Defense Standardization Program
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Standardization Stars

Development of Department of Defense Digital Engineering and Modeling Practices, MIL-HDBK-539

Multi-Functional Chemical Agent Resistant Coatings: MIL-DTL-64159 and MIL-DTL-53039 Enhanced Coatings to Forge the Future for Assets and the Warfighter

MIL-PRF-32725, Fire Extinguishing Agent, Fluorine-Free Foam Liquid Concentrate, for Land-Based, Fresh Water Applications

Development of Military Specification MIL-DTL-32689 for Circular, Miniature, Lightweight, High Density, Quick Disconnect, Tri-Start Thread Coupling, Environmental Resistant with Crimp Contacts

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Director's Forum

Standardization Stars

"Technology standards and protocols are core to our digital infrastructure, national security, and economic prosperity." – National Defense Science and Technology Strategy 2023

This year, the *U.S. Government National Standards Strategy for Critical and Emerging Technologies* and the *National Defense Science and Technology Strategy 2023* highlighted the importance of standardization to national security, particularly standards for critical and emerging technologies and modernizing our digital infrastructure. Standards are vital to the planning and preparedness required for warfighter capabilities.

To recognize the individuals and teams of the military departments and defense agencies, the Defense Standardization Program annually awards those who have invested in standardization and achieved standardization excellence in support of national security, defense systems, and the warfighter. 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 on standardization accomplishments, timing of implementation, reduction in ownership costs, breadth of application, and difficulty of coordination. Fiscal Year 2022 (FY22) marked the 35th year of recognizing outstanding standardization achievements throughout the Department of Defense (DoD) and the standardization community.

The DSP award winners serve as examples of excellence in standardization in support of the warfighter—supplying the warfighter with equipment that is interoperable, reliable, technologically superior, and affordable. The FY22 winners follow.

Distinguished Achievement Award Winner

Development of Department of Defense Digital Engineering and Modeling Practices, MIL-HDBK-539

U.S. Army, U.S. Air Force, U.S. Marine Corps, Space Force, the Department of the Navy, the Defense Logistics Agency, and the Office of the Secretary of Defense

The Digital Engineering and Modeling Practices Handbook Integrated Product Team coordinated efforts to create MIL-HDBK-539, establishing guidance on digital engineering and modeling strategies for a high level of confidence with integrated practices and collaboration. This handbook enables DoD activities and foreign partners to select standardized approaches that best meet their needs based on proven practices, improving data exchange, enhancing data quality, speeding incorporation of new technologies, offering lasting sustainment of acquisition items, increasing interoperability, and saving an estimated $2.5 million per year in reduced total ownership costs.

Standardization Achievement Award Winners

Multi-Functional Chemical Agent Resistant Coatings (CARC): MIL-DTL-64159 and MIL-DTL-53039 Enhanced Coatings to Forge the Future for Assets and the Warfighter

U.S. Army DEVCOM Research Laboratory (ARL)

The ARL team researched, developed, tested, verified, and validated resin systems, pigment packages, solvent alternatives, and antimicrobial formulations to create a new chemical agent resistant method and update the specifications. The research led to significant technological breakthroughs and the development of in-depth requirements. As a result, expanded CARC capabilities now include low solar-absorbing pigmentation and antimicrobial formations. Low solar-absorbing CARCs improve performance by reducing heat buildup associated with solar loading, resulting in cooler vehicle interiors for our soldiers, lower energy usage for cooling assets, and increased coating lifetimes. The antimicrobial coating addresses health and safety concerns while enhancing color stability over time and improving readiness and maintainability by reducing the need for frequent fungal removal cleanings. The tri-services can readily adapt antimicrobial CARC technology to similar paint applications. These specification revisions improve performance, sustainability, safety, and interoperability while enhancing functionality at a lower cost to forge the future for mission success.

MIL-PRF-32725, Fire Extinguishing Agent, Fluorine-Free Foam (F3) Liquid Concentrate, for Land-Based, Fresh Water Applications

Department of the Navy (DON), Naval Sea Systems Command (NAVSEA)

DoD has relied on aqueous film-forming foam (AFFF) to extinguish fires and protect lives for over 50 years. However, chemicals in this foam have been classified as contaminants. Therefore, the FY20 National Defense Authorization Act required the Secretary of the Navy to develop a new military specification for a fluorine-free firefighting agent during FY23 and make that agent available by FY24. Further, Congress has required DoD to cease use of fluorinated AFFF at all military installations by FY25. To fulfill these mandates, the Navy team developed, coordinated, and published MIL-PRF-32725 in just over 1 year. The Naval Sea Systems Command and Naval Research Laboratory collaborated with industry for market research and research, development, testing, and evaluation of replacement agents. This specification balanced the needs and demands of the disparate stakeholder groups through early engagement, transparency, and extensive coordination. This complex endeavor relied on groundbreaking research performed concurrent with development of specification MIL-PRF-32725 to create a product that better protects human health and the environment while providing DoD, our nation, and our allies with a highly capable firefighting agent to continue meeting our global mission.

Development of Military Specification MIL-DTL-32689 for Circular, Miniature, Lightweight, High Density, Quick Disconnect, Tri-Start Thread Coupling, Environmental Resistant with Crimp Contacts

Defense Logistics Agency (DLA), DLA Land and Maritime, Engineering and Technical Support Directorate

Mr. Jacob Bender revitalized ongoing discussions between industry and the military services to produce a new military detail specification, MIL-DTL-32689, as well as 27 specification sheets to cover various connector configurations, backshells, and accessories. Mr. Bender's leadership brought connector, original equipment, and tooling manufacturers together with the military services and other industry experts to reach consensus on the requirements, optimizing them for military use while integrating the latest features from commercial products. The new standard provides requirements for highly reliable, miniature, lightweight, and rugged connectors for the military services, NASA, and industry. Qualifying manufacturers to the new standard will ensure supply availability for years to come and Mr. Bender continues to develop improvements to attain new sources of supply and offer additional solutions.

Congratulations to the FY22 DSP award winners. Your dedication and resourcefulness in the enhancement of standards play a crucial role in providing capable, reliable, and affordable systems and equipment to those who defend our freedom. These efforts are key to the Department's success and our national security.

Michael A. Heaphy Jr.
Director
Defense Standardization Program

Every fall, DSP calls for DSP Achievement Awards nominations. I hope that our readers will consider submitting their exceptional achievements for the FY23 awards.

Development of Department of Defense Digital Engineering and Modeling Practices, MIL-HDBK-539

Award Winner: Office of the Secretary of Defense, U.S. Army, U.S. Navy, U.S. Air Force, U.S. Marine Corps, U.S. Space Force, and Defense Logistics Agency

For this project, multiple stakeholders came together and coordinated guidance on a high priority digital engineering (DE) initiative, making DoD more efficient. Guidance from MIL-HDBK-539, "Digital Engineering (DE) and Modeling Practices Handbook," eliminates DE silos, improves communication across the services, and streamlines the advancement of DE by program offices. This coordinated DE implementation guidance is expected to save $2.5 million per year in reduced total ownership costs (RTOC) from standard processes, terms, and approaches while eliminating reinvention costs, improving quality through data, and starting up program office DE efforts more rapidly. The DE Integrated Product Team (IPT) overcame barriers to defining the DoD current state from selected program offices and achieving agreement with the handbook across various DoD organizations.

Discussion

Background

DoD management recognized the value of quickly implementing DE across program teams, making DE a top priority initiative. However, program offices lacked direction in DE best practices, which resulted in implementing many forms of DE, including approaches ineffective for their organizations. Examples include contracting mechanisms inadequate for requirements and data management requirements not effectively supportive of logistic operations. These inefficient approaches drove up costs and resulted in technical data packages (TDPs) with data quality and translation issues, inefficient DE environments, additional training, and delays to acquisition schedules.

Problem/Opportunity

Over a two-year period, the handbook project received input from IPT employees from all DoD organizations. During weekly team meetings, program office reviews, and onsite adjudication reviews, leads addressed the issues to achieve DoD agreements, resulting in enterprise opportunities. The problems included the following:

- Multiple contracting mechanisms to implement DE in a program office.
- Multiple DE tools and processes throughout program offices.
- Multiple methods of defining data ownership, data sharing, data retention, and archiving.
- Cost inhibiting data management, preventing data translations.
- Inability to share the TDP between government organizations and the prime contractor without extensive modifications and costs.
- Inability to support logistic requirements and other unknown requirements.
- Lack of common instructions for DE implementations.
- Lack of understanding of DE's state in DoD.
- Lack of best practices and recommended DE environments.
- Lack of DE standards, standard interfaces, modeling, and guidance.
- Lack of standard mission engineering.
- Lack of standard cybersecurity requirements.
- Lack of standard data terms and definitions for working programs.
- Lack of contracting benchmarking examples for new programs.
- Additional training required to support DE implementations and no training standards.
- Lack of DE certification and expertise.
- Lack of DE guidance to drive RTOC with new acquisitions and logistical footprints.

Description

The Handbook IPT reached out to various government organizations, government contractors, and the ASME industry standards committee to understand the DE current state. The final handbook detailed a baseline for working terms, definitions, and practices for DE implementation and modeling activities to consider for all disciplines and functional areas in an acquisition life cycle. Designated IPT team members from the Office of the Secretary of Defense, U.S. Army, U.S. Navy, U.S. Air Force, U.S. Marine Corps, U.S. Space Force, and Defense Logistics Agency held meetings to develop the final document.

This handbook guides DE and modeling strategies for a high level of confidence in the practices of integration and collaboration technologies. DE maximizes agility, interoperability, reusability, and scalability across DoD by shifting from traditional document-centric activities to data-centric ones. This shift enables data-driven decisions and continuous access to authoritative data by the DoD community, delivering the right information to the right person at the right time throughout the life cycle.

While creating the handbook, the IPT discovered gaps between the approaches of government organizations, government contractors, and the ASME industry standards committee. The team's charter was revised by utilizing Six Sigma techniques, which resulted in a revised handbook title and refined purpose and objectives. Objectives included the following:

- Focus on program office needs.
- Keep the initial release to less than 100 pages.
- Include graphics, diagrams, and tables for over half of the document.
- Establish agreement on terms, definitions, and the state of DE.
- Plan for future revisions with iterative sprints.

The overall structure defining DE and modeling practices offered an initial area for consensus. The structure uses the term model-based enterprise (MBE), constructed as shown in Figure 1.

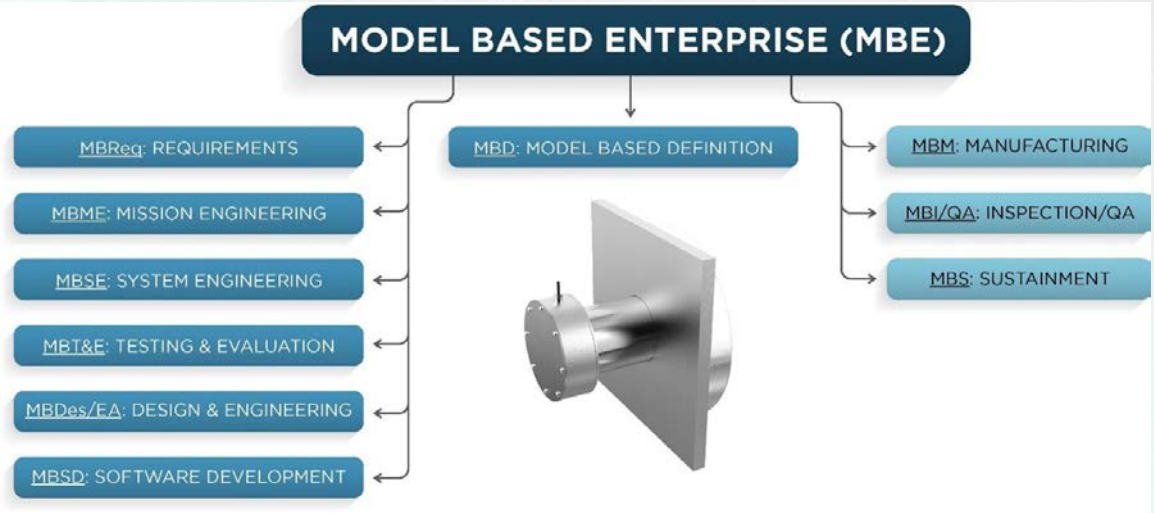

***Figure 1**. MBE Structure*

Another step in defining the current state was to set up meetings with the program offices that had initiated DE implementation. From these meeting, the Handbook IPT mapped approaches using Six Sigma process mapping techniques to compare processes. This effort yielded six major types of approaches or stages. These six stages demonstrated DE data evolution in DoD. These stages serve as a benchmark for future programs seeking the best approach to meet their needs while maximizing DE benefits.

Most program offices still use the traditional approach of data delivery via 2-dimensional (2D) documents. Other stages enable programs to pick the approach with the maximum return on investment for their needs. *Figure 2* shows the traditional approach.

Figure 2. *Data Access of Traditional 2D Documents*

The Handbook IPT created the first cross-service guidance document addressing the DoD high-priority goal of implementing DE and modeling practices. This strategy resulted in efficiencies for the government. Coordinating these efforts will continue to maximize benefits and support the warfighter. Team members are prioritizing updates using agile sprints for future revisions.

Awardee Involvement

All team members led their respective DoD service efforts on the Handbook IPT. All team members represented their organization during comment adjudication and conflict resolution at team meetings.

Outcome

"The DoD DE and Modeling Practices Handbook" enables DoD activities and foreign partners to select standardized approaches or strategies based on current, proven practices. This choice improves data exchange, enhances data quality, leads to faster incorporation of new technologies, offers lasting logistic sustainment of acquisition items, and maximizes RTOC benefits. No other DoD DE guidance document exists in ASSIST.

Payoff

The result is $2.5 million per year RTOC in savings with rapid DE implementation startups, improved quality targets to sustain acquisition items, and faster development of schedules.[1] Specific improvements follow:

- Sample contracting mechanisms to benchmark DE implementation.
- Ability to select DE tools and process of program offices to drive standardization.
- Common methods to improve interoperability with defined data ownership, data sharing, data retention, and archiving.
- Universal data formatting and translation guidance for data sharing throughout the acquisition life cycle.
- Sharing of TDP between government organizations, prime contractors, and allies (e.g., NATO and cooperative programs) using common data strategies.
- Improved planning by specifying all support logistics requirements up front.
- General guidance to support common instructions, effective communication, the DE current state using six known models, best practices and environments, standard terms and definitions, and high-level training as well as references to interfacing standards, modeling approaches, mission engineering, and cybersecurity requirements.

[1] A $2.5 million per year RTOC savings with new acquisitions and logistics footprints using DE and modeling practices guidance, based on a minimum and maximum DE startup savings of $7,000 to $25,000 per acquisition category (ACAT) program (based on 50 ACAT I and 200 ACAT II and III programs).

Current Status

On December 6, 2022, the final MIL-HDBK-539 was formally released in the ASSIST repository as a DoD handbook.[2]

Problems in Effecting Solution

The Handbook IPT had to overcome large barriers to achieve agreement, coordinating input from each organization, communicating statuses, and implementing a consolidated strategy across the entire DoD organization. Since all engineering organizations are affected, the input and adjudication process was significant, resolving over 500 comments. Service leads needed strong leadership to drive the final publication of the handbook, as culture had to change throughout DoD to move away from the traditional 2D documentation approach.

[2] MIL-HDBK-539, Digital Engineering (DE) and Modeling Practices Handbook, https://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=285031.

Multi-Functional Chemical Agent Resistant Coatings: MIL-DTL-64159 and MIL-DTL-53039 Enhanced Coatings to Forge the Future for Assets and the Warfighter

Service or Agency: U.S. Army DEVCOM Research Laboratory (ARL)

The implementation of MIL-DTL-64159 (Camouflage Coating, Water Dispersible Chemical Agent Resistant) and MIL-DTL-64159 (Camouflage Coating, Solvent Based, Chemical Agent Resistant) represents the most significant change to chemical agent resistant coating (CARC) in over 30 years. These changes expand CARC capabilities and performance to include CARC-L: low solar-absorbing (LSA) pigmentation with antimicrobial resistance to permit alternative, environmentally friendly chemistries. CARC-L significantly reduces heat buildup associated with solar loading, resulting in cooler vehicle interiors for our military personnel, lower energy usage for cooling assets, and overall increased coating lifetimes. The antimicrobial coating is a first for CARC topcoats, addressing customer-based health and safety as well as maintenance concerns associated with bacterial and fungal growth on vehicle interiors. These major changes included revisions in resin alternatives, solvent selection, and new test methods to better validate camouflage and chemical agent resistant properties.

Discussion

Background

Covering significant breadth and scope, CARC systems are specifically formulated for military performance (adverse environmental sustainment, signature management, and improved chemical agent resistance). Army Regulation (AR) 750-1 requires CARC systems on all tactical and related support equipment in the U.S. Army inventory. This guidance is also followed by the U.S. Marine Corps. Our military uses CARC on assets during all deployments and in joint mission efforts with our allies. MIL-DTL-64159 and MIL-DTL-53039 represent tremendous advances for the Department of Defense by offering technological breakthroughs as well as coherent and in-depth requirements.

Problem/Opportunity

MIL-DTL-53039, MIL-DTL-64159, and MIL-PRF-85285 specify the polyurethane (PU) chemistry for the exterior topcoats of all DoD aviation platforms and ground vehicles, most amphibious vehicles, and support equipment. Despite the ideal properties of PU for exterior coatings, its reactive precursors (isocyanates) pose significant health risks, leading to increased scrutiny of their environmental and human health factors. Prior specifications did not permit non-isocyanate alternatives. The Army Research Laboratory (ARL), through research and empirical data, has expanded the specifications to include non-isocyanate-based formulations.

To complement the resin system and related research, ARL expanded the opportunity for pigment selection and created colors, incorporating LSA pigmentation and resulting in the first CARC assets to use pigmentation to lower surface temperatures for improved durability of the coating and reduction of internal temperatures of assets for multifunctional capabilities. These stable, non-leaching pigments can be U.S. sourced. ARL updated the specification to permit such pigmentation and developed requirements to calculate the reflectance and low solar absorption properties accurately.

Increasing regulation of volatile organic compounds and more stringent user safety and air emission laws have caused the evolution of the specifications for solvents. ARL revised the specification to allow for fewer solvents and solvents not previously regulated. This proactive approach addresses many fronts, though first and foremost, enables safer and less expensive CARC systems (through lower permit and solvent costs as well as avoidance of non-compliance fines).

The specifications list and detail antimicrobial CARC. As a first for CARC topcoats, the antimicrobial coating addresses customer-based health and safety as well as maintenance concerns associated with bacterial and fungal growth on vehicle interiors. Extensive Ground Vehicle Systems Center (GVSC) surveys showed the negative effects of bacteria and fungus on many assets. ARL researched, developed, and detailed formulation in MIL-DTL-64159 and MIL-DTL-53039 to combat bacterial and fungal growth.

These specifications have incorporated a new chemical agent resistant method (CARM). To verify and validate the new CARM, multiple laboratories, in coordination with the Chemical Biological Center (CBC) for the Army, participated in round-robin testing, which included painting and analyzing over 6,000 test coupons.

Description

ARL researched, developed, tested, verified, and validated five major areas of the CARC specifications: resin systems, pigment packages, solvent alternatives, antimicrobial formulations, and the development of the CARM. Each of these major areas represent a breakthrough and significant accomplishment. In complement to one another, the research and subsequent validation has resulted in the most significant advancement since CARC's founding with specification MIL-C-46168 in 1974. The specification, through its requirements, has enabled DoD to qualify commercial vendors and offered DoD the most technological and enhanced coating system for its warfighters and assets since CARC's inception.

Awardee Involvement (Listed Alphabetically)

Mr. Thomas Considine: Mr. Considine has 18 years' experience in coatings and corrosion research. He performed qualification testing on the CARC topcoats in the lab and field exposures. Mr. Considine's extensive work with other related specifications imparted continued synergy across the full range of CARC specifications. He provided input specific to corrosion requirements and fully integrated all substrates, test references, and panel preparation methods with referenced standards and specifications. Mr. Considine collaborated on comment resolution and modernized the documents through extensive editing and formatting changes.

Dr. Dawn M. Crawford: Dr. Crawford led the ARL program to develop an antimicrobial CARC (AM CARC). She worked with numerous agencies and industry to calculate the extent of microbial contamination on military vehicles and found viable approaches to microbial resistance for CARC as a near-term solution. Her work resulted in a new AM CARC with significantly improved fungal resistance after 18 months of outdoor exposure in the tropical regions of Panama and Suriname. The AM CARC improves CARC performance by enhancing color stability after aging, promotes maintainability and readiness by reducing the frequency of rigorous cleaning to remove fungal growth on Army CARC assets, and increases the safety of military personnel by decreasing exposure to fungal contaminated assets. The tri-services can readily adapt AM CARC technology to similar DoD paint applications.

Mr. Daniel M. De Bonis: Mr. De Bonis is the chemical agent commodity item manager and the primary signature authority for MIL-DTL-64159 and MIL-DTL-53039. His efforts toward the development and finalization of both specifications required extensive technical support and communication between CARC industrial partners and the DoD service agencies implementing the new technologies. Mr. De Bonis translated and incorporated field demo and testing results for signature management improvements into the specifications. He addressed related security concerns and defined the contracting requirements for transitioning concepts from Product Manager (PdM) Vehicle Protection Systems ManTech development programs into the requirement documents. These documents are critical to implementation of the qualification process to commercially produce approved CARC per AR 750-1.

Mr. William S. Lum: Mr. Lum was instrumental in the overall construction and editing of both specifications. He provided technical input on security considerations, types, classes, grades, forms, and methods and how best to create a viable and working specification for the DoD community. Mr. Lum led the efforts to ensure that the technical requirements aligned with requirements of specification and standards, converting the technical inputs into the materials specifications. He led comment collection and organization.

Mr. Daniel Pope: Through Mr. Pope's 15 years of experience with CARC topcoats in the laboratory and the field, he offered the practical and technical perspective for the specification revision, ensuring that the requirements support DoD needs as well as

field application and validation requirements. He submitted a proposal to the Defense Logistics Agency for funding to add requirements to MIL-DTL-53039 and MIL-DTL-64159 to eliminate the use of parachlorobenzotrifluoride, a compound listed under Proposition 65 in California as a known carcinogen. He led the weekly specification meeting that gathered all the subject matter experts for the technical changes in MIL-DTL-53039 and MIL-DTL-64159. He resolved comments from vendors and government officials to enable publication. His expertise and insights created a clear vision and path for the qualification process that led to qualification of new materials on the specification.

Outcome

Payoff

The revision of the specifications resulted in significant advances—improved performance, sustainability, safety, and interoperability—and established requirements to ensure that every approved coating enhances functionality for our warfighters to accomplish their missions. The changes in resin, solvent, and pigment packages dramatically improve the longevity of the coating life, maintain the performance requirements for longer durations, and require less repainting and decreased coating usage. ARL research on the use of LSA pigments extended the life cycle of these coatings two-fold. This change improves environmental drivers and occupational use, eliminating dependency on isocyanate-based resins and harmful solvents. Combined with anti-microbial CARC systems, this revision produces assets with superior coatings requiring less maintenance and upkeep while adhering to the requirements. All these attributes complement the interoperability of coating systems approved across all DoD platforms requiring CARC, essentially every piece of tactical and related support equipment in the Army and Marine Corps inventory.

ARL, GVSC, and CBC invested over $15 million in the research, development, testing, validation, and extensive specification rewrites, technical manuals, and national stock number assignments along with detailed establishment of new colors and respective requirements. These specifications have paved the way for the future requirements and coating systems.

Current Status

Publication of MIL-DTL-64159 occurred in March 2022 with MIL-DTL-53039 following in September 2022. The DoD community, as well as raw material suppliers and CARC vendors, are actively submitting samples. ARL is expanding the Qualified Products Database with new coatings used on new and existing contracts for upcoming painting and repainting of DoD assets.

Problems in Effecting Solution

ARL's leadership and technical expertise overcame significant hurdles from technical gaps and the necessity to communicate and update users about the technical requirements changes and specific revisions of raw materials options and future color preferences. The DoD CARC commodity manager office worked with U.S. Army Combat Capabilities Development Command GVSC, CBC, and the United States Army Tank-automotive and Armaments Command to translate and incorporate field demo and testing results for signature management improvements into the specifications, converting field parameters into pass-fail criteria to capture and eliminate DoD technical gaps. ARL addressed security

concerns and defined the contracting requirements for transitioning concepts from PdM Vehicle Protection Systems and ManTech development programs into the requirement documents.

Due to the cost of the research, development, and validations, the team sought and acquired support funding. Throughout this process, the team communicated via technical reports, briefings, memorandums, and in-person meetings to address multiple items, such as acquiring national stock numbers, establishing new colors, and converting an unlimited distribution specification into a more closely controlled and higher classification specification. Despite the numerous challenges, the ARL team published both specifications in one fiscal year. Both standards can be found on ASSIST.[1, 2]

The specifications' detail coatings have unique properties and may have never been created; therefore, ARL created and developed the original formulations and provided those formulations to vendors to assist in the transition and implementation. This contribution greatly assisted vendors and raw material suppliers in demonstrating that the requirements could be met and coatings created. ARL is accepting and qualifying coatings to those specifications.

While problems and challenges arose, ARL leadership and technical experts negotiated through them to publish two detailed specifications to forge the future of DoD.

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[1] MIL-DTL-64159 (Camouflage Coating, Water Dispersible Chemical Agent Resistant): https://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=210743.

[2] MIL-DTL-53039 (Camouflage Coating, Solvent Based, Chemical Agent Resistant): https://quicksearch.dla.milqsDocDetails.aspx?ident_number=29107.

MIL-PRF-32725, Fire Extinguishing Agent, Fluorine-Free Foam (F3) Liquid Concentrate, for Land-Based, Fresh Water Applications

Service or Agency: Department of the Navy, Naval Sea Systems Command

The awardees developed MIL-PRF-32725 in accordance with Section 322 of the FY20 National Defense Authorization Act (NDAA), which states, "Not later than January 31, 2023, the Secretary of the Navy shall publish a military specification for a fluorine-free fire-fighting agent for use at all military installations and ensure that such agent is available for use by not later than October 1, 2023." The complex endeavor relied on groundbreaking research concurrent with specification development. The project satisfied the requirements of key stakeholders in the firefighting, human health, and environmental fields. The team completed development of the specification, including extensive coordination internal and external to the Department of Defense (DoD), in just over one year.

Discussion

Background

Since the 1970s, DoD has relied on aqueous film-forming foam (AFFF) in mechanical foam generating equipment, such as firefighting trucks or foam sprinkler systems, for extinguishing Class B fires (fires of flammable liquids, such as gasoline or fuel oils). AFFF forms an aqueous film with low surface tension between the foam layer and the fuel surface, preventing the escape of flammable vapors. AFFF quickly extinguishes Class B fires and keeps them out, protecting service members, firefighting personnel, and others during emergencies.

Unfortunately, the chemical constituents that make AFFF so good at extinguishing fires—per- and polyfluoroalkyl substances (PFAS)—are listed as emerging contaminants [1,2] and being quickly regulated out of use. Accordingly, Congress included mandates in the FY20 NDAA requiring the Secretary of the Navy to develop a new military specification for a fluorine-free firefighting agent during FY23 and have that agent for use by FY24. Congress is requiring DoD to cease use of fluorinated AFFF at all military installations by FY25. The Navy team had to develop, coordinate,

[1] Refer to Acquisition and Sustainment, Office of the Under Secretary of Defense, "Per- and Polyfluoroalkyl Substances (PFAS): A National Issue that Requires National Solutions" Environmental Cleanup and Compliance, 2022, https://www.acq.osd.mil/eie/eer/ecc/pfas/index.html.

[2] Refer to Assistant Secretary of the Navy (Energy, Installations and Environment), "PFAS Frequently Asked Questions," June 3, 2021, https://www.secnav.navy.mil/eie/Pages/PFAS-FAQs.aspx.

and publish the specification with enough time for DoD to meet all deadlines in the NDAA for development and use of a fluorine-free firefighting agent.

Problem/Opportunity

Environmental restrictions on the use of PFAS have limited (and continue to further reduce) the shore-based use of fire extinguishing agents prepared in accordance with MIL-PRF-24385F, "Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF) Liquid Concentrate, For Fresh and Sea Water." However, the need to quickly extinguish Class B fires remains. A replacement firefighting agent was needed to minimize release of PFAS in the environment while matching the firefighting performance of AFFF.

Description

The Naval Sea Systems Command (NAVSEA) and Naval Research Laboratory (NRL) collaborated with industry for market research and research, development, testing, and evaluation of replacement agents. NRL extensively tested prospective fluorine-free firefighting agents to replace AFFF. From bench-scale fire testing completed in Chesapeake Beach, MD, to 4,000 square foot aviation fuel fires burned in the desert of Ridgecrest, CA, the Navy's fire test teams demonstrated the capabilities of leading fluorine-free agents and narrowed the criteria for use in the new military specification. Concurrently, the specification writing team coordinated with industrial hygienists and toxicologists internal and external to DoD to establish criteria for chemical and physical properties to offer a safer new alternative firefighting agent.

The Navy balanced the needs and demands of disparate stakeholder groups. No fluorine-free fire-fighting agent extinguishes fires as quickly as AFFF, creating a grave concern for users. Concurrently, toxicologists internal and external to DoD pushed for the safest possible replacement agent. The FY20 NDAA also included a strict prohibition on the amount of PFAS in any replacement agent, limited to 1 part per billion. By engaging these key stakeholders early in the specification development process, ensuring transparency, and completing extensive coordination throughout all phases of review, the Navy team prepared the final specification in time to meet the congressional mandate.

Awardee Involvement

Mary Hunstad, the NAVSEA technical warrant holder (TWH) for fire protection systems–ships, served as final technical authority for specification development.

Dan Berkoski and Tom Ruffini, senior project engineers, assisted the TWH with authoring specific content of MIL-PRF-32725, including fire performance, test procedures, and test equipment. They helped the TWH respond to and resolve comments during document coordination. Mr. Ruffini led coordination of all

aspects of the specification with key stakeholder groups and the NAVSEA qualification team in preparation for qualifying products to QPL-32725.

John Farley of NRL led firefighting research efforts, completing laboratory tests and experiments, including live-fire testing of candidate fluorine-free agents.

Kesha Butler, the NAVSEA qualification manager, assisted the TWH with preparing the specification, including provision for qualification in accordance with all legal and DoD regulations.

Outcome

Payoff

While published for the military, firefighting and environmental groups worldwide eagerly sought this specification. The Department of Transportation, Federal Aviation Administration, is adopting the new military specification for all civilian airports in the U.S., with global allies and military partners monitoring DoD's efforts and likely to incorporate the new military specification as the Navy's research and demonstration is on the leading edge internationally. Not only does MIL-PRF-32725 detail a product that better protects human health and the environment but it meets the global mission of DoD, our nation, and our allies with a highly capable firefighting agent. DoD's goal is to acquire and use non-fluorinated foams that meet the performance requirements for critical DoD firefighting applications as replacements for the legacy AFFF. DoD seeks to find commercially available fluorine-free foams with equivalent firefighting performance, as well as the chemical and physical properties, of the legacy AFFF covered by MIL-PRF-24385.

Current Status

Published on January 6, 2023, MIL-PRF-32725 is in the ASSIST database.[3] NAVSEA is establishing QPL-32725 so that a fluorine-free foam liquid concentrate fire extinguishing agent is available no later than October 1, 2023. Once products are qualified, NAVSEA will collaborate with shore-based stakeholders on transiting from AFFF.

DoD and the Department of the Navy will continue to work with industry to improve the characteristics and performance of agents that qualify under QPL-32725.

[3] MIL-PRF-32725, "Fire Extinguishing Agent, Fluorine-Free Foam (F3) Liquid Concentrate, for Land-Based, Fresh Water Applications," https://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=285047.

Problems in Effecting Solution

This project resulted from a multiyear DoD research and development effort to find an effective PFAS-free firefighting solution meeting the life-saving performance standards of AFFF without the negative health or environmental effects of fluorinated AFFF. During development, the team widely coordinated the draft with other DoD and government activities, equipment manufacturers, and users, including Naval Air Warfare Center Aircraft Division Lakehurst, the Navy Marine Corps Public Health Center, the U.S. Army Public Health Center, the Office of the Assistant Secretary of Defense, and the Federal Aviation Administration. The team received and adjudicated over 250 comments.

An analytic method for detecting PFAS in fluorine-free foams did not exist prior to this project. After realizing the technical infeasibility of developing a method to detect 1 part per billion, the team compromised with key stakeholders to create an alternative approach while meeting the requirements of the FY20 NDAA and published the military specification ahead of the congressionally mandated deadline.

This project resulted from a multiyear DoD research and development effort to find an effective PFAS-free firefighting solution meeting the life-saving performance standards of AFFF without the negative health or environmental effects of fluorinated AFFF.

Development of Military Specification MIL-DTL-32689 for Circular, Miniature, Lightweight, High Density, Quick Disconnect, Tri-Start Thread Coupling, Environmental Resistant with Crimp Contacts

Service or Agency: Defense Logistics Agency, DLA Land and Maritime, Defense Supply Center Columbus, Engineering and Technical Support Directorate, Document Standardization Division, Interconnection Branch

Mr. Jacob Bender demonstrated outstanding leadership and accomplishments for this significant engineering standardization effort with the development of a new military detail specification (MIL-DTL-32689) and its 27 specification sheets covering various connector configurations, backshells, and accessories. This multiyear effort began in 2019 and ended on March 31, 2022, with the publication of the last backshell specification sheet, enabling full use of the connectors in different configurations. Mr. Bender is continuing to develop additional cadmium-alternative plating options with this connector family.

Discussion

Background

Aerospace vehicles and other applications have historically been heavy users of MIL-DTL-38999 connectors. In the last 20 years, commercial versions of miniature connectors (smaller than 38999 connectors) have become popular in the market. Each connector manufacturer had its own versions of miniature connectors, without standard sizes, pin arrangements, mating requirements, etc. Since 2010, industry and the military services discussed standardizing these connectors but with only moderate progress. Mr. Bender pushed the issue to the forefront in 2021–2022 and implemented all the new MIL-DTL-32689 connector's family components.

Problem/Opportunity

Mr. Bender created a standardization document covering miniature, high-reliability, lightweight, high-density circular connectors with military specification ruggedization and performance. The varied commercial designs increased parts and logistic costs, due to lack of competition for these customized designs. The different manufacturer designs also created intermateability concerns because connectors from one manufacturer could not always mate with another manufacturer's connector.

Description

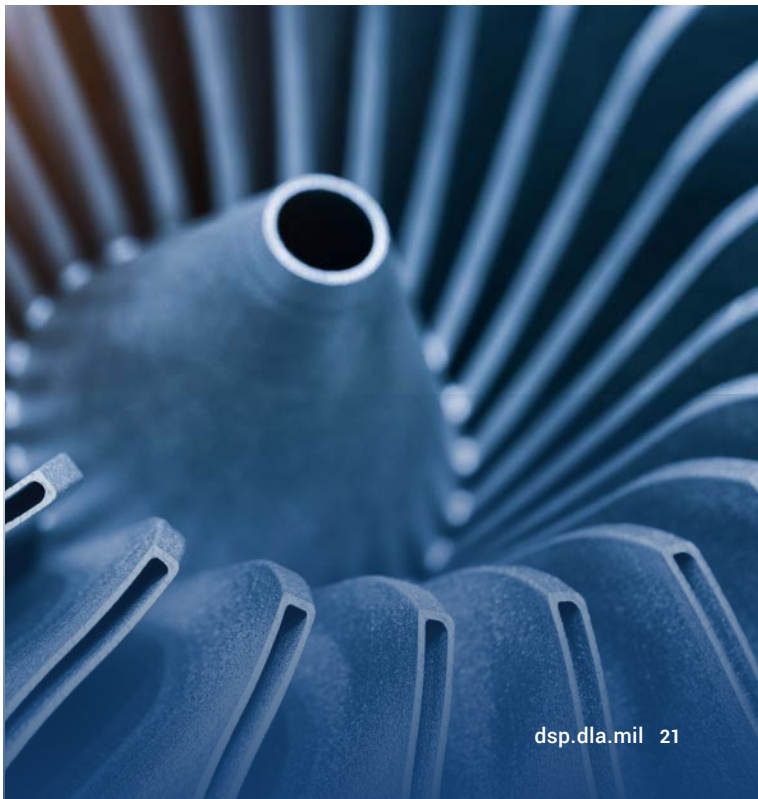
Mr. Bender brought connector manufacturers, original equipment manufacturers (OEMs), tooling manufacturers, the military services, and other industry experts together to develop a standardized design specification for military and space applications. While some manufacturers initially resisted this effort, they later joined as development of the military specification rapidly progressed and publication became imminent. Mr. Bender not only chaired the multiyear working group effort but acted as a major technical contributor. During twice monthly meetings, the group reviewed the draft document line-by-line twice to reach consensus on the requirements. The group optimized the connector design for military use and features in commercial products as well as validated grommet sealing and added sealing plugs to standard MS27488 before establishing a complete family of backshells.

Awardee Involvement

Mr. Bender is the assigned engineer for circular connectors at DLA Land and Maritime. He played a critical role in the development and completion of this effort. He was an integral member of the working group of 25 members from connector manufacturers, SAE AE-8C1 (Connector Committee) and C2 (Connector Tools Committee), major OEMs, NASA, and the Navy.

Mr. Bender's responsibilities, as the preparing activity for the new documents, included adding valuable input during teleconferences and meetings, requesting projects, generating and coordinating multiple working drafts of the basic document and specification sheets, consolidating comments and recommending their dispositions, resolving conflicting comments, obtaining final approval for the family of documents, and answering many technical and procedural questions.

Mr. Bender has detailed technical knowledge of the requirements for these military specifications. His expertise in DoD 4120.24-M, "Defense Standardization Program Procedures," and MIL-STD-961, "Defense and Program-Unique Specifications Format and Content," was vital to the development and dating of these specifications. Mr. Bender took the rough outline for the teleconferences and formulated the full military draft specifications and their requirements for official coordination. He developed the qualification procedures and finalized the specifications. Mr. Bender also prepared the justification for qualification and presented it along with the documents to the DLA Departmental Standardization Officer for final approval.



Outcome

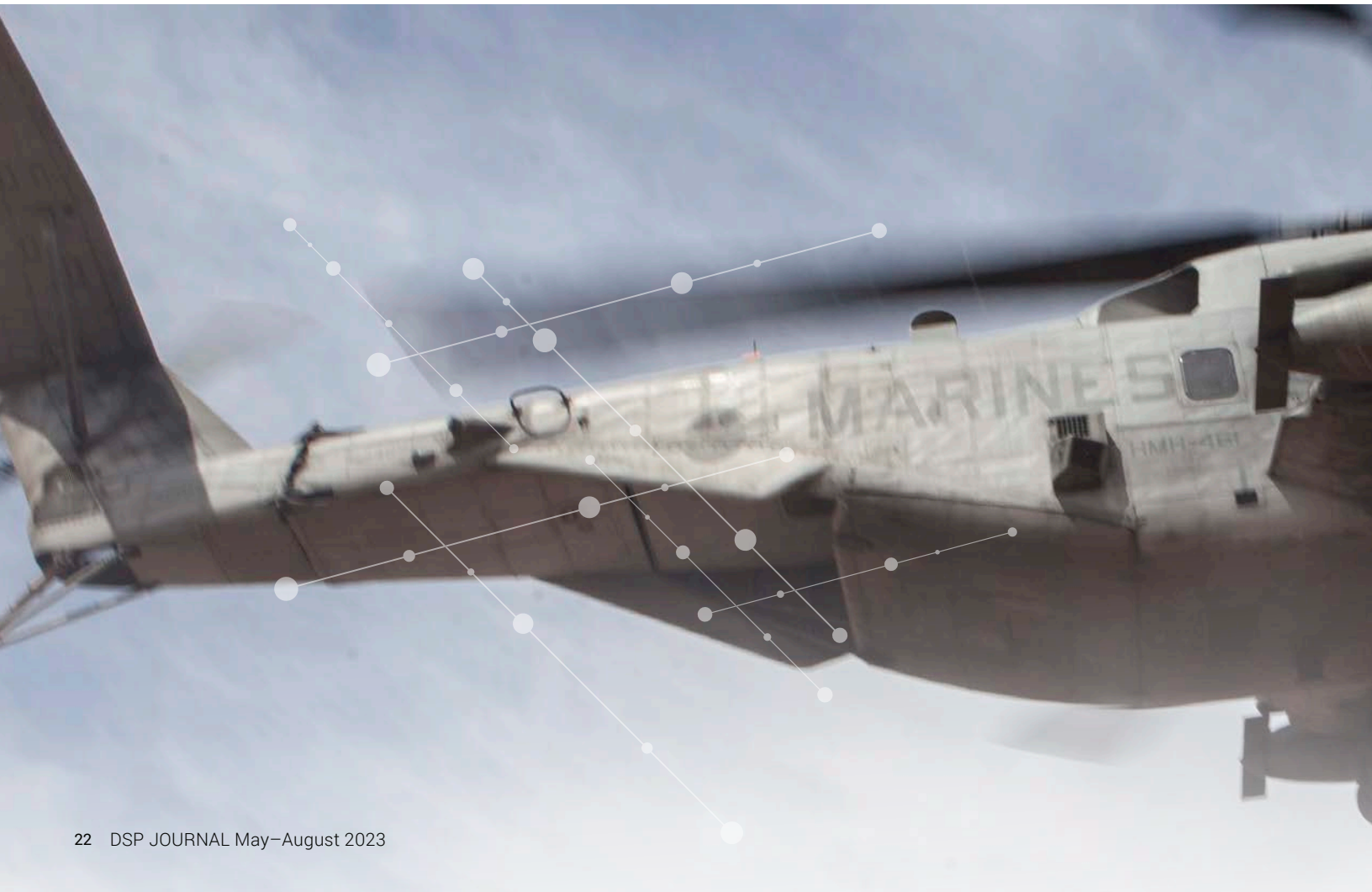
Payoff

The new standardized MIL-DTL-32689 connectors provide the military services, NASA, and industry OEMs with high-reliability, miniature, lightweight, rugged connectors for their systems. Previous military connectors had not supported the smaller sizes and lighter weights of newer weapon and space systems. The new connectors meet these needs and can be used in current systems (such as the F/A-18, F-35, H-60 Seahawk, CH-53, and NASA satellite programs) as well as every future military and NASA system for years to come.

These new specifications meet the need while avoiding non-standard connectors, which are more expensive, harder to procure, not as reliable, and become obsolete and out of production much sooner than standard military parts. The new specifications support the long system life of military and space programs without risk of obsolescence and nonavailability.

Mr. Bender's efforts support the needs of the military departments for standardization by providing high-reliability, miniature, lightweight connectors meeting the performance requirements of their systems. His efforts preclude the costly piecemeal introduction of non-standard commercial parts for a similar result.

An added benefit of this new military specification is qualification of manufacturers for these connectors, resulting in reliable supply availability.



Current Status

MIL-DTL-32689 and the 27 connector specification sheets were completed in 2022. Seven connector manufacturers expressed interest in qualifying to the new specifications. Mr. Bender has been supporting the DLA Land and Maritime Sourcing and Qualifications Division in attaining new sources of supply for the 27 specification sheets. Mr. Bender is continuing to develop the MIL-DTL-32689 specification with the addition of two cadmium-plating alternative solutions. MIL-DTL-32689 and the connector specification sheets can be found on ASSIST.[1]

Problems in Effecting Solution

Mr. Bender overcame many challenges during this project. The lack of industry standard requirements for this new type of connector led to significant research and technical discussions. Mr. Bender had to manage diverse and sometimes competing perspectives of the working group participants for consensus. He encouraged uninterested component manufacturers to support the new specification. Resolving the hundreds of official manufacturer and user comments on the working draft documents took patience, time, and tactfulness.

[1] MIL-DTL-32689: https://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=284642.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