METALWORKING TECHNOLOGY
UPDATE

NCEMT Reduces Cost and Weight of Concept 1 Dispenser System Manifold

The Concept 1 Dispenser Subsystem is an assembly that forms part of the Surface Ship Torpedo Defense (SSTD) Soft Kill Countermeasure (SKCM) suite that is currently under development by the US/UK SSTD Joint Program Office (JPO). The manifold assembly of the Concept 1 Dispenser is a complex unit, currently comprised of a number of machined aluminum plates assembled to form a honeycomb of close tolerance bores through which the Concept 1 payload is ejected. BAE Systems demonstrated the principles of operation for the radial manifold during the program demonstration and validation phase, completed in March 1999.

The engineering prototype that was developed and tested by BAE Systems was machined from aluminum alloy 5083 in the "O" annealed condition. This manifold successfully passed development tests, but exhibited local areas of melting and erosion. A reduction in cost and weight was also required before implementation. Subsequently, BAE Systems tested another prototype manufactured from PEEK™ thermoplastic. This manifold suffered severely from the effects of the gas temperature. Because of these undesirable test results and the desire to reach stringent cost and weight goals, the National Center for Excellence in Metalworking Technology (NCEMT) was tasked to perform a comprehensive design for manufacturability.

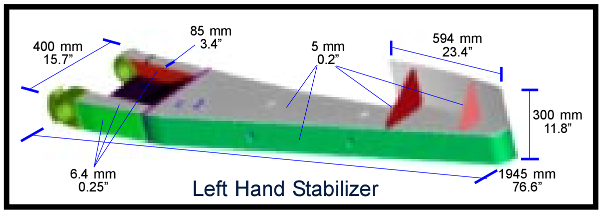
The objective of the High-Temperature Lightweight Radial Manifold (HTLRM) project was to perform a comprehensive design for manufacturability evaluation of the Concept 1 manifold assembly including material selection, product design, and manufacturing process selection. The focus was on the selection of a rapid, low-volume, net-shape or near-net-shape production process to minimize the number of parts that were needed to construct the HTLRM. The goals were to reduce the cost from $17,000 per system (two manifolds per system) to $2,000 per system and reduce manifold weight from 2.85 kg to 1.28 kg for improved flight characteristics.

The baseline evaluation resulted in the evaluation of four material/process combinations: investment cast Ti-6Al-4V, semi-solid formed A356, plastic injection molded PEEK, and machined 6061-T6. Four coating materials were evaluated as well. Preliminary samples from each of these four material/process combinations were produced and evaluated. Titanium investment casting and semi-solid metalworking of A356 were eliminated. The NCEMT also investigated using injection molded PEEK plates because of the crystalline structure produced during the injection molding process, which was not present in the machined PEEK plates previously tested. Although the crystalline structure provided increased structural strength and the testing occurred with a new gas propellant that was to burn cooler, the PEEK material failed under exposure to the gas propellant.

For 6061-T6, the NCEMT team optimized each individual manifold plate and manifold assembly for weight reduction and obtained production costs for machining these manifolds. The NCEMT produced four manifolds, two of which were coated and tested—one with electroless nickel-phosphorous boron nitride and the other with an anodized hard coat. Additionally, the NCEMT developed a separator plate that is installed between the gas generator and manifold to prevent gas impingement damage to the manifold. Two materials were evaluated for the separator plate: titanium and copper. Both of the aluminum manifolds successfully passed the test firing performed by BAE Systems at its test facility. The testing also showed that the titanium material is the preferred material for the separator plate.

The NCEMT successfully reduced the aluminum manifold weight from 2.85 kg to 1.80 kg and showed that production costs of $2552 per system ($1276 per manifold) are possible. Results are slightly above the goals for this project, but the NCEMT did significantly reduce the cost and weight for the HTLRM. It is estimated that the inventory production for deployment of this system will be 2880 systems. At the obtained machining cost of $2552 per system, the present value cost avoidance is $42.2M based on MANTECH guidelines. Thus, the NCEMT successfully reduced the cost and weight for the HTLRM. ■

Photo: Concept 1 Dispenser Manifold Assembly



Left Hand Stabilizer

NCEMT Reduces Howitzer Part Count

The NCEMT has been requested, through a program with the Tank-Automotive and Armaments Command (TACOM) of the U.S. Army, to examine the use of castings to replace multiple-piece welded components of the new Ultralightweight Field Howitzer (UFH). The UFH, designated XM777 in the U.S., was selected by a joint U.S. Army/Marine Corps initiative in 1997 to replace the existing M198 155 mm towed howitzer. The first engineering and manufacturing development (EMD) phase of the program was delivered in June 2000. To minimize weight, the UFH is fabricated using large quantities of titanium alloys, making it the world's first 155 mm howitzer weighing under 9,000 pounds, which is key to maintaining structural strength while meeting a strict lightweight requirement. However, the initial howitzer design contained too many welds, causing considerable distortion to the structure, which lowered the accuracy.

Through the NCEMT's consultation with the Program Office and the prime contractor, BAE Systems, the left and right stabilizer arms were selected for demonstration. Each of these castings will replace an assembly of 35 components. PCC Structurals, Inc. was selected to produce the parts and deliver the stabilizer to BAE Systems on September 28, 2001. This casting meets standard requirements, is 25-percent less expensive and eliminates numerous welding operations.

Based on this success, BAE Systems is exploring a number of additional components that could be cast rather than welded. It is expected that the results of this project will benefit other combat vehicles including the Advanced Amphibious Assault Vehicle (AAAV) and the Crusader. The U.S. Army's Combat Vehicle Research (CVR) program, through the NCEMT, is coordinating this activity. ■

Thin-Wall Casting Expected to Aid Engine Program

The NCEMT is continuing efforts to manufacture less expensive, more capable, thin-wall diffuser/combustor cases for the AE1107C engine used on the V-22 Osprey aircraft. Currently, the components are manufactured as fabricated and machined titanium parts by the engine manufacturer—Rolls-Royce Corporation of Indianapolis, Indiana. An alternate manufacturing process has been identified to cast these components as single-piece parts using a nickel-based alloy. However, system requirements dictate that the component weight be no more than the current titanium design. Therefore, owing to the difference in material density, the nickel-based design must rely upon significantly thinner sections than the titanium-based design. In this project, the thermally controlled solidification (TCS)-casting process—patented by PCC Structurals, Inc. of Portland, Oregon—is being enhanced to accommodate the component, which has two concentric thin-wall regions with the largest being approximately 20 inches in diameter and 11 inches in length (see figure). A wall thickness of 0.065 inches has been demonstrated on a full-scale stylized design prepared under NCEMT funding combined with that from Rolls-Royce and the U.S. Air Force. Expectations are that the process will allow a wall thickness of 0.050–0.055 inches in the final component design.

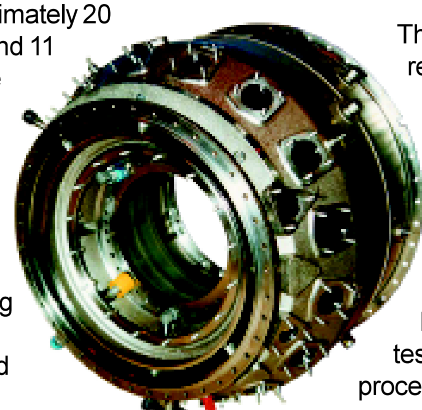


Photo: Current Diffuser

The TCS-casting process relies on withdrawing a preheated mold from a hot zone to ensure that the thin-walled castings solidify without porosity or other defects common to expansive thin-wall regions. This is important because pressure tightness is necessary in the part. The temperature gradient and solidification rate are carefully controlled in the TCS-casting process so that the resulting microstructure is very uniform and equiaxed. This ensures good quality of the casting with the required mechanical properties. The diffuser/combustor case that is being cast under the current MANTECH project has several unique features including a significantly larger thin-wall region than previous TCS-cast parts and use of a new nickel-based superalloy—RS5. After completion of an alloy screening evaluation, (which included alloys IN718 and IN939), RS5 was chosen based upon its castability as determined by several standard tests at PCC and measured mechanical properties at room temperature and typical operating temperatures (750–1300°F). In addition, RS5 offers more than a 200°F margin in operating temperature over the current bill-of-materials titanium alloy.

The component will be redesigned to accommodate both RS5 and the TCS-casting process. Casting (both process design development and fixed production process demonstration) is expected to begin in mid-2002, followed by component and engine testing in mid-2003, with final process approval late in 2003.

The project is being bolstered by more than a 50-percent cost share from Rolls-Royce. Upon successful production implementation of the technology, a $6000 cost reduction per component is expected. Other Department of Defense (DoD) and civilian aircraft engines have been identified for potential application of the technology. ■

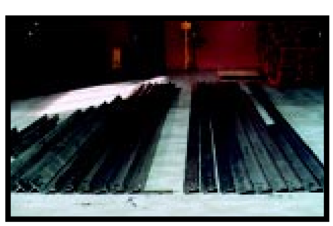
NCEMT Identifies Promising Extrusion Parameters for Aluminum Alloy 2519

General Dynamics Land Systems (GDLS) selected aluminum alloy 2519 as the main structural alloy in its production of the Advanced Amphibious Assault Vehicle (AAAV). Although 2519 rolled plate is reasonably well characterized, data on forgings are very limited and no data on 2519 extrusions were found in two literature surveys performed by National Center for Excellence in Metalworking Technology (NCEMT) engineers. GDLS has used medium-strength aluminum alloy 6061 for the extruded components on the AAAV demonstrators. Alloy 6061 has significantly lower strength than 2519 T87 plate, which likely means that the weight of the AAAV extrusions could be decreased by using properly fabricated 2519 extrusions. In addition, the 6061 extrusions are welded to the 2519 hull and no long-term corrosion data are available for 6061/2519 welded couples. Therefore, an effort was undertaken by the NCEMT to develop the manufacturing technology that is required to produce quality 2519 extrusions.

The AAAV Program identified two representative and important extruded sections on the AAAV. The first is the stanchion, which is a thin-walled square tube that is a vertical structural member on the inside of the hull, and the second was a floor "T" stiffener. The NCEMT identified promising extrusion parameters for 2519, in part from hot-working simulation studies using hot torsion and uniaxial compression data. Working closely with the Kaiser Center for Technology and with Richland Specialty Extrusions, the parameters that were identified were successful in producing a pilot-production run of 2519 extrusions (see figure) in these two shapes. Temper development was performed on the extrusions and the mechanical properties that were generated for the 2519 extrusions were clearly superior to that for the current 6061 extrusions. For example, the 2519 extrusions demonstrated a 28-percent increase in yield strength and a 47-percent increase in tensile strength with comparable elongation relative to 6061 in the same product form. Over the past year, the NCEMT has worked with GDLS and the AAAV Program Office to ensure an effective transition of the 2519 extrusion technology to commercial production.

The NCEMT identified a commercial-scale manufacturing path for 2519 extrusions that would allow production of the various extrusion geometries designed by GDLS. Most of the designs are T-shaped extrusions or square seamless tube extrusions, not unlike the representative extrusions that were successfully fabricated. The NCEMT coordinated the work between GDLS and Richland Specialty Extrusions to enable the commercial production of two T-stiffener extrusions. The extrusion and heat-treatment parameters that were previously developed by the NCEMT were readily adaptable to the new T-stiffener extrusions. Utilizing these parameters, Richland Specialty Extrusions was successful in producing 500 pounds of both T-stiffener geometries. These extrusions will be implemented in the rollout of the AAAV through the prime contractor, GDLS.

The NCEMT was successful in orchestrating the fabrication of AAAV-specific 2519 extrusions and transferring this technology to commercial production through GDLS. GDLS now has a production path for 2519 extrusions in various shapes to replace the 6061 extrusions that have been used on the AAAV demonstrators. ■



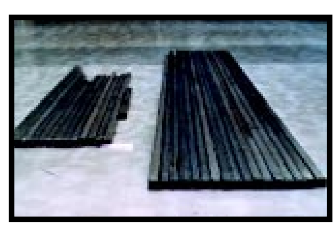


Photo: 2519 AAAV T-stiffener extrusions (left) and Stanchion extrusions (right) developed by the NCEMT.

NCEMT Facilitates Successful 'Shipbuilding Technologies 2001' September 5–6

Shipbuilding Technologies 2001, held in Biloxi, Mississippi, September 5–6, 2001, provided an effective exchange of information on shipbuilding technology developments. This annual event, initially held in Arlington, Virginia in 1998, was jointly sponsored this year by the Office of Naval Research – Navy Manufacturing Technology (MANTECH) Program, and the National Shipbuilding Research Program – Advanced Shipbuilding Enterprise (NSRP ASE).

Photo: Plenary Panel Discussion on Industry/Navy Cooperation in Shipbuilding Technology Development Moderated by Michael L. Powell, Newport News Shipbuilding

The focus of the information exchange was on technical developments generated by projects sponsored by Navy MANTECH, through its Centers of Excellence (COEs), as well as other ONR shipbuilding initiatives, and NSRP ASE. To the increasing benefit of the Navy and the domestic shipbuilding industry, such projects are more and more frequently being funded in cooperation between those organizations, with the active involvement and financial contributions of the domestic shipyards. The over 200 attendees were primarily affiliated with nine U.S. shipyards; suppliers to the shipbuilding industry; the U.S. Navy, including Naval Sea Systems Command (NAVSEA), ONR and Supervisor of Shipbuilding; and the Navy MANTECH COEs.

Photo: Rear Admiral Charles B. Young, Vice Commander, Naval Sea Systems Command (NAVSEA) giving the NAVSEA keynote address

Photo: Commander Steve Metz, AEGIS Area Commander/DDG Project Officer, Supervisor of Shipbuilding, Pascagoula, Mississippi; and Bob Merchant, Program Manager, AEGIS Destroyer Program, Northrop Grumman Ship Systems Ingalls Operations

Three Concurrent Technical Sessions dealt respectively with Materials, Standards & Design Technologies; Production Processes; and Business Process and were organized and co-chaired by technology leaders from the Navy MANTECH COEs and the NSRP ASE Major Initiative Teams.

This information exchange was facilitated by the National Center for Excellence in Metalworking Technology (NCEMT), one of the Navy MANTECH COEs. Invaluable programming assistance was provided by Scott Poelker on behalf of NSRP ASE, as well as Leo Plonsky and Bill Safier for ONR MANTECH. Another edition of this information exchange is already in the planning stage; dates and location are to be announced shortly.

Photo: John B. Todaro, Director, Office of Technology Transition, Department of Defense, Moderating Plenary Panel Discussion on National Shipbuilding Issues

Proceedings

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Concurrent Technologies Corporation (*CTC*) operates the National Center for Excellence in Metalworking Technology (NCEMT) for the U.S. Navy Manufacturing Technology (MANTECH) Program. NCEMT serves as a national resource for developing and disseminating advanced technologies for metalworking products and processes. The NCEMT applies these technologies to solve productivity problems in support of the Navy and Department of Defense needs.

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