Defense Standardization Program

Journal

April/September 2015

Standardization Stars

New Specification for Aluminum-Based Powders for Cold Spray Deposition

Biobased CLP

Advanced Robotic System for Explosive Ordnance Disposal

Updated Standard for Cargo Tie Downs

Cargo Design Standards to Meet Air Transport Requirements

Revised Performance Specification for Components for Aerospace Applications

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Director's Forum

Each year, we recognize individuals and teams who, through their standardization efforts, have significantly improved technical performance, increased operational readiness, enhanced safety, or reduced costs.

Individuals and teams are nominated for standardization awards. For FY14, we identified six as being particularly deserving of recognition. Through their efforts, sometimes taking several years, the winners have played an integral part in keeping our men and women in uniform safe and in providing them the tools they need to get the job done.

The winners are as follows:

- A team led by the U.S. Army Research Laboratory, for developing a new specification that documents the powder characteristics and operating parameters for optimal cold spray deposition of aluminum alloys for parts and repairs and saving millions in sustainment costs
- A team from the U.S. Army Armament Research, Development and Engineering Center, for updating a specification to require biobased materials as part of the formulation for cleaners, lubricants, and preservatives to improve safety without compromising performance
- A team from the Naval Surface Warfare Center, Indian Head Explosive Ordnance Disposal Technology Division, for developing a modular open systems architecture that enables integration of new technologies from multiple sources for use on explosive ordnance disposal robotic systems
- A team from the Air Force Materiel Command, for updating the standard for cargo tie-down tensioners used in aircraft to cut inventory and fuel costs and to hold their rated weights, both statically and dynamically, precluding aircraft mishaps due to inadvertent release of the devices

Gregory E. Saunders
Director
Defense Standardization Program Office

- A team from the Air Transportability Test Loading Activity at Wright-Patterson Air Force Base, for updating design standards to ensure that domestic and foreign cargo meets the requirements for transport in Air Force fixed-wing aircraft, potentially saving millions of dollars
- Muhammad Akbar, from the Defense Logistics Agency Land and Maritime, for contributing significantly to the revision of a performance specification to allow use of faster, lighter, and more complex microcircuits for aerospace applications.

Congratulations to all of our award winners. I know that DoD leadership appreciates their work. These awards help call attention to the significant contributions that standards and standardization make to supporting our men and women in uniform, helping to multiply capability through interoperability, and saving money for the taxpayer.

Standards and standardization link common solutions to common problems across all services and frequently across nations. This issue of the ***DSP Journal*** showcases the accomplishments of the FY14 award winners. I hope that reading about their accomplishments will pique your interest and might even inspire you to submit an award nomination on the good work you are doing in standardization.

New Specification for Aluminum-Based Powders for Cold Spray Deposition Saves Millions of Dollars

Award Winner: ARL-Led Team

A team led by the U.S. Army Research Laboratory (ARL), with representatives from Defense Logistics Agency (DLA) Aviation and working with the United Technologies Research Center (UTRC), developed a new military specification, MIL-DTL-32495, "Aluminum-Based Powders for Cold Spray Deposition," that covers the requirements for procuring aluminum and aluminum-based alloy powders. These powders will be used to produce deposits utilizing the environmentally friendly, cost-effective materials deposition process called cold spray (CS) for parts repair, coatings, and fabrication of components and freestanding structures. CS has been approved for use by all DoD departments and agencies and by industry. Military and aerospace applications for CS specify exacting characteristics for the CS deposit. However, powder and operating parameters were not identified for optimal aluminum deposition. The new specification documents the powder characteristics needed for optimal deposition of four aluminum alloys by means of CS and ensures that CS parts or repairs meet the needs and approval of DoD and save millions in sustainment costs. Since its May 2014 publication, this specification has resulted in DoD savings of more than $10 million. The implementation of this specification will allow the procurement of noncounterfeit products in our supply chain and reduce the threat of inferior deposits that would otherwise increase the risks of failure and additional costs arising from unnecessary repair.

Background

CS is an emerging, environmentally friendly technology initially developed in the former Soviet Union. ARL exploited this technology and established the Center for Cold Spray Research and Development (R&D) based at the Rodman Materials Research Laboratory located at Aberdeen Proving Ground in Aberdeen, MD. The center is now the focal point of CS R&D of numerous approved applications for DoD and industry. In fact, the first commercial applications for DoD have emerged out of ARL, and because the CS process has resulted in a variety of high-impact applications, there was a dire need to establish a standardized powder specification for use by DoD and industry. ARL's Center for Cold Spray Research and Development is the most well-equipped CS facility in the world to accomplish this work.

The CS process represents leading-edge technology and provides superior performance over conventional technologies, such as thermal spray, and enables the government to incorporate CS into the technical data package for new system design, as well as for the reclamation of unserviceable parts.

CS technology and the powders detailed in MIL-DTL-32495 have many purposes and applications, such as restoring worn or badly corroded parts and forming protective coatings. CS can produce thick deposits that can be used for dimensional restoration of damaged or out-of-tolerance parts. The high-velocity solid-state particle impact and deposition of CS yields a structure that is strong and impervious, providing unique repair opportunities. Its low temperature deposition and nonporous structure can yield coatings for environmental and wear protection on most substrates, including those that are heat sensitive. Aluminum powders are ideally suited for CS applications due to the ductile and lightweight characteristics of aluminum. These characteristics also make aluminum well suited to aircraft applications. CS has also been used to produce a new class of materials that could not be achieved by conventional ingot metallurgy.

Problem/Opportunity

CS aluminum powders provide equivalent or better corrosion protection than current technologies, such as paints and thermal sprays. CS aluminum surfaces provide corrosion resistance equal to that of bulk aluminum when deposited on steels and magnesium alloys. CS aluminum powders are an excellent filler material and show feasibility for field repair applications. Adhesion strengths have been verified to be on par with or better than thermal sprays. Successful demonstrations of CS reparability have been shown for several aircraft parts.

Weight and cost reduction in the aerospace industry is an ongoing process that strongly affects the design of aerospace components and assemblies. At the same time, the components experience extreme loads during service, requiring the use of materials with unique mechanical, physical, and chemical properties to ensure safety in flight. Today, aluminum alloys are one of the most necessary materials groups in the aerospace industry. Their advantageous ratio of density and strength, especially fatigue strength, even in a broad range of service temperatures makes those alloys applicable for structural, landing gear, and propulsion components.

Aluminum and aluminum alloy powders are available in many forms. Particle size distribution, powder flowability, specific alloy chemistry, and impurities all vary among distributors. CS experience at ARL has shown that aluminum powder characteristics can strongly influence the service and integrity of the aluminum deposit. The ARL research has identified the powder characteristics that yield optimal aluminum deposits.

Approach

The characteristics of a CS material are dependent on the initial powder characteristics and on CS operating parameters such as pressure and temperature. The exact characteristics demanded by the aircraft industry require that the powder used and the deposition method be exactly specified to ensure that the repair standard is satisfied. The CS team at ARL and the CS group at UTRC conducted experiments to identify the characteristics of aluminum and aluminum alloys that can produce the deposits needed. The experimental work included the characterization of the powders to determine what properties affected their performance after being consolidated by the CS process and the development of operating parameters needed to spray the aluminum powders. This experimentally derived information was then codified within the new specification. Powder characteristics contained in the specification include chemical components, particle size distributions, and handling characteristics. The specification allows the CS community to optimally spray aluminum powders and to be assured that the product will satisfy exacting aircraft and military requirements.

Outcome

According to a 2003 Government Accountability Office report, ***Defense Management: Opportunities to Reduce Corrosion Costs and Increase Readiness*** (GAO-03-753), DoD spends between $10 billion and $20 billion annually on corrosion prevention and mitigation. Clearly, technologies that improve corrosion resistance or reduce the amount of maintenance required by military and contract personnel have a great value to DoD. A recent study commissioned by the National Association of Corrosion Engineers suggests that the national corrosion bill has an annual value exceeding $270 billion, thereby furthering the value of improvements in technology to the commercial sector. The use of CS can significantly reduce the costs associated with the corrosion, wear, and damage caused during service of magnesium parts used in Army rotorcraft, Navy rotorcraft, and Air Force fixed-wing aircraft, as well as all commercial aircraft. The Army and Navy have more than 4,500 rotorcraft platforms, and each platform has at least 20 magnesium parts. This represents a major sustainment problem affecting 20 percent of the fleet at any given time and costing DoD more than $100 million annually in sustainment costs. The Navy identified magnesium component repair/spare parts shortage as part of the top 10 critical technology needs. In addition, Corpus Christi Army Depot (CCAD), TX, has millions of dollars of used magnesium housings waiting to be reclaimed as part of the Storage, Analysis, Failure Evaluation and Reclamation program that will benefit from the implementation of the new specification. The Army and Navy spent $17 million in 1 year for UH-60 main transmission and tail rotor gearbox housing assemblies alone. Sikorsky's 2009 trade study showed that the annual cost attributed to corrosion on the H-60 main gearbox to the Navy was $10.8 million and the cost to the Army was $6.7 million, for a total of $17.5 million for 600 helicopters (about 13 percent of the fleet).

Implementation of MIL-DTL-32495 will affect the following systems:

- All helicopters, including Army, Navy, and Air Force Blackhawks (H-60, H-53, CH-47, AH-64)
- Magnesium gearboxes in fixed-wing aircraft (AV-8B, P-3, F-22, F-35, V-22)
- Other systems, including High Mobility Multipurpose Wheeled Vehicles
- Original equipment manufacturers (Sikorsky, Boeing, Bell Helicopter, Pratt & Whitney, GE Aircraft Engines, Rolls Royce Allison)
- Commercial uses, including the aircraft, automobile, petrochemical, and electronics industries.

Repairs using the aluminum powders described in the specification will result in the following:

- Higher on-wing time, less repair/maintenance, and lower service failure risk
- Longer mean times between failures, fewer condemnations, and fewer in-service corrosion failures
- Improved readiness and fewer logistics problems for deployed troops
- Lower sustainment cost and easier in-theater/at-sea maintenance.

Current Status

MIL-DTL-32495 is available from ASSIST at https://assist. dla.mil/. Due to required changes from the powder industry, an interim amendment was published in September 2014. A follow-up amendment will be published in 2015. The interim amendment was deemed necessary so implementation could begin immediately. The changes are considered to be widely acceptable by all; however, protocol insists that this process be followed. Since the inception of MIL-STD-3021, "Materials Deposition, Cold Spray," in 2008, this technology has matured rapidly. Now, with the development of four classes of aluminum and aluminum-based alloy powders, implementation will continue to grow. Below are two example applications:

- ***Application 1***. A common problem on military aircraft is wear due to chafing around fastener holes in skin panels. Chafing results in skin panels that exceed fit tolerances at the fastener locations. The Repair, Refurbish, and Return to Service Applied Research Center, at the South Dakota School of Mines and Technology, and the ARL Center for Cold Spray Research and Development—in cooperation with the 28th Bomb Wing at Ellsworth Air Force Base, SD, and Air Force Engineering and Technical Services—developed a repair process for the chamfered surface of B1 bomber skin panels. In service, chamfer wears caused the fastener holes to become elongated, rendering the panels unserviceable. The panel is made from 2024-T6 aluminum. The repair utilized an aluminum powder sprayed normal to the chamfered surface of the panel. Test results demonstrated the capability of CS to provide a permanent repair for this application, restoring the full capability of the panel. CS technology has recently been approved as a low-cost (and high return on investment) solution to repair these panels and keep the B-1s flying. The first panel was repaired and installed on a B-1B for flight testing in August 2012. Cost savings to the B-1 program for refurbishment of the remaining forward equipment bay panels is estimated at $9.6 million annually. This technology can be applied to all Major Design Series (MDS) aircraft, and its application is an example of infusing new technologies into current DoD maintenance processes to reduce sustainment costs while maintaining the viability of older weapon systems. If applied to other MDS aircraft across DoD, cost savings could reach $100 million annually.

- *Application 2.* ARL has worked with the Aviation and Missile Command, Program Executive Office–Aviation, Naval Air Systems Command, and PM-UH-60 Blackhawk and CCAD to approve the use of CS for the Blackhawk and H-60 Seahawk sump and five other magnesium parts, saving DoD millions of dollars per year in sustainability costs associated with Army and Navy rotorcraft transmission housings. This application has also been implemented with the Australian Air Force through an international partnership. Recent test results—obtained from the Defence Science and Technology Organisation, under TTCP MAT-TP-1 Operating Assignment O-42—have revealed that coatings produced by ARL using the CS process will enable salvage of scrapped helicopter magnesium housings. Typical main rotor transmission housing can cost as much as $800,000.

Challenges

The biggest problem associated with the development of MIL-DTL-32495 was the level of standardization funds. The original document, "Material Powders Utilized for Surfacing by Cold Spray Deposition," was drafted in December 2008. However, due to the lack of funding and the need for R&D to characterize and evaluate the powders, this effort did not begin until funding was requested and approved by DLA Aviation's Hazardous Minimization and Green Products Branch. Once funding was received, an in-depth review and effort was initiated to develop a meaningful draft. Industry experts in the field of powders were contacted to discuss the processing and sizing of spherical metal powders, particularly those for use in CS applications. Laser light scattering methods for subsieve particle size analysis were also discussed as one of the best approaches to be considered. The new detailed military specification, developed and published by the Specifications and Standards Office at ARL's Weapons and Materials Research Directorate as the result of this project, will be for the procurement of aluminum powders used in CS deposition, including the repair of magnesium and aluminum components/parts. These aluminum powders, with their appropriate descriptions, will be assigned new national stock numbers (NSNs) and will be managed and procured, against this specification, by DLA Aviation.

About the Award Winner

The ARL-led team consisted of Richard Squillacioti and Victor Champagne from ARL's Weapons and Materials Research Directorate and Iris Labuda from DLA Aviation.

Richard Squillacioti led the standardization effort, which included, among other things, outlining the specification, coordinating multiple drafts and responding to comments, and overseeing the final review and publication of the document. Mr. Squillacioti prepared a package to obtain the required funding along with an agreement that DLA Aviation will manage and procure new NSNs for the aluminum powders qualified against the specification. He prepared all the documentation required as deliverables to satisfy the conditions of the DLA funding and to keep the standardization effort on track and current by publishing an interim amendment when the team's subject matter experts informed him of problems that a potential user had with the published specification. The current interim amendment will be replaced by an amendment 2, which that will be coordinated and published when approved.

Victor Champagne established the technical criteria for the document and the need for the document by the transition of CS technology through his R&D programs. He also established the world-class CS center at ARL, which included developing the process, and the funding, required to design, fabricate, set up, and make the equipment operational. Mr. Champagne's expertise and talent in establishing technical programs to exploit CS technology resulted in the implementation and transition of CS operations to numerous government contractors and to DoD, including Army, Navy, and Air Force depots and maintenance facilities.

Iris Labuda, through her technical and collaborative interactions, led the team to recognize the significance of CS, and its powders, as a "green" sustainable alternative to current maintenance practices. She was instrumental in having the DLA Aviation Hazardous Minimization and Green Products Branch fund the R&D and the development of the subsequent powder specification. The availability of this essential funding allowed the team's timely evaluation of the powders' characteristics, making it possible to utilize these powders for applications in the near, rather than distant, future. Furthermore, as DoD's combat support agency, DLA, via Mrs. Labuda's initiatives and logistics knowledge, will manage and procure CS powders in accordance with the developed specification against newly established NSNs. The availability of NSNs will greatly assist the DoD maintenance community in restoring and protecting Army and other DoD assets, while improving customer satisfaction, providing excellent stewardship of taxpayer dollars, and serving and safeguarding our service men and women.

The team also had the assistance of non-government contractors for the oversight of the technical aspects of the document, including the creation of a distribution list of DoD reviewers and potential users, industry vendors, and powder manufacturers.

Biobased CLP Improves Safety without Compromising Performance

Award Winner: ARDEC Team

To comply with a 2012 Executive order directing federal agencies to prioritize the purchase of biobased products (those containing plant-derived ingredients), a team from the U.S. Army Armament Research, Development and Engineering Center (ARDEC) researched the feasibility of requiring biobased materials as part of the DoD formulation for cleaner, lubricant, and preservative (CLP) used for weapons and weapons systems. Environmentally preferred biobased materials offer not only environmental benefits, but also an increased margin of safety when they are used by DoD personnel for weapons maintenance. Through coordination with the U.S. Department of Agriculture's (USDA's) BioPreferred program, as well as with industry, the team determined that biobased materials could, in fact, be required as part of CLP's formulation. The team documented the formulation change in an amendment to MIL-PRF-63460, "Performance Specification: Lubricant, Cleaner and Preservative for Weapons and Weapons Systems," the military performance specification used to qualify all CLP products procured by the Defense Logistics Agency for DoD use. The benefits of requiring this less-toxic formulation come without compromising any of the performance requirements identified in the specification. Standardizing the requirement for a percentage of biobased content in CLP will benefit all DoD personnel who regularly use CLP for weapons maintenance.

Background

Military CLP is a 3-in-1 product designed to clean, lubricate, and preserve weapons. The military's requirements for CLP are stringent, largely because of the extreme temperature and humidity conditions to which military weapons are exposed, but they strike tradeoffs in meeting all three requirements to clean, lubricate, and preserve weapons. CLP is procured by selecting a product that has been prequalified to its military specification by a DoD qualifying activity and added to a qualified products list (QPL).

Although military CLP products are available, DoD personnel at times obtain and use nonqualified CLP products that come with manufacturers' claims that they are less toxic than the military CLP products—partly due to the incorporation of biobased materials in the product formulation—and that they are superior to existing CLPs, yielding improved weapon performance.

Historically, the commercial products typically have not met the military's stringent requirements. For example, they may have lubricated better than military CLP, but they often failed to meet military specification requirements pertaining to cleaning and preserving weapons against corrosion. However, in recent years, industry has taken steps to improve the commercial CLP products, addressing military performance requirements, while simultaneously reducing the toxic properties of some of the currently qualified CLPs.

Problem/Opportunity

The ARDEC team seized on the opportunity to leverage industry efforts to incorporate more biobased materials into CLP formulations, as well as the opportunity to respond to the Executive order by engaging DoD with the USDA BioPreferred program.

The team was also motivated to take advantage of this opportunity because of the need, by DoD personnel using CLP for weapons maintenance, for a less toxic product. To avoid the toxicity, they were using commercially available nonqualified CLP products in the field that were advertised as containing biobased materials. Establishing a DoD standardized biobased content for CLP, via the military specification, would mitigate that problem, because DoD users would no longer have to look for nonqualified CLP products that may or may not be formulated with biobased materials.

Approach

Standardizing CLP's biobased content for all of DoD required three main steps:

- Establish a baseline minimum biobased content percentage that would be required of all future candidate CLP products seeking qualification. The team established the baseline through laboratory analysis of the biobased content of currently qualified CLP products listed on the QPL. The team added the minimum percentage biobased content requirement to the military specification, MIL-PRF-63460, via an amendment.
- Prepare a new product category, Military CLP Products, and submit it for consideration to be added to the USDA BioPreferred program product category listing. This unique product category will be in addition to the Firearms Lubricants category, which is for products intended to be used for lubrication only and not also for cleaning and preservation.
- Test eight commercial weapons lubricants and CLP products that claim to be less toxic and safer to use because of their biobased content to determine if they meet other select performance requirements identified in MIL-PRF-63460. Product manufacturers volunteered to participate and provided complimentary product samples.

Outcome

DoD, through the DSP, took a positive step to meet its requirement to address the Executive order pertaining to the procurement of products that contain biobased materials. Through the added requirement for biobased materials in the CLP military specification, all DoD-qualified CLPs will contain biobased materials and, therefore, will be less toxic and safer to use for all DoD personnel involved with their use for weapons maintenance. This will lessen DoD personnel's desire to obtain and use less toxic nonqualified biobased CLPs that claim to work as well as the military's qualified CLPs listed on the QPL, but do not.

Because CLP is used by all of the military departments and the Marine Corps for small-, medium-, and large-caliber weapon systems, this benefit of not compromising weapons systems reliability by using nonqualified CLPs will have broad applicability. An additional expected benefit is the response by manufacturers, which have expressed strong interest in and taken steps to refine their biobased CLP product formulations so that they can also meet the stringent performance requirements in MIL-PRF-63460. One such CLP manufacturer of an existing qualified CLP, which happens to have 15 percent biobased content, has demonstrated satisfactory product performance of key requirements with a 50 percent biobased content formulation.

Current Status

The effort to determine the biobased content of existing qualified CLP products was completed in August 2014. This baseline was published in ASSIST via amendment 5 to MIL-PRF-63460E on November 5, 2014. This effort was successful, and the minimum biobased content requirement will be updated as CLP manufacturers continue to refine their product formulations to increase this percentage while still meeting all other performance requirements. Formal USDA recognition of the new DoD product category is pending.

Challenges

The team faced no barriers in effecting this solution of DoD changing the military specification to now require biobased materials as part of the CLP formulation.

About the Award Winner

The ARDEC team consisted of Mark Napolitano, Daniel Prillaman, and Richard Wu.

Mark Napolitano developed the project and led the effort. Among other things, he prepared samples of currently qualified CLP products and coordinated with the USDA-certified laboratory to have samples analyzed to determine the baseline biobased content requirement. He also amended MIL-PRF-63460 and submitted it to the Defense Logistics Agency for publication in ASSIST, prepared a draft new USDA BioPreferred program product category description and submitted it to USDA for consideration (pending), and coordinated laboratory screening tests of eight commercial CLPs to determine if they could meet selected MIL-PRF-63460 performance requirements.

Daniel Prillaman conducted laboratory testing of eight commercial CLPs in accordance with MIL-PRF-63460 requirements. He took photographs for laboratory test results.

Richard Wu conducted laboratory testing of eight commercial CLPs in accordance with MIL-PRF-63460 requirements, and he generated the laboratory report.

Advanced Robotic System Improves Explosive Ordnance Disposal

Award Winner: NSWC Team

A team from the Naval Surface Warfare Center (NSWC), Indian Head Explosive Ordnance Disposal Technology Division (IHEODTD), made significant contributions to the standardization of explosive ordnance disposal (EOD) robotic system interfaces by developing and defining an open systems architecture (OSA) for the next-generation family of EOD unmanned ground vehicles (UGVs). This work culminated in the completion of 59 individual documents that completely define the Advanced Explosive Ordnance Disposal Robotic System (AEODRS) common architecture (CA). The documentation set is made up of interface and performance requirements documents for each of the defined AEODRS modules, along with overarching and implementation documentation. The documentation set represents the allocated baseline for the AEODRS CA, fully supports the AEODRS open architecture acquisition strategy, and provides critical technical data to support major program milestone decisions. Successful completion of these documents required extensive systems engineering and analysis to allocate requirements and define interfaces for all modules within the AEODRS family of systems (FoS), all while ensuring system-level requirements were maintained. The OSA approach will enable integration of emergent technologies from multiple potential sources on fielded AEODRS platforms, improving the overall capability of EOD warfighters.

Background

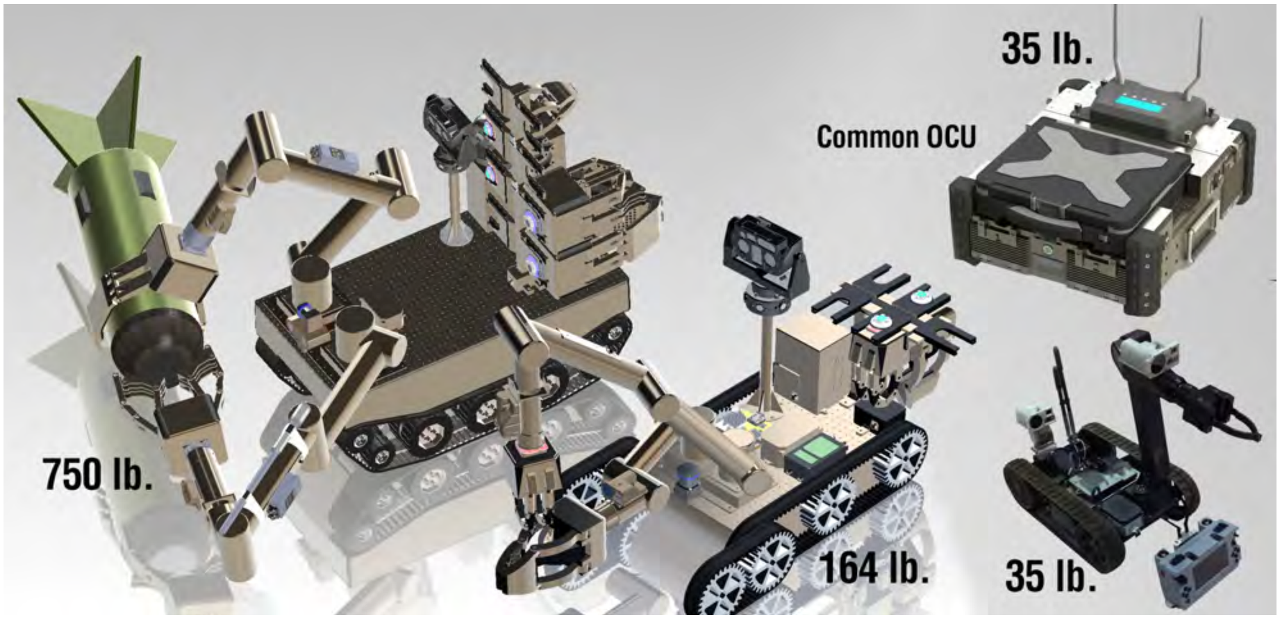
Per DoD Directive 5160.62, the Secretary of the Navy is designated the single manager for EOD technology and training. AEODRS is a Joint Service Explosive Ordnance Disposal (JSEOD) program and is an Acquisition Category IV M effort managed by Program Manager, Expeditionary Missions (PMS 408), within the Naval Sea Systems Command.

The focus of the AEODRS program is the development and fielding of an OSA family of robotic platforms to address the capability gaps and deficiencies identified in the 2005 JSEOD initial capability document, the 2005 and 2006 Joint Requirements Oversight Council memorandums, the 2006 Joint Improvised Explosive Device Defeat Organization Initial Capabilites Document, and the 2010 AEODRS Capability Development Document (CDD). The recurring theme of that documentation is the requirement to conduct EOD operations more safely, rapidly, and effectively and against a wider spectrum of current and anticipated threats.

The AEODRS FoS (Figure 1) includes three variants that differ in size, capability, and the operational constraints within which they are intended to operate:

- Increment 1—35 lb. dismounted operations platform with a handheld operator control unit (HOCU)

Figure 1. AEODRS Family of Systems



- Increment 2—164 lb. tactical operations platform
- Increment 3—750 lb. base/infrastructure operations platform.

The FoS also includes a common operator control unit (OCU).

The driving concept behind the AEODRS CA is the decomposition of each AEODRS variant into a set of intercommunicating capability modules (CMs). Each CM, a nomenclature unique to the AEODRS program, represents a major block of platform functionality. The documents defining the AEODRS CA detail the interfaces through which these blocks of functionality connect, communicate, and interact, as well as define the physical, electrical, and software components needed to integrate them. Architecture description documents (ADDs) provide an overview of the AEODRS architecture and discuss how to implement the remaining documentation. Interface control documents (ICDs) detail the physical, electrical, and logical interfaces for each of the CMs, and module performance specifications (MPSs) contain the requirements with which each CM must comply. The MPS requirements, which are derived, are the requirements each CM must individually meet to provide desired system-level performance. The last type of document within the AEODRS CA documentation set are the extension documents (EXTs), which contain information such as nomenclature definitions, global references, abbreviations, and custom interface definitions.

Each CM physically connects to adjoining CMs utilizing a standard ¼-20 threaded hole pattern and standard military style connector. Electronically, the CMs communicate over Gigabit Ethernet and utilize a 24- or 48-volt power bus to provide power to each CM. Logically, the AEODRS CA builds on the set of services and messages defined by the Joint Architecture for Unmanned Systems (JAUS) standards. Published by SAE International, those standards are available for purchase via SAE's website: http://www.sae.org. Following the JAUS communications protocols, each CM is implemented as a JAUS node and communicates with the other CM JAUS nodes over defined subsystem networks. Adhering to this set of physical, electrical, and logical interface definitions, the CMs are integrated to form and function as the robotic systems within the AEODRS FoS.

Problem/Opportunity

The Man Transportable Robotic System (MTRS) program of record, also managed by PMS 408, has successfully fielded more than 3,000 robotic systems since 2006. The two systems fielded as part of the MTRS program—the Mkl (Packbot) and Mk2 (Talon)—have had high levels of success and have solidified UGVs as essential assets in the execution of EOD missions. The MTRS platforms have an operational life expected through 2020 and continue to receive in-service engineering support for needed repairs and upgrades. Although extremely capable, the MTRS platforms have some limitations. Having initially been designed and fielded with technology that is now nearly 10 years old, requirements to repair, upgrade, and integrate new capabilities onto these systems are constant. The technology to meet the emerging requirements exists, in many cases, at an adequate technology readiness level. However, because the MTRS consists of commercial off-the-shelf platforms, integration of the desired technologies can be complicated and costly. The MTRS robotic platforms were each designed and manufactured by separate vendors, resulting in two systems with different proprietary interfaces and controllers. Thus, any upgrade or emerging robotic capability requires the involvement of the original equipment manufacturer (OEM) in the integration process. Aside from purely bolt-on modifications, any technology (advanced sensor, new controller, autonomy payload, etc.) requires OEM support and permission for access to the required interfaces on the system to enable the new capability. In many instances, OEM unwillingness to support a third-party vendor or high price points for integration have limited the integration of new capabilities onto the MTRS platforms. In some cases, only one of the two MTRS configurations was upgraded; in others, the technology was not integrated at all.

The desire to move away from this "vendor lock" model was the driving influence in adopting the OSA approach for the next generation of EOD robotic systems. The AEODRS CA was developed around the OSA concept, with the government defining clear module boundaries and maintaining ownership and control over the interfaces between the modules. By controlling the CM interfaces and providing module performance requirements for each CM, the government increases competition within industry without hindering or eliminating the ability of vendors to maintain their intellectual property. As long as vendors comply with the defined interfaces and meet the required module performance specifications, the underlying module design and technology remains proprietary to the module vendor. This "black box" approach will enable multiple vendors to compete for and provide key capabilities on the AEODRS platforms. In addition, this will allow industry leaders from multiple robotics arenas (manipulation, mobility, vision, autonomy, etc.) to integrate and provide leading robotic capabilities in a single package to the EOD warfighter.

Approach

Using, as its baseline, the AEODRS CA documentation for Increment 1, which was completed during the FY10–12 time frame, the team developed 36 new ICDs and MPSs for the 18 unique CM suites that combine to form AEODRS Increments 2 and 3. The term "suite" represents a group of similar CMs and is used to define the interfaces and requirements of the CMs within a single ICD and MPS. The term was coined and introduced into the AEODRS CA to optimize the documentation structure. In addition to creating the ICDs and MPSs, the team updated the existing five ADDs and EXTs, which apply across all increments within the AEODRS FoS. Finally, the team updated the 18 ICDs and MPSs for the nine unique CM suites that constitute Increment 1.

This work required significant amounts of engineering and analysis, along with extensive documentation reviews. Allocation of system-level requirements (weight, volume, power, boot time, etc.) and definition of module interfaces required the development of detailed concept models for each CM within Increments 2 and 3. These models, developed using the SOLIDWORKS© computer-aided design software, provided needed virtual context within which all physical interfaces and needed requirement allocations were defined.

Another key aspect of this work was the proper distribution of system-level requirements down to each CM within Increments 2 and 3. When developing the MPS documents, the team was able to distribute AEODRS CDD requirements down into module-level requirements for each CM. Using the IBM software Rational DOORS®, the team was able to trace all module-level requirements, with the MPSs, to their corresponding CDD requirements. This provided requirements traceability from the user level (CDD) down to each module within the AEODRS Increments 2 and 3 platforms (MPSs).

The team members continually conducted or participated in peer reviews of the developed documentation. These peer reviews involved the internal NSWC IHEODTD team along with AEODRS program partners from academia and industry. The reviews served as initial checks of the documentation content for errors, ranging from minor typos to modifications to module-level requirements or interfaces. Over the FY13–14 time frame, several peer reviews per document were held, resulting in several prerelease revisions of the documentation set.

Outcome

In late 2013, the documentation set for Increments 2 and 3 underwent a formal preliminary design review (PDR) to ensure its completeness. The PDR was a critical acquisition gate and involved key stakeholders from both NSWC IHEODTD and PMS 408. In February 2014, following completion of updates recommended in the PDR and other reviews, the team released the updates to the AEODRS Increment 1 documentation (version 1.4) and the newly developed documentation for Increments 2 and 3 (version 1.0). The release of the documentation set to industry supports the development and source selection of the AEODRS FoS robotic platforms by allowing potential vendors to familiarize themselves with the AEODRS CA prior to any formal solicitation.

Because the three AEODRS increments have not yet reached full operational capability, tangible payoffs, in terms of direct cost or time savings, have yet to be realized. However, prototype AEODRS platforms, particularly Increment 1, have demonstrated the ability of the AEODRS CA to provide an OSA-based platform that can meet key system requirements. AEODRS is one of the first programs within the DoD UGV community to demonstrate and test a truly open architecture/plug-and-play system at the module level. While a significant amount of effort remains to fully field the AEODRS FoS, the work completed in the development of the CA documentation has the potential for significant payoffs.

The standardization of the interfaces across the FoS will reduce the time needed to integrate new technology onto the FoS platforms, as well as reduce development and repair times. In addition, the potential for multiple vendors to provide a single module will increase competition and potentially reduce the costs of the final system.

Adoption of the AEODRS CA has been demonstrated within industry and across other government agencies. With the release of the AEODRS CA set of documentation, some vendors have begun to apply internal research and development funds to the development of AEODRS CA–compliant CMs. Also, other government agencies have adopted many of the AEODRS interface definitions into common architecture definitions for other robotic systems. The acceptance thus far of the AEODRS CA begins to demonstrate its applicability and potential for improving the efficiency with which advanced robotics technology and capabilities are delivered to the EOD warfighter.

Current Status

The latest set of CA documentation was released in February 2014. The documents are being used for source selection supporting the engineering development and fielding of all the systems within the AEODRS FoS. The Increment 1 platform is nearing the end of the engineering and development phase, with system fielding expected in FY17. Increments 2 and 3 are just entering the development phase, with fielding slated for FY19.

Challenges

The biggest challenge the team encountered in developing the AEODRS CA documentation was balancing the level at which module requirements were defined. For the module interfaces, once the module boundaries were set, the definition of the interfaces was straightforward. However, in many cases, with the development of the module requirements, portions of the modules had to be designed to properly allocate system-level requirements down to the module level. This was necessary to reduce risk and provide confidence that the requirements were technically achievable. As a simple example, assume the required speed of the system is x mph; deriving this down to the mobility module, the decision would be between (1) requiring the module to have a top speed of x with a payload of y (y being the sum of the weight of other modules) or (2) requiring motor profiles to provide the speed of x with a payload of y. In the example, the decision would be relatively straightforward and would have been to require the module to provide a speed of x with a payload of y, leaving it to the vendor to design the motor internal to its module. Instances of this were encountered throughout the development of the CA documentation. The requirements were defined and agreed upon as a result of the diligence of the team throughout the various system engineering analyses and peer reviews.

About the Award Winner

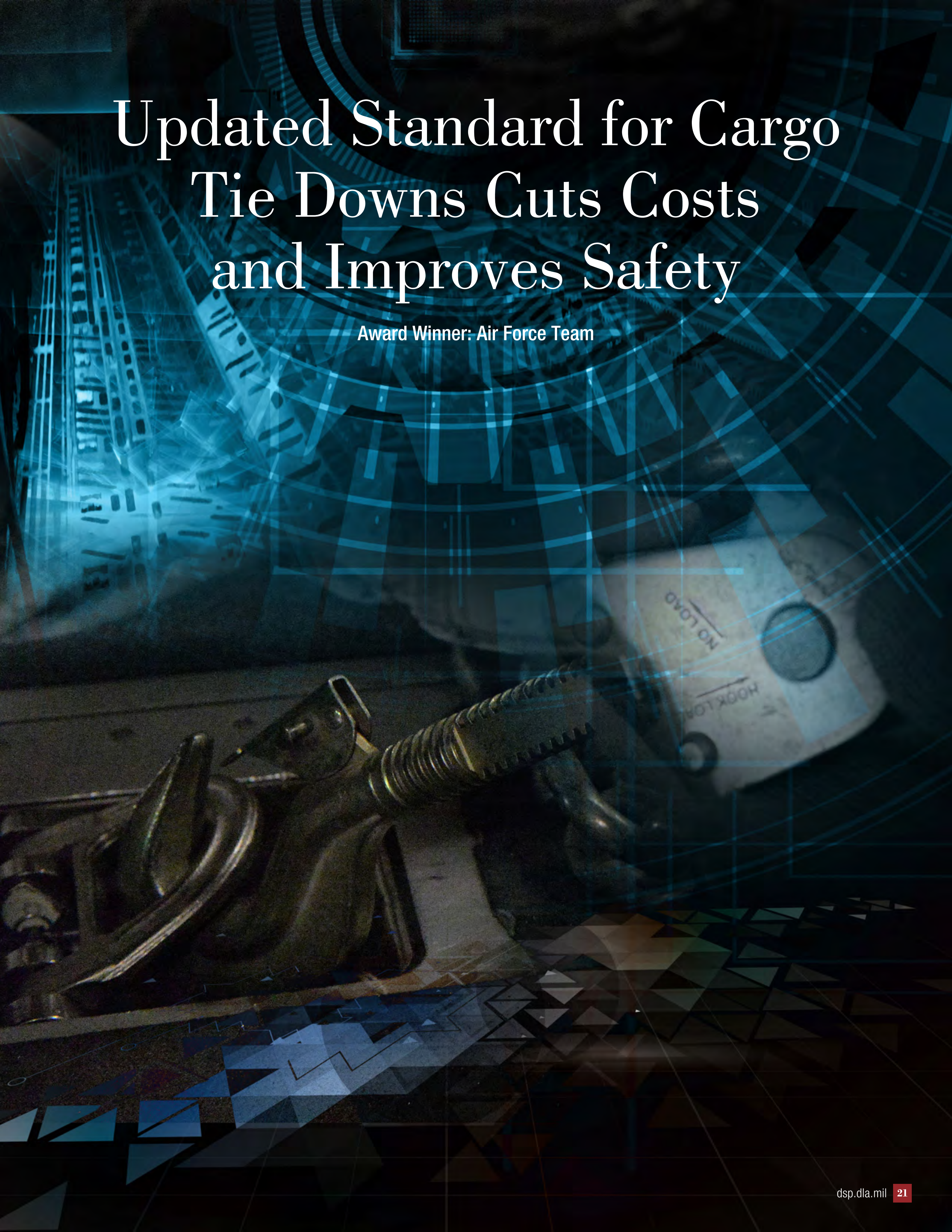
The NSWC team consisted of Michael Del Signore, Todd Zimmerman, Andrew Czop, Adam Shaker, and Juan Roman-Sanchez.

Michael Del Signore and Todd Zimmerman were each team leads for the completion of the CA documentation and were responsible for coordinating the composition of the CA documents for Increments 2 and 3 with the other team members. The team lead role encompassed ensuring consistency across all documents (and across teams), specifically with respect to the wording and completeness of module requirements and interface definitions; coordinating with external team members for peer reviews; incorporating all module requirements into the DOORS software; and performing any needed requirement traces.

Andrew Czop, Adam Shaker, and Juan Roman-Sanchez, along with Mr. Del Signore and Mr. Zimmerman, were each responsible for drafting ICDs and MPSs and for developing concept models for each CM within their assigned CM suites. They also contributed to the updating of the global ADD and EXT documents.

Updated Standard for Cargo Tie Downs Cuts Costs and Improves Safety

Award Winner: Air Force Team



A team from the Air Force Materiel Command (AFMC) undertook a project to update MIL-DTL-25959, "Tie Down, Tensioners, Cargo, Aircraft." Initially, the team focused on addressing logistical and weight issues raised by Headquarters Air Mobility Command (HQ/AMC). MIL-DTL-25959F covered four types of devices: two (MB-1 and CGU-4/E) rated at 10,000 (10K) pounds and two (MB-2 and CGU-3/E) rated at 25,000 (25K) pounds. HQ/AMC requested a single device for each type—one rated at 10K and the other rated at 25K pounds—with a hook that swivels and locks in two positions. HQ/AMC also requested that the weight of the devices be reduced to save fuel on cargo-carrying aircraft. The team developed Revision G to reflect those requirements. Shortly after MIL-DTL-25959G was published, two incidents occurred in which tie-down devices inadvertently released on an M1Al Abrams tank and a Mine-Resistant Ambush Protected vehicle while a C-5 was in flight, a great concern to the flight crew, AMC, and the Army Materiel Command. The team updated the specification, now MIL-DTL-25959H, to address the reliability of the tie downs. As a result of the team's work, the Air Force will realize logistical advantages, as well as fuel savings of approximately $167,000 per year due to the reduction in the weight of the devices. Most important, the devices are much safer; the design ensures that they hold either 10K or 25K pounds, both statically and dynamically, precluding aircraft mishaps.

Background

While a cargo-carrying aircraft (C-5, C-17, C-130, etc.) is in flight, it is critical that the cargo in the fuselage of the aircraft remain in place. A shift in cargo could cause enough of a center of gravity transformation to result in the catastrophic loss of the aircraft, along with its passengers and cargo.

The devices that released during the C-5 flight were sent to Robins Air Force Base (AFB) for inspection. Robins engineers found that the devices, which were manufactured by Davis Aircraft Products and rated at 25K pounds, could sustain a 25K pound slow static load, but could not withstand a dynamic load of 500 pounds. Often during flight, an aircraft will undergo a dynamic acceleration that will put a load on the chains and tie downs restraining the cargo, which, in the case of the C-5 flight, caused several tie-down devices to come loose.

When this incident occurred, the majority of 25K tie downs fielded were manufactured by Davis. In addition, Davis was the only contractor listed on the qualified products list (QPL), so removing Davis as a qualified vendor would shut down air cargo missions involving 25K tie downs. The devices passed all testing in MIL-DTL-25959, but still failed in mission use because the specification lacked a requirement concerning dynamic load.

As an interim measure, until the specification could be updated, the team worked with Davis to develop a kit that would prevent tie-down devices from inadvertently opening during flight. The team also developed some simple tests so the field could determine if the devices currently in inventory required a field kit to be used on their devices to guard against dynamic load failure. One such test was to simply hit the chain saddle of the device with the palm of a hand. Another test was to hold the device 3 feet in the air and drop the device on the chain saddle. The team determined that any device failing those tests would also fail under a dynamic load well before the 25K pound working load was reached.

Problem/Opportunity

HQ/AMC had two primary concerns about the cargo tie-down devices:

- ***Hook orientation***. The only difference between the two 10K devices and the two 25K devices was the hook orientation, which complicated the logistics of the devices and limited their use to certain aircraft. To address those issues, the AFMC team developed a swiveling hook. This enabled the team to merge the two 10K devices, the MB-1 and CGU-4/E, into a single device, the CGU-8/A. In addition, it merged the two 25K devices, the MB-2 and CGU-3/E, into a single device, the CGU-7/A.
- ***Weight***. HQ/AMC's Fuel Efficiency Office (FEO) was concerned with reducing fuel costs on cargo-carrying aircraft. According to the FEO, a weight reduction of 0.6 pound for a 10K device and 0.7 pound for a 25K device would yield a savings of approximately $167,000 per year across the Air Force's fleet of cargo-carrying aircraft. The calculation is as follows: weight per device multiplied by the number of tie downs assigned to each aircraft (75 of each on a C-5, 46 of each on a C-17, and 34 of the 10K and 6 of the 25K on the C-130) results in a weight reduction of 97.5 pounds on a C-5, 59.8 pounds on a C-17, and 24.6 pounds on a C-130 for all flight miles. The weight reduction multiplied by the average annual flight hours of 4,289 for the C-5, 120,458 for the C-17, and 21,702 for the C-130 across FY13–17 yields $167,000 per year.

Shortly after MIL-DTL-25959G was published, two separate incidents of tie-down failure occurred while a C-5 was in flight, which led to a detailed review of the specification. The team found that the requirements and testing sections of MIL-DTL-25959G were not representative of in-flight use. In a flight environment, cargo tie downs experience both static and dynamic loads. However, Revision G had requirements and tests only for static loads. Therefore, to preclude tie-down failures, the team needed to develop requirements and testing criteria for dynamic loads and to incorporate the new requirements into the specification. The tie downs governed by MIL-DTL-25959 are the only approved tie downs for aircraft use; therefore, it is essential that these products be reliable.

Approach

The team worked with a test engineer at the Robins AFB testing agency to develop two dynamic tests. The two tests are now incorporated into Revision H of MIL-DTL-25959 as follows:

> 4.6.7.4 Dynamic load test. A qualification CGU-8/A (CGU-7/A) shall be subjected to a dynamic load of 10,000 (25,000) pounds for 50 cycles. One cycle shall consist of a device starting in 500 pounds of tension, subsequently loaded to 10,000 (25,000) pounds in not more than 1 second, held at 10,000 (25,000) pounds for approximately 5 seconds, and then unloaded back to 500 pounds of tension within 3 seconds. This process shall be repeated for 50 iterations. Release of the chain or evidence of permanent deformation of any of the tensioner components shall constitute failure of the test.
>
> 4.6.7.5 Dynamic impact test. Tie down tensioners shall be suspended by the hook from a rigid structure at least 8 feet off the ground. The suspended tensioner shall have a chain with one end attached to the chain saddle of the tensioner and the other end of the chain attached to a weight. The weight used for the CGU-8/A shall be 15 pounds and the weight used for the CGU-7/A shall be 30 pounds. When suspended freely, the distance from the chain saddle to the bottom of the weight shall be at least 6 feet in length. The bottom of the weight shall be suspended next to the chain saddle and released so as to allow a free drop directly below the tensioner device. The test shall be repeated for 25 iterations. Evidence of permanent deformation or release of the chain from the chain saddle shall constitute failure of the test.

The first test is now required for a vendor to be placed on the QPL for the tie-down devices during qualification testing. Since the dynamic load test is destructive, the dynamic impact test was developed to be part of routine conformance testing that is nondestructive, yet would reveal whether a flaw on the devices is present prior to sending the units out to the user community. The dynamic impact test is now part of all lot sample testing prior to the government taking ownership of the devices. Both of these tests were used to test the devices that failed in the C-5 aircraft mission, and both tests caused the devices to fail. Had these tests been in place prior to shipment to the Air Force, none of the affected devices would have been placed in the inventory.

Outcome

The Air Force will realize a fuel savings of approximately $167,000 per year as a result of the reduction in the weight of the tie-down devices. In addition, the Air Force will realize other benefits that are not easily quantified. For example, qualifying and managing only two types of tie-down devices, in lieu of four types, saves the government manpower hours and testing costs. Specifically, it saves time for the engineers and equipment specialists involved in the qualification and testing, as well as for contracting personnel at the Defense Logistics Agency (DLA) involved in logistical support.

The new devices are much more user friendly, because they can be used on all aircraft in any configuration. Previously, the devices could be used only on certain cargo-carrying aircraft or only in certain configurations. For example, on previous air cargo missions, only the MB-1 10K device could be used on a C-17, whereas only a CGU-4/E device could be used on a C-5, but now, the replacement for those two devices—CGU-8/A—can be used on both aircraft. Having one stock number for a 10K device and one stock number for a 25K device makes management of the devices by AMC and DLA substantially easier, considering that they purchase some 100,000 of them each year, and reduces inventory costs.

Perhaps most important, the devices are much safer, because the design ensures that they hold the weight, either 10K or 25K, both statically and dynamically. That, in turn, will prevent aircraft mishaps, and possible loss of life, due to shifting loads.

The logistical, functional, and safety advantages that the Air Force has by using the new devices also apply to the other services, because many of the Air Force's cargo-carrying missions are performed for other services' branches. Therefore, it is common for Air Force tie-down devices to filter into the inventory of other DoD branches.

Current Status

The new devices have been stock listed, and one vendor has been placed on the QPL. Three additional vendors may be added to the list; they are currently undergoing first-article testing.

The field has been notified that the devices can be ordered, and DLA is supplying them as the orders are received. The old devices will be replaced through attrition.

Challenges

The team faced both monetary and technical challenges.

MONETARY CHALLENGES

Monetary challenges that had to be overcome included funding the testing, because, at that time, the Support Equipment and Vehicles Division had no money for testing. In addition, temporary duty funding was required for team members to travel to New York to work with Davis Aircraft Products, the manufacturer of the devices. Getting those funds approved required that a justification be written and approved by AFMC.

When developing the tests, the cost of vendor testing was a consideration, because the team did not want to drive the cost of the tie-down devices substantially higher. Therefore, the testing needed to be simple so the small defense contractors that have historically manufactured the devices can still do so cost-effectively using the equipment they already have in place. This required coordinating both with the test personnel at Robins AFB and with the contractors that made the equipment to ensure a good value to the U.S. taxpayer.

TECHNICAL CHALLENGES

No substitute tie-down devices existed. Therefore, the team needed to ensure that the cargo-carrying flight mission remained in place, yet also ensure that the flight crew and aircraft remained safe.

About the Award Winner

The Air Force team consisted of Michael Jones and Jeff Friesner, both from Robins AFB, GA, and L.G. Traylor, from Wright-Patterson AFB, OH.

Michael Jones, the engineer assigned to the cargo-carrying restraint devices project, updated MIL-DTL-25959 from Revision F to Revision G and then 1 year later to Revision H. He secured funding for testing to ensure the devices were examined for their underlying problem. He also met with the vendor of the devices that failed and aided in the development and testing of the temporary repair kits. Mr. Jones witnessed the testing and developed the language to go in MIL-DTL-25959H for the dynamic testing. He worked with DLA, the source of supply, to make sure kits were installed in new devices on the way to the field. Knowing it would take several months to develop proper testing and procure appropriate devices for mission use, Mr. Jones also worked with DLA to put inspections in place that would catch defective devices prior to purchase.

Jeff Friesner, the equipment specialist assigned to the cargo-carrying restraint devices project, worked with the field unit that reported the deficiency to help determine the cause of the premature release of the devices. He met with the vendor and helped develop the repair kits. Mr. Friesner drafted a memorandum to be sent out to the field and changed the technical order mandating that all affected devices have a repair kit installed. He fielded all calls from the field regarding the need for repair kits and helped the field order the kits. Mr. Friesner attended the testing that took place and helped determine tests that would reveal potential design defects.

L.G. Traylor served as the technical writer/editor for the document. He worked with the authors to edit and format the document to be in compliance with the basic DSP principles and concepts. This included managing the review comments and complying with requirements for publication in ASSIST.

Design Standards Ensure Cargo Meets Air Transport Requirements

Award Winner: Air Force Team

Engineers from the Air Transportability Test Loading Activity (ATTLA) at Wright-Patterson Air Force Base undertook a project to convert a U.S. Air Force handbook to a military standard, MIL-STD-1791, "Designing for Internal Aerial Delivery in Fixed Wing Aircraft." The Deputy Assistant Secretary for Science, Technology, and Engineering, Engineering Management Division (SAF/AQRE) approved the initial version, MIL-STD-1791A, in late 2012. That version was subject to Distribution Statement C, which made it difficult for foreign governments and vendors to obtain. Because of the need to support multinational operations, the ATTLA team took steps to make the standard publicly available (Distribution Statement A). MIL-STD-1791B was approved in late 2014. The project—from the development of the initial version through issuance of MIL-STD-1791B—took more than a decade to complete because the team was faced with many challenges, such as the continual development of newer aircraft, modifications of related standards, personnel changes, and resistance to making the standard publicly available. MIL-STD-1791B, now being used by all government agencies in procurements of airliftable material, has four key benefits: (1) improved safety of flight, by ensuring cargo can withstand severe flight environments such as hard landings; (2) mission time savings, by optimizing the resources needed for airlift; (3) streamlined acquisition, by providing cargo designers the key information they need in a single, publicly available document; and (4) improved multinational operations and humanitarian airlift, by ensuring domestic and foreign cargo is compatible with Air Force cargo aircraft. Total potential savings are in the millions of dollars.

Background

Prior to 2012, the U.S. Air Force had no military standard (MilStd) for designing cargo to meet air transport requirements; it had only guidelines, in the form of a handbook. Further, because of the unique military operating environment and interface requirements for Air Force aircraft, no equivalent commercial standards existed. Therefore, airlift of cargo not completely complying with the handbook was more complex and required more resources to support than was necessary for cargo that was compliant.

Problem/Opportunity

The U.S. government needed a contractually binding design standard for items (equipment, munitions, machinery, food, fuel, and so on) being procured by DoD and other government agencies that require airlift in Air Force cargo aircraft. Specifically, it needed a standard that would enable design activities, not just in the Air Force, but also in the other military services and in civil government agencies, to design products that would meet airlift and deployability requirements. Examples of agencies (and items) that need cargo airlift are the Navy (PT boats), Army/Marine Corps (M1A1 tanks), NASA (satellites and spacecraft), Federal Bureau of Investigation (mobile crime labs), and Federal Emergency Management Agency (shelters). In addition, government agencies have increasingly been procuring foreign-made equipment, which, in turn, increased the need to transport foreign government and commercial cargo in Air Force cargo aircraft. A contractually binding design standard also was needed for use by foreign governments and vendors when procuring items used to support multinational operations, such as in Iraq and Afghanistan, and humanitarian relief operations. Such a standard also would enhance interoperability among the United States and our allies.

Approach

In 2001, the ATTLA team began converting the handbook to a MilStd. Developing the initial draft, which totaled about 600 pages and was then condensed to 436 pages, took 9 years. Over that time period, the team faced many challenges. Airlift limits for newer aircraft (such as the C-17, C-130J, C-5M, and C-27J) were still being developed, and limits for older aircraft were being modified. Continual changes in those limits meant continual revisions of the document. The team also had to regularly revise the document to keep up with the modifications of related standards and the addition of new policies. It also went through several major changes when management changed and when personnel were moved to other offices.

In 2010, the team submitted the document to SAF/AQRE for approval. Subsequently, the team underwent 6 months of additional negotiations to revise the content and to allow the standard to be revised without having to coordinate with SAF/AQRE. Ultimately, SAF/AQRE approved the document as an Air Force standard but instructed that it be coordinated with the other military services to make it a DoD standard. Comments from the coordination with the other services were then incorporated into the document. The initial version of the document, MIL-STD-1791A, was issued in late 2012.

MIL-STD-1791A was a restricted document, subject to Distribution Statement C, “Distribution authorized to U.S. Government Agencies and their contractors.” Therefore, many foreign governments and foreign vendors were unable to obtain the standard, making it problematic for them to ensure compatibility with Air Force cargo transport requirements. To address that issue, the ATTLA team determined that the MilStd needed to be publicly accessible, which meant that it needed to be converted to Distribution Statement A. Changing to Distribution A also would enable the team to meet a 2012 request from the then-commander of the Army Materiel Command/Directorate of Logistics to create a public website to provide air transport requirements.

The conversion from Distribution Statement C to Distribution Statement A was an extreme challenge that took the ATTLA team another 2 years, from 2012 to 2014. Meeting the challenge required negotiations with all the cargo aircraft and tanker system program offices (SPOs) and the respective manufacturers. Most of the SPOs readily approved the team's request to openly distribute all the MIL-STD-1791 data. However, the KC-10 and C-130J SPOs initially refused, but after negotiations leading to revisions in the data included in the standard, both SPOs, in summer 2014, approved the public release of the data.

In addition to making the standard publicly releasable, the ATTLA team revised the standard to incorporate new design requirements and aircraft limits issued after 2012. It also reduced the number of pages from 436 to 354.

The updated standard, MIL-STD-1791B, was approved in December 2014. The revised document improves acquisition efficiency and provides all manufacturers with accurate information to increase the chances that new domestic or foreign and commercial or military cargo will be readily compatible with Air Force cargo aircraft.

Outcome

MIL-STD-1791 establishes general design and performance requirements for government or commercial cargo to be safely transported in the cargo compartments of Air Force fixed-wing aircraft. Cargo is defined as material such as munitions, machinery, food, and fuel. The standard covers the Air Force's prime mission cargo aircraft (C-130E/H/J, C-130J-30, C-17, C-5, etc.), cargo-carrying systems of the tanker fleet (KC-10 and KC-135), and cargo aircraft in the long-range, international segment of the Civil Reserve Air Fleet (B747, DC-10, B767, etc.). The structural and dimensional criteria for other cargo aircraft are documented in specific manuals for each aircraft. The standard, which is publicly available, brings four key benefits.

IMPROVED SAFETY OF FLIGHT

Having a contractually binding standard reduces the potential for damage to cargo, personnel, or the aircraft. MIL-STD-1791 specifies minimum structural and restraint requirements and methods for packaging the cargo to ensure it withstands severe flight environments, including crash accelerations. Savings to the Air Force are in the millions of dollars per aircraft should cargo break loose and cause major aircraft damage, aircraft crash, or loss of life. Historically, aircraft crashes and loss of life were a result of the cargo not having adequate structural integrity to keep the cargo intact or proper restraint provisions to prevent movement in flight or during a hard landing. Cargo movement in flight has resulted in shifting the aircraft center of gravity; such shifts can make the aircraft go out of balance and can prevent the aircraft from recovering back to stable flight.

MISSION TIME SAVINGS

The standard optimizes the resources needed for airlift by reducing, or eliminating, the need for special equipment. It also allows for prepositioning of necessary resources to reduce mission time. In the past, it was necessary for the aircrew to figure out, on the spot, how to airlift cargo and to obtain the necessary resources. This process sometimes took hours, or even days, to complete. Compliance with MIL-STD-1791 ensures that the cargo is safe to airlift and that the resources required to load the cargo are prepositioned prior to arrival of the airplane. Air Mobility Command aircrews have reported that, compared to the past, cargo typically is in the "ready to go" configuration when the airplane arrives. In addition, compliance with the MilStd reduces the need to consult with engineers stateside. Savings, calculated in man-hours per flight, are currently approaching $1 million.

STREAMLINED ACQUISITION

Issuing the standard as an open document streamlines the acquisition process by allowing both domestic and foreign vendors, or potential bidders, to obtain the standard on their own without having to make special arrangements. Foreign manufacturers can obtain MIL-STD-1791 without having to go through the U.S. Department of State. Domestic vendors no longer have to make special provisions with the government contracting office. Having MIL-STD-1791 in the public domain also means that it does not have to be included in procurement packages or have ATTLA engineers take the time to send the document for the thousands of procurements that occur every year.

In the past, cargo designers needed to research data on cargo aircraft on the Internet or other open sources. The information from such sources is often incomplete, missing, or misleading, and the designer may not be able to find all the important design standards. For example, a company was able to design a vehicle that met the aircraft gross weight limit as stated from a brochure, but it was not aware that it also needed to address the axle weight. The vehicle axle weight limits for each aircraft are not listed at all in the public domain. MIL-STD-1791 contains all the pertinent data for designing cargo; it lists the limitations of all cargo aircraft and is up-to-date and accurate. Having all the pertinent design requirements in a single source improves the chances of having cargo that is readily airliftable.

IMPROVED MULTINATIONAL OPERATIONS AND HUMANITARIAN AIRLIFT

When foreign governments and vendors follow MIL-STD-1791, their cargo is guaranteed to be compatible with Air Force cargo aircraft, including Air Force aircraft sold to other countries. This eliminates the time-consuming process of coordinating with the State Department and sanitizing the MilStd for each foreign request. Time savings can be measured in tens of thousands of dollars per scheduled time to complete a request. Having foreign cargo designed to MIL-STD-1791 allows for more cooperative international airlift missions. It also may make purchasing Air Force–type cargo planes by foreign countries more attractive, knowing that their cargo is airliftable in these types of airplanes.

Current Status

The updated standard, MIL-STD-1791B, was approved in December 2014 and supersedes MIL-STD-1791A. It provides design and performance requirements to ensure the airworthiness, safety, and effectiveness of Air Force fixed-wing aircraft during cargo transport. It presents design requirements and operating limits from the basic aircraft loading manuals and technical publications and is supplemented by additional useful air transport data, including the process for approval or certification of cargo for air transport.

In addition to being contractually binding, the design requirements in MIL-STD-1791 are mandatory for compliance with DoD transportability and deployability programs as established by DoD Instruction 4540.07, "Operation of the DoD Engineering for Transportability and Deployability Program."

The standard is being used for procurements by all U.S. government agencies and their contractors, which procure thousands of items annually. Further, foreign governments and foreign/domestic nongovernment organizations are requiring that their items be compatible with Air Force cargo aircraft and cite MIL-STD-1791 as the standard to meet.

MIL-STD-1791 is also being used in a pilot organization to meet an Engineering Enterprise Executive Council (EEEC) goal to create an Air Force engineering knowledge management capability.

Challenges

Addressing the voluminous amounts of interface requirements took the team many years of dedication to ensure the accuracy and completeness of the MilStd. There were more 5,300 design and interface requirements spanning all Air Force cargo aircraft, aerial delivery equipment, and other related standards. During the writing period, three new aircraft types (C-17, C-130J, and C-27J) became operational, and several related standards were changed.

The problems of constantly changing aircraft operating limits, changing policies, and changing personnel affected the amount of time it took to finish the document. The three primary authors, even though they were in different offices, kept in contact with each other over the years to edit the document. There was a period of time when the aircraft operating limits and operating policies were stable in 2009 and 2010, which allowed the team to complete the standard and submit it to SAF/AQRE for approval.

The source data are from aircraft operating manuals with limited distribution (Distribution C or Distribution D). Changing the distribution statement in MIL-STD-1791 to Distribution A was difficult, because the team needed to make the case that the limits for each aircraft and the description of each cargo delivery system did not violate the International Traffic in Arms Regulations, allow foreign access to U.S.-sensitive technologies, display proprietary data, or show restricted operational information that may compromise safety or operational capabilities. The ATTLA team presented a data package, unique to each aircraft, to each aircraft SPO, explaining that the data in MIL-STD-1791 do not violate the conditions in Distribution Statements C or D. Only the KC-10 and C-130J SPOs initially disapproved the conversion. Over a period of 2 years (2012 to 2014), the team worked with the KC-10 and C-130J engineers to painstakingly examine all applicable aircraft data and modify the information to satisfy the two SPOs.

About the Award Winner

The Air Force team consisted of Mark Kuntavanish, Eric Treadwell, Susan Breslin, Michael Schneider, and Linda Titcombe.

Mark Kuntavanish, the first author of MIL-STD-1791, resurrected and completed the effort to convert the handbook to a standard after 2 years in review at SAF/AQRE. He singlehandedly negotiated with each program office and aircraft vendor to change the distribution restriction. He also ensured MIL-STD-1791 met EEEC Goal 3.

Eric Treadwell was the second author of MIL-STD-1791. He edited the first draft of almost 600 pages, condensing it down to 436 pages. He also revised tables and figures and created hyperlinks to help readers navigate the document.

Susan Breslin was the original technical writer/editor assisting Mark Kuntavanish and Eric Treadwell in the revision and DSP coordination of MIL-STD-1791A. Later, as the Scientific and Technical Information Program manager, she provided direction for changing the document from Distribution Statement C to A to permit public release.

Michael Schneider completed the final touches on MIL-STD-1791A. He successfully obtained approval from the chief systems engineer of the Engineering Directorate to submit the standard to SAF/AQRE. In parallel, he prepared the data package for changing the distribution statement to Distribution A.

Linda Titcombe was the technical writer/editor for both MIL-STD-1791A and B. She worked with the authors to edit and format the document to be in compliance with basic DSP principles and concepts. Ms. Titcombe also helped ensure the required documentation was obtained and recorded for Distribution Statement A.

Revised Performance Specification Allows Use of Faster, Lighter, and More Complex Components for Aerospace Applications

Award Winner: Muhammad Akbar

Muhammad Akbar, from the Defense Logistics Agency (DLA) Land and Maritime, contributed significantly to the development of a new class—Class Y—of military space-level products for nonhermetic devices for inclusion in MIL-PRF-38535, "Integrated Circuits (Microcircuits) Manufacturing, General Specification for." This 3½-year effort, undertaken at the request of NASA, resulted in the establishment of testing and qualification requirements for those devices. Gaining consensus on the requirements was the culmination of cooperation among military and space agencies, manufacturers, and DLA Land and Maritime. Development of this new class provides original equipment manufacturers (OEMs) access to state-of-the-art products not previously documented by MIL-PRF-38535, enabling them to push the limits of their designs to take advantage of these products, which are faster, lighter, and significantly more complex than previously defined military components. For example, Class Y devices will provide higher data rates and more sensitive circuits. The use of the devices in state-of-the-art weapons platforms are of particular interest to NASA, as well as to the Air Force Space and Missile Systems Center (SMC), National Reconnaissance Office (NRO), European Space Agency (ESA), Japanese Space Agency (JAXA), and the aerospace industry in general.

Background

MIL-PRF-38535 establishes the general performance requirements for integrated circuits or microcircuits, as well as the quality and reliability assurance requirements, that must be met for their acquisition. The intent of this specification is to allow the device manufacturers the flexibility to implement best commercial practices to the maximum extent possible, while still providing products that meet military performance needs.

MIL-PRF-38535 required all products supplied for use in space to be ceramic and hermetically sealed. The requirements did not allow for nonhermetic ceramic space-level devices. Instead, manufacturers willing to provide space-level Class S products historically qualified a design under the Class B standard high-reliability military level and, after years of data and proven reliability, requested a Class S certification and qualification.

Problem/Opportunity

The process for a manufacturer to achieve space-level qualification for nonhermetic devices was preventing the use of high-speed, complex microcircuit devices. Designers had to avoid using the latest technologies because they had not been fully characterized in hermetic packages, which are required for military applications. That, in turn, limited the features of the products available for those applications. To address that issue, NASA, in September 2009, approached DLA, expressing interest in the development of a new class level for nonhermetic ceramic devices.

Approach

In April 2010, after several discussions with a NASA representative, Mike Sampson, on the benefits of having nonhermetic parts for space-level applications, Mr. Akbar hosted a teleconference with NASA, The Aerospace Corporation, the military services, and several interested equipment manufacturers about the potential for these devices in space-level weapons platforms. In May 2011, Mr. Akbar hosted a second teleconference with manufacturers and OEMs to discuss the Class Y type products and a possible development strategy. This led to Mr. Akbar preparing an engineering practice study (EPS) on the feasibility of including these types of products within MIL-PRF-38535. The results of the EPS generated more than 200 comments from the military services, NASA, NRO, ESA, and JAXA, with overwhelming support. In February 2012, Mr. Akbar prepared the Class Y final EPS report based on received and coordinated comments and sent the final report to the military services, NASA, aerospace industry, OEMs, and manufacturers as a basis for the new class.

In April 2012, Mr. Akbar hosted a coordination meeting at DLA Land and Maritime to discuss the detailed Class Y requirements. The meeting was attended by representatives from the Army, Navy, Air Force, NRO, Missile Defense Agency, NASA, Boeing, The Aerospace Corporation, Lockheed Martin Corporation, Northup Grumman Corporation, General Dynamics, Texas Instruments, Inc., BAE Systems, Aeroflex, Inc., Honeywell International, Inc., Xilinx, Inc., QP Semiconductor, Inc., Cypress Semiconductor Corporation, and Intersil Corporation Americas LLC.

Subsequently, Mr. Akbar presented a draft of the Class Y screening and quality/technology conformance inspection requirements at JEDEC meetings and asked the participants—DoD military services/agencies, space agencies (NASA, NRO, ESA, JAXA, German Aerospace Center), high-reliability parts manufacturers/suppliers, and major OEMs—to review and comment on the draft.

In December 2012, after receiving comments from industry, Mr. Akbar prepared the initial draft of Revision K of MIL-PRF-38535, including Class Y requirements, and coordinated the draft with the military services, NASA, The Aerospace Corporation, OEMs, and manufacturing communities, as well as with the JEDEC Class Y task group chaired by Dr. Shri Agarwal, from the NASA Jet Propulsion Laboratory (JPL).

During 2013, Mr. Akbar hosted two more coordination meetings and prepared a second draft of Revision K, incorporating all the resolved comments received on the nonhermetic packaging and testing requirements. Several technological advances in flip chip, including ball grid array (BGA) and column grid array (CGA) packages, will allow for military use of state-of-the-art package designs.

In December 2013, Mr. Akbar dated the final version of Revision K of MIL-PRF-38535 with an implementation date of June 30, 2014, for release to the military services, NASA, and the aerospace, OEM, and manufacturing communities.

Outcome

The release of MIL-PRF-38535K with Class Y requirements was a milestone success for DLA Land and Maritime. Class Y, with BGA/CGA packaging, allows for very complex components consisting of 2 million logic cells with a data transmission/reception speed of more than 30 Gbps over 1,500 inputs/outputs per device. And it makes it possible to continue pushing the limit of system designs.

Standardization of the process flows and procedures, along with qualification of the devices, will enable faster insertion and improved operational readiness of complex military platforms. SMC programs; NRO intelligence, surveillance, and reconnaissance programs; and NASA satellite programs will be able to use these valuable new products to develop the highest quality military weapons platforms to ensure successful mission outcomes. These devices are currently being used on CubeSat flight computers, robotic systems developed for the International Space Station, and various add-on payloads. Reconnaissance satellites, Ares rockets, deep space satellites, and commercial satellites such as the next-generation Global Positioning System (GPS III) are examples of other potential applications.

Current Status

Five manufacturers have pursued qualification for Class Y devices: BAE, Xilinx, Aeroflex, Honeywell, and e2v France. The complexity of these devices and the estimated cost of $90,000 per unit require a significant investment, by both the manufacturer and the military services, in support of implementing the devices. Future use of these devices will be expedited based on the certification and qualification of the Class Y program.

Challenges

Several challenges arose during the effort to establish a new class level for nonhermetic devices.

MIL-PRF-38535 testing requirements included in MIL-STD-883, "DoD Test Method Standard: Microcircuits," were designed for hermetic devices. Each test requirement and the established performance requirement had to be evaluated and rethought (reengineered) for nonhermetic applications. Manufacturers provided data on nonhermetic use of known space devices, while DLA, OEMs, and military customers compared results to the current space-level requirements. Mr. Akbar prepared a table outlining the differences between the current manufacturers' practices for nonhermetic and the current space-level hermetic requirements. This table became the starting point for negotiations among all interested parties that led to the current Class Y requirements defined in MIL-PRF-38535K.

The complexity of the devices required the evaluation of nonhermetic package configurations that were previously prohibited from use in high-reliability military specifications. Characterization of BGA and CGA packages for use in space applications required extensive negotiation between the manufacturers and the OEMs who were including those packages in their designs. Each manufacturer had a unique approach requiring evaluation and selection for a standardized approach to nonhermetic space-level microcircuits. The Office of Safety and Mission Assurance's NASA Electronic Parts and Packaging (NEPP) program at JPL has supported the Class Y effort for evaluations of flip-chip underfill and a column-attached process.

Finally, during the coordination process, Mr. Akbar had to resolve more than 1,000 suggested/essential comments. Doing so required multiple teleconferences, face-to-face meetings, JEDEC task group meetings, coordination meetings, and e-mail discussions.

About the Award Winner

Muhammad Akbar is a lead electronics engineer at the Active Devices Branch, a component of the Document Standardization Division within the Engineering and Technical Support Directorate, Defense Supply Center Columbus, DLA Land and Maritime. In addition, he has been working with the radiation hardness assurance (RHA) community to prepare RHA requirements of standard microcircuit drawings for space and high-reliability programs. Before joining DLA, Mr. Akbar worked at the U.S. Patent and Trademark Office in the radio and satellite communication technology area.

Program News

Topical Information on Standardization Programs

Work Begins on Developing Additional SD-22 Content

DoD's Diminishing Manufacturing Sources and Material Shortages (DMSMS) program released an updated version of the DMSMS guidance document—SD-22, ***Diminishing Manufacturing Sources and Material Shortages: A Guidebook of Best Practices for Implementing a Robust DMSMS Management Program***—in February 2015. It also has developed new training targeted at program management: "DMSMS: What Program Management Needs to Do and Why."

The DMSMS community now has work underway to develop additional content for future updates to the SD-22 and related DMSMS training. Below are examples of the content areas being investigated:

- The application of DMSMS management to materials and structural, mechanical, and electrical items, an area that has, to date, been overshadowed by an almost exclusive focus on electronic items
- A more nuanced approach for applying cost avoidance in relation to DMSMS management and resolutions
- Improved cost estimation approaches to improve programming and budgeting for DMSMS management and resolutions by providing additional rigor and funding justification, as appropriate
- The development of an outreach plan for the DMSMS community to best communicate with the vast number of other department stakeholders necessary to implement robust DMSMS management.

If you are interested in contributing to the development of materials in any of the above content areas or have a recommendation for an additional area for expansion of DMSMS content, please contact DSPO.

ANSI Launches Redesigned Standards Portal Website

In April 2015, the American National Standards Institute (ANSI) announced the redesign of its standards portal, a user-friendly online resource and educational tool. The site, at www.standard-sportal.org, provides answers to critical standards, conformance, market access, and trade-related questions that companies require for U.S. and international operations. The updated site features a new interface with links to need-to-know information on international trade.

The portal was originally launched in 2006 as part of a collaborative effort between ANSI and the National Institute of Standards and Technology, in cooperation with the Standardization Administration of China. Designed for industry stakeholders and policy officials, the portal initially focused on U.S.–China trade, but it has since expanded to include resources for export markets in India and Korea. ANSI's vice president of international policy, Joseph Tretler, recently signed an implementation plan for a U.S.–Brazil standards portal.

The revitalized portal features easy-to-navigate pages with informative global resources and connects users to subsites of topical material, such as international trade resources, international policy papers, and a comprehensive U.S. market directory. A new link on the portal directs visitors to fundamental information on the Standards Alliance, a public-private partnership between ANSI and the U.S. Agency for International Development, aimed at assisting developing countries with World Trade Organization and Technical Barriers to Trade compliance.

"The expansion and upgrade of the Standards Portal demonstrates ANSI's commitment to global and bilateral cooperation and trade facilitation," said S. Joe Bhatia, ANSI president and chief executive officer. "The portal will continue to respond to the needs of U.S. and international businesses by providing the resources they need to understand the standards and conformance activities driving market access."

Site visitors can also find links to access a database of national, regional, and international standards and guidelines considered integral to successful international trade. Dual-language (Mandarin and English) educational materials on the structure, history, and operation of the U.S. and Chinese standards systems are also available, in addition to helpful standards information for India and Korea in the portal's export markets section.

ANSI is a private nonprofit organization whose mission is to enhance U.S. global competitiveness and the American quality of life by promoting, facilitating, and safeguarding the integrity of the voluntary standardization and conformity assessment system. Its membership comprises businesses, professional societies and trade associations, standards developers, government agencies, and consumer and labor organizations. ANSI represents the diverse interests of more than 125,000 companies and organizations and 3.5 million professionals worldwide.

DSPO's Joseph Delorie receives SES Honorary Life Member Award

DSPO's Joseph Delorie received the Standards Engineering Society (SES) Honorary Life Member Award, Tuesday, August 11, 2015, at a ceremony held at the 64th Annual SES Conference in Baltimore, MD. This award is presented by invitation of the SES Board of Directors, upon the recommendation of the Awards committee, for unusual professional distinction and outstanding accomplishment in the field of standardization. Mr. Delorie was recognized first and foremost for his longtime work on the development and simplification of the ASSIST Database and its related set of automated tools. The award citation also noted his participation on various committees, his oversight of integrated product teams, management of standardization assessments, and overall assistance to the Department of Defense toward greater use of commercial products and processes.

Events

Upcoming Events and Information

September 22–24, 2015, Seattle, WA

SAE 2015 AeroTech Congress and Exhibition

SAE International's 2015 AeroTech Congress and Exhibition will be held at the Washington State Trade and Convention Center in Seattle, WA. AeroTech provides a forum for the global aerospace community to meet and discuss current and future challenges, opportunities, and requirements of next-generation research and development, products, and systems. Technical sessions, panel discussions, and keynote presentations make up a program that provides value to industry and government engineers, scientists, designers, program managers, operators, educators, and students. The technical program will cover a broad spectrum of topics, including avionics, environment, flight sciences, operations, manufacturing, materials, structures, propulsion, safety, and systems. AeroTech also provides a venue for engineers participating on SAE committees and advisory bodies to meet and discuss industry standardization efforts and best practices. For more information, please go to http://www.sae.org/events/atc/.

October 26–29, 2015, Springfield, VA

18th Annual NDIA Systems Engineering Conference

This conference focuses on improving acquisition and performance of defense programs and systems, including net-centric operations and data/information interoperability, systems engineering, and all aspects of system sustainment. It will be convened in October 2015 at the Waterford Conference Center in Springfield, VA. The conference is sponsored by the National Defense Industrial Association's (NDIA's) Systems Engineering Division, with technical cosponsorship by IEEE Aerospace and Electronic Systems, IEEE Systems Council, and INCOSE and with the support of the Office of the Deputy Assistant Secretary Defense for Systems Engineering and the Office of the DoD Chief Information Officer. For more information, go to http://www.ndia.org/meetings.

Events

Upcoming Events and Information

November 30–December 3, 2015, Phoenix, AZ

2015 DMSMS Conference

The 2015 Diminishing Manufacturing Sources and Material Shortages (DMSMS) Conference will be held at the Hyatt Regency Phoenix Convention Centers and Venues, Phoenix, AZ. Details on the technical program are still being worked out, but the event promises to be top-notch in every way. For more information on the event, go to dmsmsmeeting.com.

People

People in the Standardization Community

Welcome

Rade Savija recently rejoined the Naval Air Systems Command (NAVAIR) Systems Standardization Division after a 16-year hiatus in the commercial aerospace industry. Mr. Savija—a materials engineer by training—brings his experience, maturity, and new perspectives to the Defense Standardization Program at NAVAIR. A valuable addition to the NAVAIR Standardization Team, we welcome him to his new position.

Rodney Chambers joined the Microelectronics Branch of the Document Standardization Division at DLA Land and Maritime in Columbus, OH, as an Electronics Engineer. He will be working in the Bipolar Microcircuit and Linear Microcircuit areas as standardization code CC. Mr. Chambers experience in the private sector includes multiple manufacturing production engineer positions in the automotive lighting industry and electronics manufacturing. We welcome and wish him well in his new position.

Chance Hunter joined the Microelectronics Branch of the Document Standardization Division at DLA Land and Maritime in Columbus, OH, as an Electronics Engineer. He is assigned to MIL-STD-883 as standardization code CC. Before joining DLA Land and Maritime, Mr. Hunter held a variety of engineering positions for private-sector companies in the semiconductor manufacturing and automated test equipment industries. We welcome and wish him well in his new position.

Farewell

Terence Chin retired from the Naval Air Systems Command (NAVAIR) Systems Standardization Division, Lakehurst, NJ, after nearly 30 years of federal service on December 31, 2014. Terence will always be remembered for his professionalism and desire to share knowledge with others at NAVAIR and in the greater defense standardization community. May your future be one of health and happiness. Fair winds and following seas!

Upcoming Issues
Call for Contributors

We are always seeking articles that relate to our themes or other standardization topics. We invite anyone involved in standardization—government employees, military personnel, industry leaders, members of academia, and others—to submit proposed articles for use in the *DSP Journal*. Please let us know if you would like to contribute.

Following are our themes for upcoming issues:

Issue	Theme
October/December 2015	Open Systems

If you have ideas for articles or want more information, contact Tim Koczanski, Editor, *DSP Journal*, Defense Standardization Program Office, 8725 John J. Kingman Road, STOP 5100, Fort Belvoir, VA 22060-6220 or e-mail DSP-Editor@dla.mil.

Our office reserves the right to modify or reject any submission as deemed appropriate. We will be glad to send out our editorial guidelines and work with any author to get his or her material shaped into an article.


DEFENSE STANDARDIZATION PROGRAM
MAKING SYSTEMS WORK TOGETHER