TO: Superior Products Sales Marketing, Inc.
FROM: Joseph Bowers
Reference: U.S. Army Small Arms Lubrication Testing Program Agreement Number W911QX-04-GLD-02-025

November 18, 2004

The U.S. Army Research, Development and Engineering Command is conducting a joint service small arms weapon lubricant evaluation in support of ongoing desert operations. The evaluation includes developing user-defined, operationally-oriented requirements for a weapon lubricant in desert environments; establishing a performance baseline for the currently fielded lubricant (CLP); and evaluating candidate lubricants against the user requirements.

The first phase of the candidate lubrication evaluation has been completed. During this phase, the lubricant sample which your company submitted was subjected to Material Safety Data Sheet (MSDS) screening and a Health Hazard assessment; laboratory testing of physical characteristics; and weapon reliability (live-fire) testing in a simulated desert environment. For live-fire testing, your lubricant was applied to M16A2 firearm in accordance with your application instructions and evaluated against the performance baseline established by the currently fielded product (CLP).

Your product was selected for advancement to the second phase of testing based on the results listed below. A more detailed description of the test and evaluation strategy and candidate evaluation results is provided in Attachments 1–4.

Testing	Result
Health Hazard Assessment	Pass
Laboratory Screening Tests	Pass
Performance vs. CLP	Pass

All questions concerning this notification packet should be directed to the undersigned. Thank you for your participation in this program.

Joseph Bowers
RDECOM Acquisition Center
Contract Specialist
410-278-6515

Small Arms Weapon Lubricant

Test & Evaluation Strategy

1. Background

The U.S. Army Research, Development and Engineering Command is conducting an evaluation of small arms weapon lubricant performance in desert environments. The evaluation includes developing operationally-based user requirements for a weapon lubricant in desert environments; identifying commercially available candidates; and evaluating candidate lubricants against the user requirements. Industry participation was maximized during this effort including providing input to the user requirements, input to the lubricant test and evaluation methods, and candidate lubricants for consideration. The three major components of the evaluation are health hazard assessments, weapon performance tests, and laboratory tests.

2. Test & Evaluation

Health Hazard Assessment. The U.S. Army Center for Health Promotion and Preventative Medicine conducted a health hazard assessment on each candidate lubricant using the product Material Safety Data Sheet. Any candidate lubricant producing an unacceptable health hazard was eliminated from consideration.

Weapon Performance tests. A performance baseline for the currently fielded lubricant (CLP) for small arms was established and all candidates were evaluated against this performance baseline. The performance testing method was derived from several references listed in paragraph four of this document. For the performance testing, the candidate lubricants were applied to ten weapons in accordance with their prescribed application procedures. All weapons were then placed in an environmentally controlled chamber set at 104° F, as prescribed by AR 70-38, for the duration of the performance testing. The weapons were then exposed to firing cycles that comprised of 30 minutes of dusting immediately followed by firing 120 rounds per weapon. All 10 weapons were dusted at the same time using a 140 Mesh Silica Flour product at a rate of 50 ±10 grams per minute per square meter. There was no cleaning or re-application of lubricant between prescribed cycles. All malfunctions were recorded and evaluated against the performance baseline established for CLP.

The first phase of performance testing included testing candidate lubricants applied to the M16A2 rifle for 7 firing cycles. All M16A2s used in the performance testing were refurbished weapons delivered directly from Anniston Army Depot. The M16A2 test details are provided in Annex A. Candidate lubricants producing M16A2 reliability as good as or better than M16A2s with CLP moved to the second phase of weapon performance testing.

The second phase of performance testing will include testing candidate lubricants applied to the M4. Candidates meeting the M4 user requirement will move to the third phase of weapon performance testing with the M249 machine gun. Candidates meeting the M249 user requirement will move to the fourth phase of weapon performance testing with the M240, M107, M2 and M9. Candidates meeting the user requirements for the M240, M107, M2 and M9 will move to the fifth phase of testing including a range of temperature tests and weapon durability tests.

Laboratory Tests. The laboratory tests on the candidate lubricants were divided into screening tests and information tests. Screening tests were used to eliminate any candidate lubricant that failed to meet a minimum standard as indicated in the test description. Information tests were used to build a database for the potential development of a future desert weapon lubricant specification document. However, the results of the information tests were not used to eliminate candidates. The laboratory tests were conducted by independent Government and commercial laboratories. Details for each laboratory test are provided in Annexes B and C.

3. Summary

A list of candidate lubricants meeting applicable health hazard assessment criteria and passing all laboratory screening and weapon performance tests will be forwarded to appropriate weapon system managers for consideration as approved weapon lubricants for desert environments.

4. References

TOP 3-2-045 - Automatic Weapons, Machineguns, Hand and Shoulder Weapons, June 82.

MIL-STD-810E - Environmental Test Methods and Engineering Guidelines, 14 July 89.

MIL-STD-210C - Climatic Information to Determine Design and Test Requirements for Military Systems and Equipment, 9 Jan 87

AR 70-38 - Research, Development, Test and Evaluation of Material for Extreme Climatic Conditions, 15 Sep 79.

Desert Lubrication Initial Operational Capability, U.S. Army Infantry Center, 10 June 04.

MIL-C-70599A - Military Specification, M4 Carbine, 20 Jan 94

MIL-C-63989C - Military Specification, Cartridge, 5.56mm, Ball, M855, 15 Feb 94

MIL-R-63997B - Military Specification, M16A2 Rifle, 10 Feb 1988

M16A2 Weapon Performance Test & Evaluation

- 10 weapons per lubricant
- Weapons screening
  - 240 round break-in
  - 120 rounds screening
  - eliminate weapons with 2 or more malfunctions during screening (all weapons passed screening)
- Lubricate all 10 weapons following instructions provided by vendor
- Place 10 weapons per candidate in dust chamber; vertical orientation; muzzle cap in place
- Randomize magazine-to-weapon assignments
- One magazine in weapon and three magazines per weapon in MOLLE pouches
- Control temperature at 104°F as prescribed by AR 70-38
- Cycle = 30 minute dusting immediately followed by 120rds fired
- Dusting rate is 50 ± 10 grams per minute per square meter using 140 Mesh Silica Flour
- Conduct a total of 7 cycles (840 rounds) per weapon with no cleaning or re-lube between cycles
- Record malfunctions
- Determine mean cumulative failure and 90% confidence interval for each candidate lubricant

Laboratory Tests - Screening

- **Flash Point**: Testing performed according to MIL-PRF 63460D, Performance Specification Lubricant, Cleaner and Preservative for Weapons and Weapons Systems and ASTM D 92, Cleveland Open Cup method. The criteria will be that the minimum flash point will be 60°C (140°F) due to hazardous waste laws.

- **Hydrogen Embrittlement:** This test method, described by ASTM F 519, Mechanical Hydrogen Embrittlement Evaluation Of Plating Processes And Service Environments, covers mechanical tests for the evaluation and control of the potential for hydrogen embrittlement that may arise from various sources of hydrogen as in plating processes, from fluids, cleaning treatments, maintenance chemicals, and gaseous environments that may contact the surface of steels. The procedures and requirements are specified for five types of test specimens using AISI E4340 steel with demonstrated sensitivity. This test method is not intended to measure the relative susceptibility of other steels. The criteria will be that when loaded in accordance with ASTM-F-519, at 65% of the pre-determined notched fracture strength, the specimens will not catastrophically fracture within the allotted 150 hours.

- **Compatibility with Non-Metallic Materials:** Testing according to TOP 3-2-609, Chemical Compatibility of Nonmetallic Materials, U.S. Army Test and Evaluation Command, Test Operations Procedure. The criteria will be as stated in 3-2-609 in that there will not be any loss of gloss, developed texture, decomposition, discoloration, swelling, clouding, tackiness, rubberiness, bubbling, cracking, solubility or etc.

- **Compatibility with CLP:** Compatibility with CLP will be determined by mixing the lubricant with an equal amount of CLP. Observations will be made after 5 minutes with respect to the following phenomena.

    1. Hard material formed
    2. High viscosity, gummy material, formed
    3. Low viscosity, running liquid, formed
    4. Fast, exothermic reaction
    5. Vapors emitted or bubbles generated

Passing criteria is that none of these phenomena occur.

Attachment 1

Annex C

Laboratory Tests - Information

- **Cold Stability:** Testing is performed according to a modified version of MIL-PRF-87937C. The product is subjected to five temperature cycles of 0° C for one hour and then a return to ambient. A second sample goes through the same five cycles except at -18° C. The criteria will be that after having completed the temperature cycles, the product will remain homogeneous. A slight turbidity shall not be objectionable provided no precipitation is present.

- **Hot Stability:** Testing performed according to a modified version of MIL-PRF-87937C. The product is tested similar to the cold stability tests in that two product samples are subjected to five, hot then ambient cycles. The temperatures for the hot cycles are 46° C and 60° C. The samples remain in the hot cycle for 5 hours and at ambient for 19 hours. The criteria will be that after having completed both temperature cycles, the product will remain homogeneous. A slight turbidity shall not be objectionable provided no precipitation is present.

- **Chemical Paper Interference:** Lubricant interference with the chemical agent detector papers M8, and M9 will be conducted in accordance with paragraph 4.16 of MIL-PRF-63460D, Lubricant, Cleaner and Preservative For Weapons and Weapons Systems. In this test, droplets of lubricant will be sprayed on the chemical agent detector papers. The paper will subsequently be observed for color change after 5 minutes. The criteria will be that the lubricant is unacceptable if the stain portion (excluding the droplet portion) of the paper shows any discoloration.

- **Metals Corrosion:** Corrosion protection will be evaluated according to a procedure based on a modification of MIL-PRF-63460D para 4.10, Lubricant, Cleaner and Preservative for Weapons and Weapons Systems. The test will be modified to include the substrate materials represented in the construction of the weapons under evaluation. Coupon of the substrate materials will be suspended equally spaced in a large container and evaluated for weight loss after a period of 7 days and evaluated per MIL-PRF-63460D. The criteria will be that the lubricant shall not produce visual evidence of pitting, etching, or dark discoloration and that the weight gain or loss shall not be greater than 1.5 milligrams per square centimeter of exposed surface area.

- **Corrosion Protection from Propellant Byproducts:** Testing performed according to MIL-PRF 63460D, Performance Specification Lubricant, Cleaner and Preservative for Weapons and Weapons Systems. The criteria will be that after having been exposed to the ignition of WC844 propellant and 96 hours of conditioning in a humidity cabinet, there will be no rust spots 2mm or larger.

- **Viscosity:** Testing performed according to MIL-PRF 63460D, Performance Specification Lubricant, Cleaner and Preservative for Weapons and Weapons Systems and ASTM D445 , Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity). The requirements in the test document were for the product to have a minimum of 9.0 centistokes at 40° C (104° F).

- **Pour Point:** Testing performed according to MIL-PRF 63460D, Performance Specification Lubricant, Cleaner and Preservative for Weapons and Weapons Systems and ASTM D97 Standard Test Method for Pour Point of Petroleum Products. The test document required the product to have a maximum Pour Point value of -59° C (-75° F).

- **Firing Residue Removal:** Testing performed according to MIL-PRF 63460D, Performance Specification Lubricant, Cleaner and Preservative for Weapons and Weapons Systems. The criteria will be that upon completing three replicates, the product shall remove a minimum average of 80% of the residue remaining after the ignition of WC 844 propellant.

- **Humid Corrosion:** This test method is performed according to ASTM D 1748, Rust Protection by Metal Preservatives in the Humidity Cabinet. It evaluates the rust-preventive properties of metal preservatives under conditions of high humidity. A lubricant treated specimen is suspended in a humidity cabinet and subsequently examined for rust dots. This procedure is described in method 5329.2 of FED-STD-791, Lubricants, Liquid Fuels, and Related Products; Methods of Testing. No more than three corrosion dots, none exceeding 1.0 mm in length, width, or diameter shall be evident after 900 hours of exposure.

- **Salt Spray (Fog):** The test procedure used is ASTM B 117, Salt Spray (Fog) Apparatus, Operating. This test evaluates the ability of steel test panels, to which lubricants have been applied, to resist corrosion in a salt spray (fog) test environment. The environment is controlled to 95° F at 100% relative humidity produced by a 5% salt solution. The test panels are low carbon, open hearth, cold finished, 1010 steel. No more than three corrosion dots, none exceeding 1.0 mm in length, width, or diameter shall be evident after 100 hours of exposure.

- **Salt Water Corrosion:** This test method is performed according to ASTM D 5969, Corrosion Preventive Properties of Lubricating Greases. It evaluates the corrosion-preventive properties of greases using grease-lubricated tapered roller bearings exposed to various concentrations of dilute synthetic sea water stored under wet conditions. The criterion is that there shall be no presence of any corrosion spot 1.0 mm or larger in the longest dimension.

- **Water Displacement and Water Stability:** Testing performed according to Federal Test Method No. 791C, Method 3007.2, Water Displacement and Water

Stability. The criteria will be that no more than two test coupons will show signs of rust, mottling or other abnormal surface stains.

- **Cleaning Evaluation by Water Break Test:** The water break will be determined using the method outlined in ASTM F 22, Standard Test Method for Hydrophobic Surface Films by Water-Break Test. A standard contaminant is baked into a clean sample and cleaned with the working concentration of the cleaner. The criteria is that the time it takes for the draining water to become a discontinuous film should exceed one minute.

- **Evaporation Loss:** Testing performed according to ASTM D 2595, Greases, Lubricating, Over Wide-Temperature Range, Evaporation Loss Of. This method determines evaporation loss of lubricating greases at temperatures between 93° C and 316° C (200° F and 600° F). Heated air is passed over the sample for 22 hours and the weight loss is measured. By using MIL-PRF-10924G, Performance Specification Grease, Automotive and Artillery as a criterion gauge, the evaporation loss should be less than 3% when heated to 99° C.

- **Penetration:** Testing performed according to ASTM D 217, Cone Penetration of Lubricating Grease. These methods use four procedures for measuring the consistency of lubricating greases by the timed penetration of a cone of specified dimensions, mass, and finish. The criterion is that the worked penetration be 26.5mm – 29.5mm.

- **Dropping Point:** Testing performed according to ASTM D2265, Standard Test Method for Dropping Point of Lubricating Grease Over Wide Temperature Range. There were no set criteria for this test.

- **Low Temperature Torque:** This test is performed according to ASTM D 1478, Ball Bearing Greases, Low Temperature Torque Of, Standard Test Method For. This method evaluates the extent to which grease retards the rotation of a slow-speed ball bearing by measuring starting and running torques at low temperatures (below -54° C). The maximum starting torque shall not exceed 7 N-m, and the average running torque shall not exceed 5 N-m.

- **Thermal Stability:** Testing performed according to ASTM D2511, Standard Test Method for Thermal Shock Sensitivity of Solid Film Lubricants. The criteria for this test shall be that there will not be blistering, flaking, cracking or softening of the dry film.

- **Load Wear Index:** The load-carrying properties of lubricating greases are determined in accordance with ASTM D 2596, Grease, Lubricating, Measurement of Extreme – Pressure Properties of (Four-Ball Method). This method evaluates:

1. Load-Wear Index (formerly called Mean-Hertz Load), and
2. Weld Point, by means of the Four-Ball Extreme-Pressure (EP) Tester.

The Load Wear Index must exceed 30 kgf.

- **Four Ball Wear (Fluid Lubricants):** Testing performed according to ASTM D 4172, Fluid, Lubricating, Wear Preventative Characteristics of (Four-Ball Method) evaluates the anti-wear properties of fluid lubricants in sliding contact by means of the Four-Ball Wear Test Machine. The test is operated with one steel ball under load rotating against three steel balls held stationary in the form of a cradle. The criterion is that the average scar diameter produced is less than 0.8 mm.

- **Four Ball Wear (Solid Lubricants):** The wear preventive characteristics of greases in sliding steel-on-steel applications are evaluated and performed according to ASTM D 2266, Grease, Lubricating, (Four-Ball Method), Wear Preventative Characteristics Of. This test is not intended to predict wear characteristics with metal combinations other than steel-on-steel or to evaluate the extreme pressure characteristics of the grease. The criterion is that the average scar diameter does not exceed 0.6 mm.

- **Falex Endurance Life (Solid Film Lubricants):** Testing performed according to ASTM D 2625A, Film Lubricants, Solid, (Falex Pin and Vee Method), Endurance Wear Life and Load-Carrying Capacity Of. This test evaluates the endurance (wear) life of dry solid film lubricants in sliding steel-on-steel applications. The method consists of running two stationary steel vee block specimens loaded to a predetermined value against a constant rpm rotating steel pin specimen. Endurance is determined by the time to failure. The lubricant shall have an average endurance life of 60 minutes at 1,000 pound load.

- **Falex Load Carrying (Fluid Lubricants):** Testing performed according to ASTM D 2670 (Falex Pin & Vee Block Method) and MIL-L-63460D, section 4.7. This test evaluates the load carrying properties of fluid lubricants by means of the Falex Pin and Vee Block Lubricant Test Machine. The method consists of running two stationary steel vee block specimens loaded to a predetermined value against a rotating steel pin specimen. The criterion is the ability to operate for 1 minute at a 750 pound load.

- **Falex Load Carrying (Solid Film Lubricants):** Testing performed according to ASTM D 2625B, Film Lubricants, Solid, (Falex Pin and Vee Method), Endurance Wear Life and Load-Carrying Capacity Of. The load-carrying capacity of dry solid film lubricants in sliding steel-on-steel applications is determined by this method. The method consists of running two stationary steel vee block specimens against a rotating steel pin specimen, increasingly the load on the pin until failure is determined. The criterion is that the load carrying capacity be at least 2,500 pound gage load, with no single test result less than 2,250 pounds for phosphated surfaces and at least 2,250 pound gage load, with no single test result less than 2,000 pounds for grit blasted surfaces.

Attachment 2

CHPPM TOXICITY CLEARANCE

DEPARTMENT OF THE ARMY
US ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND MD 21010-5403

REPLY TO
ATTENTION OF

MCHB-TS-TTE

13 August 2004

MEMORANDUM FOR Director, Warfighter Core (CSTE-DTC-AT-WC-M/Mr. William H. Taylor, Jr.), U.S. Army Aberdeen Test Center, 400 Colleran Road, Aberdeen Proving Ground, MD 21005-5059

SUBJECT: Toxicity Clearance for SLIP 2000™ Synthetic Gun Lubricant-Cleaner-Preservative

1. References:

a. Material Safety Data Sheet (MSDS): SLIP 2000™ Synthetic Gun Lubricant-Cleaner-Preservative, Superior Products, 355 Mandela Parkway, Oakland, CA 94607.

b. SLIP 2000™ Lubricant Information, Online, http://www.slip2000.com/lubricant_info.html.

c. National Institute for Occupational Safety and Health, What You Need to Know About Occupational Exposure to Metalworking Fluid, Online, http://www.cdc.gov/niosh/pdfs/98-116.pdf.

d. U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), Metal Working Fluids: Safety and Health Best Practices Manual, Online, http://www.osha.gov/SLTC/metalworkingfluids_manual.html.

e. Laboratory Analysis, SLIP 2000™, Herguth Laboratories, Inc., 8 February 2001, 101 Corporate Place, Vallejo, CA 94590.

2. Background.

a. SLIP 2004™ Gun Lubricant-Cleaner-Preservative contains exclusive metal treatment designed to control friction, reducing heat, therefore eliminating excessive wear (reference 1b).

b. Formulated especially for use on automatic rapid-fire and repetitive shooting firearms, black powder, shotguns, rifles and pistols (reference 1b).

c. Does not contain Silicone or PTFE (Teflon) ingredients which cause stickiness or tackiness (reference 1b).

d. Product remains effective with desired results in temperatures ranging from -130°F-+1250°F (references 1a & 1b).

e. Classified as a synthetic metalworking fluid (MWF) by The National Institute for Occupational Safety and Health (NIOSH), the Occupational Safety and Health Administration (OSHA), and the Metal Working Fluids Standard Advisory Committee (MWFSAC) (references 1c & 1d).

f. Has exceeded current MIL-SPEC-63460D test requirements set forth by the U.S. Government (references 1b & 1e).

3. Toxicity.

a. Contains no petroleum oils as defined by classification as synthetic MWF (references 1c & 1d).

b. Material is not hazardous as defined by OSHA hazard communication standard. Non-hazardous ingredient: 40-70 percent synthetic hydrocarbon, 5-25 percent metallic salts. Components of all material not known to be hazardous (reference 1a).

c. Likely human exposure routes include: inhalation of fumes, skin contact (with absorption unlikely), and eye exposure. All exposures may cause irritation without the use of proper protective gear such as; gloves and safety glasses (references 1a, 1c & 1d).

d. Acute overexposure is associated with skin and eye irritation. Chronic overexposure can be associated with irritation to eyes, skin, or lungs after prolonged or repeated exposures. Overexposure may cause nervous system depression (reference 1a).

e. This product is not listed as a potential carcinogen by the National Toxicology Program (NTP), the International Agency for Research on Cancer (IARC), or the Occupational Safety and Health Administration (OSHA) (reference 1a).

4. Conclusions.

a. A Toxicity Clearance has been granted for SLIP 2000™ Synthetic Gun Lubricant-Cleaner-Preservative

b. Handling, storage, exposure control, and personal protection measures outlined in the MSDS should be followed accordingly (reference 1a).

c. It is suggested that all exposure levels for synthetic Metalworking Fluids set forth by Metal Working Fluids Standard Advisory Committee (MWFSAC), the Occupational Safety and Health Administration (OSHA), and the National Institute for Occupational Safety and Health (NIOSH) be used as exposure guidelines (references 1c & 1d).

d. As with all chemicals, unnecessary exposure should be avoided.

5. Point of Contact for this action is Dr. Wilfred McCain at DSN 584-3980 or Commercial (410) 436-3980.

GLENN J. LEACH
Program Manager, Toxicity Evaluation