

Volume 4, Number 2  
Summer 2008  
Feature

## For its Rotorcraft, Navy is Switching to Aluminum Gearboxes

By Ben Craig

The Navy is evaluating the potential for replacing select magnesium components used on its fleet of helicopters, because of a recurring maintenance problem. Magnesium is extremely prone to corrosion in saltwater environments.

The H-1, H-53, and H-60 helicopters have main and tail rotor gearboxes that have been exhibiting severe corrosion problems due to their magnesium construction. Initially, the Naval Air Systems Command (NAVAIR) collaborated with the Army Aviation and Missile Command (AMCOM) to determine if there were any feasible options for mitigating the problem (see related article: "Services Work to Reduce Maintenance Costs and Raise Helicopter Readiness").



*An aircrewman peers out of an H-60 Seahawk assigned to the "Blackjacks" of Helicopter Sea Combat Squadron (HSC) 21 on June 5, 2008, after delivering a load of ordnance onto the flight deck of the aircraft carrier USS Ronald Reagan. Photo by Joshua Scott, Mass Communication Specialist 3rd Class, U.S. Navy.*



*Ralph Laduke, Aviation Boatswain's Mate Handling 3rd Class, guides an H-60 Seahawk assigned to the "Raptors" of Helicopter Maritime Strike Squadron (HSM) 71 on June 2, 2008. Photo by Elliott J. Fabrizio, Mass Communication Specialist 2nd Class, U.S. Navy.*

According to Bill Nickerson, a materials engineer in the Materials Engineering Division at NAVAIR, this joint service effort was necessary to maximize the use of legacy magnesium parts. During the course of the effort, it was determined that for the long-term, mitigating the problem simply wouldn't be sufficient. "We have a lot of legacy magnesium components out there, and obviously we don't want to replace fully operational assets, so we're going to try to maintain those components for as long as we can to the best of our ability," said Nickerson. "What we found, from a corrosion standpoint, was that the best, state-of-the-art alloys, coatings, and processes that we have to protect and maintain magnesium cannot offer the corrosion performance of aluminum alloys and coatings."

Legacy data from the H-53D helicopter show that some of the tail gearboxes' center housings have been switched to aluminum components as a result of excessive corrosion maintenance costs. NAVAIR has already acquired performance data for the aluminum gearboxes. Based on maintenance records from the Fleet Readiness Center-East (at Marine Corps Air Station, Cherry Point, North Carolina), the aluminum components on the H-53D model clearly outperformed its magnesium counterpart on the H-53D.

Consequently, NAVAIR began looking for a suitable replacement for the magnesium components that could be easily implemented without altering the performance of the rotorcraft. Aluminum stood out as a legitimate candidate replacement material, despite its inherent drawback of having a significantly higher density, making the strength-to-weight ratio much less attractive than that of magnesium. Weight of course is always a critical factor for rotorcraft.

What NAVAIR found, at least in one specific example, was that to meet the structural and strength requirements, aluminum only had to have approximately 20 percent of the thickness of the current magnesium component. Consequently, aluminum became a much more feasible candidate, Nickerson said. "We thought—for something like an H-53 main gearbox housing—that there would be a 700- or 800-pound difference to use aluminum on the main gearbox instead of magnesium, and it ended up being an estimated less-than-200-pound difference," said Nickerson. "That's well within the operational capability of the engines, although any weight penalty must be offset against operational payload capabilities for any potential modification."



A U.S. Marine, left, and a civilian contractor with Marine Heavy Helicopter Squadron 465, work on the gearbox of an H-53 helicopter in Al Asad, Iraq, in the fall of 2006. Photo by Cpl. Richard A. Hilario, U.S. Marine Corps.

To further reduce any weight penalty incurred for using a more corrosion-resistant material, NAVAIR is looking into new aluminum casting processes, such as investment and Controlled Solidification Investment Casting (CSIC). The advantage of the new processes is that the density of aluminum can possibly be kept to a minimum while maintaining the structural strength at the required levels. These newer processes are being evaluated to determine scalability for full production and manufacturing.

"We are now at a position where we may be able to produce many of the gearbox components out of aluminum alloys using the new casting processes at reduced- or no-weight impact, and sometimes at even a weight savings, compared to sand-cast magnesium," said Nickerson.

### Implementing the New Aluminum Gearboxes Translates into Cost Savings

The Navy hasn't wasted any time inserting the material change into several upgrades that are being implemented across various rotorcraft platforms. To date, the aluminum components processed at fleet readiness centers have shown a significant reduction in corrosion compared to the legacy magnesium components. "In terms of corrosion maintenance, so far we have not had to process any aluminum components as Scrap Items," said Nickerson.

---

**"Magnesium presents a fire issue, and aluminum also eliminates that. Even if you take a direct hit to the gearbox, you're not going to have an internal fire."**

---

Among other benefits, the cost savings from switching to aluminum gearboxes looks very promising. "The H-53K program has already switched to aluminum components in its design process, reaping a significant estimated cost avoidance over a 20-year life cycle compared to magnesium designs. If aluminum components can be transitioned to other new programs, such as the H-60 upgrades, the Navy has the potential to realize millions of dollars in cost savings," said Nickerson.

By extending the replacement of magnesium gearboxes with the aluminum version to other military helicopter platforms and models, the cost savings for the military would be significant. "If we can basically spread this to all of the rotary platforms, using very low-end estimates, we're talking significant cost savings over the next 20 years by designing in aluminum components on the new Type/Model/Series platforms," said Nickerson.

Survivability is also an issue with the magnesium gearboxes. "Magnesium presents a fire issue, and aluminum also eliminates that. Even if you take a direct hit to the gearbox, you're not going to have an internal fire," said Nickerson. With the move to aluminum, NAVAIR is making progress in several categories. "Your reliability goes up, survivability goes up, and your corrosion costs go way down. What we're doing now is trying to eliminate the magnesium altogether so we don't have to keep fighting the same problem. The intent is to incorporate new aluminum casting processes in upgrades and new designs."



Sailors aboard the replenishment oiler USNS Henry J. Kaiser scurry out from under an H-60 Seahawk on May 31, 2008, assigned to the "Eightballers" of Helicopter Sea Combat Squadron (HSC) 8 after connecting cargo to the helicopter. The exercise occurred during a replenishment with the Nimitz-class aircraft carrier USS John C. Stennis. Photo by Walter M. Wayman, Mass Communication Specialist Seaman, U.S. Navy.