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REVIEW OF CANDIDATE REPLACEMENTS FOR MIL-C-372C, (CLEANING COMPOUND, SOLVENT FOR BORE OF SMALL ARMS AND AUTOMATIC AIRCRAFT WEAPONS)

INTERIM REPORT
TFLRF No. 314

By
B.R. Wright and G.L. Phillips
U.S. Army TARDEC Fuels and Lubricants Research Facility (SwRI)
Southwest Research Institute
San Antonio, Texas

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Warren, Michigan

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Wright, Bernard R. and Phillips, Gregory L.

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U.S. Army TARDEC Fuels and Lubricants Research Facility (SwRI)
Southwest Research Institute
P.O. Drawer 28510
San Antonio, Texas 78228-0510

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U.S. Army TACOM
TARDEC Petroleum and Water Business Area
Warren, Michigan 48397-5000

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8000 Jefferson Davis Highway
Richmond, Virginia 23297-5678

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Recent Environmental Protection Agency (EPA) mandates stipulate that products procured for Department of Defense utilization by the Defense Supply Center Richmond (DSCR) will be free of toxic and hazardous components. As a result of these mandates, studies were begun on MIL-C-372C (Cleaning Compound, Solvent for Bore of Small Arms and Automatic Aircraft Weapons). This work was conducted as part of DSCR's Hazardous Materials Minimization Program. This report summarizes the findings for replacement and field evaluation of candidate replacements.

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EXECUTIVE SUMMARY

Problems and Objectives: The currently used MIL-C-372C (Cleaning Compound, Solvent for Bore of Small Arms and Automatic Aircraft Weapons) contains chemicals currently listed on the Environmental Protection Agency's (EPA) Toxic and Hazardous Materials listing. The objective of this program was to identify solvents to replace the toxic and hazardous components or to identify other bore solvents formulated without any toxic or hazardous components.

Importance of Project: This project is extremely important because personnel in charge of weapons cleaning come in constant contact with the solvents, either through inhalation or dermal contact. Even though total body protection could be employed, it is extremely inconvenient, especially under field conditions.

Technical Approach: This program was approached in three separate phases:

Phase I - Conduct survey among bore solvent users to determine the solvents currently in use.

Phase II - Conduct survey of bore solvent suppliers to determine availability of solvents that are environmentally safe.

Phase III - Evaluate candidate solvents for user acceptability and performance.

Accomplishments: Commercially available solvents to replace MIL-C-372C exist that are environmentally acceptable and user friendly. Indeed, one solvent found and tested on hundreds of weapons contained a lubricant and preservative as well as bore cleaner.

Military Impact: Solvents are available that reduce the logistics of requiring a solvent cleaner and preservative. In addition to reducing the logistics burden, testing indicated that this solvent was user friendly and effective.

FOREWORD/ACKNOWLEDGMENTS

This work was performed by the U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC) Fuels and Lubricants Research Facility (TFLRF) located at Southwest Research Institute (SwRI), San Antonio, TX, during the period July 1992 through September 1995 under Contract No. DAAK70-92-C-0059. The work was funded by the Defense Supply Center Richmond through the U.S. Army TARDEC, Petroleum and Water Business Area, Warren, Michigan, with Messrs. T.C. Bowen (AMSTA-RBFF) and Luis Villahermosa (AMSTA TR-R/210) serving as contracting officer's representatives. Mr. T. Bagwell (AMSTA TR-R/210) of TARDEC's Petroleum and Water Business Area served as project technical monitor.

The authors would like to acknowledge TSGT Starks, SSGT Palma, and SSGT Ford of the 343rd Training Squadron and Messrs. Martinez and Delegado of the 76th Support Squadron for their assistance and cooperation throughout this program. Special thanks are given to the TFLRF reports processing staff for typing and editorial assistance.

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I. INTRODUCTION

Due to more stringent Environmental Protection Agency (EPA) regulations, the Defense Supply Center Richmond (DSCR) began an investigation for a possible non-toxic, non-hazardous replacement of the MIL-C-372C (1)* (Cleaning Compound, Solvent for Bore of Small Arms and Automatic Aircraft Weapons). This investigation was started as part of the DSCR's Hazardous Materials Minimization Program, and performance was tasked to the U.S. Army TARDEC Fuels and Lubricants Research Facility (TFLRF) located at Southwest Research Institute, San Antonio, TX.

II. OBJECTIVES

The objectives of this program were to 1) conduct a survey of bore solvent users to determine the requirements for an ideal weapons cleaner, 2) solicit the commercial industry for a non-toxic, non-hazardous replacement for the MIL-C-372C bore solvent cleaner, and 3) evaluate any possible candidate replacement cleaners in field testing.

III. APPROACH

TFLRF developed a questionnaire soliciting comments and suggestions for the development of a non-hazardous weapons cleaning solvent. This questionnaire was disseminated among military installations in the continental United States. The responses were summarized and the results used in the selection process of the candidate bore cleaners.

An advertisement was placed in the Commerce Business Daily by the U.S. Army Mobility Technology Center-Belvoir (MTCB), Ft. Belvoir, VA, to solicit possible replacement bore cleaners for MIL-C-372C from the commercial industry. The advertisement requested that all candidate cleaners submitted be non-toxic and non-hazardous.

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* Underscored numbers in parentheses refer to the list of references at the end of this report.

TFLRF staff members either met with weapons cleaning personnel or contacted persons affiliated with weapons cleaning at various military installations in the San Antonio and surrounding area. A list of contacts is shown in TABLE 1. All agencies visited were given a copy of the bore cleaner survey and asked to complete the survey as time permitted and then return it to TFLRF.

TABLE 1. Personnel Contacted

Name	Office
Jerry D. Rogers	Chief, Maintenance Division DOL Maintenance Ft. Sam Houston, TX
Ms. Yvette E. Arguijo Mr. Ralph Rogers	Environmental Protection Specialist San Antonio Air Logistics Center Environmental Management Office Kelly Air Force Base, TX
SMSGT Bailey MSGT Pelky	343rd Training Squadron 431 E. Bay Armory Medina Base Annex, TX
Mr. Martinez Mr. Delegado	76th Support Squadron Combat Arms Training and Maintenance Facility Kelly Air Force Base, TX
MSGT Michael Taft	149th Air National Guard Operations Support Supervisor Armament Shop Kelly Air Force Base, TX
CAPT Barnes	Commander, E Co. Weapons Area Camp Bullis, TX
Mr. Stinson	Weapons Area Camp Stanley, TX
Mr. Tom Kirschmer	Lackland Gunsmith Shop Medina Base Annex, TX

A. Details of Product Search

Three companies responded to the advertisement in the Commerce Business Daily: Break-Free CLP, JW Master Bore Cleaner, and Klear Shot lead and powder remover. Because of the chemical contents of the JW Master Bore Cleaner and the Klear Shot lead and powder remover, it was decided not to test them. The JW Master Bore Cleaner required that the cleaner be removed from all surfaces and a lubricant applied. It was also incompatible with plastics, which many weapons contain. The Material Safety Data Sheet (MSDS) for the Klear Shot lead and powder remover states under Item G ("Health Hazard Data") that the cleaner not be sprayed or atomized. Spraying is considered to be the primary method of application by all of the units TFLRF visited or contacted. TFLRF also tested the Klear Shot lead and powder remover for corrosive contents utilizing the ASTM D 130 (2) copper strip corrosion test. The copper strip, once tested, was then rated using an ASTM comparison chart. The Klear Shot lead and powder remover has a 4A rating. According to ASTM, this rating indicates a failure, and the fluid tested is considered corrosive.

B. Field Demonstration

Two units from the list of contacts shown in TABLE 1 were chosen as ideal for conducting bore cleaner evaluations. Those units are the 76th Support Squadron at Kelly Air Force Base (AFB) and the 343rd Training Squadron at Medina Base Annex. The units were contacted and asked if they would assist in evaluating bore cleaners. Both units cleaned large quantities of standard issue military weapons such as the M-16 rifle, M-203 grenade launcher, M-60 machine gun, and the 9-mm Beretta pistol.

The manufacturers that responded to the advertisement in the Commerce Business Daily were asked to submit any environmental or health information, such as the MSDS, to be approved by the environmental offices at Kelly AFB and Lackland AFB. Once approval was given, the manufacturers were asked to send a pre-determined amount of bore cleaner for testing. The cleaner was taken to the 76th Support Squadron and the 343rd Training Squadron so testing could begin. Side-by-side testing was conducted by using the current weapons cleaner on one-half of the weapons and the candidate cleaner on the other half. A modified questionnaire was developed to compare a specific candidate bore cleaner to the current weapons cleaner. The weapons inspectors were instructed to

complete the questionnaires as time permitted. A storage test was conducted at the 343rd Training Squadron Armory. Two racks of M-16 rifles, 20 rifles per rack, were used in the storage tests. One rack (#113) was cleaned with the current weapons cleaner (Brownell's D-Solve) and a Lubricant, Solvent, Additive (LSA) applied. The other rack (#114) was cleaned with Break Free Cleaner, Lubricant, Preservative (CLP-E). No additional lubricant was needed as the Break Free CLP-E has a lubricant in its formula. Both racks were then set aside for periodic monitoring and evaluation.

TFLRF staff visited both the 76th Support Squadron and the 343rd Training Squadron on a monthly basis from May 1995 to September 1995 for monitoring purposes. The questionnaires were collected and the stored weapons inspected.

C. Survey Results

TFLRF, at the start of this program, disseminated a questionnaire to a variety of military installations in the United States. The purpose of this questionnaire was to solicit comments and suggestions for the development of a non-hazardous weapons cleaning solvent from a wide range of bore cleaning users in the military. The type of units solicited ranged from Research and Development to Division Ordnance (Marine). A summary of the responses collected is shown in the Appendix.

The surveys taken during the visits to military installations in the San Antonio and surrounding area indicated that most preferred a CLP (Cleaner, Lubricant, and Preservative) type bore cleaner. In one instance (i.e., the 149th Texas Air National Guard), a stronger bore cleaning solvent is necessary because of heavy carbon build-up in the M61A1 20-mm Gattling gun. The use of a multi-purpose, non-toxic, non-hazardous bore cleaner is preferred, however, for ease of procurement and use. Other comments made included 1) use throughout a wide temperature range, 2) off-the-shelf procurement (commercially available), 3) a wider range of use to reduce the number of bore cleaners in inventory, and 4) non-toxic and non-hazardous to make the use of the cleaner not only safer to the individual but easier to dispose of.

The results of the questionnaires taken from the 76th Support Squadron and the 343rd Training Squadron indicated that the candidate bore cleaner worked well and was easy to use because of its

single application to clean and lubricate. All users, however, complained of the candidate bore cleaner odor.

D. Stored Weapons Test Results

Two weapons (M-16's) per test rack were selected at random for evaluation. The weapon identification numbers were recorded to insure that the same weapon would not be inspected during the next monitoring visit. The weapons were inspected for overall lubrication and bore cleanliness. A bore cleaner patch was used on all selected weapons and the results noted. The two M-16 rifles selected from rack #113 (cleaned with Brownell's D-Solve, LSA applied after) showed signs of bore contamination during the first visit (approximately 30 days after the start of the storage test). The bore patches from both M-16's had a visible indication of rust. The lubrication (LSA) that was applied after cleaning was still noticeable on the exterior of the weapon. Inspection of the internal components indicated that the lubricant (LSA), although still visible on some components, had a tendency to run and puddle when the weapon was stored in an upright (vertical) position. This was not seen in the weapons cleaned with the CLP-E. The two M-16's selected from rack #114 (cleaned with Break Free CLP-E) had no visible bore contamination but did have noticeable carbon on the bore cleaner patches. Lubrication was visible on the majority of the weapon, both internally and externally.

IV. DISCUSSION OF RESULTS

The results of the questionnaire and personal contact with users of the bore cleaning solvents indicated that there was no preferred solvent or method of application. In many cases, general solvents such as Dry Cleaning and Degreasing Solvent (PD-680) (3) and trichloroethane were used instead of a specification bore solvent. Also, there were several armories using a locally procured nonmilitary solvent such as Brownell's D-Solve. As a general rule, however, essentially all of the armories were receptive to evaluating a new solvent since there were shortcomings to all of the cleaning systems that were reported.

Another problem that developed during this program was obtaining the chemical composition of the solvent from the manufacturer. The response, quite often, was that this information was confidential or that the formula was sometimes slightly changed. Either answer is not acceptable if the chemical composition has to be approved by the on-base environmental office.

V. RECOMMENDATIONS

It is unclear at the moment whether MIL-C-372 specification can be modified to require the formulation to be free of hazardous or toxic chemicals. If this were possible, retaining this specification in the inventory may be worthwhile. However, if the specification cannot be modified, it would appear that the only option is to eliminate MIL-C-372 from procurement. If the specification is to be maintained, notice must be given to the supplier on the Qualified Product List that disclosure of the formulation is essential.

Based on discussions held with some users, a separate cleaner and lubricant is still desirable because of certain applications (i.e., dusty environment or the need for a heavier lubricant in the 20-mm Gattling gun and related applications). As a general rule, however, the cleaner, lubricant, preservative (CLP) was preferred to using two separate fluids.

VI. LIST OF REFERENCES

1. MIL-C-372C, Cleaning Compound, Solvent For Bore of Small Arms and Automatic Aircraft Weapons)

2. American Society for Testing and Materials Method D 130, "Standard Test Method for Detection of Copper Corrosion from Petroleum Products by the Copper Strip Tarnish Test," ASTM, 1916 Race Street, Philadelphia, PA, 1994.

3. PD-680, Dry Cleaning and Degreasing Solvent.

APPENDIX

Questionnaire for Development of a Non-Hazardous Weapons Cleaning Solvent

QUESTIONNAIRE FOR DEVELOPMENT OF A NON-HAZARDOUS WEAPONS CLEANING SOLVENT

1. DESCRIPTION OF USER, WEAPONS, AND CURRENT CLEANING PRODUCTS

What weapons do you use and clean?

M16A2	Rifles	M197	20 mm
M60	MG	M203	30 mm
M203	Grenade Launcher	M1911A1	Pistol

What type of facility (organization) do you represent?

R&D, Amphibian Assault, Reconnaissance Battalion, Division Ordnance (Marine), Configuration Management (Package & Surface Finish)

Please provide your name, title, address and phone number:

2. EVALUATION OF CURRENT WEAPONS CLEANERS

What are you currently using to clean weapons?

Safety-Kleen Mineral Spirits; Rifle Bore Cleaner (MIL-C-372); Armasol (Mini-Max); 1,1,1 Trichloroethane; MIL-L-63460 CLP (Cleaner, Lubricant, Preservative); CLP Breakfree; P-D-680

What problems have you experienced with your current weapon cleaner?
Irritates skin and respiratory, leaves residue, disposal problem, and carcinogenic.

What do you like about your current weapons cleaner?
Easy to use, excellent degreaser, powder solvent.

Do you have knowledge of corrosion caused by your current weapons cleaner? Discuss.
Armasol (Mini-Max) requires thorough lubrication after mini-max (pressure/steam) treatment.

3. REQUIREMENTS OF THE IDEAL WEAPONS CLEANER

What is important in a weapons cleaner?

Noncorrosive, nontoxic, high flashpoint, good degreaser, lubricant, cost, availability, and easy removal of excess.

What are the most difficult challenges for a weapons cleaner?

Oil and residue solvent, Gilding metal cleaning, flash drying and VOC compliance, and removing CLP from areas not disassembled.

Do you need a weapons cleaner to be usable at -65°C? What is the lowest temperature at which the cleaner must be usable?

Need a cleaner for –65°C; however, for most applications, higher temperature (30°F) is acceptable.

Do you think that a water based cleaner will not be acceptable? Why?

No. Temperature range, corrosion, and removal from certain components can be difficult.

What other products will be used with your current weapons cleaner to service or store the weapon? (i.e. lube oil, which one? preservative oil, which one? preservative paper? etc.)

Light Weapons Oil, CLP (Dual Action)

Short-Term Storage MIL-L-63460, Long-Term MIL-L-3150, VV-L-800, MIL-C-16173, MIL-C-11796, MIL-G-10924, MIL-G-23827, MIL-B-22019, MIL-L-46010, and MIL-L-46147

What other materials on the weapon must the cleaner be compatible with? (i.e. elastomers, paint, solid lubricants, etc?)

All the above; however, rubbers, plastics, fiberglass, and optics should be considerations also.

Are there logistical considerations that you must take into account in requesting a weapons cleaner?

Size of containers, environment.

What type of containers, packaging are most useful for a weapons cleaner?

Small (4 oz) for individual use, 12 oz for crew-served weapons, 1-gallon refill containers, and small spray-squirt.

Do you think that manufacturers of weapons cleaners should be pre-qualified to supply to the military, or that a commercial, off-the-shelf type product would be acceptable?

"Approved" off-the-shelf is acceptable.
Approved by whom?

4. HEALTH, SAFETY OF WEAPONS CLEANER

Have you, yourself, or do you have knowledge of someone else, experienced nausea, skin rashes, or other adverse effects from the use of your current gun cleaner? Discuss.

Yes — Some skin irritation, nausea.

Is the odor, or lack of odor, of the weapons cleaner, an important factor?

Yes — Especially in combat and indoor use.

Do you have problems disposing of the used weapons cleaner that you currently use?

No — Normal hazardous waste procedures.

Is the flammability of the weapons cleaner an important factor? What flammability limits must you consider?

Yes — Safety is a serious concern.

Are you aware of the toxicity and safety of your current weapons cleaner? Is this important to you?

Yes — Aware and Concerned.

Is it reasonable to expect someone cleaning a weapon to wear protective gloves and to work in an open area to use the weapons cleaner? Must the cleaner be safe for use in confined spaces and for contact with skin?

Gloves may be reasonable, but not available. Must be safe for use in confined spaces.

5. SPEAK OUT!

Please discuss anything else pertaining to weapons cleaners that you would like to voice, especially comments and suggestions for development of an excellent cleaning product?

CLP is acceptable in cleaning-lubricating-preserving. Prefer separate cleaner and dry lubricant. Oily finish attracts dirt/sand.

Hazmat requirements for environment and personnel are extremely important.

Please disseminate this questionnaire as widely as possible to weapons users who can provide input to develop a non-hazardous weapons cleaning solvent. This questionnaire should be returned as soon as possible and no later than May 31, 1994, to:

Mr. Bernard Wright
Belvoir Fuels and Lubricants Research Facility
Southwest Research Institute
6220 Culebra Road
P.O. Drawer 28510
San Antonio, TX 78228-0510

Questions may be directed to:

Mr. Bernard Wright, BFLRF
(210) 522-2585

Mr. Al Rasberry, Fuels and Lubricants Division
(703) 704-3732 or DSN 654-3730.

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SA-ALC/SFSP
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Directorate of Aerospace Fuels Management, AFLC
SA-ALC/SFRM
Kelly AFB, TX 78241-5000