



ARL-TR-9056 • SEP 2020



# Demonstration of Bonderite M-NT 7400 at Red River Army Depot

by Tom Braswell, Tom Considine, Lindsey Blohm, and Jack Kelley

Approved for public release; distribution is unlimited.

## **NOTICES**

### **Disclaimers**

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Citation of manufacturer's or trade names does not constitute an official endorsement or approval of the use thereof.

Destroy this report when it is no longer needed. Do not return it to the originator.



# Demonstration of Bonderite M-NT 7400 at Red River Army Depot

**Tom Braswell, Tom Considine, Lindsey Blohm, and Jack Kelley**  
*Weapons and Materials Research Directorate, CCDC Army Research Laboratory*

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188		
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. <b>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</b>					
1. REPORT DATE (DD-MM-YYYY) September 2020		2. REPORT TYPE Technical Report		3. DATES COVERED (From - To) 1 October 2019–1 November 2019	
4. TITLE AND SUBTITLE Demonstration of Bonderite M-NT 7400 at Red River Army Depot			5a. CONTRACT NUMBER		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) Tom Braswell, Tom Considine, Lindsey Blohm, and Jack Kelley			5d. PROJECT NUMBER		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) CCDC Army Research Laboratory ATTN: FCDD-RLW-MC Aberdeen Proving Ground, MD 2005			8. PERFORMING ORGANIZATION REPORT NUMBER  ARL-TR-9056		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S)		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT The US Army Combat Capabilities Development Command (CCDC) Army Research Laboratory (ARL) was invited to conduct a demonstration to help transition from the recently cancelled highly volatile organic compound-containing DOD-P-15328 hexavalent-chrome wash primer to a TT-C-490 Type IV-approved chrome-free alternative pretreatment. A technology with a similar application process as the wash primer was selected for the production facility at the Red River Army Depot (RRAD). This pretreatment was previously demonstrated successfully at the Letterkenny and Anniston Army Depots. The demonstration platforms used at RRAD were an abrasive-blasted M2/M3 Bradley Fighting Vehicle hull and several related parts assemblies. RRAD staff painters participated in the application of the alternative material using a modified high-volume low-pressure spray apparatus supplied by CCDC Army Research Laboratory. The production painters were trained onsite by Henkel personnel in the mixing and application of the pretreatment. Many were impressed with the ease of application compared with the wash primer. RRAD will move to implement the usage of the chrome-free product.					
15. SUBJECT TERMS demonstration, Bonderite, pretreatment, TT-C-490, chrome-free					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT  UU	18. NUMBER OF PAGES  27	19a. NAME OF RESPONSIBLE PERSON Tom Braswell
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER (Include area code) (410) 306-0935

## **Contents**

---

---

<b>List of Figures</b>	<b>iv</b>
<b>Acknowledgments</b>	<b>v</b>
<b>1. Introduction</b>	<b>1</b>
<b>2. Background</b>	<b>1</b>
<b>3. Spray Equipment</b>	<b>3</b>
<b>4. Demonstration of Spray-in-Place Henkel Bonderite M-NT 7400 Chrome-Free Wash Primer Replacement</b>	<b>4</b>
<b>5. Application</b>	<b>8</b>
<b>6. Parts and Assemblies Treated</b>	<b>10</b>
<b>7. Adhesion Testing</b>	<b>12</b>
<b>8. Conclusion and Mission Status</b>	<b>14</b>
<b>9. References</b>	<b>15</b>
<b>Appendix. Cancellation Notice for DOD-P-15328 Hexavalent-Chrome Wash Primer</b>	<b>16</b>
<b>List of Symbols, Abbreviations, and Acronyms</b>	<b>18</b>
<b>Distribution List</b>	<b>19</b>

## List of Figures

---

Fig. 1	HVLP gun modified to LVLP using a smaller fluid nozzle and fluid needle .....	3
Fig. 2	Stainless-steel pressure pot fitted with low-pressure gages and LVLP gun attached .....	4
Fig. 3	Bradley hull readied in wash bay .....	5
Fig. 4	Axle assemblies being sprayed with Bonderite M-NT 7400 .....	5
Fig. 5	Application with LVLP. Note masking tape to witness color change..	6
Fig. 6	Application with LVLP.....	6
Fig. 7	Application of Bonderite M-NT 7400 with garden sprayer.....	7
Fig. 8	Spray application of Bonderite M-NT 7400 onto aluminum sponson parts.....	7
Fig. 9	Finish achieved with LVLP spray gun. Note color change on Al where tape was removed.....	9
Fig. 10	Color change on steel where tape was removed .....	10
Fig. 11	Welded Al assembly not ready for paint application because of oil and weld spoils .....	11
Fig. 12	Hull not processed with Bonderite M-NT 7400 because of oil contamination.....	11
Fig. 13	Adhesion test on welded steel frame, 5B.....	12
Fig. 14	Adhesion test on Al part, 5B.....	13
Fig. 15	Adhesion test on axle assembly, 5B .....	13

## Acknowledgments

---

It cannot go without mentioning the combined efforts of the Red River Army Depot (RRAD) personnel and the Henkel Team. Everyone was focused on task to make this demonstration a success. From the forklift drivers to the painters, supervisors, quality team, and engineers, everyone was on target and congenial. Chris Otwell, paint process engineer, provided great leadership in directing everyone and keeping things on target. George Gomez, RRAD lead, was a great support in keeping the project moving forward and making sure we had all facilities in place. Jerry Bass, paint preparation manager, kept things moving and on schedule. William Miller, lead painter, clearly demonstrated his years of expertise handling a new technology, and his suggestions were greatly appreciated. RRAD is committed to making the change to a chrome-free pretreatment, and Henkel is there to support them. RRAD is geared to go full compliance using the Bonderite M-NT 7400 in production 2020.

RRAD Lead: Jorge Gomez, General Engineer, [jorge.e.gomez.civ@mail.mil](mailto:jorge.e.gomez.civ@mail.mil)

Chris Otwell – Paint Process Engineer, RRAD

Jerry Bass – Paint Preparation Manager, RRAD

Mike Wallace – Engineering Technician, RRAD

William Miller – Lead Production Painter, RRAD

ARL Lead: Thomas Braswell, Senior Systems Engineer,  
[thomas.e.braswell5.civ@mail.mil](mailto:thomas.e.braswell5.civ@mail.mil)

Jack Kelley – Materials Engineer, [john.v.kelley8.civ@mail.mil](mailto:john.v.kelley8.civ@mail.mil)

Thomas Considine – Materials Engineer, [thomas.a.considine.civ@mail.mil](mailto:thomas.a.considine.civ@mail.mil)

Henkel Team:

Benjamin Adams – Functional Coatings Application Engineer,  
[benjamin.adams@henkel.com](mailto:benjamin.adams@henkel.com)

Travis Creech – Sales Account Executive, [travis.creech@henkel.com](mailto:travis.creech@henkel.com)

Josh Schlup – Regional Sales Manager, [josh.schlup@henkel.com](mailto:josh.schlup@henkel.com)

Polly Anna Higgins – Field Service Engineer, [polly.higgins@henkel.com](mailto:polly.higgins@henkel.com)

## **1. Introduction**

---

In his mission to address the replacement of DOD-P-15328<sup>1</sup> wash primer with a compliant pretreatment in accordance with TT-C-490,<sup>2</sup> General Engineer Jorge Gomez of Red River Army Depot (RRAD) contacted the US Army Combat Capabilities Development Command (CCDC) Army Research Laboratory (ARL) Corrosion Team in the spring of 2019. RRAD requested assistance in coordinating the effort for initiating the use of a spray-in-place chrome-free pretreatment. Mr Gomez wanted to seamlessly transition to a qualified chrome-free pretreatment in place of wash primer while minimizing impact to the RRAD production process and maintaining compliance.

CCDC Army Research Laboratory coordinated the effort through a demonstration of a Type IV pretreatment in accordance with (IAW) TT-C-490 that would dovetail into RRAD's painting production and minimize changes to the process flow and equipment. ARL selected one of the Type IV TT-C-490 Qualified Products Database (QPD) products, Henkel Corporation's Bonderite M-NT 7400, as the initial material for demonstration of a spray-in-place wash primer replacement. This pretreatment was selected in part due to ARL's detailed knowledge of RRAD's process flow and equipment availability. In addition, an ongoing relationship with the Henkel Technical Team due to past successful demonstrations at Anniston Army Depot (ANAD)<sup>3</sup> and Letterkenny Army Depot (LEAD),<sup>4</sup> led ARL to coordinate another demonstration for RRAD working with the Henkel Technical Team. This demonstration consisted of the spray application of the Type IV pretreatment on a full Bradley Fighting Vehicle (BFV) hull, two steel axels, and several small components.

## **2. Background**

---

Per admixed gallon of coating, DOD-P-15328 wash primer contains 1.5 lb of hexavalent chromium pigment and over 6 lb of volatile organic compounds. It has been well documented that hexavalent chromium is a risk to human health and the environment, and as a result it is actively being phased out of commission. ARL completed program TMR-12-01<sup>4</sup> to examine the effectiveness and feasibility of alternative hexavalent-chrome-free spray-applied pretreatment technologies for multiple metal substrate types to replace DOD-P-15328. The candidate materials were laboratory tested to the requirements mandated in TT-C-490. The pretreatments that met or exceeded the requirements of TT-C-490 were listed on the specifications QPD as Type III (organic) and Type IV (inorganic) alternatives to wash primer.

The QPD, through the direction of TT-C-490, allows applicators the option to use these nonchromate alternatives without requiring drawing changes, effectively expediting the implementation of the alternative products. The most recent revision, TT-C-490G, offers even greater flexibility for implementing the products on the QPD. This revision allows for Type III and IV pretreatments to be used interchangeably, replacing hexavalent-chromium-based pretreatments such as the wash primer with chromate conversion coatings. Some of these qualified products were successfully demonstrated on military assets at ANAD,<sup>4</sup> LEAD,<sup>3</sup> and BAE York.

The success of TMR 12-01<sup>4</sup> and the revision of TT-C-490 with an added QPD facilitated the cancellation of DOD-P-15328 (Appendix). The specification was officially cancelled on 25 July 2018 with instruction to use Type III and Type IV pretreatments listed on the TT-C-490 QPD. The alternatives that meet performance requirements of TT-C-490 will be listed in the QPD for the specification. The QPD allows applicators the option to use these nonchromate alternatives without requiring drawing changes or engineering change notices.

Army Regulation (AR) 750-1<sup>5</sup> states that all Army-based ground equipment is required to have a full chemical agent resistant coating (CARC) system. The typical CARC system consists of a conversion coating or pretreatment in direct contact with the substrate, followed by an epoxy primer and polyurethane-based topcoat. Until recently, completed assemblies, whole platforms, and vehicles required a spray-applied DOD-P-15328 as the pretreatment.

RRAD remanufactures various components for the US Army, including BFVs, high mobility multipurpose wheeled vehicles, Multiple Launch Rocket System vehicles, and small arms. Previously, chromium-containing wash primers were used prior to paint application to meet the requirements of the former TT-C-490E revision. RRAD has resisted continued use of chrome wash primers due to the hazards associated with usage and disposal. The introduction of Bonderite M-NT 7400 allows RRAD to have a process fully compliant with TT-C-490 without the associated hazards of chrome wash primers and an application process that fits well within the production process at RRAD.

RRAD, through Jorge Gomez, requested that ARL conduct a demonstration of Bonderite M-NT 7400, one of the alternatives listed in the QPD. This demonstration was conducted the week of 21 October 2019 in cooperation with Henkel Corporation and the Process Engineering Division at RRAD in Building 412 D and the surrounding support bays.

### 3. Spray Equipment

ARL built and supplied a high-volume low-pressure (HVLP) spray unit, shown in Fig. 1, modified to low-volume low-pressure (LVLP), shown in Fig. 2. A smaller nozzle at 1 mm and corresponding fluid needle and low-pressure fluid gages and air gages were installed on the unit so that an applicator could achieve better atomization at a reduced delivery of the Bonderite M-NT 7400 as compared with wash primer. Whereas wash primer is normally sprayed at 8–12 oz/min during a production run, Bonderite M-NT 7400 and like pretreatments can be sprayed effectively at 3–6 oz/min to achieve a well-wetted substrate. Since the Bonderite M-NT 7400 is a true conversion coating, the equipment for spraying should be dedicated to avoid cross-contamination.



Fig. 1 HVLP gun modified to LVLP using a smaller fluid nozzle and fluid needle



**Fig. 2** Stainless-steel pressure pot fitted with low-pressure gages and LVLV gun attached

#### **4. Demonstration of Spray-in-Place Henkel Bonderite M-NT 7400 Chrome-Free Wash Primer Replacement**

---

The ARL team was asked to assist RRAD Paint Production in a demonstration of the transition from the recently cancelled DOD-P-15328 hexavalent chrome wash primer to a TT-C-490 Type IV-qualified chrome-free alternative pretreatment. ARL, in coordination with Jorge Gomez, selected as an alternative Henkel Bonderite M-NT 7400 because it has a similar application process for the production facility at RRAD. This pretreatment was previously successfully demonstrated at LEAD and ANAD. At RRAD the Bonderite M-NT 7400 was applied to multiple abrasive-blasted steel and aluminum (Al) assets, including hardware, weldments, and a BFV hull (Fig. 3). RRAD's lead painter applied the material using the HVLP/LVLP spray equipment supplied by ARL as well as a hand-pumped "garden sprayer". Application is shown in Figs. 3–8.



**Fig. 3** Bradley hull readied in wash bay



**Fig. 4** Axle assemblies being sprayed with Bonderite M-NT 7400



**Fig. 5 Application with LVLP. Note masking tape to witness color change.**



**Fig. 6 Application with LVLP**



**Fig. 7** Application of Bonderite M-NT 7400 with garden sprayer



**Fig. 8** Spray application of Bonderite M-NT 7400 onto aluminum sponson parts

## 5. Application

---

The application procedure does not significantly differ from the wash primer application. This similarity, in itself, leads to greater buy-in from the applicators on staff, as there is little in the way of retraining to be done since the application equipment is familiar to the artisans. The selected AI parts, including the BFV hull, steel weldments, and axle assembly components were prepared according to standard procedure for wash primer application. This preparation included degreasing and detergent pressure washing in a wash bay, followed by abrasive blasting in a blast booth. Following cleaning and abrasive blasting, the parts were cleaned of the blast media spoils remaining on the surfaces by staff with air nozzles. The applicators then had a 24-h window in which to apply the pretreatment.

Bonderite M-NT 7400 was supplied as a concentrate, which was mixed with deionized water to yield an 8% solution. The operators used graduated beakers and a graduated sprayer tank to assure proper mixing consistency. An analysis of the prepared solution performed by RRAD showed 19.1 mL of the concentrate yielded a 9.1% solution (pH 2.7). The procedure for mixing Bonderite M-NT 7400 is easier than mixing wash primer. Bonderite M-NT 7400 requires no significant agitation and has no induction time, whereas wash primer typically requires agitation and a 15- to 30-min induction time. Additionally, Bonderite M-NT 7400 has no practical pot-life limitations. Bonderite M-NT 7400 essentially remains in the mixing vessel until used or the remaining material can be stored in a sealed container for later use. The pot life of the wash primer is quite short (4–8 h depending on the manufacturer), which leads to significant waste in terms of operator mixing time and costly hazardous material waste disposal.

Bonderite M-NT 7400, as witnessed in multiple events, is best applied using a pressure pot and a modified HVLP or LVLP spray gun, in much the same way as the wash primer is applied. The modifications, using a smaller 1-mm fluid nozzle with corresponding fluid needle and a pressure pot with low-pressure gages, not only facilitates better atomization of the Bonderite M-NT 7400, but greatly reduces the material used, as evidenced by the unused material left over in the pot after each event.

This setup gives the operator very precise application control (3–10 oz/min). During the demo the garden sprayer was also successfully used but exhibited a much slower application rate and a visibly less-uniform application. Bonderite M-NT 7400 functions most successfully as a light mist coat; in this demonstration it was sprayed at approximately 6 oz/min through an HVLP/LVLP setup. The substrate needs only to be wetted for the pretreatment to react with the base metal.

The final step in the application of the pretreatment is to allow the product to air dry. Outside of extreme weather conditions, the dry time for coated objects can range from minutes to just under an hour. At RRAD, with the temperature at the application ranging in the 70s °F and the humidity in the 50s in percent, the dry time was less than 15 min. When the areas masked with tape on the Bradley hull were removed, the Bonderite M-NT 7400 pretreatment showed a darker, somewhat blue-gray iridescent film, easily identified in Figs. 9 and 10.



**Fig. 9** Finish achieved with LVLP spray gun. Note color change on Al where tape was removed.



**Fig. 10** Color change on steel where tape was removed

## **6. Parts and Assemblies Treated**

---

Some parts staged for pretreatment were not coated. As with wash primer and paint, the substrates must pass a visual cleanliness check and water break test IAW MIL-DTL-53072,<sup>6</sup> the CARC application specification. In some cases, parts submitted to the team had oil, grease, and/or weld smut that would interfere with the conversion coating and subsequent coating performance. These parts were not approved for painting and provided a learning experience for the RRAD crew. The remaining parts were masked as required for painting and were subsequently primed. As for the Bradley hull, even though information was captured during the demos, the hull could not be used for follow-up testing because it had to be returned for weld repair. Examples of these issues are shown in Figs. 11 and 12.



**Fig. 11** Welded Al assembly not ready for paint application because of oil and weld spoils



**Fig. 12** Hull not processed with Bonderite M-NT 7400 because of oil contamination

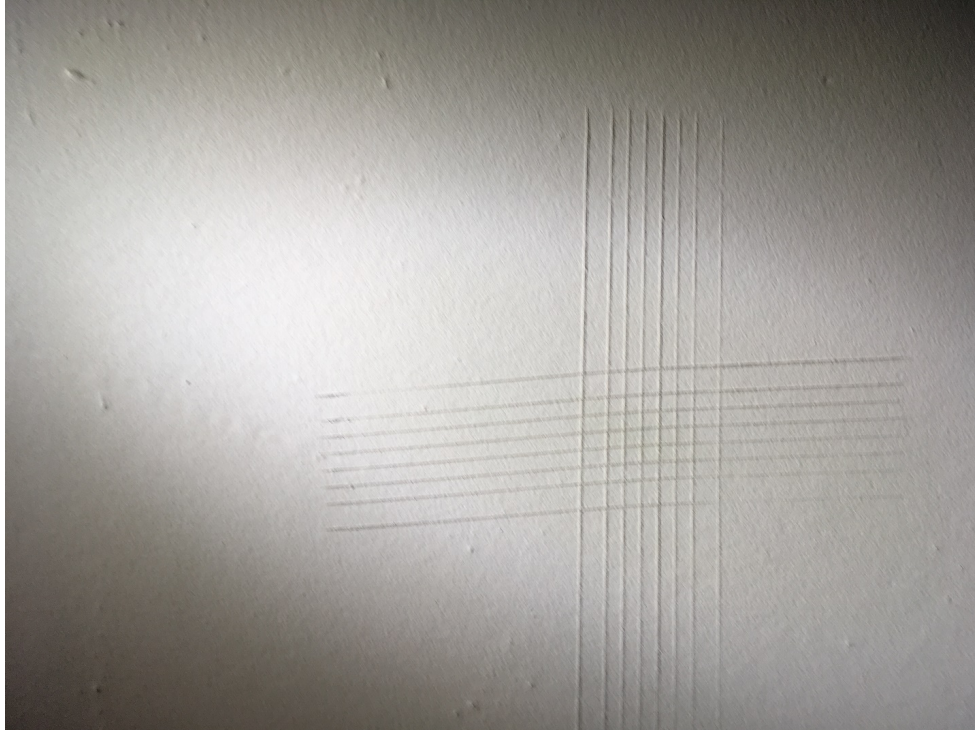
## 7. Adhesion Testing

---

All of the primed parts were scribed IAW ASTM D3359<sup>7</sup> Method B with 3M 250 tape the following day, after approximately 14 h of ambient cure. All tape adhesion tests passed at 5B without any pull-off. Examples of these adhesion tests are shown in Figs. 13–15.



**Fig. 13 Adhesion test on welded steel frame, 5B**



**Fig. 14** Adhesion test on Al part, 5B



**Fig. 15** Adhesion test on axle assembly, 5B

## **8. Conclusion and Mission Status**

---

ARL demonstrated the successful application of a chrome-free pretreatment qualified to TT-C-490 Type IV to replace DOD-P-15328. The team left the site with a path forward directed by and with assistance from the competent Henkel technicians to support the RRAD facility and begin the use of a chrome-free pretreatment, Henkel Bonderite M-NT 7400, IAW TT-C-490 Type IV. Furthermore, the lead painter and several other painters were trained in the mixing and use of the Bonderite M-NT 7400. The quality assurance representatives for paint area were also on hand to witness and buy in to the process. ARL also completed an exit interview with the general engineer, paint process engineer, paint preparation manager, and the technical team from Henkel Corporation. This meeting resulted in authorization to begin using TT-C-490 Type IV, Henkel Bonderite M-NT 7400 chrome-free pretreatment. Finally, a technical report was produced by Henkel with respect to their involvement with the demonstration.<sup>8</sup>

## 9. References

---

1. DOD-P-15328. Primer (wash), pretreatment (formula no. 117 for metals). Washington (DC): US Department of Defense; 1978 Apr.
2. TT-C-490. Chemical conversion coatings and pretreatments for metallic substrates (base for organic coatings). Washington (DC): Department of Defense (US); 2019.
3. Considine T, Braswell T, Kelley J. Demonstration of Bonderite M-NT 7400 at Anniston Army Depot. Aberdeen Proving Ground (MD): Army Research Laboratory (US); 2018 Dec. Report No.: ARL-SR-0412.
4. Kelley J, Considine T, Braswell T, Farrell A. Verification and demonstration for transition of nonhexavalent chromium, low-volatile organic compound (VOC) alternative technologies to replace DOD-P-15328 wash primer for multimetal applications. Aberdeen Proving Ground (MD): Army Research Laboratory (US); 2017 Sep. Report No.: ARL-TR-8169.
5. AR 750-1: Army materiel maintenance – maintenance of supplies and equipment. Washington (DC): Department of the Army (US); 2013.
6. MIL-DTL-53072. Chemical agent resistant coating (CARC) system application procedures and quality control inspection. Washington (DC): US Department of Defense; 2003 June.
7. ASTM International. Standard test methods for measuring adhesion by tape test. West Conshohocken (PA): ASTM International; 2017.
8. Henkel Corporation. Red River Army Depot Bonderite M-NT 7400 trial. Madison Heights (MI): Henkel; 2020 Feb.

**Appendix. Cancellation Notice for DOD-P-15328 Hexavalent-  
Chrome Wash Primer**

---

NOTICE OF  
CANCELLATION

METRIC

DOD-P-15328D  
NOTICE 2  
25 July 2018  
SUPERSEDING  
DOD-P-15328D  
NOTICE 1  
21 March 1992

DETAILED SPECIFICATION

PRIMER (WASH), PRETREATMENT (FORMULA NO. 117  
FOR METALS) (METRIC)

DOD-P-15328D, dated 21 Apr 1978, is hereby cancelled.

Future acquisitions for this item may refer to:

TT-C-490F      “Chemical Conversion Coatings and Pretreatments for Metallic  
Substrates (Base for Organic Coatings)”. Users are instructed to use the  
Type III (greater than 50% organic compounds by weight in the dried  
film) and Type IV (greater than 50% inorganic compounds by weight in  
the dried film) products listed under QPL-TT-C-490.

CAUTION: The supersession information is valid as of the date of this notice and may be  
superseded by subsequent revisions of the superseding document.

(Copies of these documents are available online at <https://assist.dla.mil>)

Custodians:  
Army - MR  
Navy - SH

Preparing Activity:  
Army - MR  
(Project 8010-2018-001)

Review activities:  
Army - AV  
Navy - AS, SA, YD

NOTE: The activities listed above were interested in this document as of the date of this  
document. Since organizations and responsibilities can change, you should verify the currency of  
the information above using the ASSIST Online database at <https://assist.dla.mil>.

AMSC N/A

FSC 8010

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

Source: <https://assist.dla.mil> -- Downloaded: 2018-08-15T15:23Z  
Check the source to verify that this is the current version before use.

## List of Symbols, Abbreviations, and Acronyms

---

Al	aluminum
ANAD	Anniston Army Depot
ARL	Army Research Laboratory
BFV	Bradley Fighting Vehicle
CARC	chemical agent resistant coating
CCDC	US Army Combat Capabilities Development Command
HVLP	high-volume low-pressure
IAW	in accordance with
LEAD	Letterkenny Army Depot
LVLP	low-volume low-pressure
QPD	Qualified Products Database
RRAD	Red River Army Depot
Type III	organic
Type IV	inorganic

1 DEFENSE TECHNICAL  
(PDF) INFORMATION CTR  
DTIC OCA

1 CCDC ARL  
(PDF) FCDD RLD DCI  
TECH LIB

4 CCDC ARL  
(PDF) FCDD RLW MC  
T BRASWELL  
L BLOHM  
T CONSIDINE  
J KELLEY