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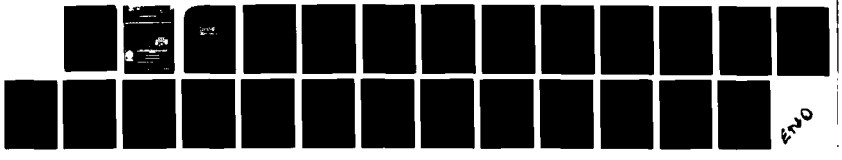

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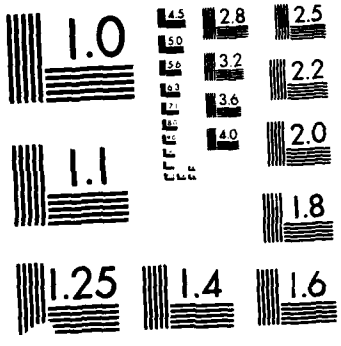

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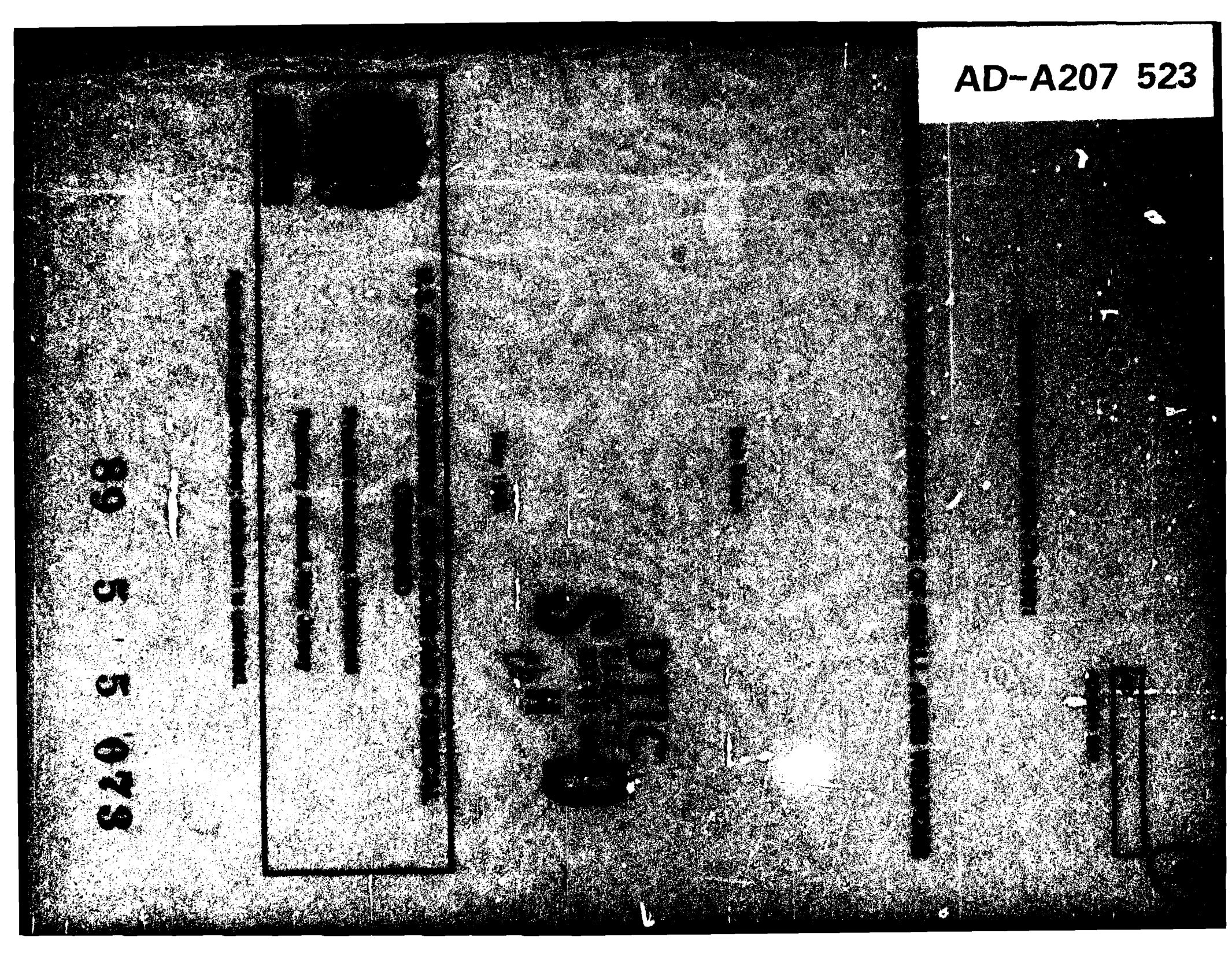

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INVESTIGATING THE CORROSION RESISTANCE OF SMALL ARMS WEAPONS

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Bob Braun

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19. ABSTRACT (CONTINUE ON REVERSE IF NECESSARY AND IDENTIFY BY BLOCK NUMBER)

The corrosion resistance of small arms has recently been a matter of high level Army interest. The Army corrosion prevention and control (CPC) program is being used to investigate the scope of small arms corrosion and formulate an appropriate course of action. The efforts to date and future directions of the CPC effort to minimize small arms corrosion and associated maintenance are presented in this report.

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CONTENTS

INTRODUCTION

In December 1986, the Armament Research Development and Engineering Center (ARDEC) at Picatinny Arsenal, New Jersey became aware of the Department of Army level correspondence with the Under Secretary of the Army, Mr. Ambrose, that small arms should be made of corrosion resistant materials. The origin of the perception that there is a small arms corrosion problem was not apparent. No significant small arms corrosion problems were being reported to ARDEC from the field nor were there any reports from Anniston Army Depot, Anniston, Alabama the depot responsible for small arms overhaul. Another source for corrosion information, quality deficiency reports (QDRs) did not reveal any unusual information.

While there was concern at the Under Secretary level, it was not clear as to the scope of the preceived problem, i.e., which specific weapons are believed to have corrosion problems in the field, or what specific parts were involved.

DISCUSSION

In April 1987, discussion with the Materials Technology Laboratory (MTL), Watertown, Massachusetts, designated as the Army Corrosion Center of Excellence, let to the conclusion that more information was needed and that the best source would be from that field.

At the suggestion of MTL, a questionnaire containing 12 questions (app A) was developed to solicit soldier's views as to whether or not there is a corrosion problem with small arms.

Distribution of the questionnaire in May 1987 was through the logistics assistance office network. Five hundred questionnaires were sent for distribution to the following nine CONUS and four OCONUS sites:

CONUS

Ft. Stewart, Georgia	24th Infantry Division
Ft. Bragg, North Caroline	82nd Airborne Division
Ft. Lewis, Washington	9th Infantry Division
Ft. Carson, Colorado	4th Infantry Division
Ft. Ord, California	7th Infantry Division
Ft. Polk, Louisiana	5th Infantry Division
Ft. Richardson, Alaska	

OCONUS	
Hawaii	25th Infantry Division
Korea	2nd Infantry Division
Germany	3rd Infantry Division
Panama	

At this time approximately 75 questionnaires have been returned. A summary of the information is currently being compiled. If significant problelms are reported, the results will be used to support submission of an engineering study project to obtain funding.

Traditionally, CPC of small arms has been addressed primarily through use of protective finishing systems combined with standard operator maintenance of cleaning, lubrication, and preservation practices. In general, this approach provided adequate corrosion resistance based on results of development testing. However, with the current emphasis on more aggressive action to combat corrosion in all Army materiel, CPC requirements are being included in contracts for new Army materiel. Statements of work (SOWs) must now include provisions for a CPC plan which must delineate how the contractor will assure that CPC will be addressed throughout the contract. A sample SOW for CPC (app B) has been prepared for inclusion in contracts. This statement requires the contractor to prepare a CPC plan and submit it to the technical agency for approval.

Recently, the nondevelopmental item (NDI) acquisition strategy has been used to fill user needs and accelerate fielding of weapon systems. Small arms programs such as the 9-mm pistol, the multipurpose bayonnet, and the sniper weapon system are examples of such NDI programs. With this approach, the traditional design and development phase is curtailed as the item or system has already been developed. Thus, there is some loss of control over materials and finishes used. In these situations, testing and evaluation by the AMC independent evaluator (TECOM or AMSAA) becomes the primary means of assessing the corrosion resistance of the item or system prior to type classification. The independent evaluator normally performs a salt spray test on small arms in accordance with MIL-STD-810. Generally a 48-hour test is used followed by storage for 48 hours. The criteria is that the weapon should be safe and serviceable. Chemical compatibility testing is also done to assess material deterioration using solvents typically encountered by the soldier, e.g., gasoline or diesel fuel. Other tests and evaluations which tend to surface problems in the area of corrosion or material deterioration include fungus resistance and temperature-humidity, high and low temperatures, sand and dust, and mud.

CONCLUSIONS

The corrosion resistance of small arms is a concern at the Under Secretary of the Army level. Currently, it is not as bad as perceived, but there is a need for more attention to CPC concerns and to be aware of trade-off decisions that may adversely impact CPC and readiness, through increased maintenance actions and increased operation and support cost.

Corrosion prevention and control must continue to become an integral part of all new materiel acquisitions. In accordance with the Army CPC program objectives, new and future small arms designs must specifically address corrosion resistance and material deterioration. Statements of work for small arms development and product improvement programs must include provisions for a CPC program. A CPC procurement request guide is available which includes sample SOW paragraphs for CPC and the applicable data item description.

APPENDIX A

SMALL ARMS CORROSION QUESTIONNAIRE

SMALL ARMS CORROSION QUESTIONNAIRE
JUNE 1987

The U.S. Army Armament Research, Development and Engineering Center, (ARDEC), Picatinny Arsenal, NJ is responsibile for the research and engineering that goes into your personal small arms weapons. ARDEC has been tasked to examine corrosion and material deterioration problems in small-arms weapons (rifles, pistols, machine guns). Information from you, the soldier, will help in determining how serious these problems are. By filling out and returning this questionnaire, you will be part of the effort to improve/reduce the maintenance of small arms. You do not have to include your name, so please answer honestly and feel free to add any comments or complaints about corrosion/material deterioration or maintenance/prevention programs.

Corrosion and material deterioration is not limited to rust on metals. Metal flaking, cracking or other problems with plastic or rubber parts are also included in the term corrosion.

1. Where are you located (Geographical Area or Military Installation)?

2. What small-arms weapons do you use (M16A1 Rifle, M2 Machine Gun, M1911 Pistol, etc.)?

3. How much time (per day, week, etc.) do you spend cleaning and maintaining each weapon? (List by Weapon Type)

	Weapon Type	Time (Minutes or hours per day/week)
Weekly Maintenance (other/than field exercise)		
Operator maintenance at end of field exercise		

4. How much of your maintenance time do you spend removing corrosion? (List by Weapon Type)

	Weapon Type	Time (Minutes or hours per day/week)
Weekly Maintenance (other/than field exercise)		
Operator maintenance at end of field exercise		

5. Do you feel that maintenance instructions in your manual are adequate? (List of Weapon Type)

Weapon Type	Yes or No	If No, tell why

6. Do you know of any better ways to maintain your weapon? If yes, briefly describe. (Include Weapon Type) - You may also include suggested changes to the manual.

7. What are some of the worst corrosion or material deterioration problems in your weapons? Which parts are most often involved (Include Weapon Type).

8. Do your weapons corrode more during field use or during storage?

9. What are some of the worst conditions (rain, salt, water, snow, heat and humidity, etc.) that you operate under? How often are your weapons exposed to these conditions (Always, most of the time, sometimes, seldom, never)?

Weapon Type	Condition	How Often?

10. Do you think that the corrosion resistance of your weapons needs to be improved? Do you have any suggestions or comments that could reduce corrosion or reduce maintenance time?

11. Have you ever reported a corrosion or material deterioration problem? If so, how was it reported (form used) and where was it sent?

12. Any other comments or criticism of your small arms weapons? (List by Weapon Type)

APPENDIX B

CORROSION PREVENTION AND CONTROL GUIDE

INTRODUCTION:

1. A Corrosion Prevention and Control (CPC) Program has been established by AMC Headquarters to minimize the occurrence of corrosion in all materiel. The AMCCOM CPC Program effort is directed at the corrosion/deterioration of materials used in armaments, munitions, and chemical systems.

2. To assure that CPC is effectively applied to related procurement request, specific guidance was prepared by the AMCCOM Corrosion Prevention Action Office. This guidance, as provided below, is intended for use within AMCCOM to assure conformance to command directives.

REQUIREMENTS:

1. In accordance with AMC-R 702-24, all development and acquisition contracts will contain applicable CPC Program provisions. This requirement applies to all system and equipment procurements and in-house developments.

2. The requirement for inclusion of CPC provisions in procurement requests is contained in AMCCOM Form 372. In the event the CPC requirement has not been included in the statement of work, the rationale must be provided.

DEFINITIONS:

1. Contractor coordinator. The contractor's point of contact or representative responsible for the CPC Program; to include CPC efforts for all associated subcontractors. The authority and responsibility of the coordinator will be described in the CPC Plan.

2. Corrosion Prevention and Control (CPC). A fundamental consideration for assuring the sustained performance and readiness of systems and equipment. The term corrosion refers to the degradation or deterioration of both metallic and non-metallic materials, as applicable throughout the logistics life cycle.

3. Corrosion Prevention Action Office (CPAO). The organization assigned the responsibility for assuring that CPC principles are applied to systems and equipment throughout the logistics life cycle. The responsible individual is designated as the Action Officer (AO).

4. Corrosion prevention and control plan. A contractor plan, prepared for the item identified in the procurement request, which describes the organization, personnel, facilities, and planned action to assure adherence to CPC principles.

5. Development and acquisition contracts. Contract efforts, including in-house developments, that apply to any life cycle phase of materiel acquisition of weapon systems hardware, components, and support equipment planned for field deployment or for use in production, surveillance, or maintenance of materiel.

6. Data item description (DID). A DD Form 1664 that defines contract data requirements by description/purpose, application/ interrelationship, and preparation instructions. Each DID is identified by a number and title.

7. In-house development. Any engineering development activity or production effort performed within the government which does not require preparation of a procurement request.

8. Materials engineering. The science or art applied in the design-selection of materials for engineering applications. Materials degradation is one facet of the process to provide the most cost effective materials to meet system requirements.

9. Procurement Initiator (PI). The individual of the functional element authorized to prepare a procurement request.

10. Procurement Request (PR). The procurement/work directive and additional documentation required by AMCCOMR 715-1, 'Preparation of Procurement Requests'.

11. Project Officer (PO). The scientist, engineer, technician, industrial specialist, or other designated employee assigned by the PI to prepare the PR. The project officer may also be appointed as the Contracting Officer's Representative (COR) to represent the contracting officer in technical matters.

12. Statement of Work (SOW). That portion of the PR which details the technical work to be accomplished for the contract.

RESPONSIBILITIES:

1. In accordance with AMCCOMR 715-1, the responsibility for preparation of the PR is that of the PO. Thus, the PO will include CPC requirements in the PR as appropriate. The standard clauses contained in Attachment 1 are provided for general use. A copy of the current Data Item Description is provieded as Attachment 2.

2. In accordance with AMCCOMR 715-1, the responsibility for assuring that system quality requirements are included in the PR is that of the director of Product Assurance. This will be accomplished by the completion of AMCCOM Form 372, 'Product Assurance Requirements Checklist'.

3. The contractor is responsible for implementation of a CPC program appropriate for the contract effort described in the SOW. A preparation guide for the contractor's CPC plan is provided in Attachment 3.

4. In accordance with AMCCOM Supplement 1 to AMC-R-702-24, the CPAO at each research, development, and engineering center is responsible for assuring that proper emphasis is given to CPC within the respective center. This will be accomplished by providing direct support to each CPC related procurement requests.

5. In accordance with AMCCOM Supplement 1 to AMC-R 702-24, the AMCCOM CPAO is responsible for assuring that proper emphasis is given to CPC within the command. This will be accomplished by providing overall guidance and direct support to non-center initiated procurement requests.

PROCEDURES:

1. The PO will include provisions in the SOW requiring the contractor to address the application of principles for corrosion prevention and control. The scope of coverage will vary depending on the extent of the contract effort.

2. As requested, the CPAO will provide guidance to the PO in preparation of the SOW. This interface is intended to assure that the SOW addresses areas of potential material deficiencies gathered from past experiences. The PO should submit the draft SOW to the CPAO to facilitate preparation.

3. The designated quality assurance engineer from the Product Assurance Directorate (PAD) will complete AMCCOM Form 372, certifying that CPC is applicable and has been included in the PR.

4. As requested, the CPAO will provide guidance to the PAD quality engineer in the review of the SOW for CPC. This review may address deviation to the guidance described in Attachment 1 or when non-inclusion has not been adequately justified.

5. As requested, the CPAO will support the PO in the review of competitive solicitations when the CPC requirement will be used as criteria for evaluation. The support may include use of materials engineering personnel or corrosion/deterioration specialists as designated by the CPAO.

6. The review of the contractor CPC program plan, developed in accordance with the Data Item Description, will be provided for by the CPAO. This will be accomplished by coordination with the PO. Concurrence and/or appropriate comments will be provided to the PO, as requested.

7. The review of CPC actions during the contract will be provided for by the CPAO. This will be accomplished by coordinating CPC requirements with the PO and establishing an interface with the contractor as appropriate.

IMPLEMENTATION:

1. The CPAO at the Armament Research, Development & Engineering Center (ARDEC) and the Chemical Research, Development & Engineering Center (CRDEC) will establish contact with the organizations within the respective center; to provide support for each contract effort.

2. The AMCCOM CPAO will establish contact with other command organizations to provide support for each contract effort.

3. The AMCCOM CPAO will assure adherence to CPC requirements by periodic review of CPC efforts at each geographical location within AMCCOM.

4. To assure adherence to CPC requirements, a copy of all contractor CPC plans will be provided to the AMCCOM CPAO by annotating distribution to AMSMC-QAH (D) on DD Form 1423.

5. Assistance in the preparation of procurement requests and in contractor related matters may be obtained from the respective CPAO. A list of current Action Officers is contained in Attachment 4.

Attachment 1

CORROSION PREVENTION AND CONTROL GUIDE FOR CONTRACT STATEMENTS

The below general statement and tasks are intended for inclusion in statement of work (SOW) for development and acquisition contracts. The content of the SOW may be modified to include specific corrosion/deterioration requirements and DI-MISC-80171 listed in Task 2 below, may be tailored.

GENERAL: Corrosion Prevention and Control (CPC)

CPC is a program directed at the planned and organized prevention and control of materiel deterioration. Emphasis in the program is on the process of deterioration whereby a material undergoes a change in its properties or state through a reaction with its environment. The prevention of corrosion/deterioration, which applies to both metallic and non-metallic materials is the action taken in the design selection of materials to avoid conditions that induce deterioration or to apply preventatives in the form of preservatives or protective packaging.

TASKS:

Task 1. Corrosion Prevention and Control (CPC)

The contractor shall include the prevention and control of corrosion as an integral discipline during the design, development, and production of systems and associated equipment. Corrosion prevention shall include design for configuration, selection of materials, techniques for deterioration prevention, delineation of protective finishes, and specifications for materials and process control.

Task 2. Corrosion Prevention and Control Plan

The contractor shall develop a cost effective plan to address the prevention and control of corrosion. The plan shall be prepared and submitted in accordance with DD Form 1423, Data Item Description DI-MISC-80171.

Task 3. Progress Reports

The contractor shall include a separate section in all progress reports covering CPC. The reports shall summarize the contractor's efforts in applying the CPC principles, including material studies conducted, technical reviews, and test results which demonstrate performance.

Attachment 2

DATA ITEM DESCRIPTION

Form Approved
OMB No 0704-0188
Exp Date Jun 30 1986

1. TITLE	2. IDENTIFICATION NUMBER
MATERIEL DETERIORATION PREVENTION PLAN	DI-MISC-80171

3. DESCRIPTION/PURPOSE

3.1 This Data Item Description (DID) identifies the format and content requirement covered by the specific and discrete task for contractor to prepare this data product identified in the contract Statement of Work (SOW). (continued on page 2)

4. APPROVAL DATE (YYMMDD)	5. OFFICE OF PRIMARY RESPONSIBILITY (OPR)	6a. DTIC REQUIRED	6b. GIDEP REQUIRED
860519	A/STRBE-V		X

7. APPLICATION/INTERRELATIONSHIP

7.1 This DID contains the format and content preparation instruction for the data product generated by the specific and discrete task requirement for this data included in the contract.

7.2 The MDPP would normally be delivered within (90) days after contract award unless otherwise specified in the delivery schedule and stated on form DD 1423. This plan is revised as required. (continued on page 2)

8. APPROVAL LIMITATION	9a. APPLICABLE FORMS	9b. AMSC NUMBER
		A3852

10. PREPARATION INSTRUCTIONS

10.1 Contract. This data item is generated by the contract which contains a specific and discrete work task to develop this data product.

10.2 Format. The MDPP and revision shall be in the contractor's format and shall be typewritten on approximately 8½ x 11 inch white bond paper. Oversize pages/ spread sheets shall be folded to the dimensions of the volume.

10.3 Content. The MDPP shall delineate all management functions in planning, organizing, staffing, directing, controlling, (i.e. by key personnel, organization, policies, objectives, responsibilities, authority, coordination, interfaces, etc.) and all technical aspects (i.e. analysis, studies, methods, processes, techniques, evaluations, inspections, tests, etc.) applicable to an effective materiel deterioration prevention and control program to include the following:

10.3.1 Selection, evaluation, and use of materials.

10.3.2 Selection, evaluation, and use of parts, components, subassemblies and assemblies.

10.3.3 Selection, evaluation, and use of treatments, finishes, and coatings including applicable processes.

10.3.4 Selection, evaluation, and use of packaging materials, treatments and processes.

10.3.5 Review and evaluation of all specifications, drawings, and technical documentation.

3. DESCRIPTION/PURPOSE (Cont'd)

3.2 The Materiel Deterioration Prevention Plan (MDPP) delineates the contractor's management and technical plan to prevent and control materiel deterioration under the contractor's deterioration prevention and control program.

7. APPLICATION/INTERRELATIONSHIP (Cont'd)

7.3 The MDPP may be applicable to any type of contract with no defined dollar value or contract duration.

7.4 This DID is related to DI-E-1131 and DI-S-1804.

10. PREPARATION INSTRUCTIONS (Cont'd)

10.3.6 Reporting and resolution of any failure or potential failure traceable to materiel deterioration.

10.3.7 All materiel deterioration prevention aspects not previously addressed including potential problem areas.

10.3.8 Specific recommendations for enhancing the effectiveness and efficiency of the materiel deterioration prevention program.

Attachment 3

CORROSION PREVENTION AND CONTROL PLAN PREPARATION GUIDE

1.0 INTRODUCTION:

1.1 The corrosion prevention and control (CPC) plan is required to outline the contractor's approach in applying corrosion prevention principles for the item described in the contract.

1.2 The intent of this guide is to provide assistance in preparation of a good CPC plan. Nothing contained herein is intended as a mandatory requirement. The format may follow that which is provided in this guide; however, the contractor should expand the content as appropriate to describe specific program plans.

1.3 The introduction should include separate paragraphs describing the purpose and/or scope of the contractor's CPC program, identifying the end item and the action to be taken in conforming to the CPC requirements. Reference may be made to associated CPC requirements documents.

2.0 PROGRAM MANAGEMENT:

2.1 The plan should identity the overall program management to be employed in meeting CPC requirements, emphasizing materials engineering functions in support of the contract effort. Schematics of the program management structure may be utilized to clarify internal company functions.

2.2 Contractor Coordinator. The individual designated as the contractor coordinator for the CPC Program should be identified. The coordinator or point of contact should be designated as the individual responsible for ensuring that CPC principles and provisions are effectively incorporated in the contract effort.

2.3 Engineering Support. The plan should identify the organizational elements that will provide support in the contract effort. This should include in-house staff and/or industrial consultants to be utilized; identifying the area of expertise as appropriate to the contract effort. Typical examples of related functions include design and development, materials, production, producibility, process control, quality control, test and evaluation, inspection, standardization, and maintenance.

2.4 Responsibilities. The responsibilities of key personnel should be identified where appropriate. This should include the relationship between organizational elements and/or personnel. The plan should also identify the means employed to assure that CPC principles are applied to subcontractor activities.

2.5 Action Office Interface. The plan should reference the intended interface with the respective Corrosion Prevention Action Office. The contractor should identify the special assistance that may be needed in the contract effort. This includes consultation with government specialists and access to design information and lessons learned.

2.6 Reports. The plan should state how program actions for corrosion/deterioration prevention will be documented. Documentation should include progress reports, deficiency assessments, and the final technical report. One copy of all reports summarizing CPC activities should be provided to the representative designated in the contract.

3.0 Technical Approach:

3.1 Recognizing that corrosion prevention and control focuses on effective materials engineering practices, the CPC Plan should contain sufficient detail of the contractor's approach and practices in preventing the occurrence of deterioration. The contractor's methodology may be provided in schematic form illustrating the design process and the relationship the various engineering functions.

3.2 Design Engineering. The main focus of hardware development is in the design, which includes the materials design/selection process; considering design requirements, design configuration, producibility, materials and process standardization, the use of finishes and coatings, and standardization. Materials selection should include use of past experience or lessons learned, which should be identified when known. The plan should address these issues and provide a listing of appropriate corrosion design guides, specifications, and standards to be used.

3.2.1 Where the design and/or manufacturing effort includes use of materials having known limitations, the plan should identify the potential deficiency and the means to be used to circumvent potential deterioration and demonstrate acceptability.

3.2.2 When the contract effort is directed at hardware where the design configuration and materials are specified but subject to modification, the plan should include an overview of potential deterioration problems and potential solutions.

3.3 Production Engineering. Contract efforts which include the production of hardware should address contractor actions to be used in assuring adherence to the technical data package and/or specifications. Details of procedures related to materials acceptance testing, process control, and quality assurance should be provided.

3.4 Test and Evaluation. The plan should include contractor practices directed at assessing resistance to corrosion or other forms of materials deterioration. It should include a list of test methods directed at a realistic assessment of long term durability in consonance with life cycle system requirements. The procedure for reporting deficiencies encountered in testing should be identified.

3.5. Program Review. The plan should identify the procedure and frequency to be used for review of the CPC effort. This should include both internal contractor and government reviews.

4.0 MISCELLANEOUS:

4.1 This guide has been provided as a means to facilitate the preparation of the contractor's plan. Guidance in preparation of the contractor's plan may be obtained by contacting the Corrosion Prevention Action Office.

Attachment 4

LIST OF
CORROSION PREVENTION ACTION OFFICERS

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