UH-72A LAKOTA LIGHT UTILITY HELICOPTER (LUH)

Operational Test and Evaluation Report

July 2007

This report on the UH-72A Lakota Light Utility Helicopter (LUH) fulfills the provisions of Title 10, United States Code, Section 2399. It assesses the adequacy of testing and the operational effectiveness, suitability, and survivability of the UH-72A Lakota LUH.

Dr. Charles E. McQueary
Director

UH-72A Lakota Light Utility Helicopter.

Executive Summary

The UH-72A Lakota Light Utility Helicopter (LUH) is effective in the performance of light utility missions, but is not effective for use in hot environments or for medical evacuation of two litter patients requiring critical medical care. The LUH is effective for air movement and aerial sustainment missions, but does not meet its prescribed performance criteria to lift required external and internal loads. The LUH provides an increase in demonstrated performance and mission effectiveness over the Kiowa and Huey aircraft it will replace (OH-58A/C and UH-1H).

The LUH aircraft is not operationally suitable due to excessive heat in the aircraft cockpit and cabin from the sun, heat generated by aircraft avionics, and inadequate ventilation. Additionally, the aircraft's Rotorcraft Flight Manual describes an avionics overheat condition where various avionics components have a 30-minute operating time if temperatures exceed safe operating ranges. This did not occur during the IOT&E.

The LUH meets required design standards for crashworthiness in accordance with the Federal Aviation Regulations to protect crew and passengers.

The LUH program executed the Initial Operational Test and Evaluation (IOT&E) in accordance with the DOT&E approved test plan. Testing was adequate to assess mission effectiveness, suitability, and survivability. Additional testing is needed to ensure deficiencies in effectiveness and suitability have been corrected.

System Overview

The LUH will replace OH-58A/C and UH-1H aircraft to provide light utility support worldwide in non-hostile operational environments. The LUH will support homeland defense, U.S. Army test and training centers, and the U.S. Army National Guard and Reserve. It is the Army's intent that LUH aircraft operate in non-hostile environments.

The Army plans to purchase 322 LUH aircraft over an eight-year period with a peak production rate of 69 aircraft per year. The Air Ambulance Detachment, Fort Irwin, California, received its full complement of six aircraft during April 2007 becoming the Army's first unit equipped with LUH aircraft. Eurocopter is the prime contractor.

Test Adequacy

The Army executed the Initial Operational Test & Evaluation (IOT&E) in accordance with the DOT&E-approved Test and Evaluation Master Plan and test plan. The LUH test execution was adequate to assess operational effectiveness, suitability, and survivability. The Army augmented the IOT&E with flight data from Reliability Verification Efforts, Source Selection Performance Demonstration, Army safety testing, and cross-country ferry flights of production aircraft to the IOT&E site at Fort Irwin, California. The combined flight hour data was adequate to demonstrate reliability. The

Army will not operate the LUH in combat. It is not a Live Fire test and evaluation covered system.

Operational Effectiveness

The LUH is effective for light utility helicopter missions. In realistic operational scenarios, the LUH successfully completed 14 of 18 difficult light utility helicopter missions. The LUH provides an increase in demonstrated performance and mission effectiveness over the Kiowa and Huey aircraft it will replace (OH-58A/C and UH-1H).

The LUH cannot meet its prescribed performance criteria to lift an external load of 2,200 pounds, or an internal load of 1,250 pounds, at 4,000 feet pressure altitude and 95 degrees Fahrenheit. The LUH demonstrated the capability to accomplish air movement and aerial sustainment missions with lighter loads.

The LUH is not operationally effective for the MEDEVAC mission because the aircraft configuration precludes medics from providing medical treatment to two litter patients. The LUH is effective performing MEDEVAC missions with two medically stable litter patients requiring no in-flight medical care; a mission with one litter patient; and ambulatory patients as seated passengers. The LUH unit successfully completed three of five IOT&E medical evacuation missions. Two missions were unsuccessful because of insufficient cabin space and configuration to permit patient treatment by the in-flight medic.

- With two litters there is not sufficient room for the medic to provide immediate medical care to the patients.
- Medics are not able to properly perform or sustain critical medical treatment such as defibrillation or cardiopulmonary resuscitation.
- There is no dedicated provision for cabin ceiling rails to hang IVs, infusion hooks, or to store and secure medical equipment.
- At night, completing medical evacuation missions was hampered by insufficient cabin and external lighting to the rear of the aircraft.

Operational Suitability

The LUH aircraft is not operationally suitable. During the IOT&E, excessive heat from the sun, heat generated by aircraft avionics, and inadequate ventilation resulted in elevated temperatures and limited operating time in the LUH cockpit and cabin. The LUH does not have the environmental control unit (air conditioner) common on most of the commercial EC 145 aircraft. High cockpit and cabin temperatures limit crew endurance and affect passengers and medical casualties. Additionally, the aircraft's Rotorcraft Flight Manual describes an avionics overheat condition where if temperatures exceed safe operating ranges, various avionics components have a 30-minute operating

time and will shut down. This did not occur during the IOT&E because of the moderate ambient temperature.

The reliability, maintainability, and availability of the LUH exceeded requirements. The LUH costs less to operate and support than the UH-60A/L helicopter. The LUH is compatible for transport by land, sea, and air. Despite excessive heat and the limited size of the cabin for MEDEVAC missions, LUH crews found the aircraft easy to fly and operate. The communications suite proved interoperable with military and civilian agencies. The pilots found the LUH to be compatible with the Air Warrior components. The New Equipment Training package is still in development as are the flight simulators.

Survivability

The Federal Aviation Administration (FAA) has certified that the LUH meets FAA standards for crashworthiness. As a commercial aircraft, the LUH does not have ballistic tolerance criteria nor does the Army intend to employ this aircraft in operational hostile environments. The Army agreed to comply with the FAA certificate and plans to limit LUH flight operations as defined in the approved flight manual. When operating the LUH, aircrews can wear various components of the Air Warrior ensemble. These components (chemical masks, night vision goggles, survival equipment) afford protection to the crew in the event of an emergency.

Recommendations

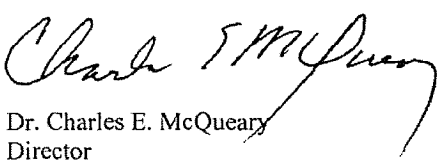
The Army executed the LUH IOT&E in accordance with the DOT&E approved test plan. There was no dedicated developmental testing for the LUH. Many deficiencies noted during the operational test of the LUH would have been identified and corrected prior to the IOT&E. In order to address deficiencies found in the IOT&E, the Army should consider the following recommendations:

Operational Effectiveness

- Reconfigure or modify the cabin to provide additional space for the medic and MEDEVAC equipment when in a two-litter configuration.
    1. Install provisions for cabin ceiling rails from which to hang IVs, infusion hooks, or to store and secure medical equipment.
    2. Add lighting to illuminate the tail rotor and rear clam shell doors to enhance safety and facilitate rear loading and unloading of litter patients.
- Develop unit tactics, techniques, and procedures to address the external and internal lift performance shortfalls.
- Continue to update, develop, and document LUH performance data to incorporate into a standardized flight manual and to facilitate more accurate mission planning.

Operational Suitability

- Install and test potential material fixes such as an environmental control system to moderate excessive cockpit, and cabin temperatures to enable operations in hot/humid environments.
- Reconfigure the LUH communication package to allow simultaneous communication on Ultra High Frequency (UHF) and Frequency Modulation (FM) channels and secure communications.
- Install engine inlet barrier filters to reduce the probability of ingesting foreign object debris and increasing overall engine life cycle costs.
- Continue to develop the Aircrew Training Manual, Performance Planning Card, and revising Weight and Balance charts.
- Assess the New Equipment Training package and the hybrid maintenance concept planned for Army National Guard units once implemented.
- Install skid shoes to protect and extend the life of the LUH landing skids.
- Relocate first aid kit and fire extinguisher to allow for immediate crew chief and passenger access.



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Contents

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Section One
System Overview

Light Utility Helicopter Mission and Program Background

The Light Utility Helicopter (LUH) will support homeland defense, U.S. Army test and training centers, and the U.S. Army National Guard and Reserve. It is the Army's intent that LUH aircraft operate in non-hostile environments. LUH-equipped units are designed to conduct the following seven missions:

- Air movement
- Aerial sustainment
- Civil search and rescue
- Casualty evacuation
- Medical evacuation
- Command and control
- Observation

The LUH replaces OH-58A/C and UH-1H aircraft that provide light utility helicopter support in worldwide operational environments. More than half of the OH-58A/C and UH-1H aircraft reside in Army National Guard Multi-function Aviation Brigades. These Aviation Brigades contain most of the Army's medical evacuation aircraft and are the Army's primary resource for conducting homeland security missions.

The Army intends to purchase 322 LUH aircraft over an eight-year period with a peak production rate of 69 aircraft per year. The Air Ambulance Detachment, Fort Irwin, California, received its full complement of six aircraft during April and May 2007, and is the Army's first unit equipped with LUH aircraft. Eurocopter is the prime contractor.

System Characteristics

General Characteristics

The LUH shown in Figure 1, is a commercial off-the-shelf aircraft derived from the Eurocopter 145. The LUH is Federal Aviation Administration certified. The Army accepted the Federal Aviation Administration Standard Airworthiness Certificate in lieu of conducting crashworthiness or electromagnetic environmental effects testing.

Figure 1. UH-72A Lakota Light Utility Helicopter (LUH)

The LUH can be operated by either one or two pilots. The aft cabin area provides seating for six passengers or crewmembers. In the utility role, the aircraft will be operated by two pilots and one crew chief, and carry up to five passengers. When configured for medical evacuation (MEDEVAC) missions, the aft cabin accommodates one crew chief, one medical attendant, and two North Atlantic Treaty Organization (NATO) standard litters for two non-critical patients.

The LUH is a twin engine aircraft and operates on NATO or U.S. jet fuels. The aircraft has provisions for a cargo hook, suspended under the aircraft by cables, to conduct external lift missions. To support medical evacuation and search and rescue operations, the aircraft is equipped with an external hoist capable of lifting 600 pounds from an altitude of 75 feet. The cockpit and lighting is compatible with night vision goggles and components of the Army Air Warrior ensemble.

Communications and Navigation

The aircraft is equipped to communicate on normal military channels and with civil agencies on public safety bands. Communications on public safety bands is necessary to support homeland defense and border patrol operations. The aircraft is capable of operating under instrument flight rules for operation in marginal weather conditions. The Mode S (beacon transponder for collision avoidance), global positioning system, and other navigation equipment meet the requirements for operations within Global Air Traffic Control Management-controlled airspace. The autopilot capability of the aircraft reduces pilot workload.

Key Performance Parameters (KPP)

The Army established LUH performance requirements in a Capabilities Development Document dated September 30, 2005. After Milestone B, the Army resubmitted the Capabilities Development Document for Joint Staff validation as the Capabilities Production Document. Table 1 presents LUH Key Performance Parameters.

Table 1. LUH Key Performance Parameters

Key Performance Parameters	Requirement
Net Ready	Communicate in its intended joint military environment and with civil agencies. Achieve information assurance accreditation.
Cabin Size	The internal cabin size shall accommodate two standard NATO litters with patients, and one medical attendant. The cabin shall have a minimum of six seats, including the crew chief's seat.
Force Protection	The aircraft shall accommodate the crew wearing mission-tailored Air Warrior Ensemble.
Survivability	The aircraft shall meet Federal Aviation Administration crashworthiness standards for seating and fuel.
Performance[a]	The aircraft shall be capable of Hover Out of Ground Effect with 906 pounds on a standard day (sea level, no wind, 59 Degrees Fahrenheit). Load consists of hoist and medical evacuation kits, two patients, medical attendant, and medical equipment.

a. The aircraft shall be in a standard configuration, consisting of two pilots, one crew chief, specialized mission equipment such as hoist or six passenger seats for lift missions, all communications/navigation equipment, and internal fuel for 2.8 hours endurance. Standard crew and passengers individually weigh 206 pounds with gear.

Additional Required Performance Attributes

The aircraft must meet performance requirements while operating in a high/hot environment of 4,000 feet pressure altitude and 95 degrees Fahrenheit and with the aircraft in a standard mission configuration as defined in Table 1. Performance requirements with an internal mission load of 1,250 pounds include:

- Cruise airspeed of 125 knots or greater.
- A minimum operational range of 217 nautical miles.
- Operational endurance of 2.8 hours.
- Hover out of ground effect (HOGE) internal lift capability in the high/hot environment (4,000 feet pressure altitude and 95 degrees Fahrenheit).
- HOGE with an external mission load of 2,200 pounds.
- Operations and support cost less than the UH-60A/L Black Hawk.
- Reliability and maintainability reflecting a 90 percent probability of successful completion of a 3.67-hour mission without a mission abort. This mission profile allows for a single refueling stop.

Maintenance Concept

The Army intends to use Contractor Logistics Support (CLS) to provide repair parts and maintainers for unit and depot-level maintenance for all LUH units except the Army National Guard (ARNG). The ARNG will use a hybrid maintenance concept, which will employ ARNG soldiers to provide unit-level maintenance and CLS for depot-level logistics. Petroleum, oils, and lubricants remain a unit cost.

Section Two

Test Adequacy

The Army executed the Initial Operational Test & Evaluation (IOT&E) in accordance with the DOT&E-approved TEMP and test plans. The LUH test execution was adequate to assess operational effectiveness, suitability, and survivability. The Army augmented the IOT&E with flight data from Reliability Verification Efforts, Source Selection Performance Demonstration, Army safety testing, and cross-country ferry flights of production aircraft to the IOT&E site at Fort Irwin, California. The combined flight hour data was adequate to demonstrate reliability. The Army will not operate the LUH in combat. It is not a Live Fire test and evaluation covered system.

Reliability Validation Effort (November 2005 to August 2006)

The program provided aircraft logbook data for one LUH aircraft that flew 252 hours over a ten-month period, including the maintenance data collected during the source selection demonstration. These data, collected along with the LUH ferry flight hours to fly the aircraft to Fort Irwin for the IOT&E, contributed to the reliability estimate for the LUH aircraft. These flight hours were flown in realistic LUH mission environments and used to demonstrate reliability, availability, and maintainability.

Source Selection Performance Demonstration (February to March 2006)

Prior to Milestone C, the Army conducted a 30 flight hour demonstration of aircraft performance to support the source selection process. During this demonstration, Army test pilots flew prototype Eurocopter UH-145 aircraft at the limits of the authorized flight envelope to confirm maximum aircraft performance. Data collectors recorded maintenance data in the aircraft's logbooks.

Safety Release Flights (December 2006 to January 2007)

The Army conducted 36 hours of flight testing at Fort Rucker, Alabama, to confirm the safety of production LUH aircraft for use by Army aircrews. These flights concentrated on single engine flight profiles, night vision goggles, the Air Warrior Ensemble, autorotations, and external lift missions carrying a fire-fighting water bucket. At the completion of this testing the Army determined that the aircraft was safe for use by Army aircrews during IOT&E.

Ferry Flights (February 2007)

Army pilots accumulated 51 fight hours to ferry two LUH aircraft from Fort Rucker, and one aircraft from the contractor's facility at Columbus, Mississippi, to Barstow-Daggett Airfield/Fort Irwin, California for the IOT&E. These ferry flights provided the opportunity to assess aircraft reliability during extended missions. On each

day of the ferry, all aircraft logged a minimum of 3.4 hours with at least one refueling. The ferry mission profile was very similar to the mission profile envisioned in the mission reliability requirement.

Initial Operational Test (March 2007)

An Army Air Ambulance Detachment, equipped with three LUH aircraft, conducted all IOT&E test events. This unit's mission is to provide medical evacuation support to the National Training Center at Fort Irwin, California. The test unit consisted of pilots from the Fort Irwin Army Air Ambulance unit as well as two pilots from an Army National Guard unit. The test unit had been equipped with UH-60A Black Hawk helicopters.

The realistic mission scenario for the test was a notional train derailment, with nuclear and hazardous waste, fire, and medical casualties. The test unit completed 18 missions, flying 22.9 flight hours, six hours of which were conducted at night:

Mission	Iterations
• Response Team Insertion	2
• Aerial Sustainment (External Lift)	4
• Medical Evacuation	5
• Civil Search and Rescue (Hoist)	1
• Training	1
• Passenger Transport	5

During each mission, crews communicated with civil air traffic controllers, military ground agencies, and landing zone controllers at the simulated train derailment site. The crews also communicated air-to-air with Marine Corps aircraft, between LUH aircraft, and with a civilian fire-police ground station in San Bernardino, California. Crews conducted missions at night using night vision goggles. During Emergency Response Team insertion missions, crews and passengers wore nuclear, biological, and chemical air warrior garments. Pilots assessed the instrument flight capabilities of the aircraft by conducting instrument approaches to Barstow-Daggett Airfield in Barstow, California. Medics used life monitors and intravenous saline to simulate life-saving care for medical evacuation patients. A representative cadre of contractor logistical support performed maintenance and other logistics support operations for the unit aircraft.

The IOT&E missions were by design, a difficult subset of light utility helicopter missions. Mission profiles for conducting light utility tasks, shown in Figure 2, illustrate that Command and Control (civil) and Reconnaissance (observation) missions, which predominately require level flight with light loads, represent the majority (64 percent) of the light utility helicopter unit mission set.

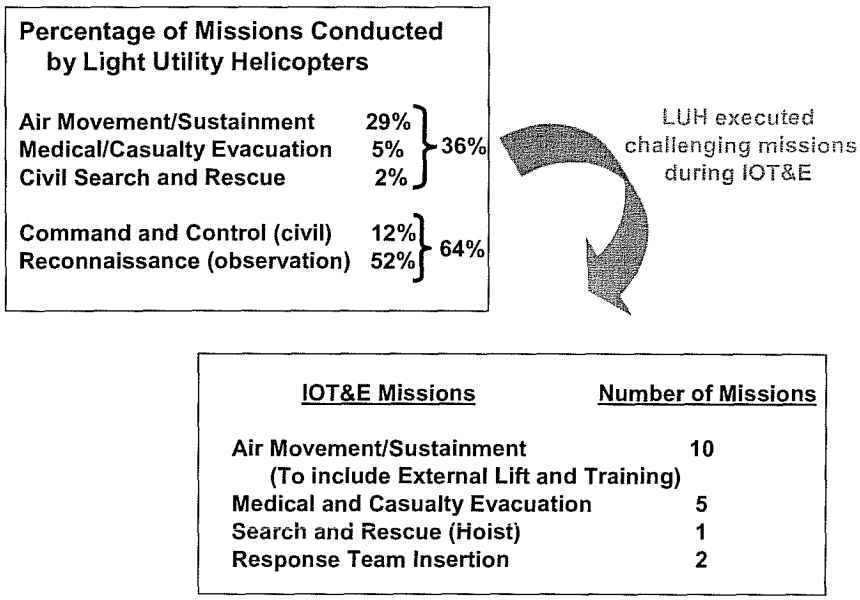

Figure 2. Mission Comparison

To maximize the 22.9 IOT&E flight hours, the Army chose to conduct challenging sustainment, medical evacuation, and search and rescue missions. LUH performance and reliability during routine command and control and observation missions were also demonstrated during the Reliability Verification Effort and ferry flights.

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Section Three

Operational Effectiveness

The LUH successfully completed 14 of 18 difficult light utility helicopter missions in realistic operational scenarios. The LUH provides an increase in demonstrated performance and mission effectiveness over the Kiowa and Huey aircraft it will replace (OH-58A/C and UH-1H).

The LUH cannot meet its prescribed performance criteria to lift an external load of 2,200 pounds, or an internal load of 1,250 pounds, at 4,000 feet pressure altitude and 95 degrees Fahrenheit. The LUH demonstrated the capability to accomplish air movement and aerial sustainment missions with lighter loads.

The LUH is not operationally effective for the MEDEVAC mission because the aircraft configuration precludes medics from providing medical treatment to two litter patients. The LUH crews could perform MEDEVAC missions with:

- a single litter patient.
- ambulatory patients as seated passengers.
- two medically stable litter patients requiring no in-flight care.

Table 2. Operational Requirements

Operational Criterion	Threshold Requirement	Met / Not Met
Net Ready	Voice interoperability	Met
Cabin Size	Transport of Two Litters Attending to Patients	Met Not Met
Force Protection	Compatible w/Air Warrior	Met
Survivability	Crashworthiness	Met
Performance	1. Transport 906 Pounds 0 feet Pressure Altitude, 59 degrees 2. Transport and External Load- 2,200 Pounds 4,000 feet Pressure Altitude, 95 degrees 3. Transport with Internal Load- 1,250 Pounds 4,000 feet Pressure Altitude, 95 degrees, 2.8 hour mission	Met Not Met- Lifted 1,370 pounds Not Met- Lifted 1,117 pounds
Instrument Flight Rules (IFR)	Certified for IFR flight	Met

Mission Effectiveness

During operational testing, the LUH successfully completed 14 of 18 difficult aerial sustainment, air movement, and medical evacuation light utility helicopter missions. LUH crews completed missions in day and night conditions, and with chemical protective gear. Command and control and reconnaissance missions were demonstrated during the IOT&E as part of other missions and when pilots contacted civil authorities and first responders on single channel Very High Frequency (VHF) and Ultra High Frequency (UHF) radio networks. Pilots established communications on Frequency Modulation (FM) radio nets (non-secure) and single channel VHF and UHF radio nets with the Army and Air Force. During the IOT&E, pilots found LUH avionics and flight management systems effective and easy to use.

Table 3. Mission Success Summary

Mission	Mission Success	Operationally Effective	Comments
Aerial Sustainment	2/4	Yes	• Provides 40% more payload and mission duration than the UH-1H aircraft it replaces. • Does not meet 2,200 pound external load requirement. • Does not meet 1,250 pound internal load requirement in high/hot* environments. • To meet the high/hot internal load requirement the LUH must reduce the internal weight by 143 pounds or reduce mission endurance by 22 minutes (or a combination of the two).
Air Movement	8/8	Yes	• Successfully conducted passenger transport, training, and response team insertion missions.
MEDEVAC	3/5	No	• With two litters, there is not sufficient room for the medic to provide immediate medical care to two patients. • There is no dedicated provision for cabin ceiling rails to hang IVs, infusion hooks, or to store and secure medical equipment.
Search & Rescue	1/1	Yes	• Successfully demonstrated the capability to hoist personnel into the cabin.
Total	14/18		

* High/Hot= 4,000 feet pressure altitude, 95 degree Fahrenheit, 2.8 hour mission, with 30 minute fuel reserve

Aerial Sustainment

During the IOT&E, the LUH successfully completed two of four aerial sustainment (external lift) missions. Two missions were not successful because of insufficient fuel or power margin to safely lift the required load of 2,200 pounds. During the two aerial sustainment missions, the LUH successfully delivered external loads weighing 1,190 pounds. During safety testing at Fort Rucker, the LUH demonstrated the capability to conduct fire-fighting missions with a fire-fighting water bucket weighing approximately 1,400 pounds. In that mission, the LUH successfully completed nine water delivery sorties without incident.

The LUH does not meet the 2,200-pound external lift requirement. The aircraft can successfully deliver lighter external loads. For example, a typical fire-fighting mission would require 10,000 pounds of water to extinguish a small range fire. It would take an aircraft approximately 15 minutes to accomplish this task using a 2,200-pound water bucket. Using a 1,500-pound water bucket, the LUH can accomplish the mission in 24 minutes with enough fuel remaining to continue flying for more than another hour.

Air Movement and Civil Search & Rescue

The LUH unit successfully completed eight of eight air movement missions (passenger transport, training, and response team insertion). The cabin space and seats provide enough space to accommodate the crew and five passengers with mission equipment and baggage. Seatbelt length limits crew members range of movement and are too small for large passengers. Crews prefer inertial reel restraint systems that give the pilots, crew chiefs, and medics greater range of motion and more freedom of movement.

The LUH unit successfully executed one civil search and rescue mission, which demonstrated the capability to hoist personnel into the cabin. During this mission, a caution light indicated that the hoist was over heating after three hoist cycles. After waiting a few minutes for the hoist motor to cool, the crew resumed and completed the hoist mission without incident. On all missions, aircraft flight characteristics and avionics systems facilitated mission accomplishment.

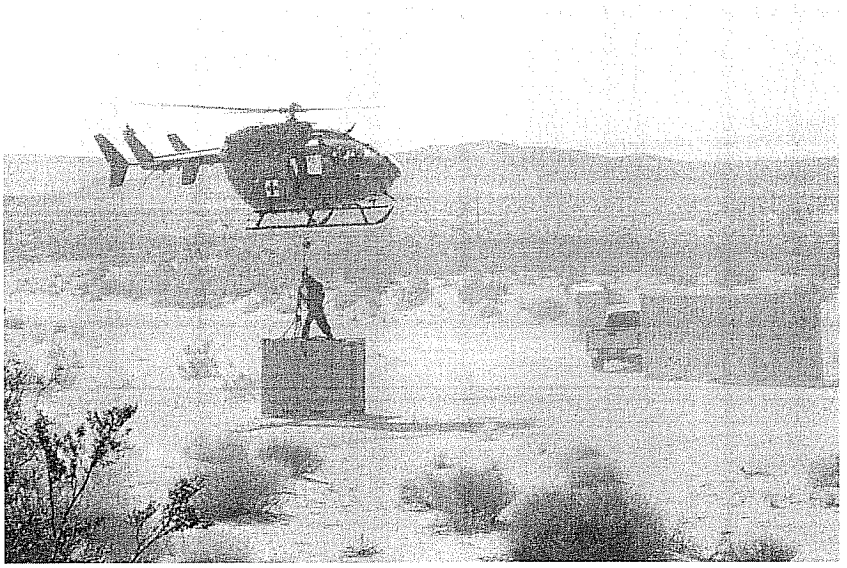


Figure 3. Sling load operations during an aerial sustainment mission

Medical Evacuation

The LUH is not operationally effective for the MEDEVAC mission because the aircraft configuration precludes medics from providing medical treatment to two litter patients. The LUH unit successfully completed three of five IOT&E medical evacuation missions. Two missions were unsuccessful because of insufficient cabin space and configuration to permit patient treatment by the in-flight medic.

- With two litters, there is not sufficient room for the medic to provide immediate medical care to the patients. Figure 4 illustrates the limited space (6.5 inches) between the two litters.
- Medics are not able to properly perform or sustain critical medical treatment such as defibrillation or cardiopulmonary resuscitation.
- There is no dedicated provision for cabin ceiling rails to hang IVs, infusion hooks, or to store and secure medical equipment.
- At night, completing medical evacuation missions was hampered by insufficient cabin and external lighting to the rear of the aircraft.

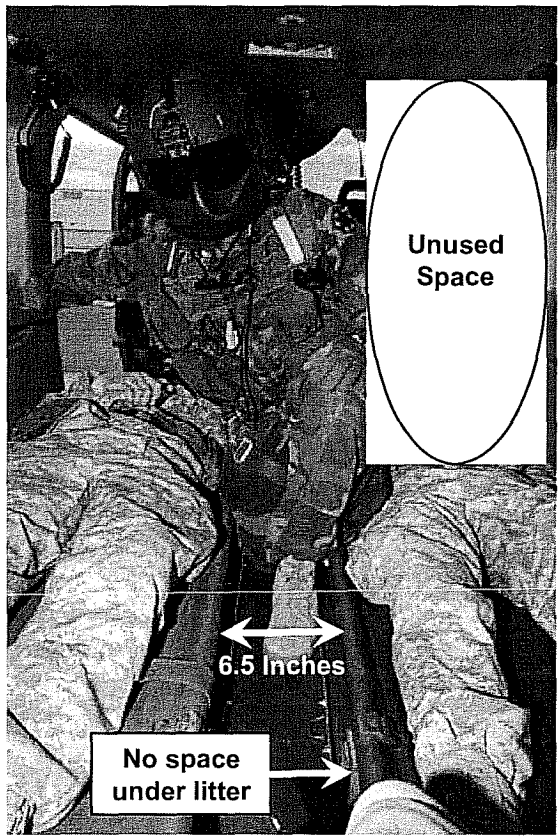


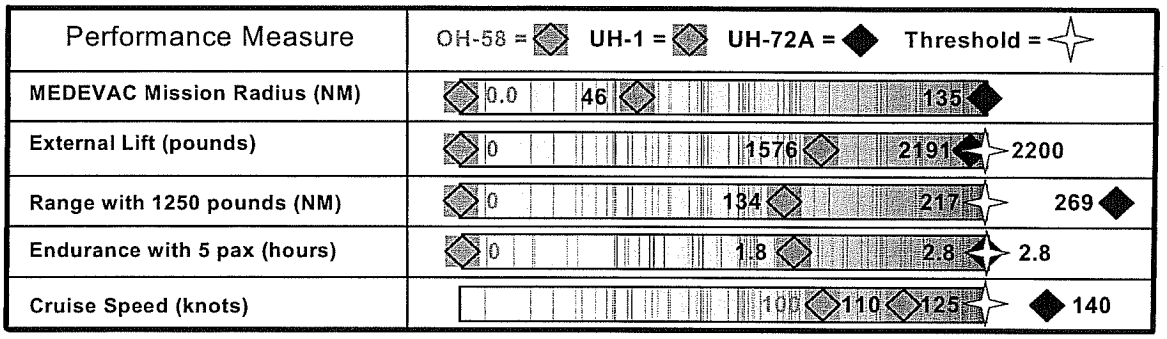
Figure 4. LUH Two-Litter Configuration

During the three successful MEDEVAC missions crews demonstrated:

- The ability to transport and provide critical care to a single litter patient.
- The ability to transport ambulatory patients seated as passengers.
- The ability to transport two medically stable litter patients that do not require flight medical treatment.

Aircraft Performance

The LUH meets the performance requirements for hover, range, endurance, and speed, but does not meet external and internal lift requirements. Figure 5 compares LUH, OH-58 and UH-1 aircraft performance. The LUH has the most capability in each performance measure.



Key: NM = nautical miles; pax = passengers

Figure 5. LUH Performance

Hover Performance (KPP) and Internal Lift Capability

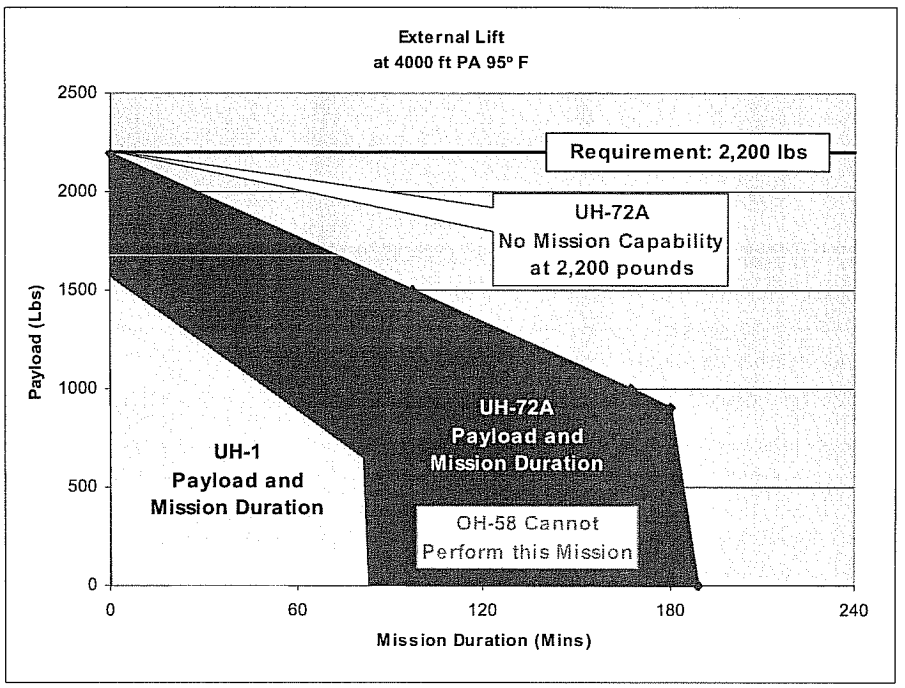
The LUH meets the hover performance requirement and out performs the UH-1 helicopter for utility missions. In standard day conditions (sea level pressure altitude and 59 degrees Fahrenheit), the LUH must be able to hover out-of-ground-effect (HOGE) with a standard MEDEVAC load (medic, two patients, hoist, and medical equipment all weighing 906 pounds). Both the LUH and UH-1 can hover under these conditions meeting the KPP. In a MEDEVAC mission profile in which the aircraft fly at a maximum speed to an extraction site, HOGE for 10 minutes while hoisting aboard two patients and return at maximum speed, the LUH performance is better. The LUH will arrive at the extraction site sooner because of its faster cruise speed. The LUH can perform this mission to a range of 135 nautical miles while the UH-1 mission range is 46 nautical miles. The OH-58A/C cannot perform this mission and does not have the power to hover with the same mission load.

The LUH does not meet the HOGE in a high/hot environment (4,000 feet pressure altitude, and 95 degrees Fahrenheit) internal load requirement of 1,250 pounds. In order to meet the 2.8 hour mission endurance requirement with a 30 minute reserve the LUH must reduce the internal weight by 143 pounds or reduce mission endurance by 22 minutes, or a combination of the two, to operate with internal loads in high/hot environments.

External Lift

The LUH does not meet the external load requirement to lift 2,200 pounds, at 4,000 feet pressure altitude, 95 degrees Fahrenheit, with 2.8 hours of endurance and

30 minute fuel reserve. The LUH provides 40 percent more payload and mission duration than the UH-1H. The LUH can lift 2,191 pounds, but has no fuel for mission execution. As shown in Figure 6, the LUH can provide 97 minutes of mission time with an external load of 1,500 pounds while the UH-1H can provide only 7 minutes. At 1,000 pounds, the LUH provides over three times as much mission time as the UH-1H. The OH-58 provides no external lift capability. A realistic operational external load for the LUH is 1,500 pounds. The rationale for the 2,200 pound requirement is the weight of the large fire-fighting "Bambi" bucket filled with water.



Key: PA = pressure altitude

Figure 6. External Lift Performance

Range

The LUH exceeds the range requirement for the transport of five passengers, providing twice as much range as the UH-1 and over twice as much seating as the OH-58. The LUH can transport five passengers in high-hot conditions (4,000 feet pressure altitude, 95 degrees Fahrenheit, 30 minutes of reserve fuel) 269 nautical miles versus a user requirement of 217 nautical miles. Under similar conditions, the UH-1H can transport five passengers 139 nautical miles. The OH-58 can carry two passengers to a range of 304 nautical miles and would require multiple trips to transport five passengers.

Endurance

The UH-72A meets the endurance requirement to transport five passengers for 2.8 hours. For this mission, the LUH can transport five passengers to conduct aerial surveillance for as long as possible, return to the departure airfield, and land with a 20 minute fuel reserve. Under similar conditions, the UH-1 endurance is 1.8 hours. The OH-58 has neither the endurance nor passenger seating to perform this mission.

Cruise Speed

The LUH is capable of cruising at 140 knots and exceeds the cruise speed requirement of 125 knots. Cruise speed for the UH-1 is 110 knots and 100 knots for the OH-58.

Effectiveness Summary

The UH-72A is operationally effective for light utility helicopter missions. The LUH is effective for the conduct of air movement and aerial sustainment missions, but has less lift capability than the user requires. In realistic operational scenarios, the LUH successfully completed 14 of 18 difficult light utility helicopter missions.

- The LUH is not operationally effective for the MEDEVAC mission because the aircraft configuration precludes medics from providing medical treatment to two litter patients. The LUH unit successfully completed three of five IOT&E medical evacuation missions. Two missions were unsuccessful because of insufficient cabin space and configuration to permit patient treatment by the in-flight medic.
- The LUH does not meet the external load requirement to lift 2,200 lbs, at 4,000 ft pressure altitude, 95 degrees F, with 2.8 hours of endurance and 30 minute fuel reserve. The LUH aircraft can successfully deliver smaller payloads and provides 40 percent more payload and mission duration than the UH-1H.
- The LUH does not meet the HOGE in a high/hot environment (4,000 feet pressure altitude, and 95 degrees Fahrenheit) internal load requirement of 1,250 pounds. In order to meet the 2.8 hour mission endurance requirement with a 30 minute reserve the LUH must reduce the internal weight by 143 pounds or reduce mission endurance by 22 minutes, or a combination of the two, to operate with internal loads in high/hot environments.
- The LUH provides and increase in range, external lift, endurance, and speed over the Kiowa and Huey aircraft it will replace (OH-58A/C and UH-1H).

Section Four

Operational Suitability

The UH-72A LUH aircraft is not operationally suitable. During the IOT&E, excessive heat from the sun, heat generated by aircraft avionics, and inadequate ventilation, resulted in elevated temperatures and limited operating time in the LUH cockpit and cabin. The LUH does not have the environmental control unit (air conditioner) common on most of the commercial EC 145 aircraft. High cockpit and cabin temperatures limit crew endurance and affect passengers and medical casualties. Additionally, the aircraft's Rotorcraft Flight Manual describes an avionics overheat condition where various avionics components have a 30-minute operating time if temperatures exceed safe operating ranges. This did not occur during the IOT&E because of moderate ambient temperature.

The reliability, maintainability, and availability of the LUH exceeded requirements. The LUH costs less to operate and support than the UH-60A/L helicopter. The LUH is compatible for transport by land, sea, and air. Despite excessive heat and the limited size of the cabin for MEDEVAC missions, LUH crews found the aircraft easy to fly and operate. The communications suite proved interoperable with military and civilian agencies. The pilots found the LUH to be compatible with the Air Warrior components. The New Equipment Training package is still in development as are the flight simulators.

Human Factors

Excessive Cabin Heat

Pre-IOT&E safety testing in December 2006 and January 2007 indicated that high cabin temperatures in the California desert would affect crew performance and endurance. The Army developed formal guidelines to limit crew flight time for the IOT&E based on measured cabin temperature and humidity. The Army published separate guidelines, illustrated in Figure 7, for crews in standard flight suits and for those in Mission Oriented Protective Posture (MOPP) IV protective over-garments. Additionally, elevated cabin temperatures can exacerbate medical problems of MEDEVAC patients/casualties evacuated in the LUH.

During the IOT&E, heat from the sun, heat generated by aircraft avionics, and inadequate ventilation resulted in elevated temperatures and limited operating time in the LUH cockpit/cabin. The LUH cockpit/cabin is well-sealed and does not have a suitable ventilation system. Cockpit and cabin temperatures, on average, reached 15.6 and 11.2 degrees Fahrenheit, respectively, above the outside air temperatures. The highest temperature observed in the cockpit during IOT was 104.9 degrees Fahrenheit. When the outside air temperatures were moderate (50-60 degrees), the cockpit temperature rose, on average, 10 degrees above the outside air temperature. During one mission in the

IOT&E, the cockpit temperature rose 24.9 degrees above an outside air temperature of 80 degrees Fahrenheit.

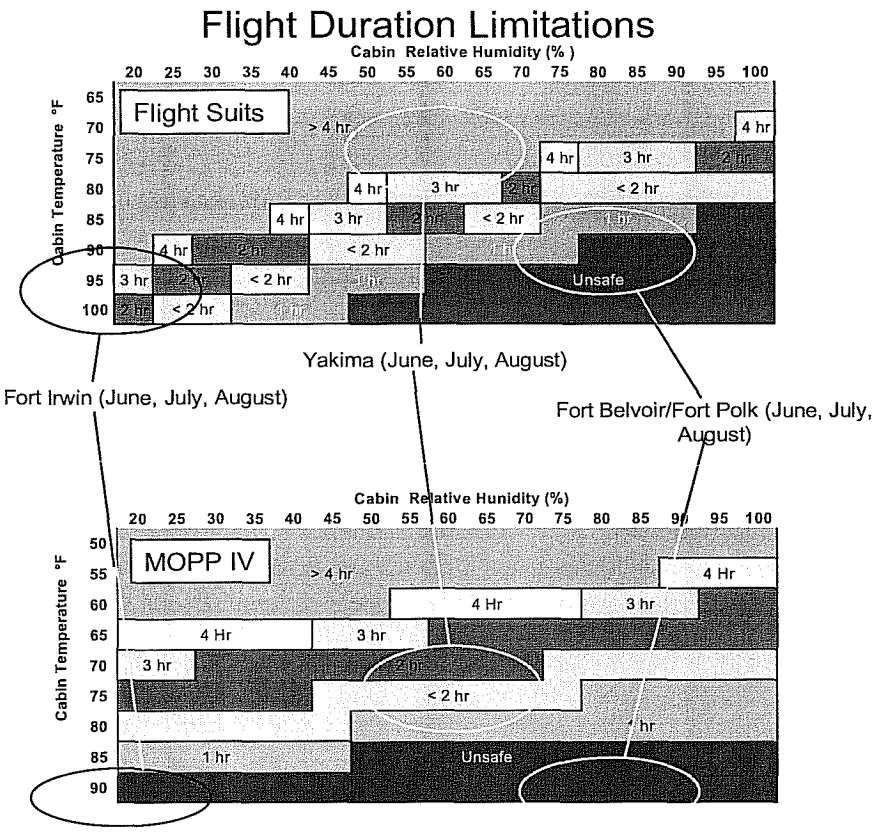


Figure 7. LUH Flight Duration Limits

The potential for elevated cockpit/cabin temperatures extends beyond the IOT&E and limits or prevents operation of fielded aircraft. According to the Army's fielding plan, the LUH will be fielded to areas with high temperatures and humidity, especially during the summer months. Figure 7 shows, even without the average 15.6 and 11.2 degrees increase in cockpit and cabin temperatures, use of the LUH at many of the planned fielding sites will be limited to 1 to 3 hours for crews in flight suits. In nuclear, biological, and chemical protective gear, or with elevated cabin temperatures and high humidity, the LUH may not be suitable to operate.

Potential exists for various avionics to shutdown if operating limits exceed temperature limits. The current aircraft Rotorcraft Flight Manual for the LUH describes a condition where a caution light (AVIO OVHT) illuminates if internal temperatures of the communication/navigation systems or the Automatic Flight Control System exceed 40 degrees Celsius or 104 degrees Fahrenheit (safe operating temperature limits). Illumination of the AVIO OVHT light indicates operating time is approximately 30 minutes before the system could shutdown. Crews must take action to eliminate the master caution light by cooling the cockpit or landing as soon as practicable. The internal

cockpit temperatures reached 104 degrees Fahrenheit during the IOT&E on one occasion. The avionics overheat condition describe in the flight manual did not occur during the IOT&E. The Army should investigate this reported condition over the summer months with the first unit equipped at Barstow, California.

Reliability, Availability, and Maintainability (RAM)

The LUH exceeded reliability, availability, and maintainability (RAM) requirements. Table 4 presents the demonstrated and threshold LUH RAM requirements. In each case, the demonstrated values exceeded threshold values. Contractors maintained all operational test unit aircraft and provided all logistics support during the IOT&E in accordance with the fielding plan.

Table 4. LUH Reliability, Availability, and Maintainability Metrics

Metric	Threshold	Demonstrated Value
Reliability[a]	> 90%	> 98%[b]
Availability	> 0.90	0.94
Maintainability (Mean Time to Repair)	< 2.0 hours	1.5 hours (contractor)

[a] Probability of completing a 3.67 hour mission

[b] Since no system aborts occurred during the scored 256.7 flight hours, a point estimate of the reliability could not be calculated. At the 80% confidence level, reliability exceeds 98%.

The Sikorsky Aircraft Corporation will provide logistical fleet management and is responsible for overhaul and repair of engines, avionics, and autopilot components for future fielding of the LUH. Sikorsky will provide contractor field teams to perform LUH maintenance including the hybrid (soldier/contractor) maintenance concept anticipated for Army National Guard units.

Figure 8. LUH is contactor maintained

Operating and Support (O&S) Costs

The LUH meets the Army user requirement to cost less to operate and support than the UH-60A/L Black Hawk aircraft. A comparison of the operations and support cost per flying hour of the LUH with the UH-60A/L in Table 5, illustrates that the LUH will cost less to operate and maintain than the Black Hawk aircraft. The costs for the LUH represent the average cost for the first year of the Contract Logistic Support. Other overhead personnel costs to operations and maintenance are not included in this estimate.

Table 5. Cost per Flight Hour by Aircraft Type (Estimate)

	Spares/Repairs	Petroleum	Labor	Total
UH-60A	$1,750	$252[a]	>$202 [b c]	> $2,204
UH-60L	$1,735	$252[a]	> $195 [b c]	> $2,182
LUH (Full CLS)	$830	$198[d]	$1,147	$2,175
LUH (Hybrid CLS)	$1,334		$600	$2,132

[a] Operating and support management database for FY08.
[b] FY08 Military manpower costs ($36.00 per hour) from Army Military-Civilian Cost System.
[c] Maintenance man-hour per flight hour estimates from Army.
[d] FY08 costs for jet fuel and lubricants.

Interoperability

During operational testing, the LUH conducted reliable communications with numerous military and civilian agencies. These included standard military and civilian air traffic control agencies as well as civil emergency networks, fire departments, and

other non-government agencies. LUH has multiple radio systems which are versatile and provide adequate communications in a variety of scenarios. The radio systems were easy to use. The aircraft is well equipped to communicate with various agencies in support of homeland defense missions. The LUH is compliant with Information Assurance requirements in accordance with its Intra-Army Information Assurance Certification.

A communications issue noted in the IOT&E was the inability to communicate simultaneously on both UHF and FM channels – a common use by Army aviators on military airfields. Internal military communications and air traffic control flight following, including the Army's Training Centers, are handled with UHF and FM. The LUH has one multi-band Wulfsberg RT 5000 radio that is dual UHF/FM, but it cannot transmit and receive on both bandwidths simultaneously. Army's current plan to correct this issue is to install an ARC 231 multi-band radio on each aircraft which will enable simultaneous communications on both UHF and FM. The ARC 231 will also provide a military secure communication capability that the LUH does not have, with the HAVEQUICK II (UHF) and SINGGARS (FM) radios.

Transportability

The LUH meets requirements for transport aboard strategic aircraft, naval ships, and ground vehicles. The LUH meets the dimensional requirements for loading the aircraft on either a C-17 or a C-5. Military Surface Deployment and Distribution Command assessed that the LUH is compatible with lighter aboard ships, sea barges, and roll-on/roll-off ships. The LUH is transportable by ground vehicles, such as a commercial low boy or military flat bed trailers. The aircraft also contains provisions required for external transport by other helicopters.

Developmental Test Shortfalls

During the LUH IOT&E testers and evaluators noted several significant findings normally discovered by the program as part of developmental testing:

- Forward and aft center of gravity can easily change based upon mission tasks and cargo loads in the LUH. Crews must closely monitor and recalculate center of gravity to maintain proper weight and balance of the aircraft as the mission progresses.
- The performance planning section of the operators' manual was not similar with standard Army operator manuals. Performance planning derived from the Rotorcraft Flight Manual during the IOT&E for calculating mission performance for power requirements such as, HOGE gross weight, range, endurance, and maximum cruise speed was consistently higher than the demonstrated performance. The Army is currently working with the Director of Training and Doctrine to develop a new Aircrew Training Manual, Performance Planning Card, and Weight and Balance charts

- The LUH meets FAA certification for civil Electromagnetic Environmental Effects (E3). The Army conducted a gap analysis between the LUH FAA certification requirements and Military E3 standards. There is a risk that potential issues could limit operations and/or military utility in and around military airfields or medical ships in support of disaster relief. The aircraft should not conduct shipboard operations until appropriate E3 testing is completed.
- During the IOT&E, LUHs were flown without engine inlet barrier filters. Post IOT&E, preliminary findings of an engine fire on a First Unit Equipped aircraft indicated foreign object ingestion. Installation of engine inlet barrier filters reduce the probability of ingesting foreign object debris and extend overall engine life cycle costs by reducing sand and dust ingestion, especially in environments as the deserts of the National Training Center and Yuma Proving Ground. The Army plans to introduce an Extreme Environment Preventative Maintenance Plan to integrate Engine Inlet Barrier Filters on the LUH beginning in April 2008.
- The LUH is being procured without skid shoes that protect the landing gear. Based on field data across the Army fleet of aircraft, skid shoes prolong the life of the landing gear and reduce overall life cycle costs.
- The Army plans to incorporate aircraft decontamination procedures for the LUH similar to other Army aircraft. This has not been tested. The aircrew is able to operate, with limitations, the aircraft while in a chemical protective suit.

Refueling

The LUH in not capable of pressure refueling as required. During refueling, aircraft engines must be shut down to allow refueling through an open port, increasing the time it takes to refuel. This impacts missions requiring sustained operations such as MEDEVAC or long-range air movement.

Safety

The Army conducted missions during the IOT&E with two pilots and a crew chief in each aircraft. During MEDEVAC missions a medic was added to the crew. The crew chiefs and medic had difficulty performing their missions during MEDEVAC and hoist missions due to confined cabin configuration for medical gear and medic movement within the cabin of the LUH.

The first aid kit, mounted on the left rear clamshell door, cannot be accessed by the crew chief or passengers in the event of an accident without climbing over the rear seats or exiting the aircraft and opening the clamshell doors at the rear.

The fire extinguisher for the aircraft is located at the rear of the cockpit between the pilot and co-pilot. With most cabin seating configurations, the fire extinguisher is not accessible to the crew chief or passengers in the cabin area of the aircraft. This is

especially true in the MEDEVAC configuration when the medic's flight equipment bag is secured between two rear facing seats behind the pilot and co-pilot's seats.

The seat belts in the cabin restrict the movement of the crew chief. The restraint system is small or restrictive for passengers wearing protective gear for hazard material handling or chemical protection.

On one occurrence during the IOT&E the crew chief's intercommunications system (ICS) cord disconnected because of the cord's short length while performing crew member tasks. The Army has identified the potential for the ICS cord to inadvertently disconnect and plans to extend the length of the ICS cord.

During Safety Testing, observers noted potential safety hazards:

- Pilots of small stature cannot actuate the fire suppressant system with the restraint harness locked.
- Location of hand holds and the lack of non-slip steps on the outside of the aircraft make it difficult for pilots to establish a stable position from which to conduct pre and post-flight inspections.
- Releasing the throttle stop to allow the throttle to be rotated past its normal operating limit was extremely difficult. This difficulty could prevent the pilot from enabling manual throttle operation to execute emergency procedures in the case of engine malfunctions.

Other Human Factors

A number of the features and equipment within the LUH eased pilot workload. These include:

- Internal Communications System (ICS) boxes are convenient to use.
- External hoist is simple to use and the cable spools/unspools at a high rate.
- Navigation and communications packages are user-friendly.
- Pilot outside field-of-view and visibility is excellent. The crew station offers an exceptionally wide field-of-view (90 degrees up by 50 degrees down).
- The autopilot system is effective.
- The LUH is an excellent instrumented flight rules (IFR) aircraft to facilitate operational flight in marginal weather conditions.

Training

The training plan and program design for the LUH are adequate. In preparation for the IOT&E, Eurocopter of North America in Columbus, Mississippi, presented instruction on the flight and training manual. Army-trained Instructor Pilots accomplished unit-level mission training at Barstow-Daggett Airfield in California. The Army produced a draft Aircrew Training Manual to support the IOT&E and prepare the

crewmembers for the test and initial fielding. The Army prepared the Program of Instruction, lesson plans, and flight training guides necessary to support New Equipment Training for fielding to new units.

In accordance with the Army Aviation Warfighter Center-approved Program of Instruction, the initial aircraft qualification for the rated crewmembers will be at the Eastern Army National Guard Aviation Training Site in Indiantown Gap, Pennsylvania. The single training site will provide standardized and consistent flight and maintenance training for the LUH crewmembers. The Army plans to introduce and use flight simulators in training later this calendar year.

Suitability Summary

The LUH Lakota aircraft is not operationally suitable. During the IOT&E, excessive heat from the sun, heat generated by aircraft avionics, and inadequate ventilation resulted in elevated temperatures and limited operating time in the LUH cockpit and cabin. Additionally, the aircraft's Rotorcraft Flight Manual describes an avionics overheat condition where various avionics components have a 30-minute operating time if temperatures exceed safe operating ranges. This did not occur during the IOT&E.

- The LUH exceeded reliability, availability, and maintainability requirements.
- The LUH meets the Army requirement to cost less to operate and support than the UH-60A/L Black Hawk aircraft.
- Elevated cockpit/cabin temperatures limits operation of the LUH in hot environments. Cockpit and cabin temperatures, on average, reached 15.6 and 11.2 degrees Fahrenheit, respectively, above the outside air temperatures.
- During MEDEVAC and hoist missions medics and crew chiefs had difficulty performing tasks due to less than adequate space for gear and movement within the cabin of the LUH.
- The LUH communication and navigation system, the autopilot system, and the instrument flight rule package eased pilot workload.
- The aircraft is well equipped to communicate with various agencies in support of homeland defense missions. The LUH cannot communicate simultaneously on both UHF and FM channels – a common use by Army aviators.

Section Five

Operational Survivability

The LUH meets required design standards for crashworthiness in accordance with the Federal Aviation Administration (FAA) standards to protect crew and passengers. As a commercial aircraft, the LUH does not have ballistic tolerance criteria nor does the Army intend to employ this aircraft in operational hostile environments.

Crashworthiness

The FAA has certified that the LUH meets FAA standards for crashworthiness. The FAA Airworthiness Certificate remains valid as long as the Army operates and maintains the aircraft in accordance with the contractor's flight manual and FAA guidelines. The Army agreed to comply with the FAA certificate and plans to limit LUH flight operations as defined in the approved flight manual. If modifications to the FAA Airworthiness Certificate are required, the Army will coordinate with Eurocopter to obtain appropriate certifications.

The LUH meets FAA standards for retention of high mass components such as engines and transmissions in the event of a crash, seat impact criteria for crew and passengers, fuel tank drop criteria, loss of lubricants, and electromagnetic environmental effects. As a commercial aircraft, the UH-72A does not have ballistic tolerance requirement nor does the Army intend to employ this aircraft in hostile operational environments.

The LUH successfully completed autorotation testing as part of the Army's safety release flight tests.

Force Protection

LUH aircrews completed missions wearing various components of the Army Air Warrior Ensemble during operational testing. These components included chemical and biological protective masks and hoods, night vision devices, and basic survival equipment. Visual distortion of the protective mask was no worse than experienced on other aircraft, and cockpit lighting was compatible with the use of night vision devices.

Cabin and cockpit heating issues dictated flying the chemical and biological missions in the cooler morning hours. Use of this equipment in even moderate ambient temperatures would impose a health risk to the aircrew.

Figure 9. Crew member wearing part of the Air Warrior Ensemble

Survivability Summary

The Federal Aviation Administration certified that the LUH meets FAA standards for crashworthiness.

- The Army agreed to comply with the FAA certificate and plans to limit LUH flight operations as defined in the approved flight manual.
- The LUH meets FAA standards for retention of high mass components such as engines and transmissions in the event of a crash, seat impact criteria for crew and passengers, fuel tank drop criteria, loss of lubricants, and electromagnetic environmental effects.
- The Air Warrior Ensemble including chemical and biological protective masks and hoods, night vision devices, and basic survival equipment during operational testing, provide adequate protection to the LUH crew.
- As a commercial aircraft, the LUH does not have ballistic tolerance criteria nor does the Army intend to employ this aircraft in hostile operational environments.

Section Six

Recommendations

The Army executed the LUH IOT&E in accordance with the DOT&E approved test plan. There was no dedicated developmental testing for the LUH. Many deficiencies noted during the operational test of the LUH could have been identified and corrected prior to the IOT&E. In order to address deficiencies found in the IOT&E, the Army should consider the following recommendations:

Operational Effectiveness

- Reconfigure or modify the cabin to provide additional space for the medic and MEDEVAC equipment when in a two-litter configuration.
    1. Install provisions for cabin ceiling rails from which to hang IVs, infusion hooks, or to store and secure medical equipment.
    2. Add lighting to illuminate the tail rotor and rear clam shell doors to enhance safety and facilitate rear loading and unloading of litter patients.
- Develop unit tactics, techniques, and procedures to address the external and internal lift performance shortfalls.
- Continue to update, develop, and document LUH performance data to incorporate into a standardized flight manual and to facilitate more accurate mission planning.

Operational Suitability

- Install and test potential material fixes such as an environmental control system to moderate excessive cockpit, and cabin temperatures to enable operations in hot/humid environments.
- Reconfigure the LUH communication package to allow simultaneous communication on UHF and FM channels and secure communications.
- Install engine inlet barrier filters to reduce the probability of ingesting foreign object debris and increasing overall engine life cycle costs.
- Continue to develop the Aircrew Training Manual, Performance Planning Card, and revising Weight and Balance charts.
- Assess the New Equipment Training package and the hybrid maintenance concept planned for Army National Guard units once implemented.
- Install skid shoes to protect and extend the life of the LUH landing skids.
- Relocate first aid kit and fire extinguisher to allow for immediate crew chief and passenger access.