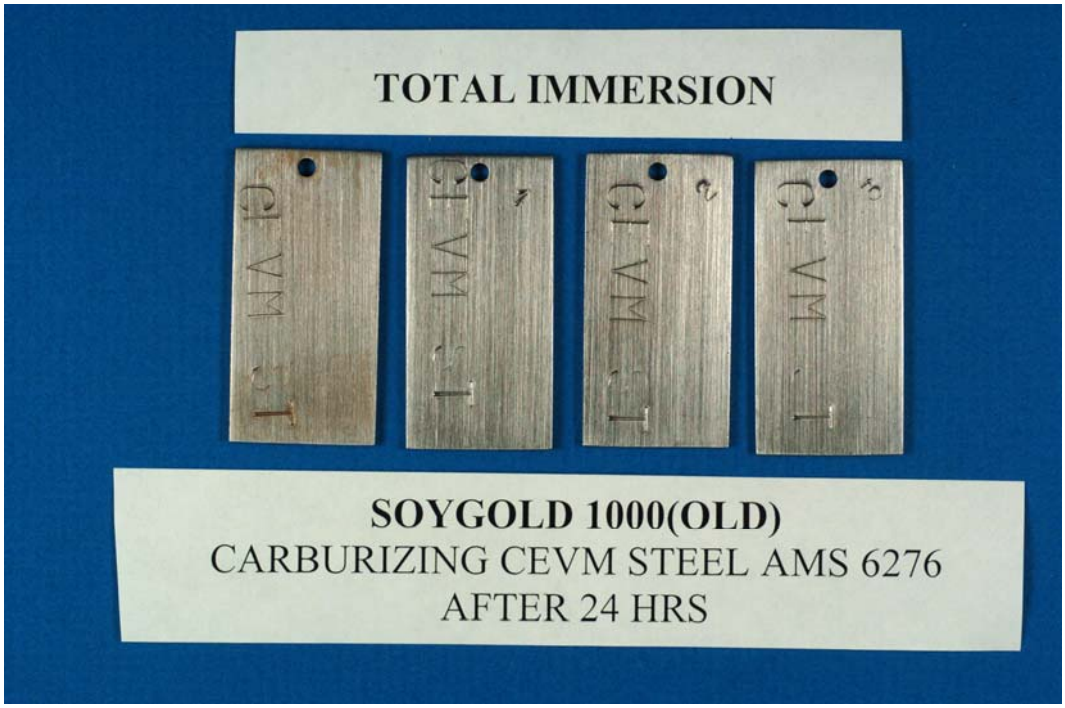

Figure F-3.3.1-19. CG-1, Old, 24 hr.

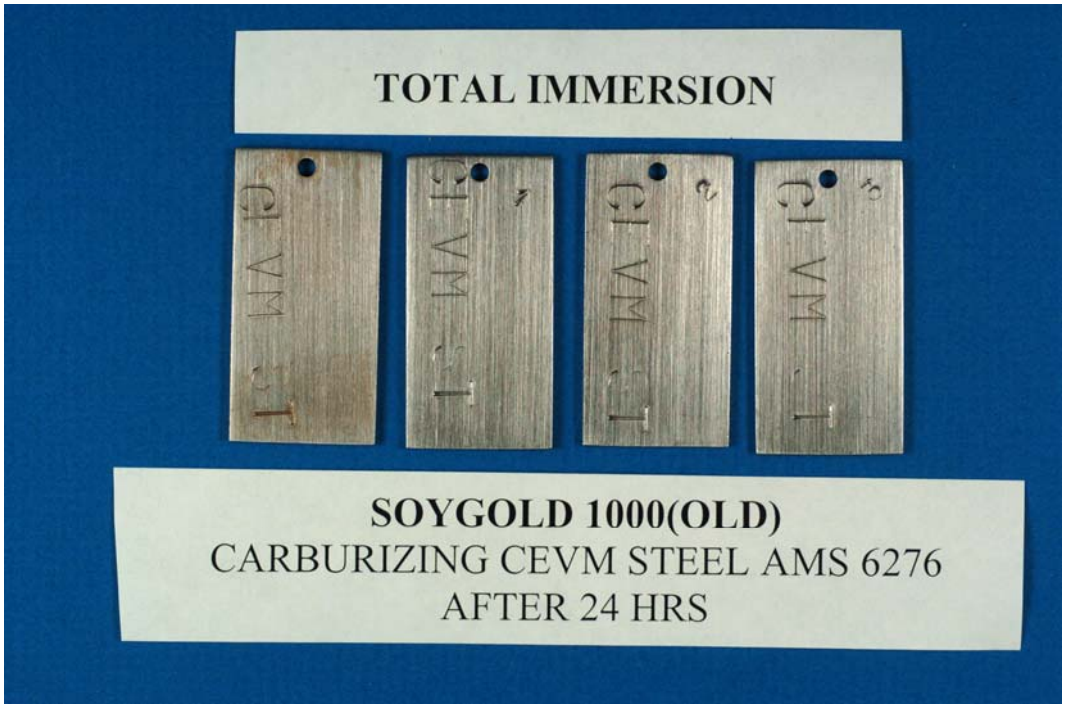

Figure F-3.3.1-20. CG-1, Old, 168 hr.

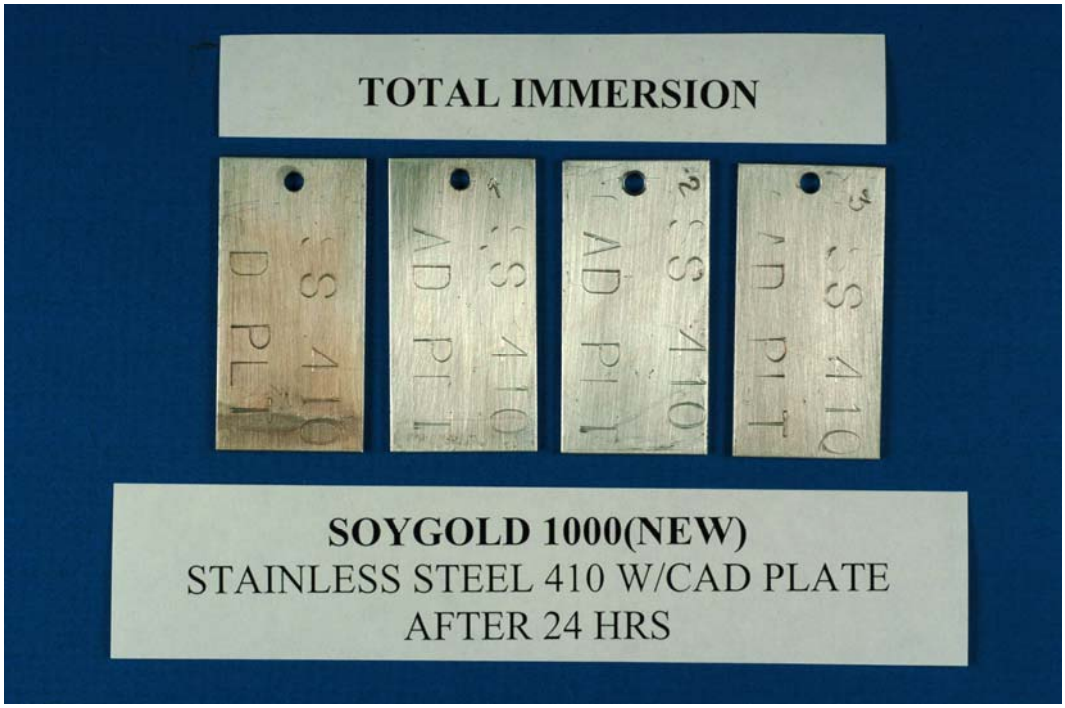

Figure F-3.3.1-21. CP-1a, New, 24 hr.

Figure F-3.3.1-22. CP-1a, New, 168 hr.

Figure F-3.3.1-23. CP-1a, Old, 24 hr.

Figure F-3.3.1-24. CP-1a, Old, 168 hr.

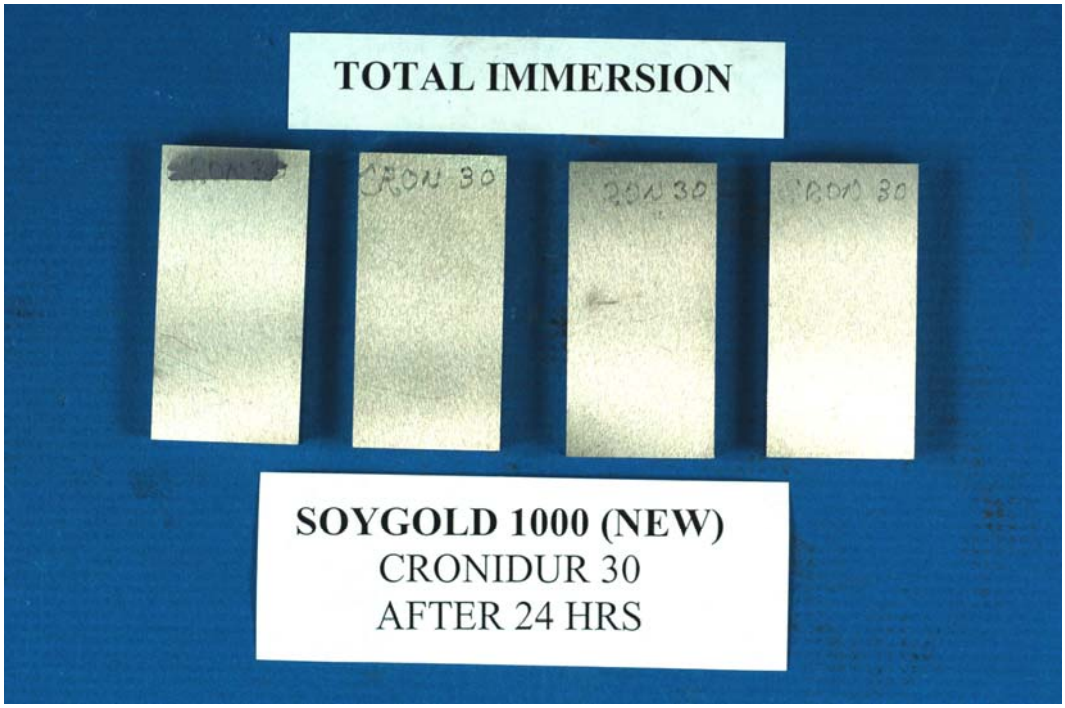

Figure F-3.3.1-25. CR-1, New, 24 hr.

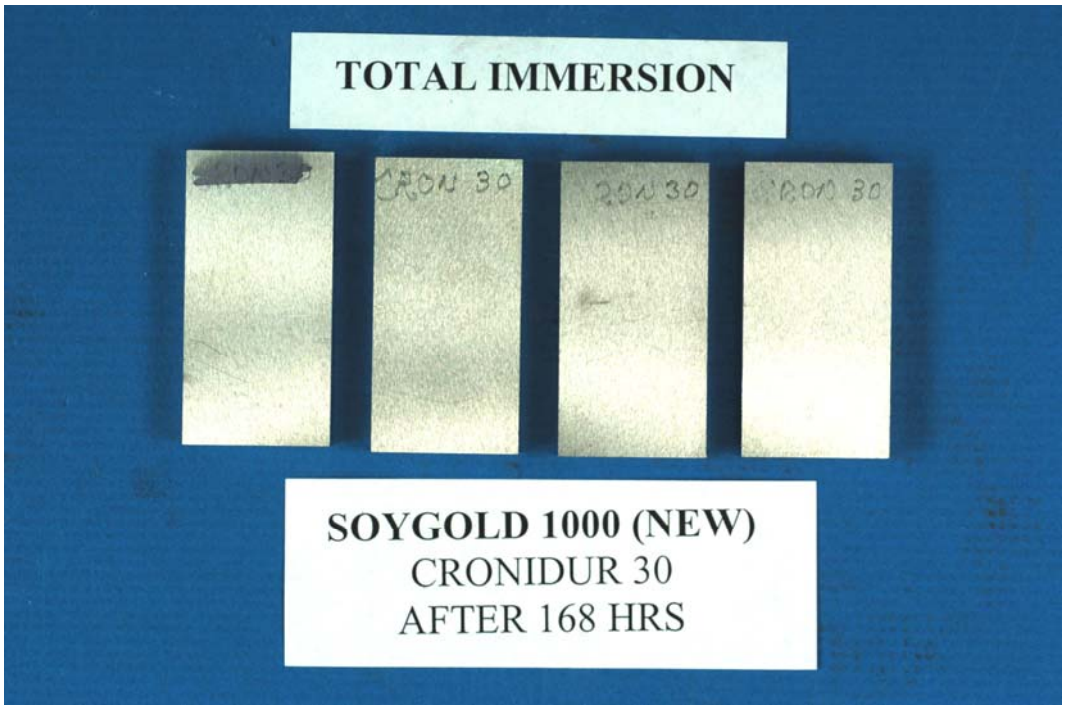

Figure F-3.3.1-26. CR-1, New, 168 hr.

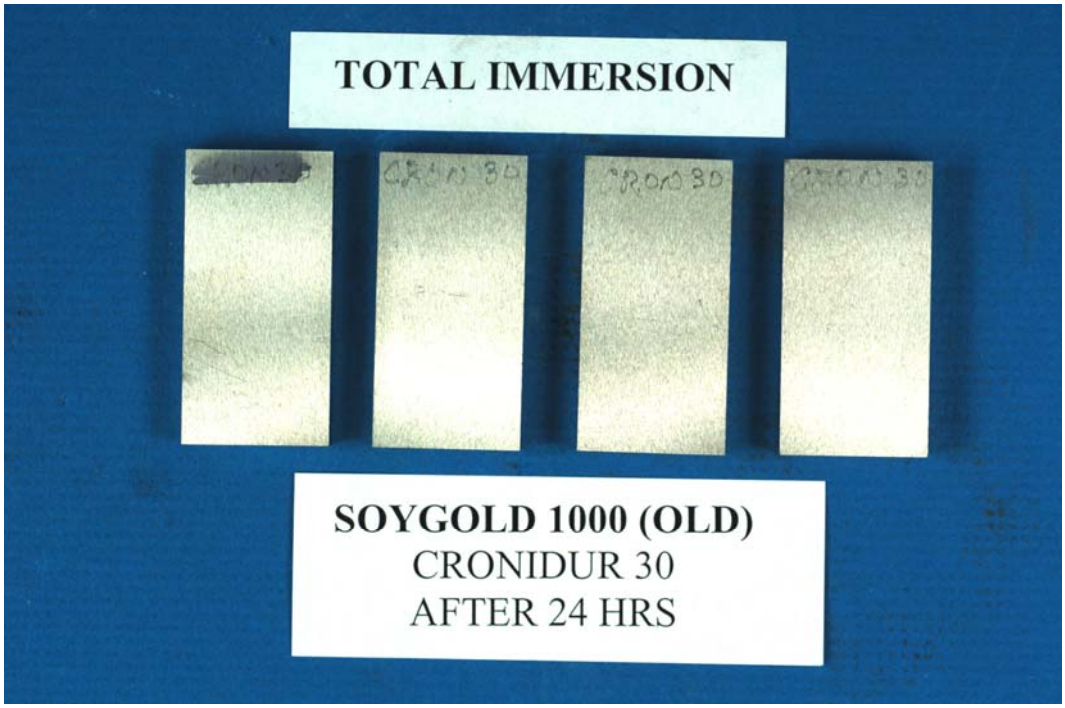

Figure F-3.3.1-27. CR-1, Old, 24 hr.

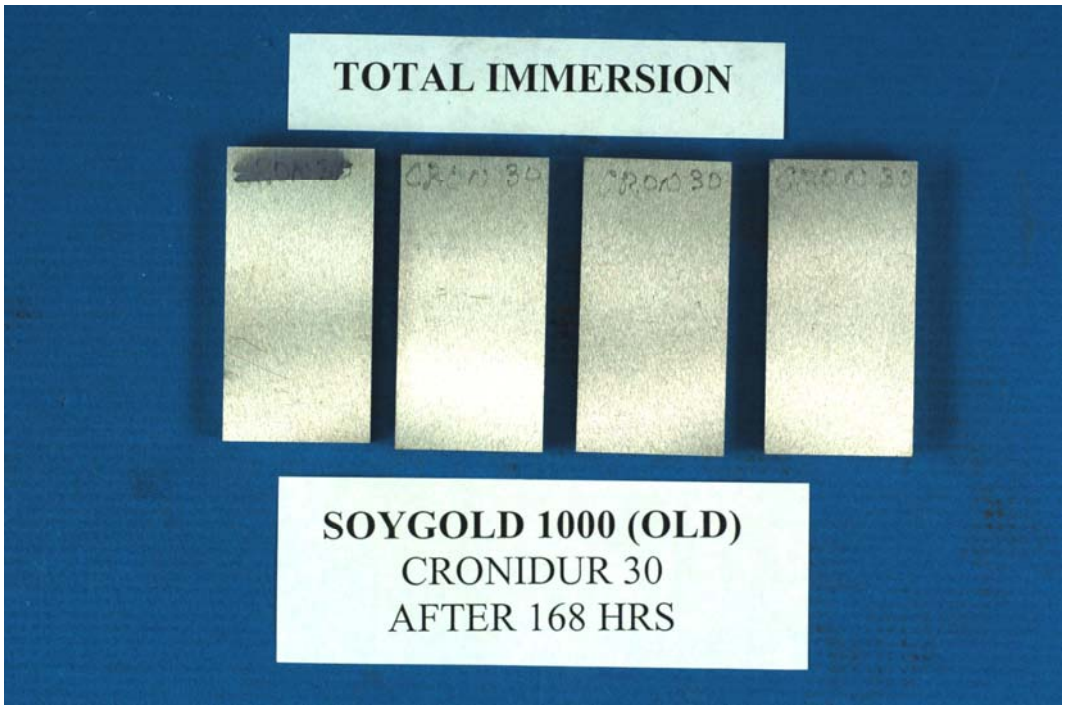

Figure F-3.3.1-28. CR-1, Old, 168 hr.

Figure F-3.3.1-29. CS-1, New, 24 hr.

Figure F-3.3.1-30. CS-1, New, 168 hr.

Figure F-3.3.1-31. CS-1, Old, 24 hr.

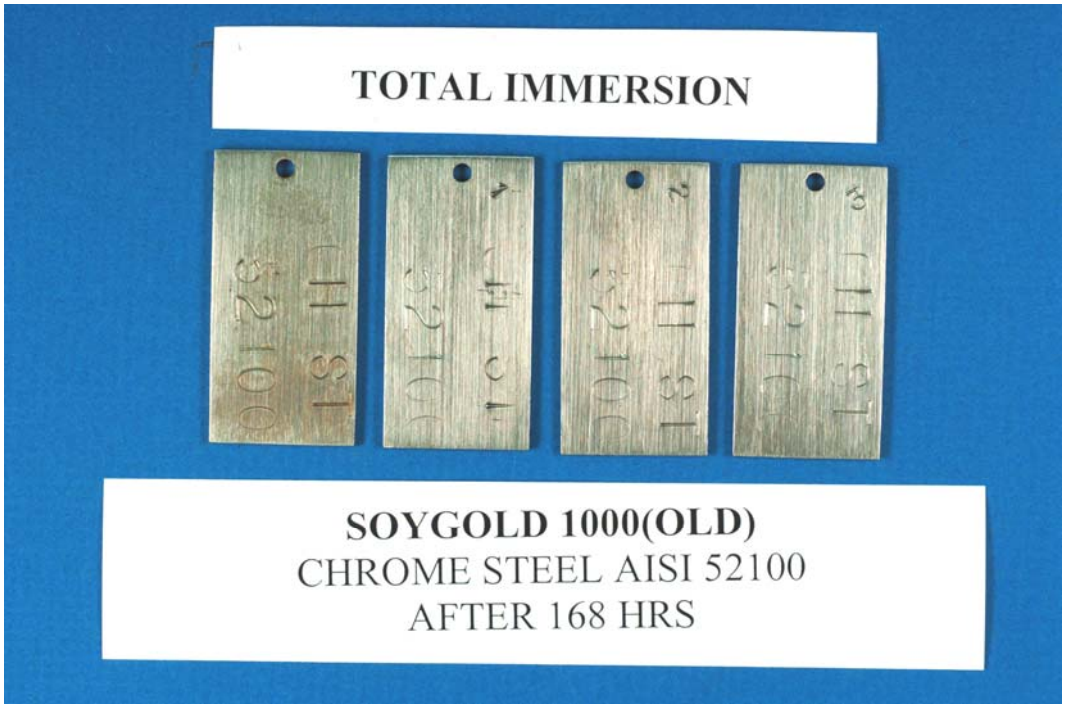

Figure F-3.3.1-32. CS-1, Old, 168 hr.

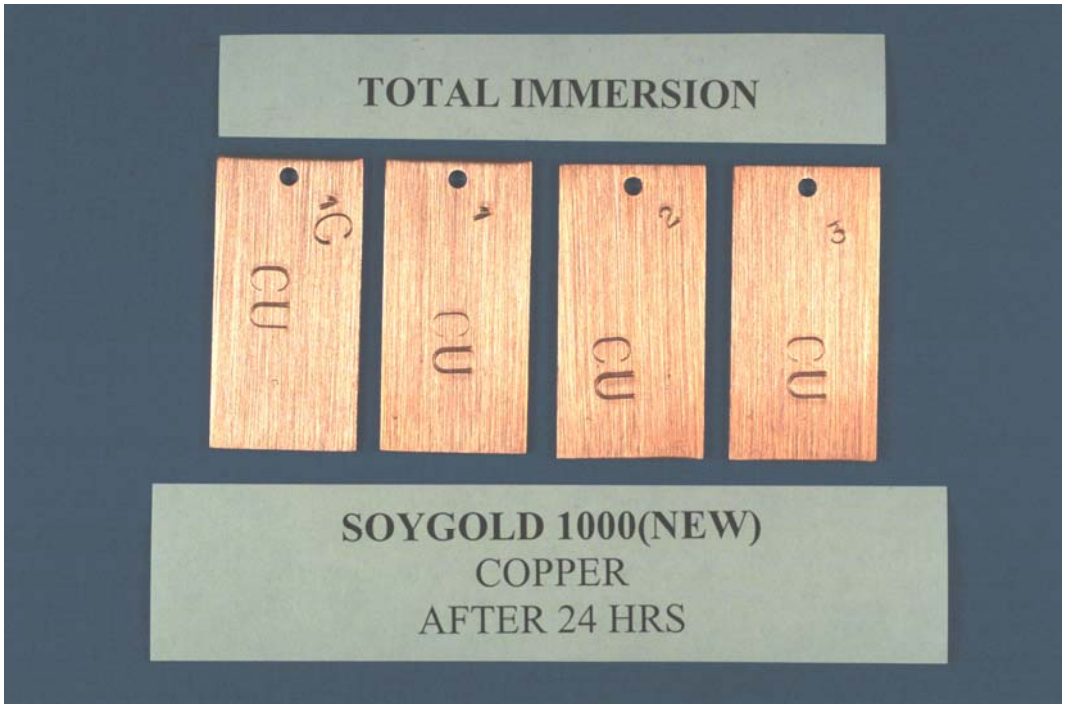

Figure F-3.3.1-33. CU-1, New, 24 hr.

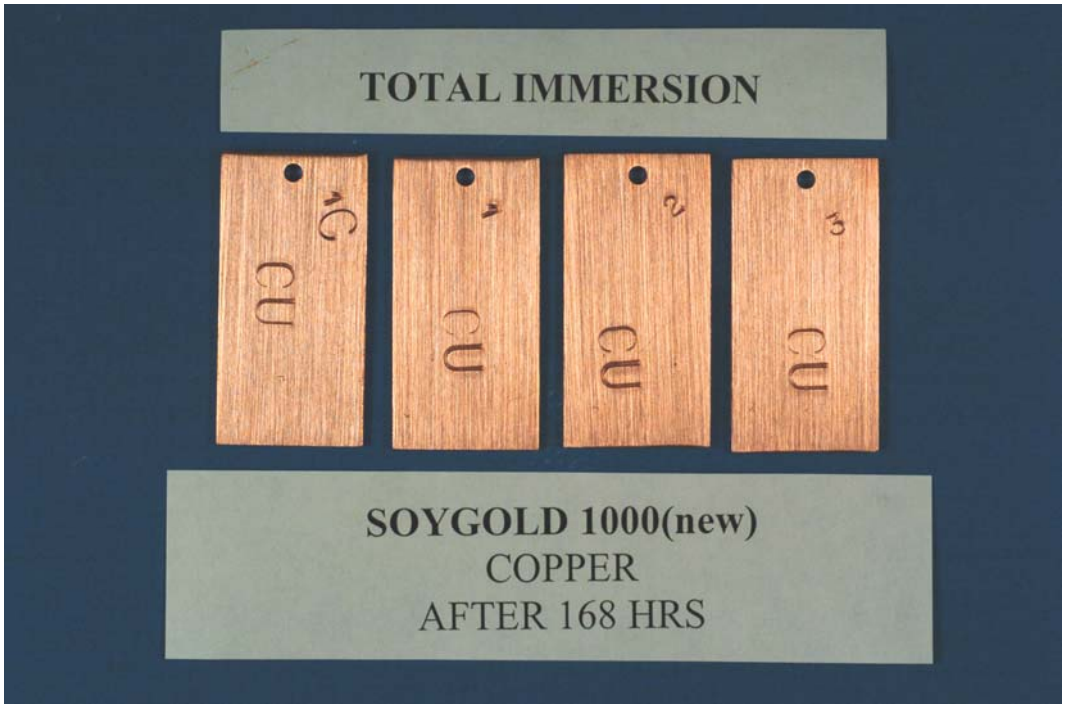

Figure F-3.3.1-34. CU-1, New, 168 hr.

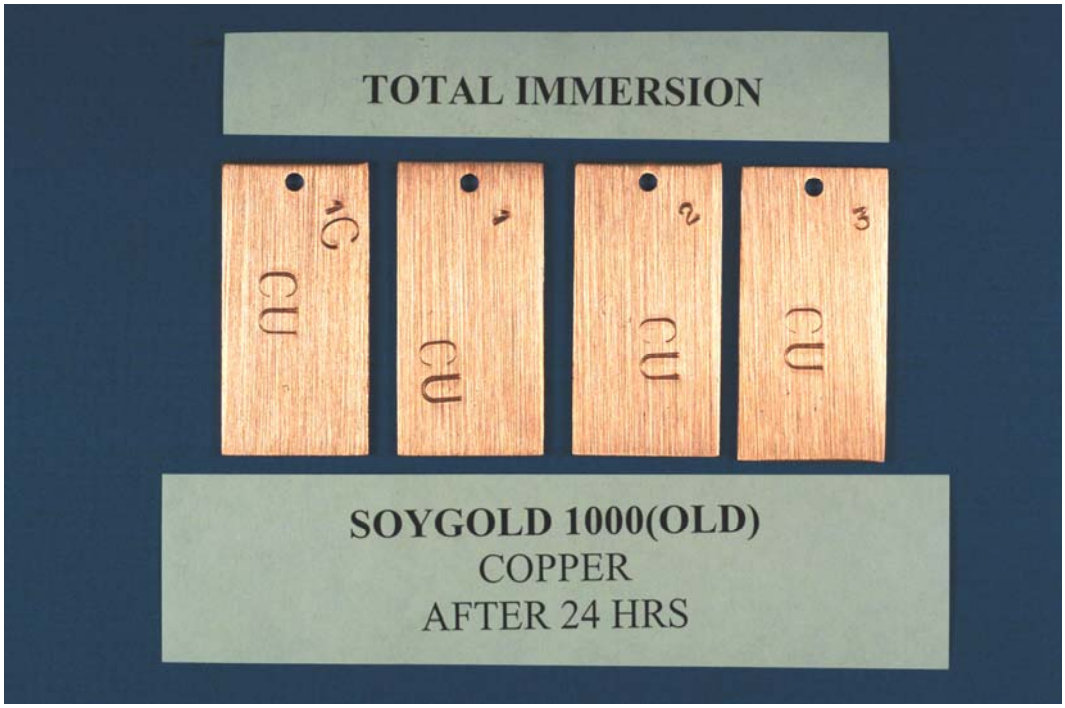

Figure F-3.3.1-35. CU-1, Old, 24 hr.

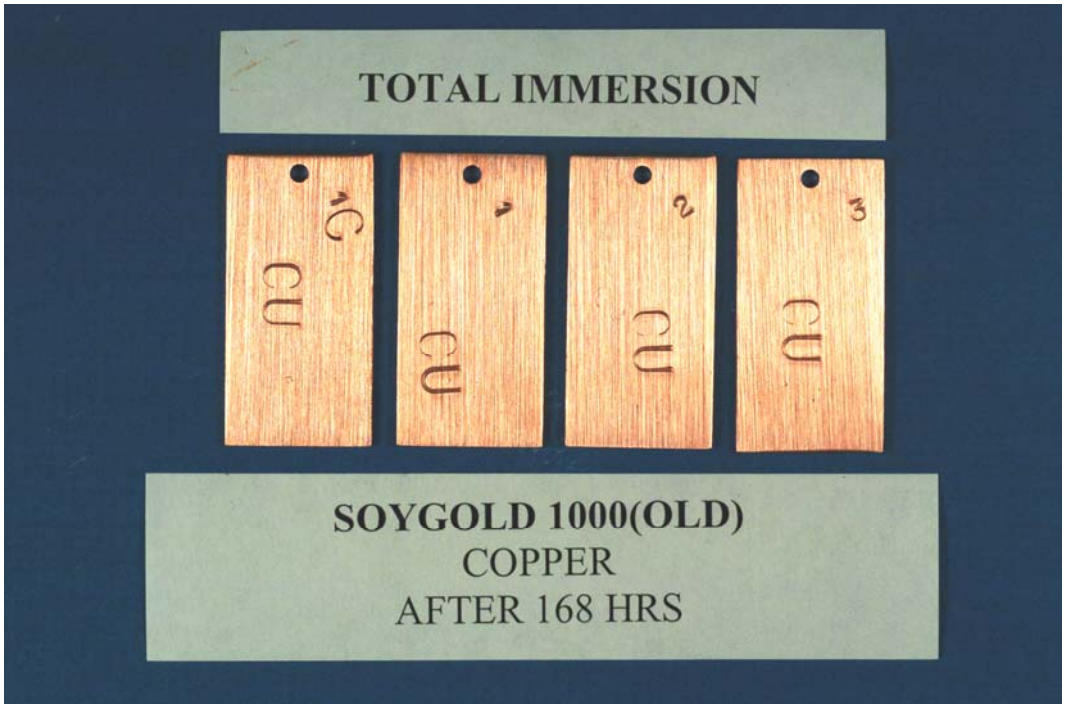

Figure F-3.3.1-36. CU-1, Old, 168 hr.

Figure F-3.3.1-37. HT-1, New, 24 hr.

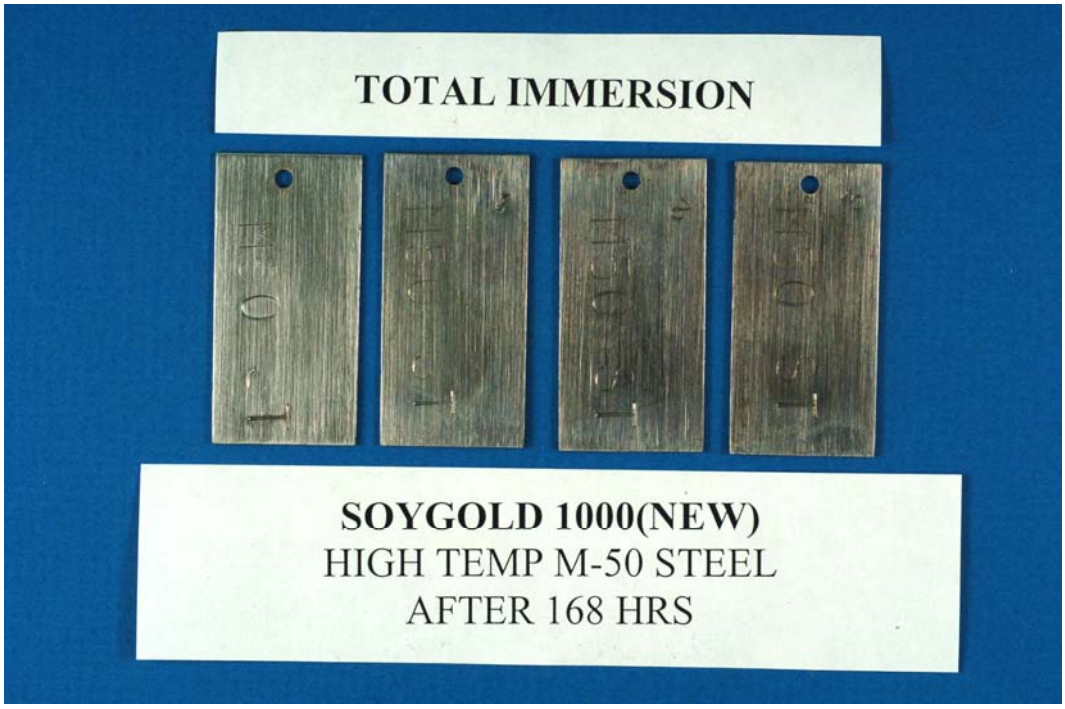

Figure F-3.3.1-38. HT-1, New, 168 hr.

Figure F-3.3.1-39. HT-1, Old, 24 hr.

Figure F-3.3.1-40. HT-1, Old, 168 hr.

Figure F-3.3.1-41. NB-1, New, 24 hr.

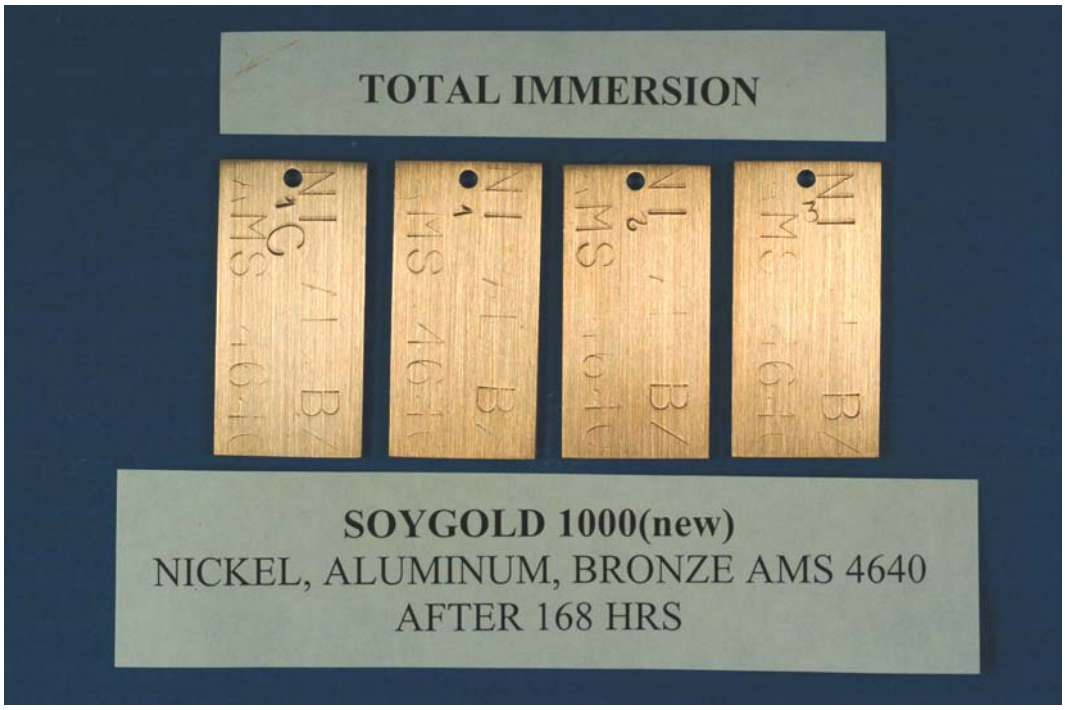

Figure F-3.3.1-42. NB-1, New, 168 hr.

Figure F-3.3.1-43. NB-1, Old, 24 hr.

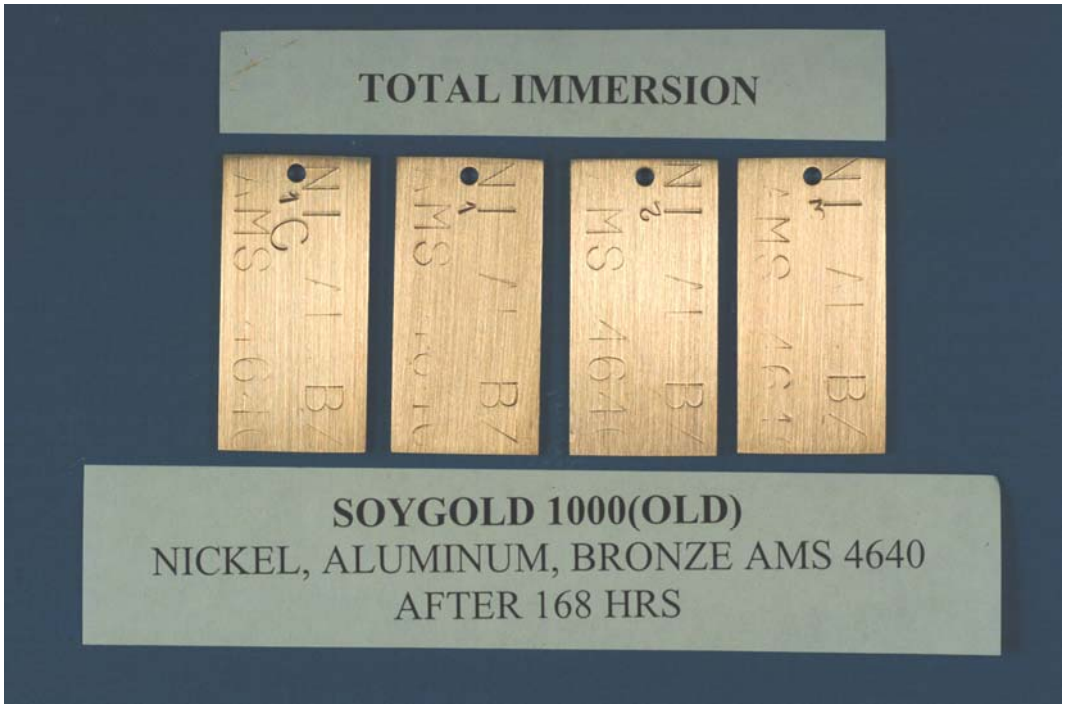

Figure F-3.3.1-44. NB-1, Old, 168 hr.

Figure F-3.3.1-45. NI-1, New, 24 hr.

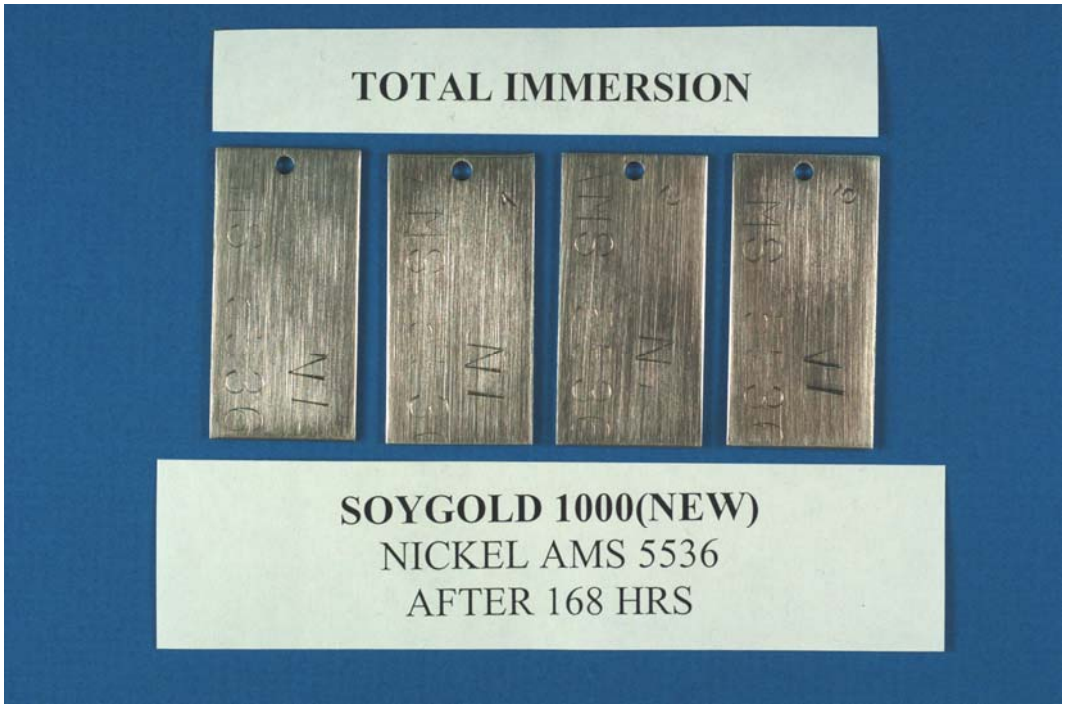

Figure F-3.3.1-46. NI-1, New, 168 hr.

Figure F-3.3.1-47. NI-1, Old, 24 hr.

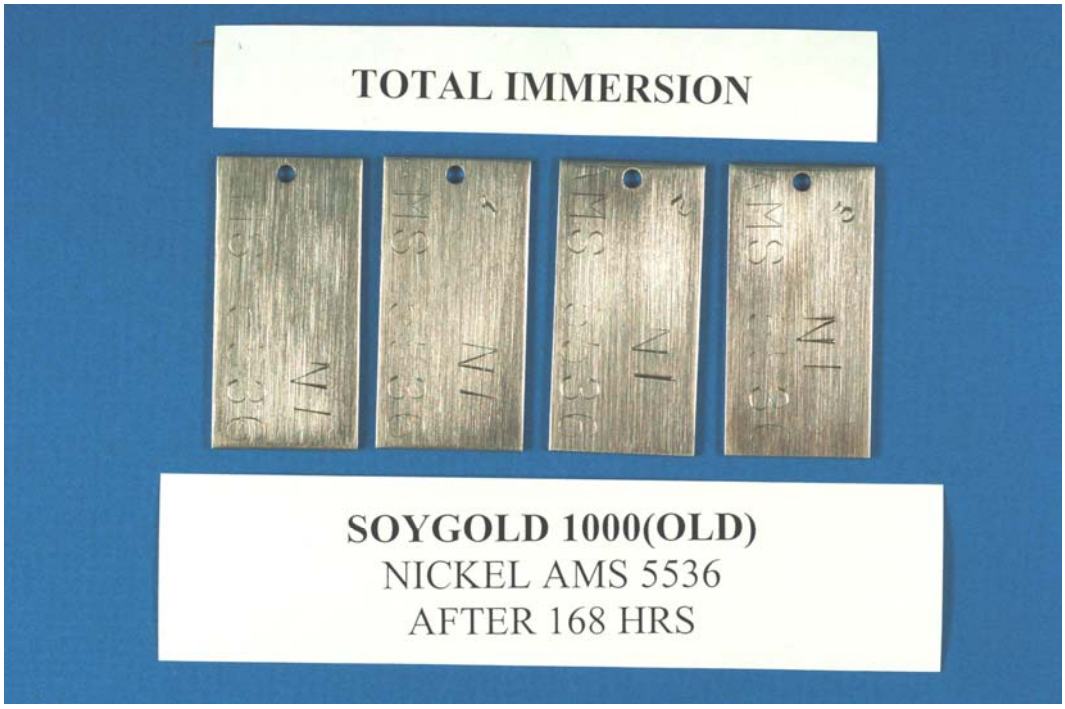

Figure F-3.3.1-48. NI-1, Old, 168 hr.

Figure F-3.3.1-49. PH-1a, New, 24 hr.

Figure F-3.3.1-50. PH-1a, New, 168 hr.

Figure F-3.3.1-51. PH-1a, Old, 24 hr.

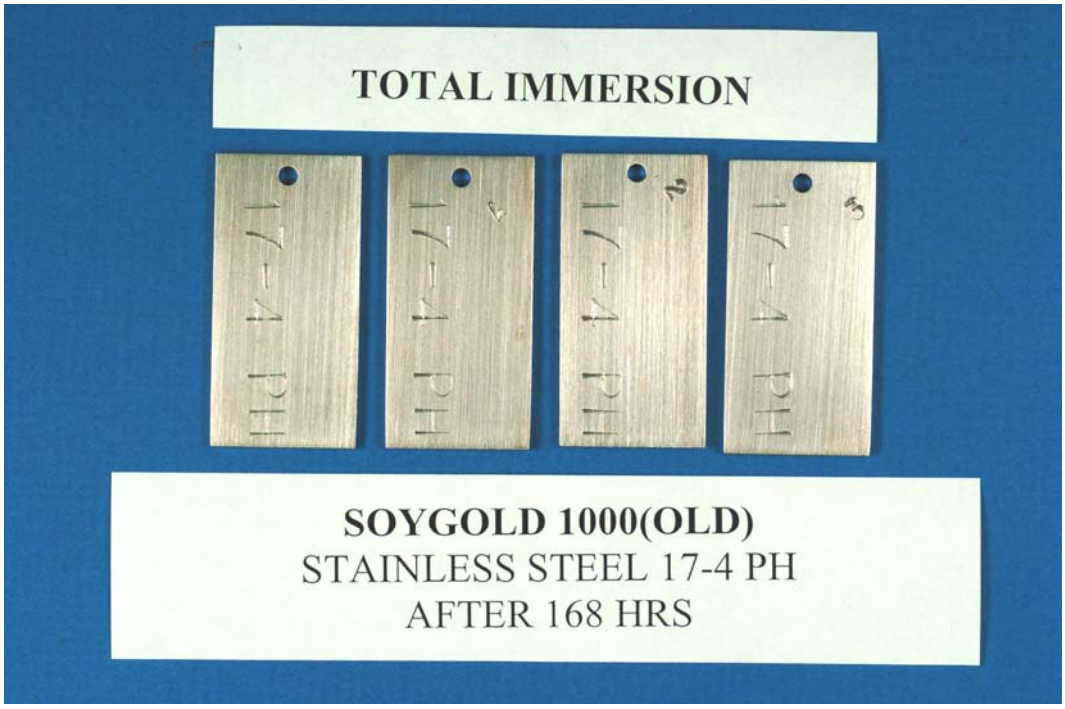

Figure F-3.3.1-52. PH-1a, Old, 168 hr.

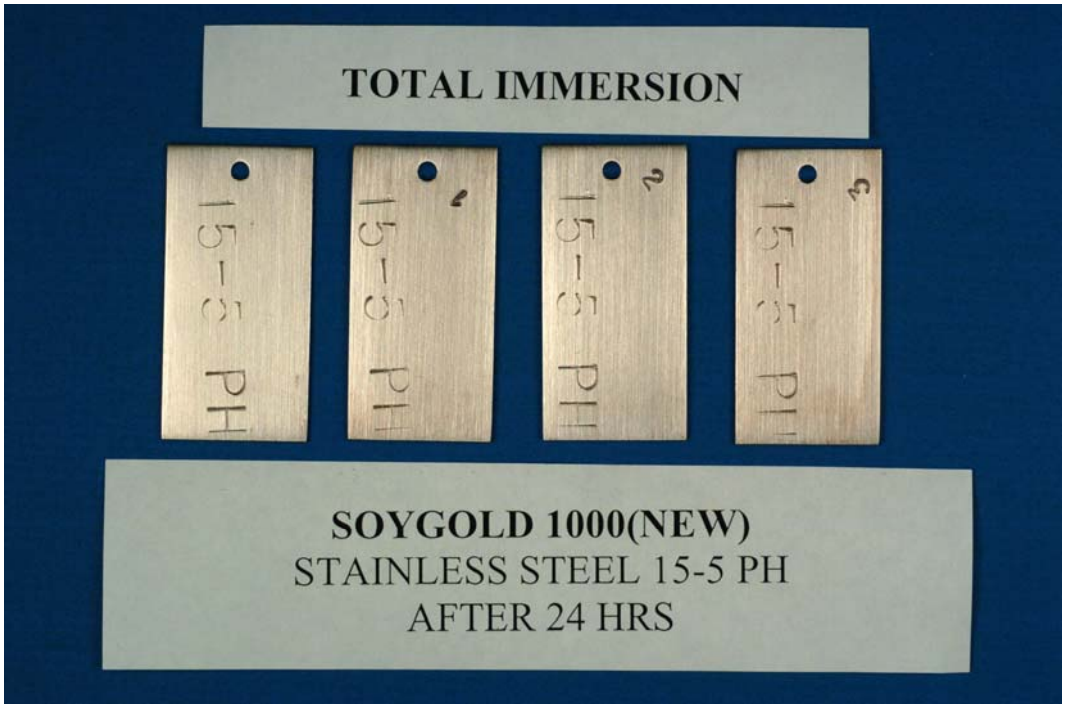

Figure F-3.3.1-53. PH-1b, New, 24 hr.

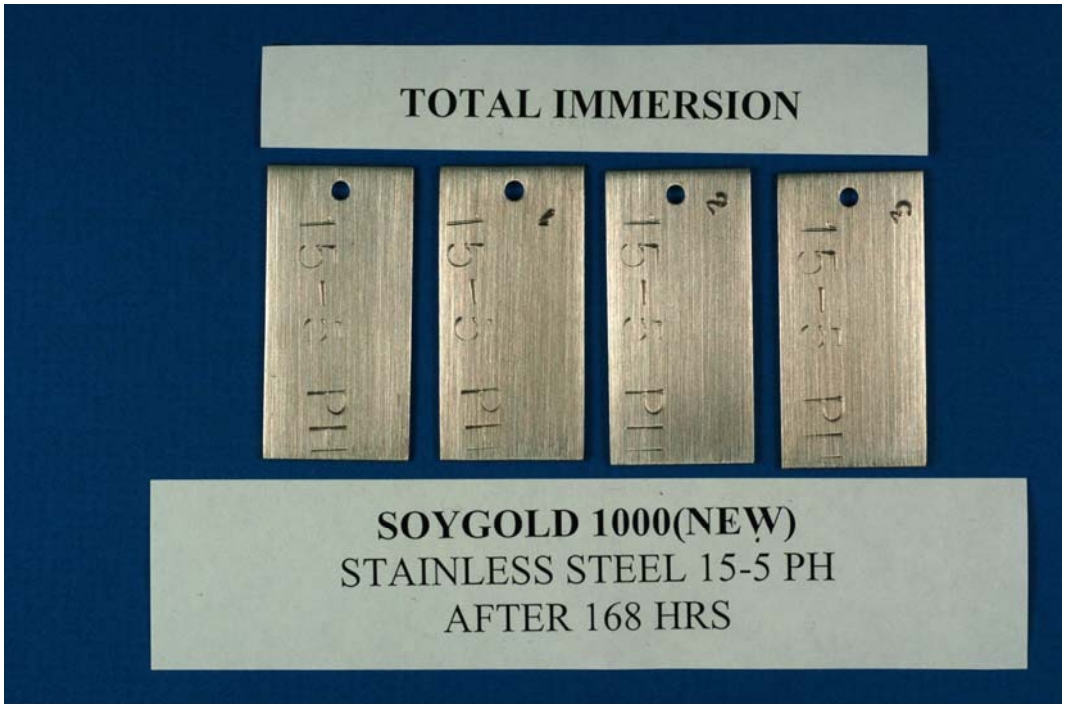

Figure F-3.3.1-54. PH-1b, New, 168 hr.

Figure F-3.3.1-55. PH-1b, Old, 24 hr.

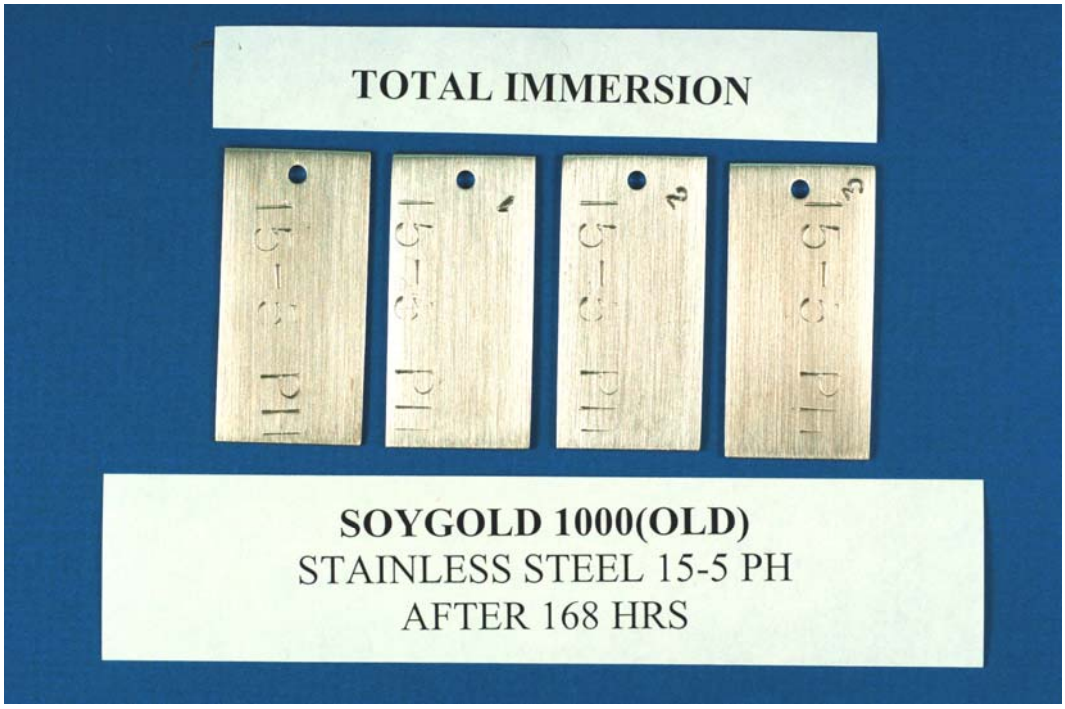

Figure F-3.3.1-56. PH-1b, Old, 168 hr.

Figure F-3.3.1-57. PH-1c, New, 24 hr.

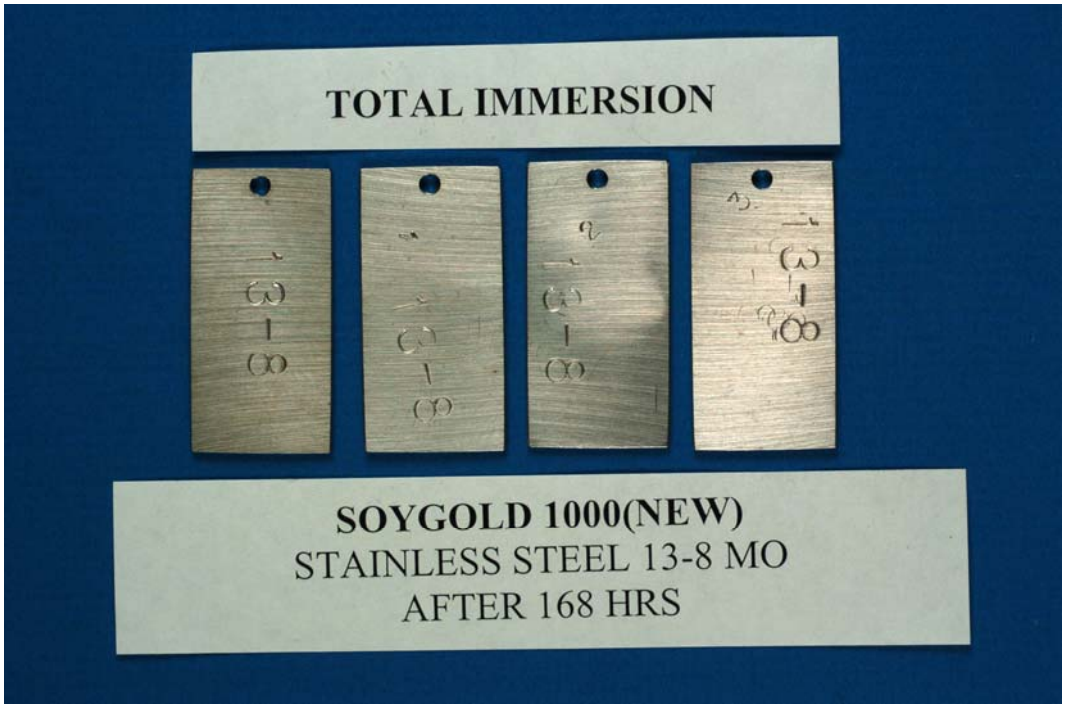

Figure F-3.3.1-58. PH-1c, New, 168 hr.

Figure F-3.3.1-59. PH-1c, Old, 24 hr.

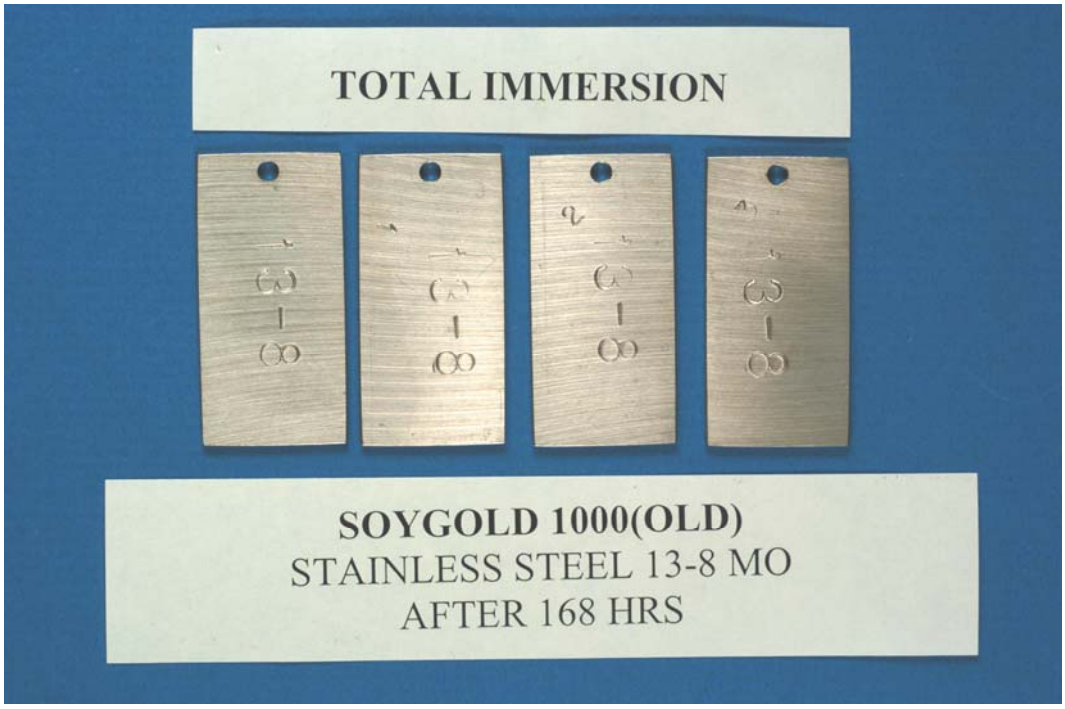

Figure F-3.3.1-60. PH-1c, Old, 168 hr.

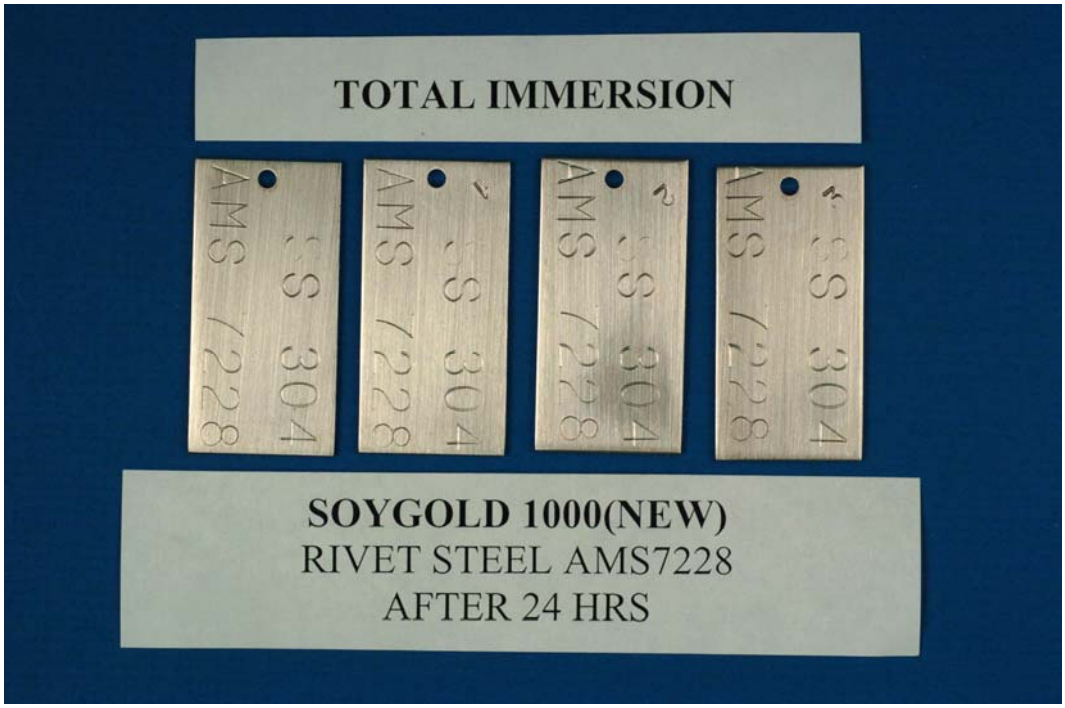

Figure F-3.3.1-61. RS-1, New, 24 hr.

Figure F-3.3.1-62. RS-1, New, 168 hr.

Figure F-3.3.1-63. RS-1, Old, 24 hr.

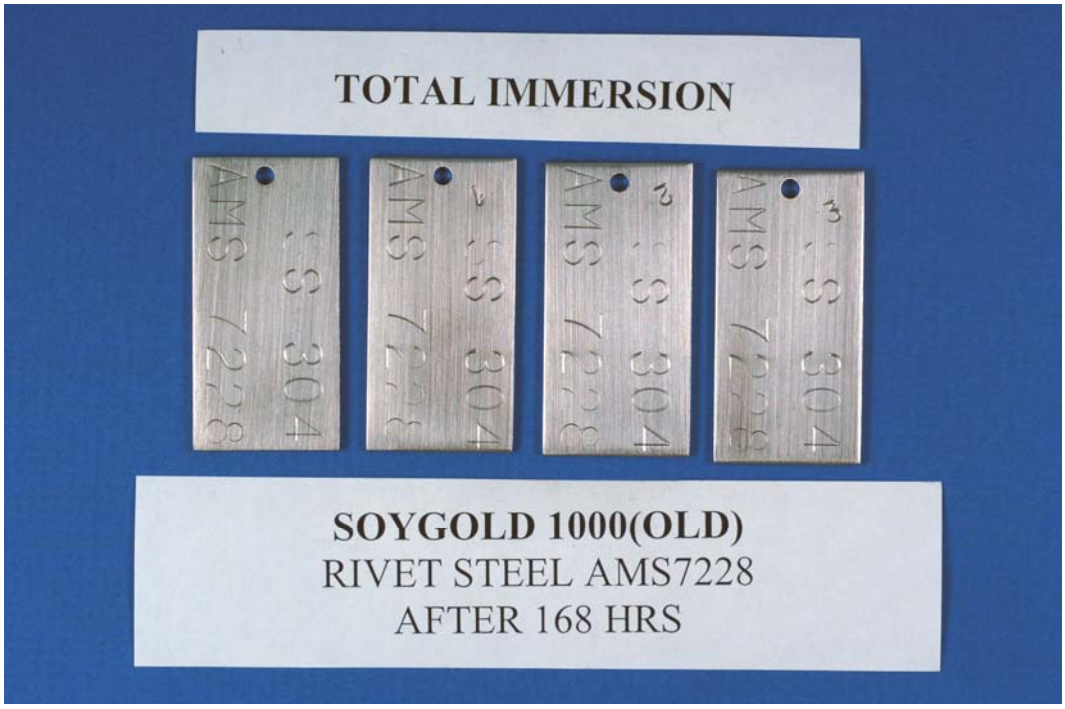

Figure F-3.3.1-64. RS-1, Old, 168 hr.

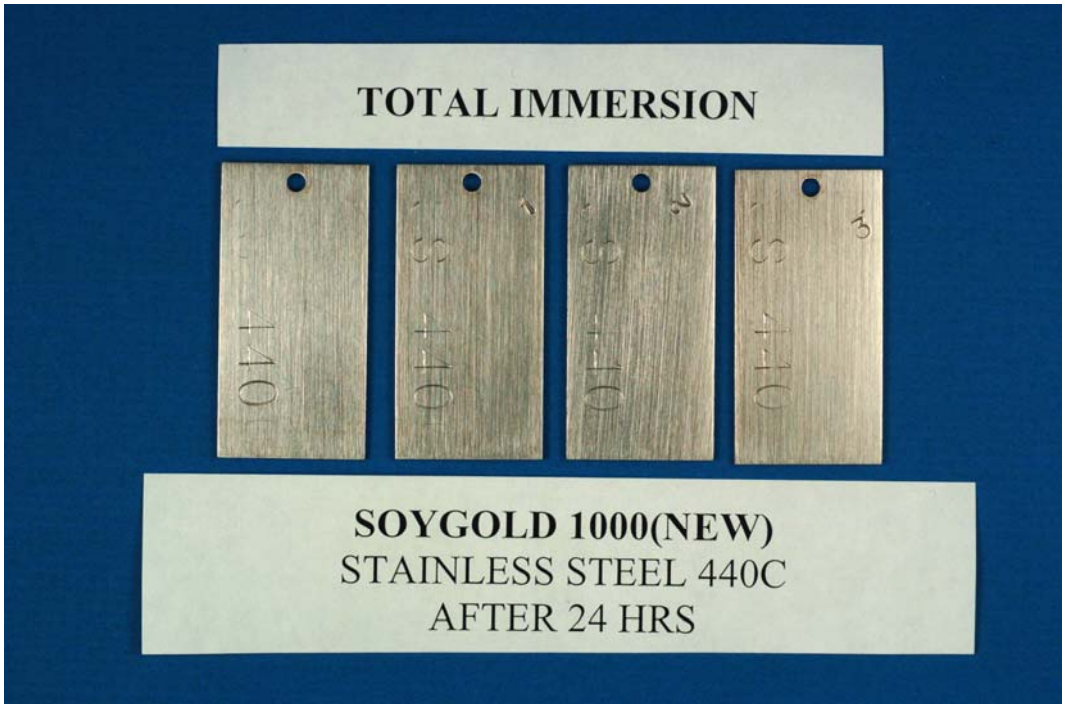

Figure F-3.3.1-65. SS-1, New, 24 hr.

Figure F-3.3.1-66. SS-1, New, 168 hr.

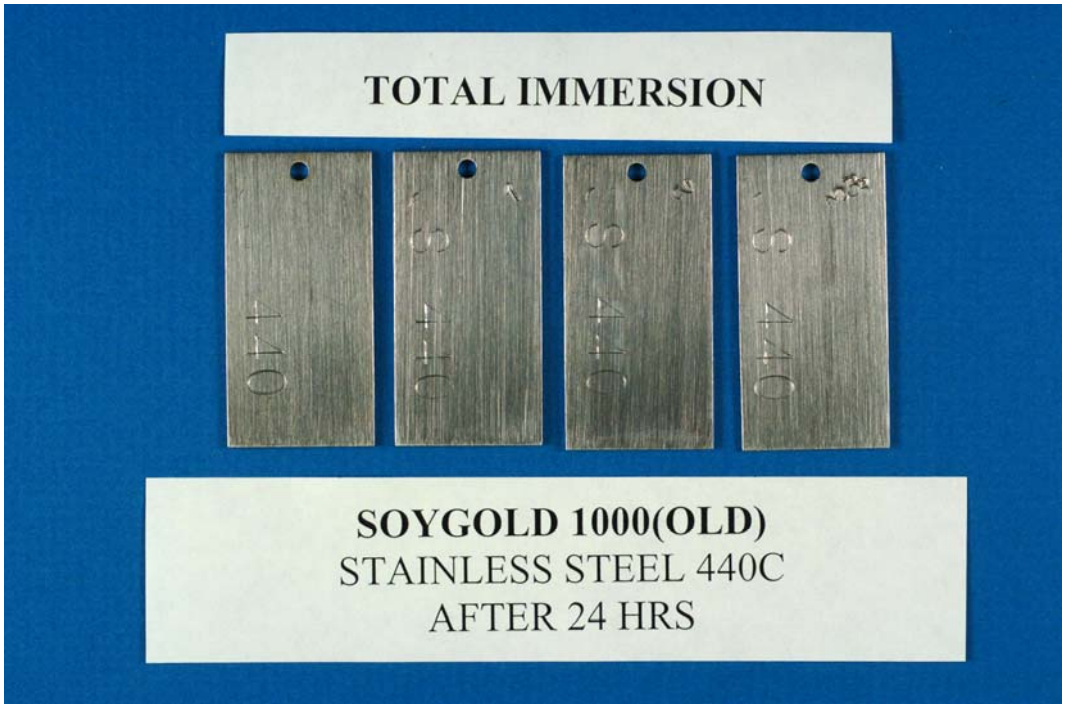

Figure F-3.3.1-67. SS-1, Old, 24 hr.

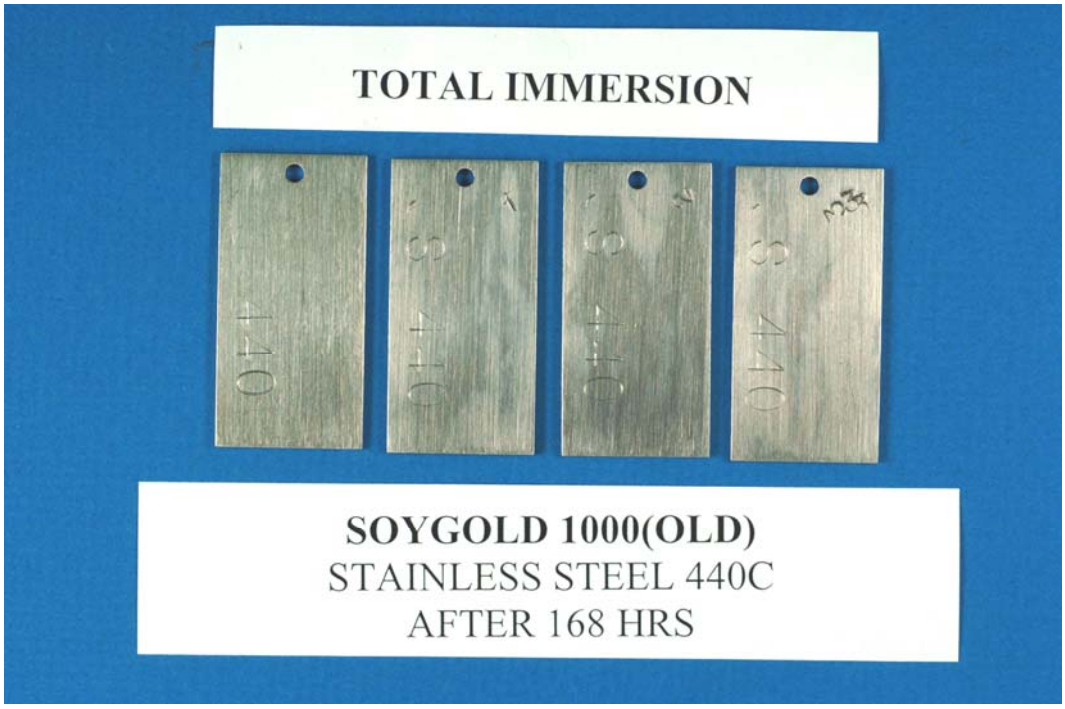

Figure F-3.3.1-68. SS-1, Old, 168 hr.

Figure F-3.3.1-69. ST-1, New, 24 hr.

Figure F-3.3.1-70. ST-1, New, 168 hr.

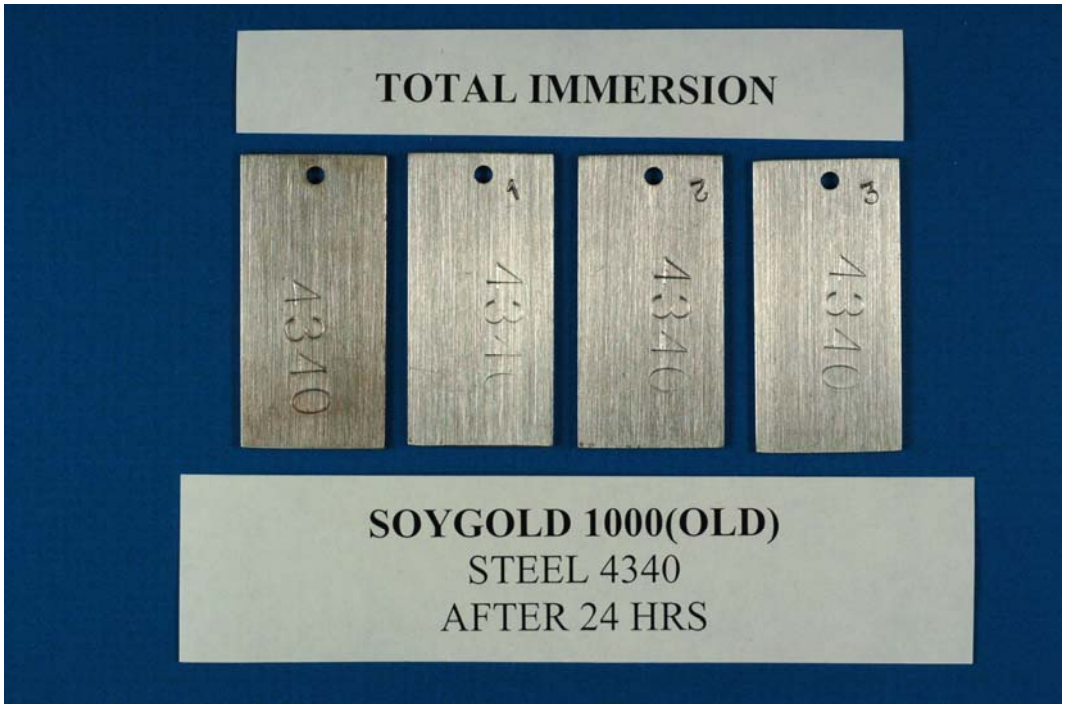

Figure F-3.3.1-71. ST-1, Old, 24 hr.

Figure F-3.3.1-72. ST-1, Old, 168 hr.

Figure F-3.3.1-73. TI-1, New, 24 hr.

Figure F-3.3.1-74. TI-1, New, 168 hr.

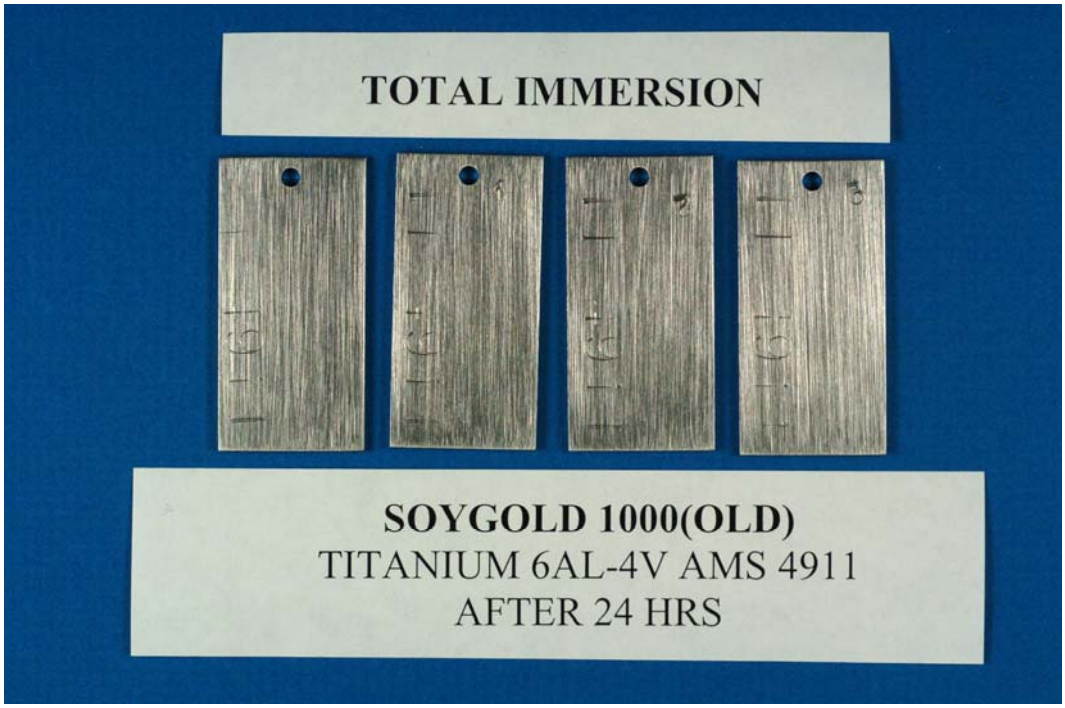

Figure F-3.3.1-75. TI-1, Old, 24 hr.

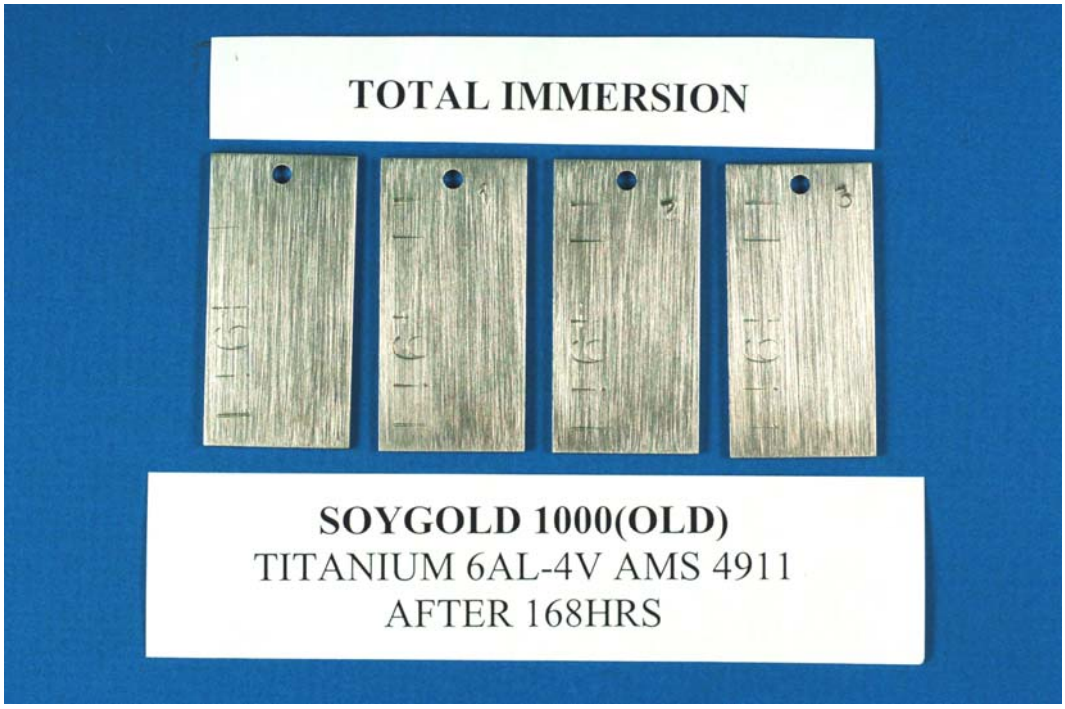

Figure F-3.3.1-76. TI-1, Old, 168 hr.

APPENDIX G. SMI REPORT

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SMI, Inc.
12219 SW 131 Avenue
Miami, Florida 33186-6401 USA
Phone: (305) 971-7047
Fax: (305) 971-7048

Attn: William Taylor
USA Aberdeen Test Center W81C5M
358 Colleran Road
APG MD 21005-5059

Date: 27-Apr-2006

SMI/REF: 0604-518-8O

Product: **#8 Old** *(received 04-Apr-2006)*

Dilution: As received

ASTM F 945-01
Stress-Corrosion of Titanium Alloys
by Aircraft Engine Cleaning Materials (Method A)

8. Procedure:

8.1 Test a minimum of nine specimens of each alloy using the following procedure.

8.1.1 To establish acceptability of the titanium alloy sheet materials for use in these tests, test three restrained test specimens of each alloy without contacting any test solution after acid cleaning.

8.1.2 To establish sensitivity of the titanium alloy sheet materials to stress corrosion attack, wet three restrained test specimens of AMS 4916 alloy by immersing in the 100-ppm sodium chloride solution and three restrained test specimens of AMS 4911 alloy by immersing in the solution of 3 weight % sodium chloride. Hang to dry with the bend zone down. Remove and test as in 8.2.

8.1.3 To evaluate the effect of the candidate solution, wet three restrained test specimens of each alloy by immersing in the candidate solution at the maximum recommended concentration. Hang to dry with the bend zone down and test as in 8.2.

8.2 Heat the restrained specimens in an air circulation furnace in accordance with method(s) to be specified by the purchaser as follows:

8.2.1 *Method A* - Heat at 900 ± 20°F (480 ± 10°C) for 8 ± 0.2 hours.

8.2.2 *Method B* - Heat at 500 ± 20°F (260 ± 10°C) for 168 ± 4 hours.

8.2.3 After heating, remove the specimens from the furnace, allow to cool, and inspect for cracks.

8.3 *Preliminary Evaluation* - Inspect all of the restrained specimens visually using 20-diameters magnification.

8.3.1 If cracks are found on the untreated (control) specimens, repeat the entire stress corrosion test using acceptable titanium alloy sheet material.

8.3 *Preliminary Evaluation* continued:

8.3.2 If cracks are found on all candidate solution-treated specimens, this shall be cause for rejection of the candidate cleaning material.

8.3.3 All restrained specimens not found to be cracked during visual inspection at 20-diameters magnification prepare for further inspection as follows:

8.3.3.1 Remove the bolt restraints.

8.3.3.2 Rinse in warm tap water; do not permit to dry.

8.3.3.3 While wet, immerse in acid cleaning solution of 5.3 for 15 ± 5 seconds.

8.3.3.4 Rinse in tap water and air dry.

8.3.3.5 Inspect metallographically as in 8.4.1.

8.4 *Metallographic Inspection.*

8.4.1 Make a cross section of each specimen at the bend normal to the bend axis (parallel to the test panel long axis). Cut the specimens using a fine-tooth hacksaw or other apparatus capable of producing a smooth cut with minimal disturbance of specimen edges. Make the cut approximately at the center axis in line with the holes. The metallographic specimen shall encompass material from the bend to a point approximately 0.5 inches (13 mm) from the bend. Examine the cut surface over the 0.5 inch (13 mm) distance on both sides of the bend zone at 500 diameters following metallographic preparation appropriate to the specimen alloy composition.

9. Determination of Test Results

9.1 Detection of cracks on either the tension or compression surfaces of any of the untreated (control) specimens shall be cause to repeat the entire stress corrosion test using acceptable titanium alloy sheet material.

9.2 Failure to detect cracks on either the tension or compression surfaces of all of the NaCl-solution-treated specimens shall be cause to repeat the entire stress corrosion test using titanium alloy sheet having a demonstrated susceptibility to stress corrosion cracking.

9.3 Examine tension and compression surfaces of candidate-solution-treated specimens for cracks and make one of the following dispositions:

9.3.1 Failure to detect cracks on any specimen shall constitute an acceptance test for the candidate cleaning material.

9.3.2 Detection of cracks on all specimens shall be cause for rejection of the candidate cleaning material.

9.3.3 If some of the specimens do not exhibit cracks, the entire stress corrosion test may be repeated at the option of the testing facility.

Method A:

Alloy		OBSERVATION	RESULT
AMS 4911 Blank Control	# 1	No evidence of cracking.	AMS 4911 Titanium sheet meets acceptability and sensitivity criteria
	# 2	No evidence of cracking.	
	# 3	No evidence of cracking.	
AMS 4911 3% Salt Control	# 1	Cracking evident.	
	# 2	Cracking evident.	
	# 3	Cracking evident.	
AMS 4911 Candidate Solution	**# 1**	**No evidence of cracking.**	**Conforms**
	# 2	**No evidence of cracking.**	**Conforms**
	# 3	**No evidence of cracking.**	**Conforms**
AMS 4916 Blank Control	# 1	No evidence of cracking.	AMS 4916 Titanium sheet meets acceptability and sensitivity criteria
	# 2	No evidence of cracking.	
	# 3	No evidence of cracking.	
AMS 4916 100 ppm Salt Control	# 1	Cracking evident.	
	# 2	Cracking evident.	
	# 3	Cracking evident.	
AMS 4916 Candidate Solution	**# 1**	**No evidence of cracking.**	**Conforms**
	# 2	**No evidence of cracking.**	**Conforms**
	# 3	**No evidence of cracking.**	**Conforms**

Respectfully submitted,

Patricia D. Viani, SMI Inc.

SMI, Inc.
12219 SW 131 Avenue
Miami, Florida 33186-6401 USA
Phone: (305) 971-7047
Fax: (305) 971-7048

Attn: William Taylor
USA Aberdeen Test Center W81C5M
358 Colleran Road
APG MD 21005-5059

Date: 27-Apr-2006

SMI/REF: 0604-518-8N

Product: **#8 New** *(received 04-Apr-2006)*

Dilution: As received

ASTM F 945-01
Stress-Corrosion of Titanium Alloys
by Aircraft Engine Cleaning Materials (Method A)

8. Procedure:

8.1 Test a minimum of nine specimens of each alloy using the following procedure.

8.1.1 To establish acceptability of the titanium alloy sheet materials for use in these tests, test three restrained test specimens of each alloy without contacting any test solution after acid cleaning.

8.1.2 To establish sensitivity of the titanium alloy sheet materials to stress corrosion attack, wet three restrained test specimens of AMS 4916 alloy by immersing in the 100-ppm sodium chloride solution and three restrained test specimens of AMS 4911 alloy by immersing in the solution of 3 weight % sodium chloride. Hang to dry with the bend zone down. Remove and test as in 8.2.

8.1.3 To evaluate the effect of the candidate solution, wet three restrained test specimens of each alloy by immersing in the candidate solution at the maximum recommended concentration. Hang to dry with the bend zone down and test as in 8.2.

8.2 Heat the restrained specimens in an air circulation furnace in accordance with method(s) to be specified by the purchaser as follows:

8.2.1 *Method A* - Heat at 900 ± 20°F (480 ± 10°C) for 8 ± 0.2 hours.

8.2.2 *Method B* - Heat at 500 ± 20°F (260 ± 10°C) for 168 ± 4 hours.

8.2.3 After heating, remove the specimens from the furnace, allow to cool, and inspect for cracks.

8.3 *Preliminary Evaluation* - Inspect all of the restrained specimens visually using 20-diameters magnification.

8.3.1 If cracks are found on the untreated (control) specimens, repeat the entire stress corrosion test using acceptable titanium alloy sheet material.

8.3 *Preliminary Evaluation* continued:

8.3.2 If cracks are found on all candidate solution-treated specimens, this shall be cause for rejection of the candidate cleaning material.

8.3.3 All restrained specimens not found to be cracked during visual inspection at 20-diameters magnification prepare for further inspection as follows:

8.3.3.1 Remove the bolt restraints.

8.3.3.2 Rinse in warm tap water; do not permit to dry.

8.3.3.3 While wet, immerse in acid cleaning solution of 5.3 for 15 ± 5 seconds.

8.3.3.4 Rinse in tap water and air dry.

8.3.3.5 Inspect metallographically as in 8.4.1.

8.4 *Metallographic Inspection.*

8.4.1 Make a cross section of each specimen at the bend normal to the bend axis (parallel to the test panel long axis). Cut the specimens using a fine-tooth hacksaw or other apparatus capable of producing a smooth cut with minimal disturbance of specimen edges. Make the cut approximately at the center axis in line with the holes. The metallographic specimen shall encompass material from the bend to a point approximately 0.5 inches (13 mm) from the bend. Examine the cut surface over the 0.5 inch (13 mm) distance on both sides of the bend zone at 500 diameters following metallographic preparation appropriate to the specimen alloy composition.

9. Determination of Test Results

9.1 Detection of cracks on either the tension or compression surfaces of any of the untreated (control) specimens shall be cause to repeat the entire stress corrosion test using acceptable titanium alloy sheet material.

9.2 Failure to detect cracks on either the tension or compression surfaces of all of the NaCl-solution-treated specimens shall be cause to repeat the entire stress corrosion test using titanium alloy sheet having a demonstrated susceptibility to stress corrosion cracking.

9.3 Examine tension and compression surfaces of candidate-solution-treated specimens for cracks and make one of the following dispositions:

9.3.1 Failure to detect cracks on any specimen shall constitute an acceptance test for the candidate cleaning material.

9.3.2 Detection of cracks on all specimens shall be cause for rejection of the candidate cleaning material.

9.3.3 If some of the specimens do not exhibit cracks, the entire stress corrosion test may be repeated at the option of the testing facility.

Method A:

Alloy		OBSERVATION	RESULT
AMS 4911 Blank Control	# 1	No evidence of cracking.	AMS 4911 Titanium sheet meets acceptability and sensitivity criteria
	# 2	No evidence of cracking.	
	# 3	No evidence of cracking.	
AMS 4911 3% Salt Control	# 1	Cracking evident.	
	# 2	Cracking evident.	
	# 3	Cracking evident.	
AMS 4911 Candidate Solution	**# 1**	**No evidence of cracking.**	**Conforms**
	# 2	**No evidence of cracking.**	**Conforms**
	# 3	**No evidence of cracking.**	**Conforms**
AMS 4916 Blank Control	# 1	No evidence of cracking.	AMS 4916 Titanium sheet meets acceptability and sensitivity criteria
	# 2	No evidence of cracking.	
	# 3	No evidence of cracking.	
AMS 4916 100 ppm Salt Control	# 1	Cracking evident.	
	# 2	Cracking evident.	
	# 3	Cracking evident.	
AMS 4916 Candidate Solution	**# 1**	**No evidence of cracking.**	**Conforms**
	# 2	**No evidence of cracking.**	**Conforms**
	# 3	**No evidence of cracking.**	**Conforms**

Respectfully submitted,

Patricia D. Viani, SMI Inc.

APPENDIX H. REFERENCES

3.1-1 AR 40-5, Army Regulation, Medical Services, Preventive Medicine, 22 July 2005.

3.1-2 EPA Method 24, Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings.

3.1-3 ASTM D2369, Standard Test Method for Volatile Content of Coatings.

3.1-4 EPA Method 5030B/8260B, Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS): Capillary Column Technique.

3.1-5 ASTM D93, Standard Test Methods for Flash-Point by Pensky-Martens Closed Cup Tester.

3.2-1 ASTM D2879, Standard Test Method for Vapor Pressure-Temperature Relationship and Initial Decomposition Temperature of Liquids by Isoteniscope.

3.2-2 ASTM D847,Standard Test Method for Acidity of Benzene, Toluene, Xylenes, Solvent Naphthas, and Similar Industrial Aromatic Hydrocarbons.

3.2-3 ASTM D1133, Standard Test Method for Kauri-Butanol Value of Hydrocarbon Solvents.

3.3-1 ASTM F483. Standard Test Method for Total Immersion Corrosion Test for Aircraft Maintenance Chemicals.

3.3-2 ASTM D235, Standard Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent).

3.3-3 ASTM D1193, Standard Specification for Reagent Water.

3.3-4 ASTM D329, Standard Specification for Acetone.

3.3-5 ASTM F945, Standard Test Method for Stress-Corrosion of Titanium Alloys by Aircraft Engine Cleaning Materials.

3.3-6 ASTM F519, Standard Test Method for Mechanical Hydrogen Embrittlement Evaluation of Plating Processes and Service Environments.

3.3-7 ASTM G30, Standard Practice for Making and Using U-Bend Stress-Corrosion Test Specimens.

3.3-8 ASTM G44, Standard Practice for Exposure of Metals and Alloys by Alternate Immersion in Neutral 3.5% Sodium Chloride Solution.

3.3-9 ASTM D6361, Standard Guide for Selecting Cleaning Agents and Processes.

3.3-10 ASTM G1, Standard Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens.

3.3-11 ASTM D1353, Standard Test Method for Nonvolatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer, and Related Products.

3.4-1 MIL-PRF-680A, Performance Specification for Degreasing Solvent.

3.4-2 ASTM A1008, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

3.4-3 MIL-G-10924F, Grease, Automotive and Artillery.

3.4-4 ASTM F22, Standard Test Method for Hydrophobic Surface Films by the Water-Break Test.

3.4-5 MIL-H-83282, Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Metric, NATO Code Number H-537.

3.4-6 MIL-G-81322, Grease, Aircraft, General Purpose, Wide Temperature Range.

APPENDIX I. ABBREVIATIONS

AAMCOM	=	U.S. Army Aviation and Missile Command
ANSI	=	American National Standards Institute
APG	=	Aberdeen Proving Ground
AR	=	Army Regulation
ARL	=	U.S. Army Research Laboratory
ASTM	=	American Society for Testing and Materials
ATC	=	U.S. Army Aberdeen Test Center
CHPPM	=	U.S. Army Center for Health Promotion and Preventive Medicine
DTC	=	U.S. Army Developmental Test Command
DoD	=	Department of Defense
EPA	=	Environmental Protection Agency
GC/MS	=	gas chromatography/mass spectrometry
Kb	=	kauri butanol
LLC	=	Limited Liability Company
MEK	=	methyl ethyl ketone
MSDS	=	material safety data sheet
NFESC	=	Naval Facilities Engineering Service Center
NVR	=	nonvolatile residue
PPE	=	personal protection equipment
SAE	=	Society of Automotive Engineers
SPOTA	=	Sustained Painting Operations for the Total Army
TARDEC	=	U.S. Army Tank-Automotive Research, Development and Engineering Center
VOC	=	volatile organic compound

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APPENDIX J. DISTRIBUTION LIST

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CSTE-DTC-AT-CS-R Aberdeen Proving Ground, MD 21005-5059	1

Secondary distribution is controlled by Commanding Officer, U.S. Naval Facilities Engineering Service Center, ATTN: Mr. Brad Hollan.

(Page J-2 Blank)

Appendix B

North Island Naval Aviation Depot
Temporary Engineering Instruction (TEI)
for Testing of SG1000 in the Bearing Cleaning Process

TEMPORARY ENGINEERING INSTRUCTION (TEI)

NAVAL AVIATION DEPOT
NORTH ISLAND
SAN DIEGO, CA 92135-7058

ORIGINATING CODE 43460		DATE 4/27/2006	TEI NO. NI MATL-008-05
MODEL/EQUIPMENT NA		FSCM & PART NO. SOYGOLD 1000	
NOMENCLATURE INSTRUCTIONS FOR RINSE EFFICIENCY TESTING OF SOYGOLD 1000 SOLVENT		BUNO/SERIAL NO. NA	A/C SEQ NO. NA
SHOP/SHOP REQ SER NO. 43460	REFERENCE(S) (a) NAVAIR 01-1A-503	COST REDUCTION POTENTIAL ☐ YES ☒ NO	

BACKGROUND

Soygold 1000 cleaning solvent has been identified as a possible alternative to MIL-PRF-680 products used for cleaning aeronautical bearings. The solvent has low VOC and HAP emission, which makes it attractive to activities, located in air pollution control districts where MIL-PRF-680 products are no longer compliant.

Naval Facilities Engineering Service Center (NFESC) has developed a Joint Test Protocol detailing the process through which the solvent will either be deemed acceptable for its intended use or non-viable. As the cognizant activity for Tri-Service Manual NAVAIR 01-1A-503, which directs inspection, maintenance and repair of aeronautical bearings, Naval Air Depot, North Island was selected as the site for performance testing of the solvent.

TEMPORARY INSTRUCTIONS

1. GENERAL

1.1 The subject solvent shall be used to clean and rinse representative samples of aeronautical bearings.

1.2 Only non-RFI bearings shall be used as test samples.

1.3 Test samples are not to be returned to service. At the conclusion of testing, samples shall be scrapped.

1.4 Record the results of visual inspection as either "pass" or "fail".

1.4.1 Samples that exhibit no degradation related to the process are considered passing.

1.4.2 Samples that exhibit degradation beyond that observed before processing are considered failing.

2. SAMPLE IDENTIFICATION

2.1 Bearings to be used as samples shall be provided by engineering.

2.1.1 Equal numbers of samples shall be drawn from Group A – propulsion, Group B – airframe, and Group – E rotating electrical bearings.

2.1.2 The Bearing Shop shall apply one of the eleven lubricants or preservatives (see Table 1) to two samples from each group.

2.1.3 A metal tag, stamped with a unique alpha-numeric identification, shall be attached to each sample with a retaining wire.

2.1.4 The unique identification shall be created from the letters and numbers in Table 1. The first letter identifies the group (A, B, or E), the number identifies the lubricant or preservative (1, 2, ...11), and the second letter identifies either prototype (X) or standard (Z) cleaning process.

ORIGINATOR/EXT	APPROVED	DATE	TEI NO.
Manny Goulart, x57690	Tim Woods	4/27/2006	NI MATL-008-05

NAVAVNDEPOT 5605/13 (9-97)

SHEET 1 OF 7

2.2 An example of the identification follows Table 1.

2.3 The "dirty" samples shall be held by engineering until pre-processing begins.

3. SAMPLE PREPARATION

3.1 Seventy-two samples will be required for testing. Each sample shall be assigned a unique identification number and catalogued in Table 1.

3.2 Sixty-six samples shall be prepared as specified in 3.2.1 through 3.2.4.

3.2.1 Clean samples per the applicable process specified in Chapter 5 of reference (a).

3.2.2 Visually inspect bearings for cleanliness and corrosion.

3.2.3 Samples shall be reprocessed until clean. Corroded samples shall be scrapped and replaced.

3.2.4 Lubricate two bearings from each group with each of the following lubricants or preservatives: Greases – MIL-PRF-81322, MIL-PRF-27617, MIL-PRF-23827, MIL-PRF-81827, MIL-PRF-18709, Nye Rheotemp 500; Oils – MIL-PRF-23699, MIL-PRF-6081, MIL-PRF-7808; Preservatives – MIL-PRF-32033, MIL-C-11796.

3.2.5 The remaining six samples shall maintained in their "used" condition.

3.2.6 Contact engineering before proceeding.

4. PHOTO-DOCUMENTATION

4.1 Pre-process documentation of sample condition shall be performed by Engineering.

4.2 Each sample shall be photographed. Particular attention shall be given to areas of corrosion or other conditions related to surface chemistry.

4.3 Photo-documentation shall be supplemented by written documentation where necessary.

5. PRE-PROCESSING

5.1 The thirty-six samples assigned an 'X' suffix shall be processed as follows.

5.1.1 Perform steps 1 (demagnetize), 2 (pre-clean) and 3 (degrease) of the current Solvent Based Cleaning Process, illustrated in Figure 5-6 of reference (a), on all samples. Processing shall be accomplished at the Bearing Shop, Building 35.

5.1.2 Follow the procedure for each step as specified in sections 5-37 and 5-38 of reference (a).

5.1.3 Allow parts to drain for a minimum of 30 minutes.

5.1.4 Place each sample in a zip-lock bag. Place all bagged samples in an accumulation container.

5.1.5 Notify engineering that samples are ready for pick-up.

6. PROTOTYPE RINSING PROCESS

6.1 Engineering shall be responsible for transferring test samples from the Bearing Shop to the location of the prototype rinse tank at the Materials Engineering Division.

6.2 The test samples shall be placed in a cleaning basket like that illustrated in Figure 1. Place only as many bearings in the basket as can be safely lifted by a single individual. Do not stack test samples.

6.2.1 Place one basket of samples on the agitation platform of the KT9000 Cleaning Tank (see Figure 2).

6.2.2 Immerse and agitate the samples in the Soygold 1000 solvent for 5 minutes.

6.2.3 Raise the samples to the freeboard area and allow them to drain for a minimum of 1 minute.

6.2.4 Examine the bearings for cleanliness.

6.2.5 If samples are still dirty, repeat 6.2.2 through 6.2.4. If samples are clean, proceed to the next step.

6.2.6 Allow the samples to drain for an additional 15 minutes.

6.2.7 Place each sample in a zip-lock bag. Place all bagged samples in an accumulation container.

6.3 Record the total time for agitation and draining (excluding drain time in 6.2.6) in Table 2 under "Soygold Process Time".

7. POST-PROCESSING STEPS

7.1 Following the processing of section 6, the samples shall be returned to the Bearing Shop.

7.2 Engineering shall be responsible for transferring test samples from the Materials Engineering Division to the Bearing Shop.

7.3 Perform steps 4(carbon remover), 5(hot water rinse), 6(water displacing oil) on sample A12X only. Perform steps 4, 5, 6, 7 (MIL-PRF-680 rinse) and 8 (IPA dry) of the current Solvent Based Cleaning Process, illustrated in Figure 5-6 of reference (a), on all remaining samples. Processing shall be accomplished at the Bearing Shop, Building 35.

7.3.1 Accumulate clean, dry samples in the Bearing Shop Clean Room, Building 35.

7.3.2 Clean, dry samples shall be visually inspected for any indication of process-induced corrosion and non-volatile residue.

7.3.3 Any visual indications of corrosion, staining, or non-volatile residue shall be reported to engineering. Hold all samples for engineering evaluation.

8. COMPARATIVE SAMPLES

8.1 The thirty-six samples assigned a 'Z' suffix shall be cleaned exactly as specified in Chapter 5 of reference (a). These samples will be compared with the prototype samples to determine relative effectiveness and efficiency of the modified process.

8.2 After cleaning, the samples shall be stored in the clean room for evaluation by Engineering.

9. DOCUMENTATION OF RESULTS

9.1 Representative samples of successful processing shall be photographed. Photographs shall be annotated to identify the sample.

10. THIS DIRECTIVE IS CANCELLED 120 DAYS AFTER RELEASE.

Table 1. Characters for Sample Identificaiton

Column 1 (Bearing Group)		Column 2 (Lubricant/Preservative Type)		Column 3	
				Prototype Sample	Standard Sample
GROUP A	A	MIL-PRF-81322	1	X	Z
GROUP B	B	MIL-PRF-27617	2		
GROUP E	E	MIL-PRF-23827	3		
		MIL-PRF-81827	4		
		MIL-PRF-18709	5		
		Nye Rheotemp 500	6		
		MIL-PRF-23699	7		
		MIL-PRF-6081	8		
		MIL-PRF-7808	9		
		MIL-PRF-32033	10		
		MIL-C-11796	11		
		Dirty [1]	12		

Example: Two bearings selected from Group A, lubricated with MIL-PRF-6081, will be designated A8X and A8Z, respectively.

[1] Two samples from each group will not be cleaned prior to testing and will be representative samples of bearings "from the field".

Table 2.

SAMPLE NO.	PART NO.	SAMPLE DESCRIPTION	LUBE/PRES	SOYGOLD PROCESS TIME	NOTES

ORIGINATOR/EXT	APPROVED	DATE	TEI NO.
M. GOULART	T. R. WOODS	4/27/2006	NI MATL-008-05

Table 2. (cont.)					
SAMPLE NO.	PART NO.	SAMPLE DESCRIPTION	LUBE/PRES	SOYGOLD PROCESS TIME	NOTES

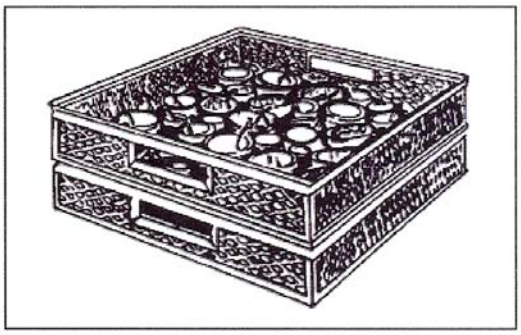


Figure 1. Cleaning Baskets

Figure 2. Cleaning Tank

ORIGINATOR/EXT	APPROVED	DATE	TEI NO.
Manny Goulart, X57690	Tim Woods	4/27/2006	NI MATL-008-05

Appendix C

Demonstration Bearings

Figure C-1
Bearing Identification A1X, Propulsion Bearing Group,
MIL-PRF-81322 Preservative/Lubricant, SG1000 Rinse

Figure C-2
Bearing Identification B1X, Airframe Bearing Group,
MIL-PRF-81322 Preservative/Lubricant, SG1000 Rinse

Figure C-3
Bearing Identification E1X, Electrical Bearing Group,
MIL-PRF-81322 Preservative/Lubricant, SG1000 Rinse

Figure C-4
Bearing Identification A1Z, Propulsion Bearing Group,
MIL-PRF-81322 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-5
Bearing Identification B1Z, Airframe Bearing Group,
MIL-PRF-81322 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-6
Bearing Identification E1Z, Electrical Bearing Group,
MIL-PRF-81322 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-7
Bearing Identification A2X, Propulsion Bearing Group,
MIL-PRF-27617 Preservative/Lubricant, SG1000 Rinse

Figure C-8
Bearing Identification B2X, Airframe Bearing Group,
MIL-PRF-27617 Preservative/Lubricant, SG1000 Rinse

Figure C-9
Bearing Identification E2X, Electrical Bearing Group,
MIL-PRF-27617 Preservative/Lubricant, SG1000 Rinse

Figure C-10
Bearing Identification A2Z, Propulsion Bearing Group,
MIL-PRF-27617 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-11
Bearing Identification B2Z, Airframe Bearing Group,
MIL-PRF-27617 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-12
Bearing Identification E2Z, Electrical Bearing Group,
MIL-PRF-27617 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-13
Bearing Identification A3X, Propulsion Bearing Group,
MIL-PRF-23827 Preservative/Lubricant, SG1000 Rinse

Figure C-14
Bearing Identification B3X, Airframe Bearing Group,
MIL-PRF-23827 Preservative/Lubricant, SG1000 Rinse

Figure C-15
Bearing Identification E3X, Electrical Bearing Group,
MIL-PRF-23827 Preservative/Lubricant, SG1000 Rinse

Figure C-16
Bearing Identification A3Z, Propulsion Bearing Group,
MIL-PRF-23827 Preservative/Lubricant, MIL-PRF-680 Rinse

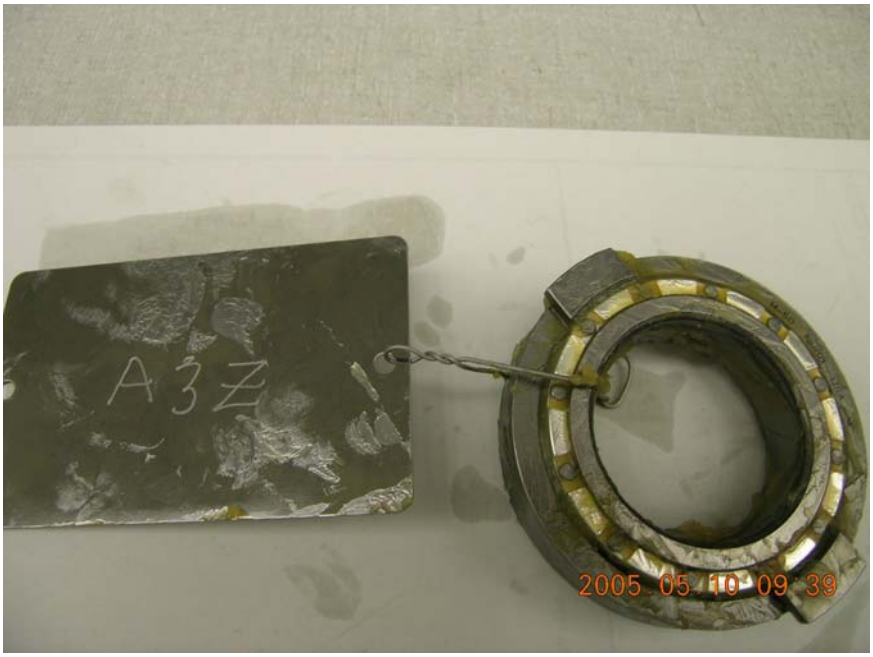


Figure C-17
Bearing Identification B3Z, Airframe Bearing Group,
MIL-PRF-23827 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-18
Bearing Identification E3Z, Electrical Bearing Group,
MIL-PRF-23827 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-19
Bearing Identification A4X, B4X, and E4X, Propulsion, Airframe, and Electrical Bearing Groups, MIL-PRF-81827 Preservative/Lubricant, A9X, B9X, and E9X, Propulsion, Airframe, and Electrical Bearing Groups, MIL-PRF-7808 Preservative/Lubricant, SG1000 Rinse

Figure C-20
Bearing Identification A4Z, B4Z, and E4Z, Propulsion, Airframe, and Electrical Bearing Groups, MIL-PRF-81827 Preservative/Lubricant, A9Z, B9Z, and E9Z Propulsion, Airframe, and Electrical Bearing Groups, MIL-PRF-7808 Preservative/Lubricant MIL-PRF-680 Rinse

Figure C-21
Bearing Identification A6X, Propulsion Bearing Group,
Rheotemp 500 Preservative/Lubricant, SG1000 Rinse

Figure C-22
Bearing Identification B6X, Airframe Bearing Group,
Rheotemp 500 Preservative/Lubricant, SG1000 Rinse

Figure C-23
Bearing Identification E6X, Electrical Bearing Group,
Rheotemp 500 Preservative/Lubricant, SG1000 Rinse

Figure C-24
Bearing Identification A6Z, Propulsion Bearing Group,
Rheotemp 500 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-25
Bearing Identification B6Z, Airframe Bearing Group,
Rheotemp 500 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-26
Bearing Identification E6Z, Electrical Bearing Group,
Rheotemp 500 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-27
Bearing Identification A7X, Propulsion Bearing Group,
MIL-PRF-23699 Preservative/Lubricant, SG1000 Rinse

Figure C-28
Bearing Identification B7X, Airframe Bearing Group,
MIL-PRF-23699 Preservative/Lubricant, SG1000 Rinse

Figure C-29
Bearing Identification E7X, Electrical Bearing Group,
MIL-PRF-23699 Preservative/Lubricant, SG1000 Rinse

Figure C-30
Bearing Identification A7Z, Propulsion Bearing Group,
MIL-PRF-23699 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-31
Bearing Identification B7Z, Airframe Bearing Group,
MIL-PRF-23699 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-32
Bearing Identification E7Z, Electrical Bearing Group,
MIL-PRF-23699 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-33
Bearing Identification A8X, Propulsion Bearing Group,
MIL-PRF-6081 Preservative/Lubricant, SG1000 Rinse

Figure C-34
Bearing Identification B8X, Airframe Bearing Group,
MIL-PRF-6081 Preservative/Lubricant, SG1000 Rinse

Figure C-35
Bearing Identification E8X, Electrical Bearing Group,
MIL-PRF-6081 Preservative/Lubricant, SG1000 Rinse

Figure C-36
Bearing Identification A8Z, Propulsion Bearing Group,
MIL-PRF-6081 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-37
Bearing Identification B8Z, Airframe Bearing Group,
MIL-PRF-6081 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-38
Bearing Identification E8Z, Electrical Bearing Group,
MIL-PRF-6081 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-39
Bearing Identification A10X, Propulsion Bearing Group,
MIL-PRF-32033 Preservative/Lubricant, SG1000 Rinse

Figure C-40
Bearing Identification B10X, Airframe Bearing Group,
MIL-PRF-32033 Preservative/Lubricant, SG1000 Rinse

Figure C-41
Bearing Identification E10X, Electrical Bearing Group,
MIL-PRF-32033 Preservative/Lubricant, SG1000 Rinse

Figure C-42
Bearing Identification A10Z, Propulsion Bearing Group,
MIL-PRF-32033 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-43
Bearing Identification B10Z, Airframe Bearing Group,
MIL-PRF-32033 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-44
Bearing Identification E10Z, Electrical Bearing Group,
MIL-PRF-32033 Preservative/Lubricant, MIL-PRF-680 Rinse

Figure C-45
Bearing Identification A12X, Propulsion Bearing Group,
Dirty From Field, SG1000 Rinse

Figure C-46
Bearing Identification B12X, Airframe Bearing Group,
Dirty From Field, SG1000 Rinse

Figure C-47
Bearing Identification E12X, Electrical Bearing Group,
Dirty From Field, SG1000 Rinse

Figure C-48
Bearing Identification A12Z, Propulsion Bearing Group,
Dirty From Field, MIL-PRF-680 Rinse

Figure C-49
Bearing Identification B12Z, Airframe Bearing Group,
Dirty From Field, MIL-PRF-680 Rinse

Figure C-50
Bearing Identification E12Z, Electrical Bearing Group,
Dirty From Field, MIL-PRF-680 Rinse

Appendix D

Bearing Cleaning Process Equipment

Figure D-1
NADEP North Island Bearing Cleaning Line, (Demonstration)
“New Bearings”

Figure D-2
NADEP North Island Bearing Cleaning Line, (Demonstration)
“Used Bearings”

Figure D-3
Stage 1, Bearing Cleaning Process, (Demonstration)
Demagnetizer

Figure D-4
Stage 2, Bearing Cleaning Process, (Demonstration)
Pre-clean (Hot 1010 Oil) Parts Washer

Figure D-5
Stage 3, Bearing Cleaning Process, (Demonstration)
Degrease (Xxcel XLS52) Parts Washer

Figure D-6
Stage 4, Bearing Cleaning Process, (Demonstration)
Carbon Remover Parts Washer
"Used Bearings" Returned from Field Only

Figure D-7
Stage 5, Bearing Cleaning Process, (Demonstration)
Hot Water Rinse Immersion Tank
"Used Bearings" Returned from Field Only

Figure D-8
Stage 6, Bearing Cleaning Process, (Demonstration)
Water Displacing Oil Immersion Tank
"Used Bearings" Returned from Field Only

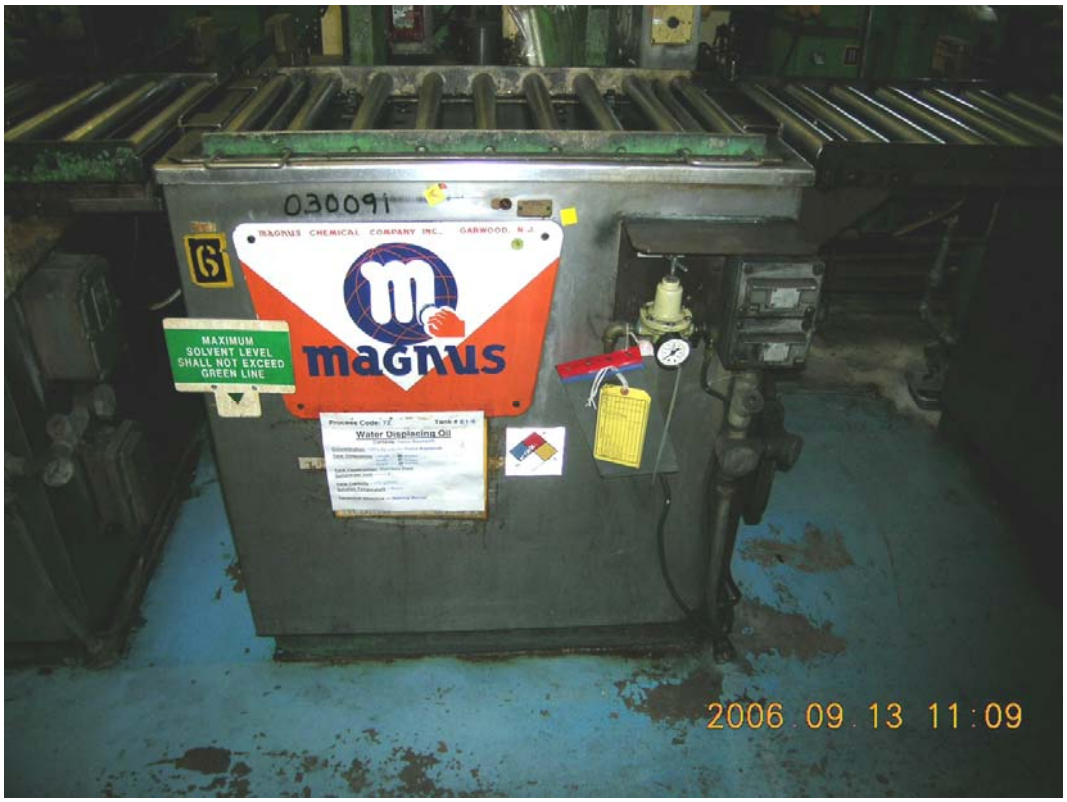


Figure D-9
Stage 7A, Bearing Cleaning Process, (Demonstration)
MIL-PRF-680 Standard Cleaning Solvent Parts Washer

Figure D-10
Stage 7B, Bearing Cleaning Process, (Demonstration)
MIL-PRF-680 Standard Cleaning Solvent Parts Washer

Figure D-11
Stage 7C, Bearing Cleaning Process, (Demonstration)
MIL-PRF-680 Standard Cleaning Solvent Parts Washer

Figure D-12
Stages 7A, -B, -C, Bearing Cleaning Process, (Demonstration)
SG1000 Alternative Cleaning Solvent Parts Washer

Figure D-13
Stage 8, Bearing Cleaning Process, (Demonstration)
Vapor Isopropyl Alcohol Rinse

Figure D-14
Stage 9, Bearing Cleaning Process, (Demonstration)
Physical Inspection of Cleaned Bearings

Appendix E

North Island Naval Aviation Depot
Materials Engineering Laboratory
SG1000 Test Report (BR-0025-05)

MATERIALS ENGINEERING LABORATORY
NAVAL AIR DEPOT NORTH ISLAND
P O BOX 357058
SAN DIEGO, CALIFORNIA 92135-7058

TEST REPORT

REQUESTER Brad Hollan, NFESC, 805-982-1320	RECEIPT DATE 3/11/2004
CONTROL NUMBER N6921804WR00054	REPORT DATE 1/19/2006
REFERENCE a) ESTCP Demonstration Plan b) NAVAIR 01-1A-503	REPORT NUMBER BR-0028-05
SAMPLE IDENTIFICATION (Nomenclature, Part Number, Serial Number) Methyl Soyate cleaning solvent	
PARENT EQUIPMENT (Aircraft/Engine Model No., BUNO) Cleaning process equipment in NADEP NI Bearing Shop, Bldg 35, Code 93601	

Background:
The purpose of this report is to list and support the findings of the NAVAIR Depot North Island Materials Engineering Lab, Bearings Group after completion of the testing described in Ref (a), the "Demonstration Plan for Alternatives to High Volatile Organic Compund Solvents Used in Aeronautical Antifriction Bearing Cleaning," as provided by the Environmental Security Technology Certification Program at the Naval Facilities Engineering Service Center in Port Hueneme, CA. The objective of this testing was to evaluate the possible use of environmentally friendly "SoyGold 1000" brand Methyl Soyate as an alternative to MIL-PRF-680 (Stoddard) cleaning solvents during bearing processing. The NAVAIR Depot, North Island was selected to perform the testing as the cognizant activity managing Ref (b), the Tri-Service Manual NAVAIR 01-1A-503. Section V of this manual describes the processes and solvents to be used in cleaning aeronautical antifriction bearings.

Test Plan:
Methyl Soyate is proposed as a "drop-in" replacement for MIL-PRF-680 in cleaning processes. This demonstration closely models the procedure illustrated in Ref (a), Figure 5-6. A total of 72 total bearings will be processed. The bearings will be equally divided among three of the five bearing groups, propulsion (Group A), airframe (Group B), and electrical (Group E). Two clean bearings from each group will have one of eleven lubricants or preservatives applied, resulting in 66 samples. The remaining six samples will be comprised of two bearings from each group in the "used" condition, as received directly from the field . This will result in 36 duplicate pairs of samples. One sample from each duplicate pair will be processed in either the standard (Z) or prototype (X) process. An example showing each type of bearing, with grease applied and tagged for indentification is shown in Encl 1, Image 1. See Encl 2, Results Table for the specific lubricants.

All bearings will be processed as illustrated in Encl 3, Process flow chart. The bearing will first pass through a demagnetizing coil, then be pre-cleaned in hot 1010 oil, and degreased in XXcel XLS-52. All parts will go through these steps as they will remain part of any new process. A selection of "dirty" bearings from the field will additionally go through carbon remover, a rust inhibiting hot water rinse, and water displacing oil before rejoining the rest of the samples.

ORIGINATOR Bennett Dahlin, 4.9.7.6.0, 619-767-1170	APPROVING OFFICIAL Penelope Ulander, 4.9.7.0.0, 619-545-9733

NI MATLAB AP-008-A (12/01)

The soy solvent and standard process samples diverge at this point. A series of three rinse tanks, which are progressively cleaner with respect to contaminants currently use MIL-PRF-680 qualified solvent. All the tanks in the process are air agitated tanks similar to the one shown in Encl 1, Image 2. Half of the bearings will go through these standard rinse tanks, while the other half will be processed in a segragated tank filled with clean SoyGold 1000 brand Methyl Soyate. This tank is equipped with a filtering system which will be run during processing to keep the methyl soyate solvent as clean as reasonably possible. This system is shown in Encl 3, Images 3 and 4.

All parts will then be dried in a vapor isopropyl alcohol dryer, and then transferred to the North Island Bearing Shop cleanroom for inspection (see Encl 3, Image 5) by the report originator, Materials Engineer Bennett Dahlin and Bearing Engineering Technician Teresa Durazo.

Test Plan Deviation:
The alcohol dryer, used as the final cleaning step to displace petroleum solvent, was inoperable with no ECD for repair. Lacking this machine and having some schedule constraints, the parties present for the inspection agreed to physically dip the parts in isopropyl alcohol and to air-dry any remaining alcohol with compressed air. Additionally, two lubricants were unavailable and omitted from testing.

Results:
Encl 2, Results Table lists the findings for each sample. They are arranged first by lubricant/contaminant, then by process used, then by bearing group. The parameters were prioritized in this way because, in general, all samples that went through the same process and were contaminated with the same lubricant appeared to be in the same final condition regardless of the type of bearing. The notes specify relative qualities observed by Materials Engineer Bennett Dahlin and Bearing Technician Teresa Durazo with respect to appearance and resistance to rotation for bearing inspection. Residual films and contaminants were not quantified as part of this testing. Quantitative testing of various solvent properties, including residual films, will be conducted at other facilities in accordance with the Joint Test Protocol. Photodocumentation of remaining films and residues could not be accomplished because of lighting "hot spots" created by the highly polished, reflective curved surfaces of the bearings.

Conclusions:
The AG Products SoyGold 1000 solvent does meet the minimum requirements to be used as an acceptable replacement for MIL-PRF-680 as a rinse agent in bearing cleaning processes. While it is acceptable, there are two areas where this product could use improvement. First, a slight film of solvent is left behind on the bearings despite a final rinse with isopropyl alcohol. The film is light enough not to affect most inspections, and can be easily wiped off manually if necessary. However, if enough soy solvent adheres after the parts are allowed to drain and after an alcohol rinse, additional processing time and/or steps may be required. Additionally, there may be associated environmental and cost effects resulting from an increased waste stream from the alcohol rinse equipment. Also, because of the failure of the vapor alcohol dryer, a physical dip was used. Lubricants 4 and 9 did not leave a noticable residue, however it is suspected that this is because the samples may have been somewhat agitated during the alcohol dip, not because of a difference in true process effects with those lubricants. A proper vapor drying step would likely leave a noticable film, but slightly less than that seen on the rest of the samples that were more gently dipped in alcohol as the heat of the vapor process improves rinsing while lack of agitation reduces rinsing.
The second drawback is the reduced efficiency of the methyl soyate relative to MIL-PRF-680 products. Small amounts of grease that remain in crevices and other difficult areas after conventional degreasing are usually removed by the first of the three MIL-PRF-680 rinse steps, resulting in a cleaner part. An increase in the time parts spend in the degreaser or methyl soyate tank may help, however, this is a case of diminishing returns in the time required in the degreaser for the last bit of cleanliness.
There are several other commercial products worthy of evaluation and consideration that blend methyl soyate with ethyl lactate that claim to leave less of a film and act as a better degreaser than methyl soyate alone. These include STEPOSOL SC from the Stepan Company, or VertecBio Gold from Vertec Biosolvents.

Enclosure 1

Process Images:

Image 1: Example of greased bearings prior to processing.

Image 2: Typical agitated bearing cleaning tank.

Enclosure 1 continued:

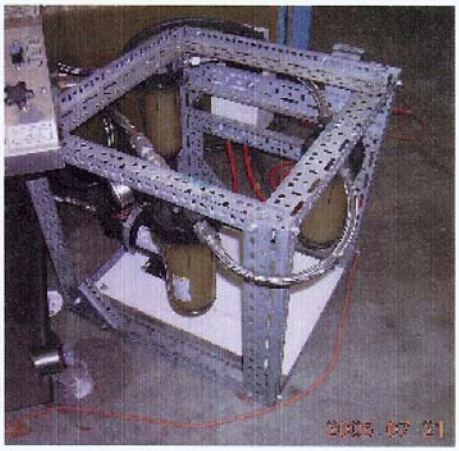


Image 3 & 4: SoyGold solvent tank and filtration system.

Image 5: Inspecting processed bearings.

Enclosure 2

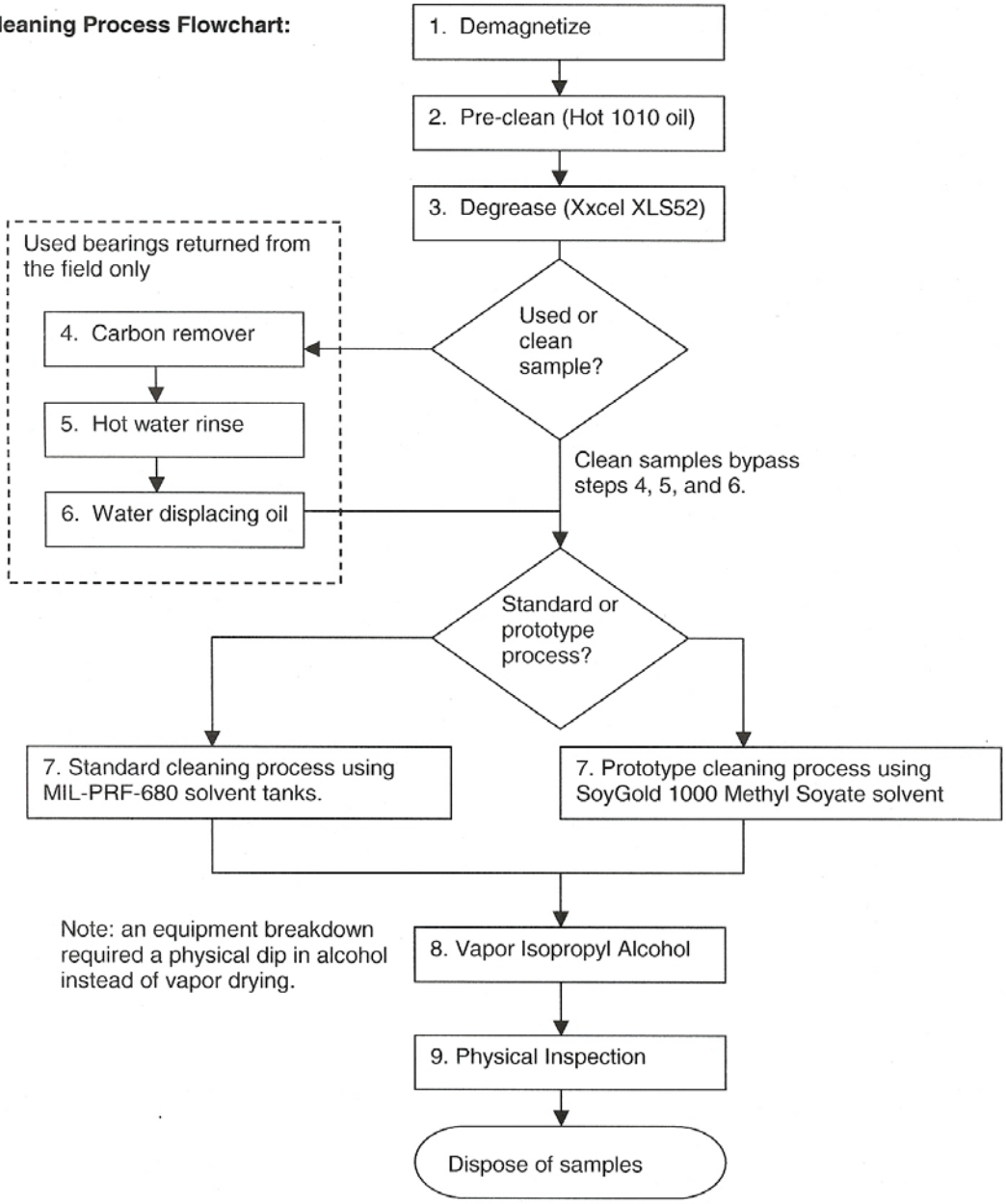
Results Table:

Sample ID	Group	Lube/Pres	Process	Notes
A1X	Propulsion	MIL-PRF-81322	Prototype	Minimal remaining grease, slight noticable film
B1X	Airframe	MIL-PRF-81322	Prototype	Minimal remaining grease, slight noticable film
E1X	Electrical	MIL-PRF-81322	Prototype	Minimal remaining grease, slight noticable film
A1Z	Propulsion	MIL-PRF-81322	Standard	Negligible remaining grease, no noticable film
B1Z	Airframe	MIL-PRF-81322	Standard	Negligible remaining grease, no noticable film
E1Z	Electrical	MIL-PRF-81322	Standard	Negligible remaining grease, no noticable film
A2X	Propulsion	MIL-PRF-27617	Prototype	Negligible remaining grease, slight noticable film
B2X	Airframe	MIL-PRF-27617	Prototype	Negligible remaining grease, slight noticable film
E2X	Electrical	MIL-PRF-27617	Prototype	Negligible remaining grease, slight noticable film
A2Z	Propulsion	MIL-PRF-27617	Standard	Negligible remaining grease, no noticable film
B2Z	Airframe	MIL-PRF-27617	Standard	Negligible remaining grease, no noticable film
E2Z	Electrical	MIL-PRF-27617	Standard	Negligible remaining grease, no noticable film
A3X	Propulsion	MIL-PRF-23827	Prototype	Minimal remaining grease, slight noticable film
B3X	Airframe	MIL-PRF-23827	Prototype	Minimal remaining grease, slight noticable film
E3X	Electrical	MIL-PRF-23827	Prototype	Minimal remaining grease, slight noticable film
A3Z	Propulsion	MIL-PRF-23827	Standard	Negligible remaining grease, no noticable film
B3Z	Airframe	MIL-PRF-23827	Standard	Negligible remaining grease, no noticable film
E3Z	Electrical	MIL-PRF-23827	Standard	Negligible remaining grease, no noticable film
A4X	Propulsion	MIL-PRF-81827	Prototype	Some residual grease & thickener, no noticable film
B4X	Airframe	MIL-PRF-81827	Prototype	Some residual grease & thickener, no noticable film
E4X	Electrical	MIL-PRF-81827	Prototype	Some residual grease & thickener, no noticable film
A4Z	Propulsion	MIL-PRF-81827	Standard	Some residual grease & thickener, no noticable film
B4Z	Airframe	MIL-PRF-81827	Standard	Some residual grease & thickener, no noticable film
E4Z	Electrical	MIL-PRF-81827	Standard	Some residual grease & thickener, no noticable film
A5X	Propulsion	MIL-PRF-18709	Prototype	Contaminant unavailable, not tested.
B5X	Airframe	MIL-PRF-18709	Prototype	Contaminant unavailable, not tested.
E5X	Electrical	MIL-PRF-18709	Prototype	Contaminant unavailable, not tested.
A5Z	Propulsion	MIL-PRF-18709	Standard	Contaminant unavailable, not tested.
B5Z	Airframe	MIL-PRF-18709	Standard	Contaminant unavailable, not tested.
E5Z	Electrical	MIL-PRF-18709	Standard	Contaminant unavailable, not tested.
A6X	Propulsion	Rheotemp 500	Prototype	Some residual grease, slight noticable film
B6X	Airframe	Rheotemp 500	Prototype	Some residual grease, slight noticable film
E6X	Electrical	Rheotemp 500	Prototype	Some residual grease, slight noticable film
A6Z	Propulsion	Rheotemp 500	Standard	Slight residual grease, no noticable film
B6Z	Airframe	Rheotemp 500	Standard	Slight residual grease, no noticable film
E6Z	Electrical	Rheotemp 500	Standard	Slight residual grease, no noticable film
A7X	Propulsion	MIL-PRF-23699	Prototype	No residual oil, slight noticable film
B7X	Airframe	MIL-PRF-23699	Prototype	No residual oil, slight noticable film
E7X	Electrical	MIL-PRF-23699	Prototype	No residual oil, slight noticable film
A7Z	Propulsion	MIL-PRF-23699	Standard	No residual oil, no noticable film
B7Z	Airframe	MIL-PRF-23699	Standard	No residual oil, no noticable film
E7Z	Electrical	MIL-PRF-23699	Standard	No residual oil, no noticable film

Sample ID	Group	Lube/Pres	Process	Notes
A8X	Propulsion	MIL-PRF-6081	Prototype	No residual oil, slight noticable film
B8X	Airframe	MIL-PRF-6081	Prototype	No residual oil, slight noticable film
E8X	Electrical	MIL-PRF-6081	Prototype	No residual oil, slight noticable film
A8Z	Propulsion	MIL-PRF-6081	Standard	No residual oil, no noticable film
B8Z	Airframe	MIL-PRF-6081	Standard	No residual oil, no noticable film
E8Z	Electrical	MIL-PRF-6081	Standard	No residual oil, no noticable film
A9X	Propulsion	MIL-PRF-7808	Prototype	No residual oil, no noticable film
B9X	Airframe	MIL-PRF-7808	Prototype	No residual oil, no noticable film
E9X	Electrical	MIL-PRF-7808	Prototype	No residual oil, no noticable film
A9Z	Propulsion	MIL-PRF-7808	Standard	No residual oil, no noticable film
B9Z	Airframe	MIL-PRF-7808	Standard	No residual oil, no noticable film
E9Z	Electrical	MIL-PRF-7808	Standard	No residual oil, no noticable film
A10X	Propulsion	MIL-PRF-32033	Prototype	No residual oil, slight noticable film
B10X	Airframe	MIL-PRF-32033	Prototype	No residual oil, slight noticable film
E10X	Electrical	MIL-PRF-32033	Prototype	No residual oil, slight noticable film
A10Z	Propulsion	MIL-PRF-32033	Standard	No residual oil, no noticable film
B10Z	Airframe	MIL-PRF-32033	Standard	No residual oil, no noticable film
E10Z	Electrical	MIL-PRF-32033	Standard	No residual oil, no noticable film
A11X	Propulsion	MIL-C-11796	Prototype	Contaminant unavailable, not tested.
B11X	Airframe	MIL-C-11796	Prototype	Contaminant unavailable, not tested.
E11X	Electrical	MIL-C-11796	Prototype	Contaminant unavailable, not tested.
A11Z	Propulsion	MIL-C-11796	Standard	Contaminant unavailable, not tested.
B11Z	Airframe	MIL-C-11796	Standard	Contaminant unavailable, not tested.
E11Z	Electrical	MIL-C-11796	Standard	Contaminant unavailable, not tested.
A12X	Propulsion	Dirty from field	Prototype	No residual contaminants, slight noticable film
B12X	Airframe	Dirty from field	Prototype	No residual contaminants, slight noticable film
E12X	Electrical	Dirty from field	Prototype	No residual contaminants, slight noticable film
A12Z	Propulsion	Dirty from field	Standard	No residual contaminants, no noticable film
B12Z	Airframe	Dirty from field	Standard	No residual contaminants, no noticable film
E12Z	Electrical	Dirty from field	Standard	No residual contaminants, no noticable film

Enclosure 3

Cleaning Process Flowchart:



Appendix F

NEHC
Administrative Health Hazard Assessment of
SG1000

DEPARTMENT OF THE NAVY
NAVY ENVIRONMENTAL HEALTH CENTER
620 JOHN PAUL JONES CIRCLE SUITE 1100
PORTSMOUTH VA 23708-2103

6262
Ser IH9/ 000959
16 MAY 2005

From: Commanding Officer, Navy Environmental Health Center
To: Commanding Officer, Naval Facilities Engineering Service Center, (ATTN: Code 421/Mr. B. Hollan), 1100 23rd Avenue, Port Hueneme, CA 93043-4370

Subj: ADMINISTRATIVE HEALTH HAZARD ASSESSMENT: SOYGOLD® 1000 SOLVENT, MANUFACTURED BY AG ENVIRONMENTAL PRODUCTS, L.L.C.

Ref: (a) PHONCON NAVENVIRHLTHCEN M. Swartout/NFESC B. Hollan of 4 Apr 05
(b) NAVENVIRHLTHCEN INSTRUCTION 6270.8
(c) Soygold® 1000 Solvent Material Safety Data Sheet of 22 Mar 04
(d) International Agency for Research on Cancer Monographs (IARC)
(e) 29 CFR 1910.1000 Subpart Z-Occupational Safety and Health Administration (OSHA) Toxic and Hazardous Substances
(f) National Toxicology Program (NTP) Report on Carcinogens, Eleventh Edition, 2005
(g) ANSI Z87.1-2003: Personal Eye and Face Protection Devices
(h) ANSI Z358.1-2004: Standard for Emergency Eyewash and Shower Equipment
(i) OPNAVINST 5100.23F
(j) OPNAVISNT 5100.19D
(k) 29 CFR 1910.1200, "Hazard Communication Standard"

1. As indicated in references (a) and (b), this letter serves as an administrative health hazard assessment for a product referred to as Soygold® 1000 Solvent. References (b) – (k) are cited, along with peer-reviewed data sources, to verify the information provided in the manufacturer's material safety data sheet (MSDS).

2. The management and control techniques outlined in paragraphs (3) – (7) are essential to the safe and healthful use of Soygold® 1000 Solvent. Management and control techniques should be focused on eye, skin, and inhalation exposure scenarios. The order of listing for routes of exposure is not an indication of relative importance.

3. According to the manufacturer's MSDS, Soygold® 1000 Solvent may produce transient eye irritation. Users of Soygold® 1000 Solvent should wear chemical workers' goggles that meet the criteria delineated in reference (g). An eyewash/deluge shower that meets the design and installation criteria in reference (h) should be provided. If the Soygold® 1000 Solvent comes into contact with the eyes, the globe of each eye should be flushed with water for at least 15 minutes. The eyelids should be everted to ensure the entire surface area of each globe is adequately irrigated. Immediate medical attention should be sought if eye irritation develops.

4. The manufacturer's MSDS indicates Soygold® 1000 may cause mild skin irritation. To avoid skin contact, users should wear impervious gloves and consult the cognizant Navy industrial hygienist regarding their selection. In the event of skin contamination, a solution using mild non-germicidal soap can be used to wash skin surfaces.

5. At ambient temperatures Soygold® 1000 Solvent has a relatively low vapor pressure (1.8 millimeters of mercury at 68° Fahrenheit) corresponding to its high boiling point (632° Fahrenheit). Soygold® 1000 Solvent is not recommended for use under conditions that could increase vapor concentrations through elevated pressures or temperatures.

6. No specific air exposure levels have yet been developed for the product by regulatory agencies. In their absence the permissible exposure limit (PEL) of 5 milligrams of oil mist (mineral) per cubic meter of air should be referenced. Thus, a National Institute for Safety and Health (NIOSH) certified respirator equipped with oil mist (P series) filters may be considered. Per Chapter 15 of reference (i), all personnel requiring respiratory protection must be included in the command respirator program.

7. Soygold® 1000 Solvent is classified as an ester consisting of a series of long chained fatty acids. Ingestion of quantities less than one teaspoon would not be expected to necessitate hospital referral or further medical intervention.

8. Personnel using the Soygold® 1000 Solvent should be given basic and at least annual refresher training as described in references (i) and (k). This training should include a discussion of the possible health hazards and their recognition, the symptoms of overexposure, first aid, and the personal protective equipment (PPE).

9. The recommendations contained in this letter are not a substitute for a detailed evaluation by the cognizant Navy industrial hygienist. The effectiveness of control measures provided in paragraphs (3) – (7) should be verified through air sampling or other surveillance techniques. Medical department representatives should become familiar with health and safety issues pertaining to the Soygold® 1000 Solvent.

10. This administrative health hazard assessment did not address the possible use of the Soygold® 1000 Solvent aboard submarines. Please contact Mr. Rich Hagar, NAVSEA 05Z93, at 202-781-3628 for procedures pertaining to a submarine materials review. If you require additional information, please call Mr. Mike Swartout, Acquisition Technical Support

Subj: ADMINISTRATIVE HEALTH HAZARD ASSESSMENT:
SOYGOLD® 1000 SOLVENT, MANUFACTURED BY AG ENVIRONMENTAL PRODUCTS, L.L.C.

Department, Industrial Hygiene Directorate, by telephone at DSN: 377-0745 or commercial 757-953-0745. He can be reached by FAX at 757-953-0689 or by e-mail at swartoutm@nehc.med.navy.mil.

M. A. Miller

M.A. MILLER
By direction

Copy to:
BUMED (M3F4)