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Technical Report ARPAD-TR-89002

IMPROVING THE CORROSION RESISTANCE OF SMALL ARMS

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Bob Braun

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U.S. ARMY ARMAMENT, MUNITIONS AND CHEMICAL COMMAND

Product Assurance Directorate

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An overview of recent corrosion prevention and control (CPC) activities within the Army and some long term and short term actions taken to improve the corrosion resistance of small arms weapons are contained in this report. Also included is a summary of the specific efforts to determine the extent of reported corrosion problems with small arms, and actions to reduce corrosion in both current and future weapons. Keywords: Aluminum alloys, Aluminum alloy 7075-T6, Protective Coatings, Lubricants, M-16 A1 Rifles, Plastics, Adhesives, Composite materials. (AW)

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CONTENTS

INTRODUCTION

Corrosion of Army materiel and the resulting impact on readiness has been a concern for many years. Rusting of ferrous metals, corrosion of aluminum, cracking of plastics, deterioration of elastomers, failures of protective finishes, are all symptoms of the corrosion problem. During the past year new emphasis has been placed on the importance of corrosion prevention and control (CPC) in Army materiel, including small arms weapons. Actions have occurred on three levels; (1) Army wide, (2) within the Army Materiel Command, and (3) within the U.S. Army Armaments Munitions and Chemical Command (AMCCOM), and the U.S. Army Armament Research, Development and Engineering Center (ARDEC).

DISCUSSION

On the Army level, AR 750-59, 25 August 1988, specifically covers the Army corrosion prevention and control program. This regulation makes the Deputy Chief of Staff for Logistics (DCSLOG) responsible for management of the Army CPC program. All the major commands must be participants. The regulation focuses on CPC in design, and testing, as well as maintenance, training, and awareness.

At the AMC level, the U.S. Army Test and Evaluation Command (TECOM), has written and published a new Test Operation Procedure (TOP) to address corrosion testing in real environments. TECOM TOP 1-1-061, Corrosion and Deterioration Testing in Humid Tropic Environments, was published in November 1987. The TOP provides for testing at the U.S. Army Tropic Test Center, Ft. Clayton, Panama. Typical testing would require a minimum exposure time of one year with monthly inspections to determine the extent of corrosion. This TOP is a result of the new CPC regulation which requires systems to be tested in natural, most corrosive, field environments.

Another testing thrust is the reporting of all corrosion problems that occur during testing by the independent evalulator, TECOM. Test incident reports (TIRs) are being used to document corrosion whether or not it degrades performance. This information is also entered in the central test database. The goal is to identify corrosion early, before the item is fielded, and thereby control or eliminate it.

Another activity at the AMC level is the drafting of a supplement to implement the new Army regulation. The supplement, when published, will replace the current AMC regulation 702-24, Materiel Deterioration Prevention and Control. Publication of the supplement is expected in approximately 6 months. The supplement will detail how the Army regulation will be implemented within the AMC organization.

At the small arms weapons materiel developer level, AMCCOM/ARDEC CPC activities include the following:

1. Based on numerous field problems with 7075-T6 aluminum, a CPC alert was issued in January 1988 (app A) to promote awareness of the problems and to recommend that alternatives be considered. This was given wide distribution throughout the command.

2. Two new ARDEC CPC policy statements were issued:

a. Commanding Officer's Policy Statement 88-32 - 18 April 1988, "Corrosion Prevention and Control for Armament Applications" (app B)

b. Commanding Officer's Policy Statement 88-31 - 24 March 1988, "Use of Organic Materials in ARDEC Armament Applications" (app C)

These two policies require that material specialists review technical data packages to assume proper use of materials and protective finishes. This includes plastics, adhesives, coatings, sealants, lubricants, elastomers, and composites.

3. Guidance was issued in May 1988 to preparers of inspection documents (i.e., military specifications and QAPs). More comprehensive inspections of protective finishes was to be provided for in inspection documents.

4. In an effort to promote additional emphasis on the importance of protective finishes, a change was made to the general specification for weapons (MIL-W-63150 - Weapons and Support Material, Standard Quality Assurance Provisions For). Amendment 3 upgrades inspection characteristics for protective finish to major defects during the process and inspection.

5. Production contracts for materiel that requires use of a phosphate coating process (i.e., TT-C-490 or DOD-P-16232) now include a contract clause that requires technical agency approval of the process to be used. This assures that the contractor understands the process and knows how to properly control it so as to consistently meet the specification requirements such as coating weight and salt spray resistance.

6. A CPC Lessons Learned book being prepared at ARDEC was expected to be completed in early October 1988. The guide will show examples of CPC problems, and include a list of do's and dont's as well as materials that should be avoided. When published, the guide will be given broad distribution throughout the Command.

While the above are generic CPC accomplishments, there have also been some other CPC activities at the materiel developer level that relate specifically to small arms.

In January 1987, the corrosion resistance of small arms became an issue at the Under Secretary of the Army level. The implication was that the U.S. Army should

require that small arms be made from corrosion resistant materials. In reply to the Under Secretary, it was pointed out that the Army CPC program was intended to focus on such issues, particularly on new weapon designs. However, the inquiry prompted a need for feedback from the field to determine the extent of corrosion problems with small arms. A questionnaire was developed and a field survey was conducted in the June - September 1987 timeframe. The questionaires were distributed to several logistic Assistance Offices (LAOs). Field survey results were obtained from nine sites primarily in the U.S.

The findings from the field (primarily M16 rifle) are summarized below:

1. Better materials and manual procedures are needed for preventing and repairing corrosion.

2. In hot, humid climates, such as Panama and Texas, there is a need for reducing the humid environmental conditions in arms rooms through air conditioning and dehumidifying.

3. To prevent corrosion during storage, weapons must be coated with heavy oil, especially in hot, humid climates.

4. Suggest providing solvent tanks to facilitate cleaning, so that the weapon could be immersed in cleaning solvent CLP.

Further information was obtained from the field in January 1988 through the LAO for the 25th Infantry Division, Schofield Barracks, Hawaii. At the direct support level approximately 5500 small arms were worked on in fiscal year 1987 and no corrosion problems were encountered.

The primary small arms overhaul facility is the Anniston Army Depot, Alabama. In September 1987 a review was made of the small arms maintenance area. This review was promppted by several quality deficiency reports (QDRs) received from the depot. These QDRs were for protective finish discrepancies on repair parts being received for use in depot rebuild of small arms. Essentially these reflected a contract compliance problem, in that the parts did not have the proper finish required by the drawings.

To minimize this problem in the future, protective finish inspection requirements in military specifications and QAPs have been upgraded to provide more comprehensive evaluation prior to acceptance of the parts by the Government.

Efforts are continuing at ARDEC to obtain funding for an engineering study that would investigate new materials, lubricants, and protective finishes for small arms weapons. The M16A2 rifle will be used as the test bed for the study. Funding and approval of this study could lead to long term solutions to reduce corrosion and material

degradation problems in small arms. The funding request is planned for the September - October 1988 timeframe. The final materials, finishes, and lubricants selected would be subjected to tropic testing per the TECOM TOP in addition to the rigorous performance testing conducted on new small arms weapons.

CONCLUSIONS

The corrosion of small arms does not appear to be a significant problem that adversely impacts readiness. However, there is a need for providing improved corrosion protection wherever possible. For the short term, assuring proper application and adequate inspection of the specified protective finishes will provide some improvement. For the long term, CPC must become an integral part of the design discipline. The use of materials known to have corrosion problems must be eliminated, particularly in new designs. New weapon designs will receive a more thorough evaluation for CPC concerns. The following actions are expected to improve the corrosion resistance of weapons to be fielded in the future.

1. Contract statements of work for new weapons now contain CPC clauses requiring a CPC plan with actions to assure the design addresses CPC. This is to involve materials engineers in the design process, and to avoid use of problem materials (e.g., 7075-T6 aluminum), and to avoid specifying nondurable protective finishes.

2. Technical data packages for new weapon designs will be reviewed by ARDEC materials specialists for the purpose of assuring that the selection of materials and protective finishes is appropriate for the application.

3. New weapon designs will receive more thorough evaluation for CPC concerns during technical testing by the AMC independent evaluator. Those tests leading to type classification will be of particular concern. TECOM TOP 1-1-061 along with existing TOPs 3-2-045 and 3-2-504 provide test procedures that will assess the corrosion resistance of small arms in adverse environments.

4. For the long term, it is planned to obtain funding for an engineering study that will specifically pursue improved materials, finishes, and lubricants that would support the concept of maintenance free small arms. If successful, this would essentially eliminate corrosion and material deterioration problems in future small arms weapons.

APPENDIX A

AMCCOM CORROSION PREVENTION ACTION TEAM (CPAT) ALERT
PROBLEMS EXPERIENCED WITH USE OF 7075-T6 ALUMINUM

AMCCOM CPC BULLETIN

DATE: January 1988 ISSUE: 01

AMCCOM CORROSION PREVENTION ACTION TEAM ALERT

Subject: Problems experienced with use of 7075-T6 Aluminum

Use of 7075-T6 aluminum in AMCCOM mission items must be avoided. Field experience with this material has substantiated its vulnerability to stress corrosion cracking and exfoliation corrosion.

Stress corrosion cracking has occurred in the 7075-T6 base plug on the M483A1, 155mm Projectile. Exfoliation corrosion of 7075-T6 has been experienced on the aluminum ogive on this same round and on the lower receiver of the M16A1 Rifle.

The cases of exfoliation corrosion occurred where the protective coating was damaged, eliminating all protection of the vulnerable 7075-T6 aluminum.

The Missile Command has prohibited use of 7075-T6 aluminum on any of its items, and has also prohibited use of 2024-T3 and T4.

Application of 7075 aluminum in the T6 temper should be limited to applications where there is no conceivable source of either residual or applied tensile stresses in the short transverse grain direction. When the absence of such stresses cannot be verified, use of the T6 temper should be avoided entirely.

An alternatives is the use of the T73 temper, at some sacrifice in tensile strength. For more guidance on the use of 7075 aluminum contact the Metallic Materials Branch, Armament Technology Division, of the Armament Engineering Directorate at ARDEC.

References:
Corrosion and Corrosion Protection Handbook
Edited by Philip A. Schweitzer C. 1983
Page 131

Corrosion Prevention Action Office
Product Assurance Directorate
Picatinny Arsenal, NJ 07806-5000

APPENDIX B

ARDEC POLICY STATEMENT 88-32

DEPARTMENT OF THE ARMY
ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
PICATINNY ARSENAL, NEW JERSEY 07806-5000

REPLY TO ATTENTION OF

SMCAR-CO

18 APR 1988

MEMORANDUM FOR: SEE DISTRIBUTION

SUBJECT: Commanding Officer's Policy Statement 88-32
Corrosion Prevention and Control for Armament Applications

1. Reference: AMCCOM Suppl 1 to DARCOM-R 702-24, 25 Aug 86, Subject: Material Deterioration Prevention and Control.

2. Policy Statement: Corrosion Prevention and Control (CPC) will be included in the Life Cycle Engineering Process as a means of assuring the reliability and durability of armament systems.

3. Discussion:

a. This policy is to ensure the use of the ARDEC in-house materials capability as a tool to enhance overall system life cycle performance. The scope of this policy includes all materials; i.e., metallic, organic, and energetic materials used in armaments.

b. Materials participation applies to R&D (6.2-6.7), production and deployment. All centers, directorates and offices responsible for engineering applications shall coordinate with and actively involve and utilize the services of the Armament Engineering Directorate's (AED) material engineering staff. All elements will be responsible for inclusion of AED material and engineering support in their Program Planning Work Breakdown Structure or equivalent.

c. The Armaments Technology Division (ATD), AED is the lead organization within ARDEC for ensuring proper utilization of materials and related processes. An ARDEC Corrosion Prevention Action Office (CPAO) located within ATD will be the focal point for CPC. For in-house projects, ATD's role will be that of a participating member of the project management team. For contractual efforts, the ATD role will be that of a member of the government project management team. ATD will review that portion of the proposed Technical Data Package (TDP) concerned with material usage during all steps of the TDP development and preparation and will assess the proposed use of material, processing and quality assurance/quality control provisions and any subsequent changes related to materials. An agenda item will be included in each IPR through development which specifically addresses materiel deterioration/Corrosion Prevention and Control efforts and status.

4. Proponent: Armaments Engineering Directorate, SMCAR-AET-O, Mr. John Nardone, extension 44222.

JOSEPH RAPPIANI, JR.
Brigadier General, USA
Commanding

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APPENDIX C

ARDEC POLICY STATEMENT 88-31

DEPARTMENT OF THE ARMY
ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
PICATINNY ARSENAL, NEW JERSEY 07806-5000

REPLY TO ATTENTION OF

SMCAR-CO

24 MAR 1988

MEMORANDUM FOR: SEE DISTRIBUTION

SUBJECT: Commanding Officer's Policy Statement 88-31
Use of Organic Materials in ARDEC Armament Applications

1. Reference: None.

2. Policy Statement: Organic materials engineering will be included in the Life Cycle Engineering Process as a means of assuring the proper use of plastics, adhesives and organic matrix composites in armaments.

3. Discussion: This policy is to ensure the use of the ARDEC in-house materials capability as a tool to enhance overall system life cycle performance. The scope of this policy includes all plastics, adhesives, coating, sealants, lubricants and elastomers, as well as resin matrix composites used in armaments. All ARDEC elements responsible for engineering applications which make use of organic materials shall actively involve and utilize the services of the Organic Materials Branch (Org Mat Br), Arm Tech Div, AED, which is the lead organization for implementation of this Policy Statement. Org Mat Br participation applies to R&D (6.2-6.7), production and deployment and will preferably begin during concept exploration. All ARDEC elements will be responsible for inclusion of the Org Mat Br in their Work Breakdown Structure or equivalent. For in-house projects, the Org Mat Br engineers' role will be that of a participating member of the project team. For contractual efforts, the role will be that of a member of the government project management team. Org Mat Br will review that portion of the proposed Technical Data Package (TDP) concerned with organic material usage and will concur in the proposed use of all organic materials, processing and quality assurance/quality control provisions and any subsequent changes concerning organic materials reflected in engineering change proposals, requests for waivers or requests for deviations.

4. Proponent: Organic Materials Branch, Armaments Technology Division, SMCAR-AET-O, Mr. Harry E. Pebly, extension 42212.

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