Defense Standardization Program

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2022

Standardization Stars

Distinguished Award Winner:
MIL-STD-889, Revision D, "Galvanic Compatibility of Electrically Conductive Materials"

Revision of MIL-DTL-46027, "Armor Plate, Aluminum Alloy, Weldable 5083, 5456, and 5059," for Improved Protection, Manufacturing, and Service Life

Insensitive Munitions Disposal

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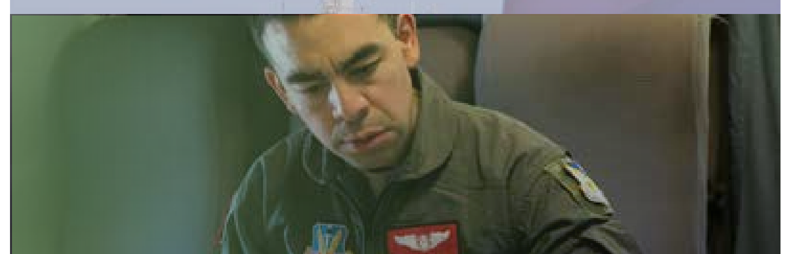

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Director’s Forum

Standardization Stars

The goals of the Defense Standardization Program are to improve military operational readiness, reduce total ownership costs, and reduce cycle time. Standards capture and codify common solutions so that they may be shared across the military services and defense agencies, with industry and with our allies. They are a vital facet of the planning and preparedness required for warfighter capabilities. They are used to provide the warfighter with equipment that is interoperable, reliable, technologically superior, and affordable.

The Defense Standardization Program annually recognizes individuals and teams from the military departments and defense agencies who have achieved significant results in supporting the standardization mission. Every year, Standardization Executives and Departmental Standardization Officers seek exceptional performers in their departments and agencies. The Defense Standardization Program Office analyzes each nomination and rates them for standardization accomplishments, timing of implementation, reduction in ownership costs, breadth of application, and difficulty of coordination. This year, instead of our typical awards ceremony format, we took advantage of the opportunity to recognize the FY21 awardees at our bi-annual conference in front of a larger audience, which consisted of both in-person and virtual participants. This issue of the *DSP Journal* highlights the accomplishments of the awardees, which includes teams from each of the military departments.

This year’s winners worked with allies, partners in industry, and other standards developers to develop new techniques, tools, and procedures to tackle complex, militarily-unique technical challenges. They are as follows:

DISTINGUISHED ACHIEVEMENT AWARD WINNER
MIL-STD-889D; GALVANIC COMPATIBILITY OF ELECTRICALLY CONDUCTIVE MATERIALS REVISION TEAM; NAVAL AIR WARFARE CENTER

Corrosion affects maintenance costs and operational readiness. DoD estimates corrosion costs at more than $20 billion annually. However, roughly a third of those costs could be avoided through investment in sustainment, design, and preventative measures. This team reduced costs by codifying a new method for calculating the corrosion current between dissimilar metals. The revised method better indicates corrosion potential; for example, identifying metal pairings that reduce the average yearly corrosion rate by as much 60 times. The team coordinated with each of the military services, original equipment manufacturers (OEMs), non-government standards bodies, such as SAE international, ASTM international, and NACE International, and adjudicated hundreds of comments. This method reduces the occurrence of corrosion damage and structural failure, especially in complex systems, such as aircraft and electronics.

STANDARDIZATION ACHIEVEMENT AWARD WINNERS

REVISION OF MIL-DTL-46027, "ARMOR PLATE, ALUMINUM ALLOY, WELDABLE 5083, 5456, AND 5059," FOR IMPROVED PROTECTION, MANUFACTURING, AND SERVICE LIFE; U.S. ARMY

The revision encompasses the latest process advances in 5083 armor plate, including hardening of plates with more than three times the maximum thickness of the previous version. This improvement enables production using high-speed machining rather than welding components, improving quality, enhancing survivability, reducing costs, and increasing manufacturing throughput. After its approval, ASSIST published the revision last September. The cost savings from using 14 components machined from thick plate for the U.S. Army armored multipurpose vehicle is estimated at between $45 million to $75 million across a fleet of approximately 3,000 vehicles. The team worked with other government agencies, aluminum plate producers, and various OEMs to develop the new qualification procedure for plates beyond four inches, opening new possibilities for use of thick plates and enabling breakthroughs in production of current and future armored ground systems.

U.S. AIR FORCE EXPLOSIVE ORDNANCE DISPOSAL TECHNOLOGY DIVISION–EQUIPMENT REVIEW BOARD TEAM; U.S. AIR FORCE

This team facilitated the creation of material solutions along with standardized joint-service technical manuals outlining the use of new tools and tactics for disposing of insensitive munitions. The team worked with dozens of scientists, chemists, engineers, and project managers to deploy a $250 million science and technology portfolio and solve one of the biggest explosive problems of the 21st century. While the use of insensitive munitions has doubtlessly saved hundreds, probably thousands of lives, it also made the job of explosives ordinance disposal technicians exponentially more difficult. This team created innovative material solutions, some of which are 3D printable, standardized technical manuals for use of the new tools, and solved a critical safety problem for U.S. joint forces and 28 NATO allies.

> "Congratulations to the FY21 winners. Your dedication and resourcefulness in enhancing standards plays a crucial role in supplying capable, reliable, and affordable systems and equipment to those who defend our freedom. This work is the foundation of success for the Department of Defense.
>
> The DSP Achievement Awards call for nominations is disseminated every fall. It is my hope that our readers will submit their exceptional achievements for the FY22 awards."

Michael A. Heaphy Jr.
Director
Defense Standardization Program Office

MIL-STD-889, Revision D, "Galvanic Compatibility of Electrically Conductive Materials"

Award Winner: Naval Air Systems Command (NAVAIR); Naval Air Warfare Center Aircraft Division Lakehurst (NAWCAD LKE); Mission Operations and Integration Department; Systems Standardization and Packing, Handling, Storage, and Transportation (PHST); Joint Base McGuire-Dix-Lakehurst (JBMDL), NJ; NAWCAD, Air Systems Group (ASG): Corrosion and Wear Branch, Code AB23600

The successful publication of MIL-STD-889, Revision D, "Galvanic Compatibility of Electrically Conductive Materials," improves the military standard for selecting corrosion control materials throughout the design phase of DoD assets, such as aircraft and ground combat vehicles. DoD benefits from reduced corrosion costs through investment up front in the early stages of the acquisition cycle for preventative measures, such as protective coatings, avoidance of dissimilar metals, and other corrosion preventative design guidelines. Mitigating corrosion reduces downtime due to repair as well as control, thereby increasing mission readiness.

The revised military standard defines and classifies galvanic compatibility of electrically conductive materials. Previously, galvanic tables were based solely on the corrosion voltage potentials of two conductive materials in a galvanic couple. However, since the potential difference does not incorporate the corrosion current, the galvanic potential difference between material couples does not truly indicate galvanic corrosion. Therefore, the publication classifies dissimilar materials based on corrosion current in lieu of the voltage potential difference and outlines the procedures for generating electrochemical corrosion current data for the analysis of new electrically conductive materials, coatings, and surface treatments.

DISCUSSION

BACKGROUND

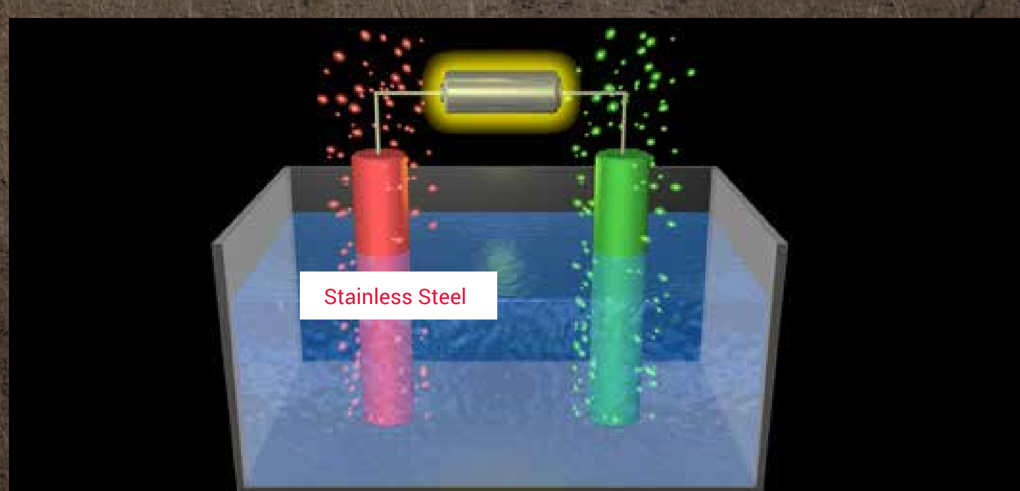
With more than $20 billion spent annually, corrosion is a major cost for maintaining defense equipment and facilities.[1] As a primary cause of structural failure, corrosion, particularly galvanic corrosion between dissimilar materials, puts aircraft and other military platforms out of service for rework and repair. Galvanic corrosion occurs when exposure to an electrolyte common between two dissimilar conductive materials in electrical contact creates an electrical current between the two. Due to the recurrent use of disparate materials, galvanic corrosion is the most serious corrosion mechanism in naval aircraft because of the corrosive seawater environment. Cracks commonly initiate from galvanically driven corrosion pits around fastener holes. A U.S. Air Force study[2] concluded that 80% of structural failures originated from these corrosion pits.

Consequently, there is a need to improve protection from galvanic corrosion. The historical method of predicting the effects of the corrosion developed a galvanic series by arranging materials in order of observed corrosion potentials. The relative position of the two metals in the series predicts the metals most likely to suffer increased galvanic corrosion in a specific environment.

One type of galvanic series lists the metals of interest in order of their corrosion potentials, starting with the most active (electronegative) and proceeding to the most noble (electropositive). Listing the potentials themselves (versus an appropriate reference half-cell) enables calculation of the potential difference between metals in the series.

Generally, when coupled, the more active (anodic or electronegative) metal undergoes electron dissolution while the more noble (electropositive or cathodic) metal increases in electron density. The distance between the two metals in the series drives the mitigation approach. The further the distance between two metals in the series, the greater the potential difference between them and, thus, the greater the potential driving force for galvanic corrosion.

In mixed material assemblies, however, the electrochemical kinetics (i.e., the corrosion current) of the materials influence the severity of corrosion in addition to the galvanic potential difference, yet the two are not directly related.



[1] United States Government Accountability Office (GAO), GAO-19-513, "Defense Management: Observations on Changes to the Reporting Structure of DOD's Corrosion Office and Its Implementation of GAO Recommendations," May 2019, p. 2.

[2] G. Shoales, et al., "Compilation of Damage Findings from Multiple Recent Teardown and Analysis Programs." Proc. of the 25th Symposium of the International Committee on Aeronautical Fatigue (ICAF), May 27–29, 2009 (Stockholm, Sweden: ICAF, 2009).

As a result, an improved method for predicting galvanic corrosion using a mixed-potential approach was proposed.

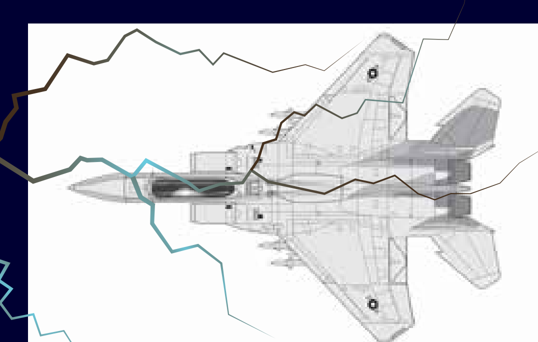
PROBLEM/OPPORTUNITY

What is the danger of relying on galvanic tables based on the voltage (potential)?

SCENARIO: AN ENGINEER PERFORMING MAINTENANCE ON THE WING OF AN F-18 AIRCRAFT

After a few years of the aircraft's service life, the engineer opens the wing to reveal hundreds of bolt holes, all galvanically corroded. The repair procedure grinds away corroded material and inserts a bushing to restore the hole diameter. Two bushing material options are available: stainless steel and titanium. How does the engineer select which bushing to use? Previous **revisions to MIL-STD-889 indicate that stainless steel is a much better material** to use because of its lower potential (voltage) difference with aluminum.

However, the next time the aircraft comes in for repair, corrosion is much worse around the bushings and they all must be removed and replaced with bigger ones, causing even worse corrosion. The galvanic potential tables produce a compounding corrosion issue by depicting stainless steel as a better material choice over titanium based on the potential difference.



Although the potential (voltage) between titanium and aluminum indicates that titanium is a worse pairing with aluminum, this pairing takes longer to corrode. Aluminum alloys corrode at a slower rate when coupled with titanium than when coupled with stainless steels. This experience proves that, even though the potential difference between the aluminum and titanium is not favorable, pairing materials based on kinetics can delay corrosion and maintain aircraft longer than pairs chosen based on potential.

DESCRIPTION

The new method of calculating the corrosion current between two dissimilar metals is also referred to as the materials' mixed potential. When the same electrolyte couples two different materials, both polarize to a new potential between the two uncoupled corrosion potentials, as explained by mixed-potential theory: when two dissimilar materials come in physical contact in the presence of an electrolyte, the total current from the corroding material must equal the total current from the noble material.

Plotting the current produced as a function of applied potential illustrates this curve crossing, called a polarization curve. The magnitude of current flow and the increase in corrosion rate due to this coupling come from the tendency of each of the materials in the couple to deliver current when its potential is forced to change, called polarization. For galvanic corrosion, the curve crossing or intersection of the anodic curve of the less noble metal of the couple with the cathodic curve of the more noble metal gives the galvanic corrosion current (I_{corr}) and potential of the couple for equal surface areas, as depicted in *Figure 1*.

As shown in *Figure 1* the corrosion current (I_{corr}) is calculated from the intersection of the anodic curve of the less noble member of the couple (aluminum) with the cathodic curve of the more noble metal in the couple (titanium). When creating the same plots for aluminum and stainless steel, the I_{corr} (or corrosion current) for the aluminum and stainless-steel couple

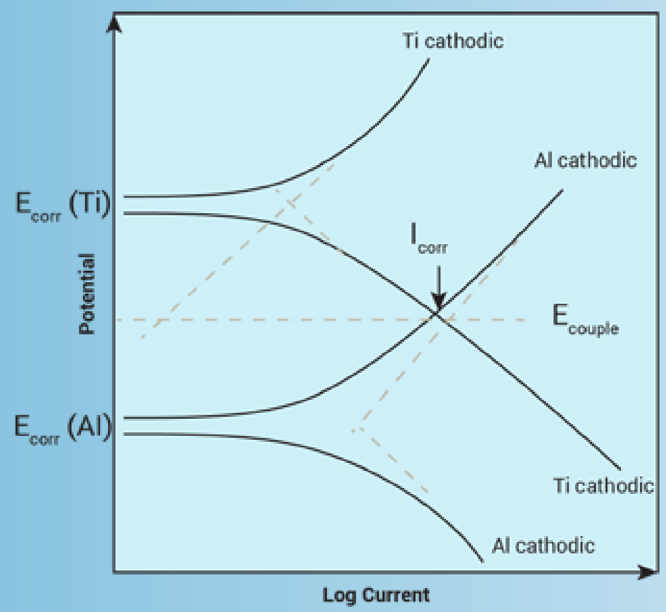


***Figure 1:** Polarization Curve Crossing between the Less Noble Material (Aluminum, Anode) and the More Noble Material (Titanium, Cathode)*

are greater that the corrosion current for the aluminum and titanium couple. Because of the lower corrosion current of the titanium and aluminum couple, the corrosion rate of the aluminum is lower when coupled with titanium. The method based on the voltage (potential) differences selects stainless steel instead of aluminum, since the potential (voltage) difference between aluminum and stainless steel is lower.

Appendix B of MIL-STD-889, Revision D, details how to obtain the polarization curves for various dissimilar material couples. Instead of using the intersection of an anodic curve of a less noble metal of the couple with a cathodic curve of a more noble metal to calculate the corrosion current, this appendix offers information on generating joint sample polarization curves. First, sum the anodic reactions of both conductive materials. Then, sum the cathodic reactions of both conductive materials. The intersection point of the summed anodic reactions with the summed cathodic reactions produces the galvanic potential and current. Galvanic potential is the potential value at the intersection point. Galvanic current is the current value at the intersection point. The galvanic current can then calculate the corrosion rate of the anodic member of the couple using Faraday's law.

AWARDEE INVOLVEMENT

This significant NAVAIR team effort involved collaboration across multiple sites. The awardees of the NAVAIR Patuxent River Corrosion and Wear Branch established a method of obtaining potential dynamic polarization data. Academia, industry, and NAVAIR completed round-robin testing, per ASTM E691. Appendix B of MIL-STD-889, Revision D, establishes and specifies the method, which offers a best practices approach for generating consistent and valid data across laboratories. The NAWCAD LKE System Standardization and PHST Branch awardees prepared the draft revision and coordinated it with DoD and industry. They further compiled, organized, and prioritized the 274 comments from the document coordination. The coordination cycle was extensive and the stakeholders included all the military services, original equipment manufacturers, and non-government standards bodies, such SAE International, ASTM International, and NACE International. The Patuxent River awardees adjudicated the compiled comments before the Lakehurst awardees edited, prepared for publication, and ultimately issued the final draft.

OUTCOME

Through their extensive work, the awardees published Revision D to MIL-STD-889 on July 21, 2021, with an updated title of "Galvanic Compatibility of Electrically Conductive Materials" to reflect the increasing use of non-metallic composite materials in military platforms. Revision D to MIL-STD-889 consists of four parts: the main body of the standard and three appendices. The main body details design requirements. Appendix A recommends surface protective treatments. Appendix B specifies the required methods for the preparation and acquisition of polarization data for dissimilar material couples. Appendix C supplies a tutorial on galvanic corrosion.

Table III in MIL-STD-889D confirms that titanium is a better match over stainless steel for coupling with aluminum, even though the previous predictions used the metal with the lower voltage difference, i.e., stainless steel. A286 Passivated stainless steel was used with 7075 aluminum with a trivalent chemical conversion coating, or A/7075Cr+3. Per Table III in MIL-STD-889D, when A286 Passivated couples with A/7075Cr+3, it receives a rating of 3, translating to 1 to 4.99 mils per year (or 1,000 to 4,990 micro-inches per year). When A/7075Cr+3 couples with titanium Ti-6AL-4V, it has a rating of 1, translating to a corrosion rate of 0.01 to 0.09 mils per year (or 10 to 90 micro-inches per year). Therefore, the revised method better indicates corrosion potential, showing titanium as a much better match for aluminum because it has an average yearly corrosion rate 60 times lower than aluminum coupled with stainless steel.

PAYOFF

MIL-STD-889 will become an integral part of defense contractors' corrosion control and prevention plans. Not instituting a proper corrosion protection program is costly to DoD. The Defense Acquisition University (DAU) and Office of the Secretary of Defense (OSD) have attempted to quantify the effect of corrosion on maintenance costs and readiness, estimating that corrosion costs DoD more than $20 billion annually and "approximately 25% of all systems/equipment and facility maintenance is attributable to corrosion."[3] According to OSD estimates, approximately 30% of current DoD corrosion costs could be avoided through investment in sustainment, design, manufacture, and other preventative measures, such as paint and avoidance of dissimilar metals.

Revision D to MIL-STD-889 incorporates a new, more reliable method to access the compatibility of dissimilar materials, decreasing corrosion problems during the entire lifecycle of the military platform and potentially saving DoD billions of dollars. Referencing MIL-STD-889D in materials and process contract specifications will ensure inclusion of uniform material selection and coating compatibility in the initial design and verification as a part of the test and acceptance programs applicable across all services' aerospace weapons systems. Ultimately, the MIL-STD-889 D revision will improve the safety, reliability, and maintainability of DoD's aerospace weapon systems. The increased corrosion protection afforded by proper use of MIL-STD-889 during the design phase is one of the key factors in corrosion prevention, reducing fleet downtime and improving mission readiness.

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[3] DAU Acquipedia, "Corrosion Prevention and Control (CPC)," accessed August 2022.

CURRENT STATUS

MIL-STD-889, Revision D, published on July 21, 2021, resides in the ASSIST database, and can be instituted and implemented in system acquisition documents. MIL-STD-889 will be one of several key documents for corrosion prevention and control in systems engineering plans and lifecycle sustainment plans, and ensure inclusion of corrosion control requirements in the design and verification as part of test and acceptance programs. Most defense contracts will require suppliers to use MIL-STD-889 to minimize corrosion and many manufacturers of non-military equipment will follow the same approach. The specification shift from galvanic potential tables to accurate galvanic corrosion rates is a positive modification to reduce corrosion damage and structural failure, especially in complex systems, such as electronics and aircraft.

PROBLEMS IN THE EFFECTING SOLUTION

- Coordinating beyond DoD.
- Coordinating and negotiating with stakeholders.
- Pursuing the participation of corrosion specialists, program managers, systems engineers, lifecycle logisticians, contracts, and cost estimate and budget personnel.
- Adjudicating the voluminous comments.
- Resolving controversy and disagreements.
- Pursuing final concurrence of the military standard.
- Round-robin testing encompassing academia, industry, and NAVAIR to generate consistent and valid potentio-dynamic polarization data across laboratories.

Revision of MIL-DTL-46027, "Armor Plate, Aluminum Alloy, Weldable 5083, 5456, and 5059," for Improved Protection, Manufacturing, and Service Life

Award Winner: U.S. Army

On September 21, 2021, the Defense Logistics Agency approved and published the revision to the detail specification MIL-DTL-46027M, "Armor Plate, Aluminum Alloy, Weldable 5083, 5456, and 5059," authored by the Development Command (DEVCOM) Army Research Laboratory (ARL) Weapons & Materials Research Directorate. This major revision encompasses the latest process advances in 5083 armor plate, enabling strain hardening in plates up to 10.5 inches thick, well beyond the prior maximum of 3.0 inches from the 2015 revision. Through the increase in maximum thickness of 5083 aluminum armor plate, high-speed machining can produce vehicle components previously only fabricated as welded components.

The resultant machined components are less expensive to integrate into welded combat vehicle hulls than their welded analogs and improve quality, enhance survivability, and increase manufacturing throughput. Components manufactured from thick 5083 plate are applicable to aluminum-hulled combat systems, have been prototyped, and are being demonstrated on the U.S. Army armored multipurpose vehicle (AMPV), the M109 family of vehicles, and other future platforms. The revised specification significantly improves production and reduces component inventory. Further, the inclusion of guidance for proper storage of plates prior to application and an optional requirement for mechanical testing under thermal load maximizes the integrity and quality of armored system builds and repairs.

DISCUSSION

BACKGROUND

As production of the new AMPV ramped up in 2017, ManTech initiated a project to streamline the production timelines of armored hulls by simplifying manufacture of combat vehicle hull components. At the time, multiple plates and forgings were machined, fit-up, welded, inspected, repaired, and reworked to ultimately fabricate an aluminum combat vehicle hull. To minimize the number of complex welded component assemblies, thicker aluminum alloy 5083 source materials were needed. Forging, extruding, or rolling thicker plates produce thicker source materials for wrought armor quality 5083. Over the course of four years, the ManTech project worked with industry to mature the processes required to produce strain-hardened aluminum armor plates up to 10.5 inches thick, utilize high-speed machining to fabricate these plates in single-piece hull components, and integrate the plates into combat vehicle hulls. Numerous mechanical and ballistic experimental calculations fully verified the properties of the thick, wrought plate.

PROBLEM/OPPORTUNITY

In addition to the significant gains in production speed, product simplification, cost avoidance, and improved quality through the utilization of thick, wrought armor plate, the team integrated ongoing ARL investigations of lifecycle material performance associated with thermal degradation of 5083 aluminum armor plate into the specification.

Recently, mechanical property degradation resulting from exposure to elevated temperatures (beyond 55°C) for extended periods was confirmed and quantified, necessitating tighter control of material expected to withstand these conditions over its service life. Coupling these results with avoiding the cumulative degradation of properties from the significant thermal cycling of repeated welding steps no longer required when using components machined from thick plate greatly improves the resultant properties and overall service life, offering a true win-win-win scenario of more rapid production by the original equipment manufacturers (OEMs), extended service life for the program executive office (PEO), and improved protection for the soldier.

DESCRIPTION

In 2019, initiation of the Thick Plate Working Group occurred through a series of face-to-face meetings and later transitioned to virtual meetings every two weeks during the COVID-19 pandemic. The working group planned to supply large, complex, ballistic-qualified components for AMPV production and demonstrate their applicability for other aluminum-armored systems.

The Thick Plate Working Group consisted of government representatives from DEVCOM ARL; PEO Ground Combat Systems; Program Manager (PM) Mounted Armored Vehicle (MAV); PM Self-Propelled Howitzer Systems; Deputy Assistant Secretary of the Army Plans, Programs, and Resources (DASA PP&R); the aluminum plate manufacturer Constellium; machining specialists Johnston Welding and Fabrication (JWF) and Wagstaff; and combat vehicle manufacturer BAE Systems. The DoD Corrosion Policy & Oversight Office, under a Testing & Evaluation Program, supported further interest to improve this specification with respect to quantification of the mechanical degradation of sensitized and thermally exposed aluminum armor plates.

AWARDEE INVOLVEMENT

The key to success for any specification effort includes not only the development or revision of its requirements and characteristics but its review and maintenance to keep the document relevant and up to date so its implementation can continue over time. This major effort to revise MIL-DTL-46027 consisted of not only defining the ballistics requirements of thicker plates but including the new thermal requirements to best preserve the critical properties of plates and maximize service life. To facilitate this goal, our team consisted of five specifically designated individuals from ARL, each with their own specific talents and expertise. The following team members contributed to the success of this highly visible and critical standardization effort.

Dr. Bryan Cheeseman*: As project leader of the U.S. Army Weight Sensitive Armor Protection (WSAP) ManTech project, Dr. Cheeseman worked closely with industry to solve issues plaguing the production of aluminum-hull combat vehicles. Under WSAP, Dr. Cheeseman formed and led an integrated project team to mature the use of thick 5083 plate for combat vehicle hull production. Constellium Rolled Products matured the manufacturing processes that enabled strain hardening of 5083 aluminum for very thick (10.75 inch) plates. BAE Systems uncovered problematic combat vehicle hull weldments and, with JWF and Wagstaff, designed and developed cost-effective, single-piece machined analogs to replace these weldments. DASA PP&R developed a comprehensive cost model demonstrating the viability of the machined components and PM MAV, with BAE, demonstrated these components in a production environment. ARL led the modification of MIL-DTL-46027M to allow for the thick plate.*

Mr. Denver Gallardy: *As the leader for ballistics qualifications, Mr. Gallardy collected the ballistic performance data and calculated the ballistic acceptance requirements for the expanded thickness range in MIL-DTL-46027, including increasing the ballistics thickness to 4.0 inches and determining the V50 offsets for qualification plates machined from the greater thicknesses up to 10.5 inches. Mr. Gallardy participated in all the working group meetings as well as the review and evaluations of the comments during the coordination of the specification.*

Dr. Heather A. Murdoch*: Dr. Murdoch first uncovered the issues of degradation and variability in mechanical response of 5000-series aluminum armor and led the team that quantified changes in corrosion resistance and mechanical properties because of exposures to elevated temperatures expected in service (or storage). Her work introduced the new requirements in MIL-DTL-46027 for thermal stability and best practices for long-term storage and those additional precautions will preserve critical armor plate material properties and quality.*

Dr. Kevin Doherty*: As a member of the team for this revision from the beginning, Dr. Doherty actively participated in the face-to-face project meetings at ARL and the Constellium Ravenswood, WV, production facility. After the onset of the COVID-19 pandemic, he maintained his participation in the Thick Plate Working Group meetings and supplied technical content and editorial support during the draft and coordination stages for this specification.*

Mr. Brian E. Placzankis*: Mr. Placzankis led the revision efforts for the MIL-DTL-46027 specification, editing, coordinating, and facilitating communications between ARL other government agencies, additional aluminum plate producers, and additional OEMs as Revision M of MIL-DTL-46027 neared completion. Mr. Placzankis attended the in-person and then virtual Thick Plate Working Group meetings with the team. He worked closely with Dr. Murdoch in selecting the optimal language for the new thermal requirement sections and the best practices for long-term outdoor storage of MIL-DTL-46027–qualified armor plates.*

OUTCOME

PAYOFF

Current estimates on cost savings from the use of 14 components machined from thick plate for AMPV production are approximately $15,000 per vehicle, even when estimating a 50% production improvement (with current practice, this is estimated at $25,000 per vehicle). The Army will acquire approximately 3,000 AMPVs during procurement, for an overall estimated savings of $45 million to $75 million. In addition, enhancements to production throughput are being characterized.

CURRENT STATUS

Improvements to combat vehicle hull manufacturing are being validated. Fourteen thick machined plate components were welded into an AMPV hull on the production line at

BAE Systems in York, PA, in January–February 2022. Industrial engineers save manufacturing time by using the thick plate components. Once these results are proven, the transition of these components to an AMPV technical data package (TDP) for full-rate production (FRP) will be proposed during FRP contract negotiations, with the non-recurring engineering cost associated with changes to the TDP folded into the FRP costs.

PROBLEMS IN EFFECTING THE SOLUTION

The first major challenge in the ManTech thick plate program was selecting the most effective processing pathway for thicker components (extruded versus rolled plate) for performance and cost. In addition to the extensive work of producing and demonstrating thicker rolled plates, ballistic evaluation and cost analysis of thick 5083 extrusions were performed. Although extrusions did not prove as effective as rolled plate, this work yielded a revision and improvement to the detail specification MIL-DTL-46083E, "Aluminum Alloy Armor, Extruded, Weldable," as a byproduct.

The greatest technical hurdle was finding a method to ballistically qualify first articles of the thick plates. As thicknesses increase, the ballistics projectiles needed to defeat the plates must increase in caliber and velocity. Increases in caliber and velocity demand larger gun barrels and increased testing costs, which the team sought to minimize. The prior thickness limit of this specification had been 3.0 inches but, by maintaining the caliber used for 3.0-inch plates and increasing the projectile velocity to near its maximum velocity, the procedure remained valid for up to 4.0 inches of thickness.

An extensive series of ballistic experiments was performed on thick plates, followed by evaluation of several options to reduce the ballistic testing costs. The solution machined (milled) off the opposing faces of a thick plate sample to reduce it to a standard 4.0-inch dimension, which was tested for qualification using established ballistic facilities at ARL and the Aberdeen Test Center. Maintaining the ballistic testing at a caliber and velocity consistent with the prior specification saves the government significant time and money on qualification.

These experiments set and established the ballistic offsets for defined ranges of plate thicknesses beyond 4.0 inches, extending all the way to the maximum of 10.5 inches. The calculation of these requirements completed all the conditions needed to revise the specification, with the revision process concluded after an extensive coordination process, including other government agencies, additional aluminum plate producers, and various OEMs. The completion of this new qualification procedure for plates beyond 4.0 inches thick in MIL-DTL-46027M opens new possibilities for the use of thick 5083 plates, enabling breakthroughs in production of current and future armored ground systems.

Insensitive Munitions Disposal

Award Winner: U.S. Air Force Explosive Ordnance Disposal Technology Division–Equipment Review Board Team

To improve the safety of the handling and employment of munitions, insensitive munitions were developed, creating unique problems and limitations for the Joint Explosive Ordnance Disposal (EOD) community's equipment and procedures toolset. These munitions resist traditional EOD procedures, hindering effective and safe disposal of insensitive high explosives. Recognizing this deficiency, the Air Force EOD Equipment Review Board framed the problem, tested concepts, found alternatives, and fielded a solution to the 7,500-member Joint EOD Force. In doing so, the team facilitated the creation of a material solution along with standardized joint-service technical manuals outlining the use of new tools and tactics for disposing of insensitive munitions. The Air Force EOD Technology Division's Equipment Review Board Team not only solved a critical safety problem for U.S. joint forces but also for NATO allies.

DISCUSSION

BACKGROUND

In 1634, a gunpowder factory in Malta accidently detonated, causing a massive explosion. This incident killed 22 people and damaged numerous buildings and property. In 1943, a truck filled with 24 aerial depth charges detonated, killing 40 people and injuring 386 more. In 1984, a munitions fire at a Soviet naval base caused reactions that killed between 200 and 300 people. In 2008, a series of detonations ripped through Albanian munitions depots, killing 24 people and injuring 300 more. These examples illustrate a dangerous problem with munitions handling and, unfortunately, represent only a few of hundreds of tragic incidents involving munitions handling processes and personnel.

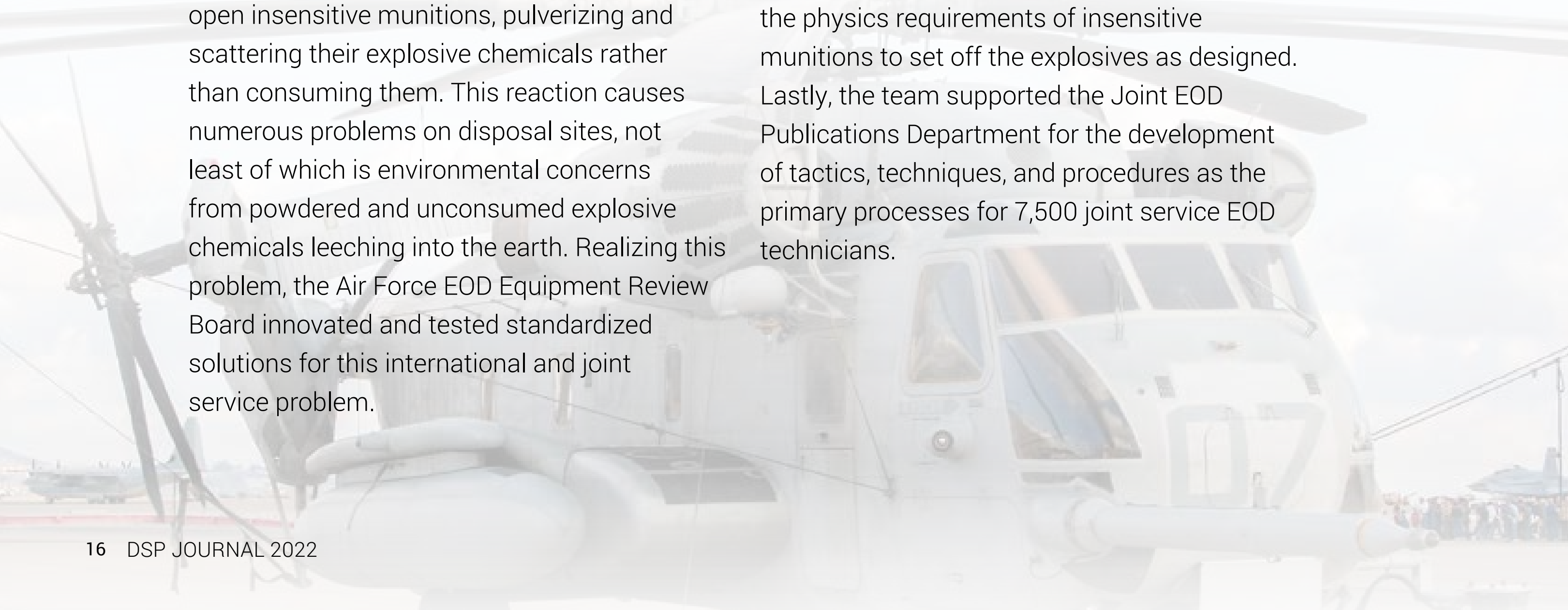
Recognizing the dangerous profession of munitions handling, NATO sought to remove these hazards while improving the safety and reliability of delivering combat power

by developing a policy so that munitions contain insensitive high explosives, preventing sympathetic reactions, the detonation of a munition or explosives induced by the detonation of another like munition or explosive charge. Although safer for munitions handling, these insensitive munitions create huge problems for EOD personnel.

PROBLEM/OPPORTUNITY

Insensitive high explosives are difficult to initiate and require specific parameters for detonation. While resulting in safer munitions handling practices, these munitions render the traditional disposal procedures of EOD technicians ineffective and potentially hazardous. With traditional munitions, EOD personnel place a donor charge on the item and initiate the demolition of explosives, creating a sympathetic reaction and activating the disposal of the munition. Thus, EOD consumes the explosives and the munition item effectively disappears.

However, insensitive munitions do not react in the same way. Traditional procedures break open insensitive munitions, pulverizing and scattering their explosive chemicals rather than consuming them. This reaction causes numerous problems on disposal sites, not least of which is environmental concerns from powdered and unconsumed explosive chemicals leeching into the earth. Realizing this problem, the Air Force EOD Equipment Review Board innovated and tested standardized solutions for this international and joint service problem.



DESCRIPTION

The Air Force EOD Equipment Review Board improved mission capabilities for 28 allies and all four services through an innovative approach. The team concluded a comprehensive study of the problem through extensive research and developmental efforts to repurpose a U.S. Marine Corps explosive breaching tool. The team developed a three-dimensional (3D) print file for the tool, enabling immediate implementation of the solution across the globe. This effort swiftly delivered a capability previously unachievable with standard tools and equipment.

The team continued standardization of technology acquisitions by collaborating with Special Operations Command. Using its research and development power, the Equipment Review Board Team leveraged Special Operations testing and capacity to accelerate new technology development and acquisitions and repurposed an initiation device for detonating insensitive munitions material solutions. The team acquired other material solutions from differing mission capabilities to design a cylindrical disposal tool meeting the physics requirements of insensitive munitions to set off the explosives as designed. Lastly, the team supported the Joint EOD Publications Department for the development of tactics, techniques, and procedures as the primary processes for 7,500 joint service EOD technicians.

AWARDEE INVOLVEMENT

The Air Force Equipment Review Board Team is composed of military members of the Air Force detachment at the Joint EOD Technology Division. The team served as the primary point of entry to the Military Technical Acceptance Board, a body of O-4 officers from each branch of the military. The team managed the decision-making process and workflow for acquisition and development of insensitive munitions technologies. It managed development, testing, and validation of tools for approval by the General Officer Joint EOD Program Board. The team led and managed weekly meetings and synthesized input from dozens of scientists, chemists, engineers, and project managers to deploy a $250 million science and technology portfolio.

OUTCOME

PAYOFF

By using the Special Operations framework, the team saved an estimated $2 million and sped material delivery by more than seven years. By standardizing the insensitive munitions tool and procedures across the Joint EOD Program, the team precluded the need for individual services to spend research and development funds to design and develop divergent procedures. The benefit of this standardization is priceless since, during the Iraq and Afghanistan wars, EOD teams performed in joint billets and multi-service roles. The forecasted personnel needs of America's next war indicate that EOD's joint posture will not change; therefore, the program requires standardized procedures to not only dispose of America's insensitive munitions but those of our enemies. The Equipment Review Board delivered on this mandate. The joint EOD force now has a material solution and procedures in development for one of the biggest explosive problems of the 21st century. Most impressive, some of the material solutions are 3D printable, saving countless dollars and precious time when needed at scale.

CURRENT STATUS

The insensitive munitions problem is at a 95% solution. The material solution has been developed, with completion of the technical manuals expected in the next three to six months. The Military Technical Acceptance Board is scheduled to meet with the Technical Training Acceptance Board to iron out the addition of insensitive munitions disposal procedures to the Joint EOD Inter-Service Training Review Organization curriculum so that every American service member and our international partners from 98 nations who attend the U.S. Navy's EOD school will learn insensitive munitions disposal procedures. The Equipment Review Board Team met with Air Force EOD force development managers to add insensitive munitions procedures to Air Force EOD annual training and team leader certification courses.

PROBLEMS IN EFFECTING THE SOLUTION

The technology acquisition world is fraught with barriers and the team fought against numerous obstacles. The laws of physics and chemistry created a huge roadblock to solving the chemical reaction issue of insensitive munitions. The Joint EOD Program has 13 modernization efforts competing for time and money. The team exercised astute prioritization by investing resources in a solvable problem instead of chasing a never-ending science and technology effort. Moreover, the team overcame cultural problems by shedding science and technology projects and industry products advocating for resourcing without producing a favorable outcome. The Equipment Review Board Team navigated these challenges and delivered a comprehensive solution for the Joint EOD Program, the Department of Defense, and our NATO partners.

News and Events

MICHAEL A. HEAPHY JR. TO SERVE AS U.S. HEAD OF DELEGATION TO THE NATO LIFE CYCLE MANAGEMENT GROUP

The Defense Standardization Program Office is pleased to announce that Mr. Michael A. Heaphy Jr. was designated as the United States of Head of Delegation (HoD) to the North Atlantic Treaty Organization (NATO) Life Cycle Management Group (LCMG). He succeeded Ms. Merry Lutz, who has taken another job in the Department of Defense.

The aim of the LCMG is to optimize defence capabilities considering performance, cost, schedule, quality, operational environments, integrated logistics support, and obsolescence over the life cycle of the system. As a main group subordinate to the Conference of National Armaments Directors, the LCMG is responsible for NATO policies, methods, procedures, and agreements concerning the acquisition, use, support, and disposal of armaments systems and services and equipment to meet NATO life cycle, quality, and interoperability requirements.

In the LCMG HoD role, Mr. Heaphy will represent the United States at LCMG meetings and conferences as well as engage with subject matter experts and interested parties on the portfolio of standardization documents emanating from groups subordinate to the LCMG. Mr. Heaphy has extensive experience in systems engineering and standardization, which will enable him to fulfill this role effectively.

NATO USE OF CIVIL STANDARDS WORKSHOP SLATED FOR FEBRUARY 2023

The Hellenic National Defence General Staff is organizing the third iteration of the NATO Use of Civil Standards Workshop, under the auspices of the NATO Standardization Management Group and with the guidance of the NATO Committee of Standardization. The workshop will be held on February 7–9, 2023, in Athens, Greece.

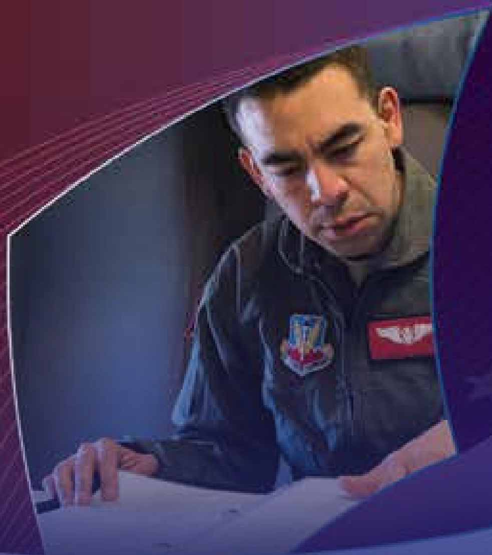
The theme is focused on emerging and disruptive technologies (EDTs) related to operations, artificial intelligence and big data, biotechnology, and innovation. For more information about this event, select the Education and Training tab, Events, at https://nso.nato.int.

DODM 4245.15, MANAGEMENT OF DMSMS, HAS BEEN PUBLISHED!

On October 26, 2022, DoD Manual (DoDM) 4245.15, "Management of Diminishing Manufacturing Sources and Material Shortages" (DMSMS), was approved by the Assistant Secretary of Defense for Sustainment. The manual provides mandatory procedures for DoD Instruction 4245.15 at a high level of detail with references to SD-22 and additional guidance on how to perform DMSMS functions. The new DoDM bridges the gap between policy and guidance. An essential aspect of the new manual is the establishment of mandatory record-keeping requirements for every program office. These requirements include both cost- and efficiency-related data elements. Collecting, maintaining, and using this data will provide DoD with unprecedented new DMSMS management capabilities. Program offices will improve their processes by uncovering what is working and what is not as well as benchmark their performance against other program offices. This publication is just one important step in the continuing process improvement journey.

Ms. Robin Brown, Office of the Secretary of Defense DMSMS and Parts Management Program Manager, welcomes any thoughts and comments on the new manual. She may be reached via email at Robin.Brown@dla.mil.

DoDM 4245.15 can be found on the Washington Headquarters Services DoD Issuances site: http://www.esd.whs.mil/Directives/Recent-Publications/.



DEFENSE STANDARDIZATION PROGRAM

MAKING SYSTEMS WORK TOGETHER