

Congressional Reports Overview

DOT&E prepared seven Beyond Low-Rate Initial Production Reports (BLRIPs), one Early Fielding Report, and four special reports for the Secretary of Defense and Congress in FY10, as well as the Ballistic Missile Defense Annual Report and a report on the Airborne Laser. This section includes Executive Summaries of two of the BLRIP reports. Summaries for the remaining reports are not included due to classification, as noted in the table below.

PROGRAM	REPORT TYPE	DATE
BLRIP Reports		
Acoustic Rapid Commercial Off-the-Shelf (COTS) Insertion (A-RCI) AN/BQQ-10(V) Sonar System (Classified)	OT&E BLRIP Report	October 2009
<i>Virginia</i> Class Submarine (Classified)	Combined OT&E/LFT&E BLRIP Report	November 2009
Department of the Navy Large Aircraft Infrared Countermeasures (DoN LAIRCM) (Classified)	OT&E BLRIP Report	December 2009
Vertical Launch Anti-Submarine Rocket (ASROC) with the Mk 54 Mod 0 Lightweight Hybrid Torpedo (VLA Mk 54) (Classified)	OT&E BLRIP Report	January 2010
CV-22 Osprey	OT&E BLRIP Report	January 2010
USS <i>San Antonio</i> Class (LPD 17) Amphibious Transport Dock Ship (Classified)	Combined OT&E/LFT&E BLRIP Report	June 2010
USMC H-1 Upgrades (AH-1Z)	Combined OT&E/LFT&E BLRIP Report	September 2010
Special Reports		
Assessment of the Mine Resistant Ambush Protected (MRAP) Family of Vehicles (Classified)	Combined OT&E/LFT&E Special Report	March 2010
Operational and Live Fire Report of the M915A5 Truck Tractor, Line Haul (Classified)	Combined OT&E/LFT&E Special Report	May 2010
Live Fire and Operational Test and Evaluation Report on the Mine Resistant Ambush Protected (MRAP) All-Terrain Vehicle (M-ATV) (Classified)	Combined OT&E/LFT&E Special Report	June 2010
DOT&E Independent Assessment of the Army's Phase I and Phase II Follow-On Testing of Hard Body Armor (Classified)	Special Report	July 2010
BMDs Reports		
Airborne Laser (ABL) (Classified)	Missile Defense Report	January 2010
2009 Assessment of the Ballistic Missile Defense Systems (Classified)	Annual Report	February 2010
Early Fielding Reports		
Littoral Combat Ship (LCS) 1 (Classified)	Early Fielding Report	July 2010

ANNEX – CONGRESSIONAL REPORTS

CV-22 Osprey

The CV-22 is operationally effective with significant limitations and operationally suitable with limitations for supporting Special Operations missions. The speed and range of the basic V-22 airframe exceed the capabilities of existing Air Force Special Operations Command (AFSOC) aircraft and the recently retired MH-53 Pave Low helicopter, enabling greater mission flexibility and survivability. The intended capabilities added by electronic warfare and communications equipment unique to the CV-22 have not reached their full potential and limit mission accomplishment. This report discusses the ability of AFSOC crews to accomplish assigned missions using the CV-22 as tested without all the intended mission enhancements.

The Initial Operational Test and Evaluation (IOT&E) and Live Fire testing were adequate to reach this conclusion and were executed in accordance with the test plan approved by the Director, Operational Test and Evaluation (DOT&E). This report covers the Air Force CV-22 variant. The DOT&E report on the Marine Corps MV-22 variant was published in September 2005.

System Overview

The V-22 Osprey is a multi-mission, tiltrotor aircraft with Marine Corps and Air Force variants. The air vehicles for Air Force and Marine Corps missions are nearly identical, with common subsystems and military components sustainable by each Service's logistics system. The CV-22 Air Force variant adds Special Operations Forces (SOF)-unique mission equipment such as additional communications radios, a multi-mode radar, a multi-mission advanced tactical terminal (MATT), and an advanced electronic warfare suite. As a result, the CV-22 is heavier by about 1,800 pounds of mission weight plus 2,000 pounds of additional fuel. The CV-22 will replace the MH-53J/M Pave Low helicopter and supplement MC-130 aircraft. The Air Force plans to procure 50 CV-22s.

Because the CV and the MV air vehicles are nearly identical, the aircraft have similar capabilities and deficiencies including aerial refueling characteristics, intense downwash, a limited defensive maneuvering envelope in helicopter mode, lack of an all-aspect defensive gun system, and a significant maintenance burden to maintain operational mission capable rates. While some of these deficiencies are significant, operational workarounds allow the aircraft and crew to accomplish all assigned missions.

The Air Force intends to use the CV-22 high-speed, long-range, all-weather, vertical takeoff and landing capabilities to support SOF. In order to support the diverse array of SOF missions, the CV-22 Osprey must be capable of infiltrating defended hostile or politically denied airspace to deliver Joint Service Special Operations teams via vertical takeoff and landing, airdrop, or alternate insertion/extraction operations in day or night, over land or water. The CV-22 must be able to communicate and operate within the existing command structures of a diverse set of worldwide situations, from peacetime crisis response to covert/ clandestine low intensity conflict through support to major conventional warfare. Additionally, access to timely intelligence and coordination with joint and combined forces is essential to SOF mission execution. The CV-22 command, control, communications, and computer support must be global, secure, jointly interoperable, and flexible, such that it can be tailored to a wide range of diverse mission needs.

Test Adequacy

The operational and live fire testing of the CV-22 aircraft was adequate to support an evaluation of CV-22 operational effectiveness, operational suitability, and survivability. There were some limitations in the IOT&E test planning and execution: the test team evaluated the Suite of Integrated Radio Frequency Countermeasure (SIRFC) performance against 10 prioritized radio-frequency emitters and Directed Infrared Countermeasures (DIRCM) performance against five infrared threats; evaluation of GPS-denied operations was minimal; detailed (DIRCM) data were not recorded; and the survey questionnaires were inadequately designed. Both the cold weather and out-of-continental-U.S. deployments were canceled, with DOT&E concurrence.

The Air Force Operational Test and Evaluation Center (AFOTEC) conducted the CV-22 IOT&E test in three phases from September 2007 through April 2008 at three locations:

- The Hurlburt Field and Eglin Air Force Base electronic warfare ranges, Florida
- The Nevada Test and Training Range (NTTR)
- The Electronic Combat Range (ECR), China Lake, California.

The specific threat types and scenarios at NTTR and ECR are described in the classified annex to this report. Four CV-22 Block 10 aircraft participated in the operational test, with the third and fourth arriving in January 2008. The IOT&E missions

totaled 284 sorties and 665 flight hours over 25 weeks. The average utilization rate was approximately 38 flight hours per aircraft per month throughout the test. The aircraft were operated and maintained in an operationally realistic manner.

Operational Effectiveness

The CV-22 is operationally effective in performing the range of Special Operations missions called for in the requirements document with significant limitations. The demonstrated speed and range of the aircraft expand the operational ability of AFSOC to support global Special Operations commitments and permit options that are not possible with legacy aircraft. The 220-knot, turboprop-class performance in airplane mode allows for global deployment using long-range air refueling capability. The current lack of strategic (KC-10) aerial refueling capability and high frequency radio requires an MC-130P Combat Talon escort, as did legacy Pave Low helicopter operations. Additionally, the ability of the CV-22 to depart from forward helicopter landing zones and transition to airplane mode for long-range, unrefueled cruise – for insertion of Special Operations teams at previously unreachable distances, or extraction of casualties – is a capability unique to the CV-22.

The maneuverability of the CV-22 in airplane mode, in combination with the intended (but not fully realized) performance of onboard sensors, electronic warfare systems, and situational awareness equipment, gives SOF a new ability to operate in low- to medium-threat environments, and perform Special Operations support beyond the capabilities of current Special Operations helicopters or fixed-wing aircraft.

The Terrain Following/Terrain Avoidance radar and flight control systems enable high speed, low-level flight at night and in poor visibility, increasing mission flexibility and survivability.

Poor reliability and performance shortfalls of the DIRCM system, the SIRFC system, and the MATT as installed on the CV-22 limit mission accomplishment by necessitating avoidance of threats and reliance on visual cueing and manual dispense of chaff and flares if unknown threats are encountered. The program should consider incorporating improvements in the DIRCM system, developed by the Navy Large Aircraft Infrared Countermeasures (LAIRCM) program, which have proven effective in testing on other aircraft. Integration of the MATT with a Blue Force Tracker must be improved. Both MATT and DIRCM were effective on the legacy Pave Low aircraft. The program should work with the Army to identify performance fixes to the SIRFC system.

Failures of the Icing Protection System, the Engine Air Particle Separator (EAPS) system, and the communication suite degraded the ability of the platform to conduct effective covert or clandestine operations. Operational workarounds mitigate most of these deficiencies at the cost of increased workload in flight and during ground maintenance.

Significant downwash from the CV-22's proprotors in hover mode makes fastrope and hoist operations challenging, causes brown-outs in austere landing sites, precludes rappel operations, and makes water operations challenging for even combat swimmers because of intense water turbulence. AFSOC currently restricts the CV-22 from hovering in salt-water environments because of the rapid degradation of engine performance from salt encrustation on the engines. This salt contamination causes a reduction of power available within minutes and necessitates increased maintenance workload following salt-water operations.

The CV-22, as currently configured, is capable of delivering 18 mission-equipped troops 538 nautical miles (500 required) using a 20-foot hover-in-ground-effect at the mission destination; if terminal operations require a hover-out-of-ground-effect, the mission radius drops to approximately 335 nautical miles with operationally realistic power and engine performance safety margins in place. Additionally, if atmospheric conditions require the use of the Icing Protection System, the mission radius drops further. High-altitude landing zone operations further reduce the available mission radius or payload capability.

The CV-22 has an objective requirement for strategic aerial refueling from the KC-10 tanker. This capability is not yet available because of airspeed and refueling system incompatibilities. This strategic tanker capability shortfall requires AFSOC to devote scarce MC-130 aircraft to support each deploying CV-22.

Operational Suitability

The CV-22 is operationally suitable with limitations for supporting Special Operations missions. The system fell short of its required mission capable rate (82 percent) during the IOT&E as a whole (58 percent), but during the final two-thirds of the IOT&E (the deployed portion), the system demonstrated sufficient mission capable rates (74 percent) to support expected combat utilization rates. During operational testing, the CV-22 exceeded most reliability and maintainability thresholds with the exception of the critical failure rate, which was affected primarily by failures of the electronic survivability equipment unique to the CV-22 (SIRFC and DIRCM systems). Deficiencies in both maintainer and aircrew technical publications during IOT&E also degraded suitability, and the Environmental Control System and EAPS performed poorly in desert conditions. Maintaining an acceptable mission capable rate resulted in a significant maintenance burden (24 hours a day, 7 days a week).

Many human factors and safety issues that were identified during MV-22 testing are still present on CV-22 systems. These include fuel, environmental control, heads-up display, lighting, and aft cabin systems.

Survivability

DOT&E assesses survivability of the CV-22 against low- and medium-threats as high during the enroute portions of missions when all defensive electronics are working. Limits on defensive maneuvering and the lack of an all-aspect defensive weapon increase susceptibility to enemy fire during terminal phases in and near landing zones where threats are likely. Survivability of the CV-22 against certain modern fielded threats in the high-threat category is assessed as low because of deficient performance of the electronic combat systems. This is discussed in the classified annex to this report. While deliberate entry by the CV-22 into such high-threat conditions would likely be avoided if possible, inadvertent or necessary exposure could occur in certain urgent, high-priority missions.

Recommendations

The V-22 Joint Program should consider the following recommendations and AFOTEC should verify the corrections of deficiencies during FOT&E:

Operational Effectiveness

- Correct and retest CV-22 SIRFC deficiencies that were also observed in the SIRFC IOT&E as installed in MH-47 and MH-60 helicopters (classified annex). The deficiencies include the inability to detect certain threats, incorrect jamming profiles, misinformation presented to aircrew, delayed jamming, ineffective jamming, and false returns. In addition, pursue system performance against higher-end threats by improving the high-power jammer.
- Resolve DIRCM in-flight self-calibration failures in conjunction with the Large Aircraft Infrared Countermeasures program office; consider fixes already completed on other Air Force aircraft. Identify, fix, and test other DIRCM deficiencies experienced during IOT&E.
- Develop, install, and test a defensive gun system to enhance survivability against close-in threats.
- Conduct testing against GPS jamming.
- Resolve display and control deficiencies with the MATT and improve training and flight manual procedures to facilitate receiving real-time threat updates and survivor/evader information.
- Correct the CV-22 software deficiencies associated with erroneous measurement of outside air temperature used by the flight control computers.
- Resolve deficiencies with the V-22 Mission Planning System, including certification for basic flight performance calculations and automated release points for airdrop.
- Resolve air refueling deficiencies including slow refueling rate and fuel system malfunctions such as low feed tanks and trapped fuel. Pursue a strategic (KC-10) air refueling capability.
- Improve the radio communications suite range and sensitivity. Consider adding a high frequency radio capability to permit independent CV-22 operations in international airspace. Consider certification for area navigation for filing international flight plans.
- Improve Forward Looking Infrared video quality and discrimination to permit precision navigation and operations in confined landing zones in poor visibility conditions.
- Characterize engine degradation of power in salt spray and pursue options to permit AFSOC operations in salt-water environments. Determine whether improved tactics, techniques, and procedures can minimize engine salt encrustation.

Operational Suitability

- Improve the reliability of the Icing Protection System and the EAPS system.
- Evaluate cold-weather operations.
- Improve the aircraft system critical failure rate, which was dominated by SIRFC, DIRCM, and Icing Protection System failures.
- Improve the maintainer and aircrew technical publications.
- Improve internal and external lighting issues including: accessibility of cabin lighting controls, cumbersome rotor tip light controls, searchlight time delays, and night vision goggles heads-up display symbols.
- Add tie-down points and anti-skid decking inside the cabin.
- Optimize the litter configuration for SOF use, including extended medical care during long-distance evacuations.
- Improve the Environmental Control System to allow extended operation in hot environments.

ANNEX – CONGRESSIONAL REPORTS

USMC H-1 Upgrades (AH-1Z)

The AH-1Z is operationally effective, operationally suitable, and survivable. The IOT&E and live fire testing were adequate and were executed in accordance with the DOT&E-approved test plans.

This document completes reporting by the Director, Operational Test and Evaluation (DOT&E) on the Initial Operational Test and Evaluation (IOT&E) of the United States Marine Corps (USMC) H-1 Upgrades program, which consists of improvements to two variants, the AH-1Z Cobra attack helicopter and the UH-1Y Huey utility helicopter. This report covers the AH-1Z variant tested in IOT&E Phase 3, conducted from March-June 2010. The UH-1Y completed its IOT&E in Phase 2 in May 2008, and DOT&E published its report on the UH-1Y in September 2008.

System Description and Mission

The AH-1Z is an upgrade to the legacy AH-1W helicopter. Along with the UH-1Y, the AH-1Z equips Marine Corps Light Attack Helicopter Squadrons, supporting their missions to provide combat assault helicopter support, attack helicopter fire support, and fire support coordination for aviation and ground forces during amphibious operations and subsequent operations ashore. Light Attack Helicopter squadrons deploy and operate from air-capable ships and forward operating bases ashore in support of combat, contingency, training, and non-combat operations. The AH-1Z must have the ability to operate at night and in adverse weather conditions at extended ranges while maintaining a suppressive weapons capability against surface-to-air threats.

The H-1 Upgrades program consists of the design, development, and integration of a new four-bladed rotor system, a new drive train, a redesigned tail boom and tail rotor assembly, and a new mission avionics suite for the UH-1 and AH-1 helicopters. Replacement of the two-bladed main rotor system with the new four-bladed system is intended to increase payload, endurance, and speed, and improve flight-handling qualities in comparison to the legacy AH-1W helicopter. The upgraded digital cockpit integrates communication, navigation, target acquisition, and weapon employment functions, with the goal of reducing pilot workload and increasing crew situational awareness.

Test Adequacy

The operational and live fire testing of the H-1 Upgrades aircraft were adequate to support an evaluation of the AH-1Z operational effectiveness, operational suitability, and survivability. The minor limitations to testing – short shipboard operating periods and limited use of opposing forces during tactical missions – did not hinder this assessment.

The Navy's Commander, Operational Test and Evaluation Force (COMOPTEVFOR), through Air Test and Evaluation Squadron Nine (VX-9), conducted the H-1 Upgrades Operational Evaluation in three phases. The Navy conducted IOT&E Phase 1 from May 2006 through January 2007, primarily during daylight conditions because of limitations of the Top Owl Helmet-Mounted Sight Display (HMSD) system while flying at night. The second phase of IOT&E, with the Optimized Top Owl HMSD system, included more flying at night. Because of poor weapons system reliability, the Navy terminated AH-1Z testing during Phase 2 (while completing UH-1Y testing) and added a third phase to the IOT&E. VX-9 flew 49 percent (39 of 80) of the IOT&E Phase 3 tactical missions at night. This was sufficient to assess the aircraft's ability to operate at night.

Four AH-1Z low-rate initial production aircraft configured with the Optimized Top Owl HMSD system and with system configuration set 5.3.1 software participated in IOT&E Phase 3. Unlike the IOT&E Phase 1 and Phase 2 aircraft, the IOT&E Phase 3 aircraft were equipped with production models of the Target Sight System.

During all phases of operational testing, VX-9 operated and maintained the aircraft in an operationally realistic manner reflecting fleet operations.

Operational Effectiveness

The AH-1Z is operationally effective. During operational testing, when VX-9 employed the AH-1Z in flights of two or more aircraft, the AH-1Z successfully accomplished 89 percent of its assigned missions, which included Deep Air Support, Close Air Support, Assault Support, Strike Coordination and Reconnaissance, and Forward Air Controller (Airborne).

The AH-1Z provides the Marine Corps with an improvement in attack helicopter capabilities compared to the current AH-1W, with increased speed and range and more than double the payload capability. The AH-1Z also provides expanded range and maneuverability, thereby increasing the aircraft's effectiveness in air combat maneuvering.

Structural limitations of the main rotor blade cuff and yoke result in some restrictions of the maneuvering flight envelope, especially at high gross weights at high altitudes. Because of the relative ease with which the aircrew can cause the aircraft to

exceed its G-limits (potentially overstressing the aircraft), aircrew were cautious while performing air combat maneuvering with an attendant loss of situational awareness while one of the two pilots had to constantly monitor the G-meter.

Testing during phase 3 showed improved performance of the Target Sight System (TSS) and the Optimized Top Owl HMDS compared to the systems tested during phases 1 and 2. Incorporation of these systems contributes to the accurate delivery of ordnance equal to or better than that of the AH-1W. The increased detection, recognition, and identification ranges of targets provided by the TSS increases the survivability of the AH-1Z. The TSS laser designation accuracy at maximum ranges when using the color TV sensor is inconsistent, and reduces the range at which the Hellfire missile can be employed with this sensor. Using the forward-looking infrared (FLIR) for laser designation increases accuracy to the maximum employment range of the Hellfire missile.

The Multi-Function Displays with moving map capability, combined with the digital cockpit and the Optimized Top Owl HMDS, increases situational awareness and aircrew confidence in their ability to perform missions while reducing pilot workload in flight (compared to the AH-1W). The communications and navigation capabilities of the AH-1Z met or exceeded requirements, but excessive delays in the transmission of secure voice communications caused pilots to have to employ workarounds leading to the potential pilots will miss important information.

The mission planning system is labor-intensive and not well integrated. These deficiencies resulted in excessive workloads for the pilots. The integrated stores management system required specific keystroke sequences to avoid system crashes. Each system crash requires a system reset and therefore distracts the aircrew and interferes with the aircrew's situational awareness.

Operational Suitability

The AH-1Z is operationally suitable. During operational testing, the AH-1Z exceeded reliability thresholds for mean flight hours between failure and mean flight hours between abort. The AH-1Z's 7.6 maintenance man-hours per flight hour is 43 percent lower than the AH-1W (which is historically 13.3).

Aircraft availability was greater than 95 percent (mission capable rate) and exceeded the required threshold of 85 percent. Maintainers considered the publications adequate and much improved from earlier phases of testing. The limited information available in maintenance publications addressing aircraft structural repairs and repair of the Optimized Top Owl HMDS system necessitated heavy reliance on contractor fleet support personnel in those specific areas. The aircraft's blade fold system has shipboard compatibility deficiencies.

The rotor system is operating with greatly reduced life-cycle times because of structural limitations on its principal components, the yokes and cuffs. The Navy intended these parts to last 10,000 flight hours, i.e., the full expected life of the aircraft, but in operational use they are being replaced after 700 to 1,200 hours. This costs not only the actual replacement dollars (up to \$14.8 million over the projected 10,000 flight hours life span of each aircraft), but also the maintenance hours and the aircraft down time. For a combined fleet (UH-1Y and AH-1Z) of 349 aircraft, this could be a considerable life cycle cost to the program. The Navy is working on a main rotor redesign plan scheduled to deliver upgraded rotor heads in 2015. The redesign is expected to address the structural G-limits and increase the lifetimes of the parts. By 2015, the program will have delivered 160 UH-1Y and AH-1Z aircraft that will require premature retrofit as incidents, failures, or inspections require.

While a C-17 can carry three AH-1W aircraft, only one AH-1Z fits within the C-17 cargo hold. Transporting a squadron of AH-1Z aircraft will require three times the number of strategic lift assets than for the AH-1W squadron. This increase in demand for strategic lift aircraft will slow the transport of other high-priority items into theater.

Survivability

DOT&E previously reported on the Live Fire Test and Evaluation of the H-1 Upgrades. The September 2008 report on the UH-1Y contains further details regarding this testing.

Operational and live fire testing indicates that the AH-1Z aircraft is survivable against small arms and automatic weapons fire (up to 12.7 mm) and legacy man-portable air defense systems (MANPADS). A number of features enhance the survivability of the AH-1Z in combat operations by reducing either the susceptibility or the vulnerability of the aircraft compared to the legacy AH-1W.¹ These include the Hover Infrared Suppressor to reduce engine exhaust signature, improved aircraft survivability equipment, ballistic impact-tolerant flight components, redundant hydraulic systems, and built-in fire detection/suppression systems in the fuel cells. Operational testing included few flights against live opposing forces, limiting the ability to evaluate susceptibility. Vulnerability testing indicates that some improvements are needed for flight-critical components, including transmissions, fuel cells, flare dispensers, and fire suppression in the dry bays.

¹ Susceptibility is commonly defined as hit avoidance, while vulnerability is defined as hit tolerance.

Recommendations

Operational Effectiveness

- Increase color TV-to-laser boresight accuracy to allow for employment of precision-guided munitions, such as the Hellfire missile, at maximum ranges.
- Improve G-limit warning systems to reduce pilot-intensive focus on the G-meter during maneuvering flight.
- Improve the design of the legacy rocket pod intervelometer switch that controls the firing sequence of the rockets, or adopt a new launcher. Because of the age and associated wear of this switch, it is difficult for ordnance personnel to verify the rocket pod is in the ARM vice LOAD position.
- Resolve software anomalies with the stores management system to permit any desired sequence of weapon selection.
- Resolve nonintegrated mission planning system issues to reduce excessive pilot workload associated with pre-flight mission planning.
- Resolve excessive time delays that occur when the aircrew are transmitting secure voice communications.
- Address unreliable auto track function of the TSS against moving targets to provide better target tracking of time-critical targets and reduce pilot workload.
- Develop infrared position lights to assist pilots in maintaining visual contact with other aircraft during low light level operations.

Operational Suitability

- Continue efforts to redesign the cuff and yoke to increase structural integrity, service life, and flight envelope. Conduct developmental and operational tests of the aircraft with the redesigned rotor system to verify performance.
- Develop damage assessment criteria and repair procedures to be included in the AH-1Z Structural Repair Manual prior to the aircraft's first deployment.
- Redesign the blade fold racks to reduce their size and weight and increase their durability for shipboard compatibility.
- Develop quick disconnect fittings for the cables connecting the helmet to the aircraft in order to expedite aircrew emergency egress from the aircraft.
- Fully fund and implement all tail rotor water intrusion redesign efforts.
- Conduct an end-to-end shipboard compatibility assessment to include shipboard ordnance storage, transport, loading, and unloading of the greater amount of ordnance the AH-1Z consumes.

Survivability

- Continue the redesign of the main rotor transmission and combining gearbox housings to overcome the deficiency demonstrated during earlier run-dry tests. The main transmission redesign should be tested in a fully loaded condition (i.e. rotor blades and hub installed with hover power applied).
- Redesign the AH-1Z main fuel cells to meet self-sealing requirements.
- Implement a configuration management plan that, when consistent with susceptibility to likely threats, will put only pyrophoric materials such as the MJU-49 flares in the forward flare buckets and the more sensitive pyrotechnic materials like the MJU-32 flares in the aft buckets (located in the tailboom area away from the crew). This would reduce the likelihood of dry bay fire leading to catastrophic damage to the aircraft and possible crew injury or incapacitation due to smoke and fumes.
- Improve the ballistic tolerance of the main rotor pitch change adapter to reduce the likelihood of damage to the clevis and pitch control rod that could cause catastrophic damage to the aircraft.
- Incorporate self-sealing breakaway valves between fuel bladders and lines to prevent post-crash leakage of fuel.
- Add fire detection/extinguishing systems to the dry bays adjacent to fuel cells, the engine compartment, the main transmission, auxiliary power unit dry bays, and oil cooler areas to reduce the likelihood that an uncontained fire could cause catastrophic damage to the aircraft.

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