Evaluation of the Special Warfare Kits of the UH-1Y Helicopter

Kacie Fleck
Naval Air Warfare Center Aircraft Division
Integrated Systems Evaluation, Experimentation & Test Department
H-1 Upgrades Flight Test Integrated Product Team
22474 James Road
Patuxent River, MD 20670
301-757-9935
kacie.fleck@navy.mil

Abstract—The United States Marine Corps (USMC) Special Warfare Mission Kits were tested for fit, form, and function on the upgraded UH-1Y “Huey”. Special Warfare Kits are utilized for rapid insertion of USMC personnel where terrain or other mission constraints will not allow the helicopter to land and takeoff safely. The evaluation consisted of ground and flight test of the fast rope, Special Patrol Insertion/Extraction (SPIE), and rappel mission kits; static line and free fall parachute operations; and the internally mounted AN/ASC-26 communications package. Ground testing was conducted to evaluate each mission kit when installed on the UH-1Y. Certified Helicopter Rope Suspension Techniques (HRST) Masters and Jumpmasters were used during the evaluation conducted at Naval Air Station (NAS) Patuxent River. Flight tests were conducted in NAS Patuxent River local flying area and Marine Corps Base (MBC) Quantico with support from Reconnaissance and Amphibious Raids and Special Operations Training Group from New River, North Carolina. This paper describes the aircraft and test equipment, documents flight test planning, scope, and risk mitigation measures used, presents test results, including enhanced capabilities from the legacy UH-1N aircraft, and documents “lessons learned” for future flight test evaluations.

1. INTRODUCTION

The Special Warfare Kits are used for specific operations conducted by the U.S. Marine Corps (USMC). The Special Patrol Insertion/Extraction (SPIE), fast rope, and rappelling Special Warfare Kits, as well as parachute operations, were used to insert and/or extract personnel where the aircraft was unable to land. The AN/ASC-26 command and control system was a communication suite carried in the aft cabin of the UH-1Y aircraft. The AN/ASC-26 package was designed to allow Tactical Ground Force Commanders and Airborne Mission Commanders to command and control dispersed forces during helicopter borne assaults and combat support operations.

The objective of the testing discussed in this paper was to validate, through ground and flight evaluation, the fit, function, and operability of the UH-1Y SPIE, parachute operations equipment, fast rope, and rappelling Special Mission Kits. An additional objective of this testing was to validate, through ground evaluation, the fit, function, and operability of the AN/ASC-26 command and control system.

2. DESCRIPTION OF AIRCRAFT AND TEST EQUIPMENT

The UH-1Y is a twin engine, medium class, utility helicopter that is currently in the Development Test and Evaluation (DT&E) phase of the acquisition process. The UH-1Y is being upgraded from the UH-1N Huey and includes an all-composite four-bladed rotor system, upgraded avionics, and an all-glass cockpit. The UH-1Y is designed to perform the following missions when configured with the proper support equipment:

- Control, coordination, target acquisition, and terminal guidance for supporting arms
- Airborne command and control for assault support operations
- Aerial reconnaissance
- Aeromedical evacuations
- Search and rescue operations
- Tactical recovery of aircraft and personnel
- Suppressive weapons capability against ground-to-air threats
- Assault transport and maritime special operations
- Search and rescue operations

Testing for many of these missions was conducted under the Special Warfare Kits test plan. The support equipment for each mission is detailed in the following paragraphs.

Fast Rope

Fast rope operations are used routinely by the USMC to quickly insert personnel where terrain or other mission constraints will not allow the helicopter to land and take off safely. The fast rope gantries utilized in the UH-1N were planned to be replaced by permanently installed fast rope bars located on the forward portion of the cabin roof on each side of the UH-1Y helicopter and were evaluated for form, fit, and function during ground testing. The UH-1N legacy fast rope gantry was utilized for the flight evaluation of fast rope operations on the UH-1Y. The 1 3/4 in. diameter fast rope came in 60, 90, and 120 ft lengths and had a tensile strength of 35,000 lb. The rope was attached to the helicopter via the horizontal fast rope bar. A maximum of two people were authorized to be on the rope at the same time with a minimum of 20 ft between them. A more detailed description of the fast rope kit can be found in Standard Operating Procedure (SOP) for Helicopter Rope Suspension Techniques (HRST), reference 1, and the HRST Operations Manual, reference 2.

Rappel

Rappelling is a standard method used to insert USMC personnel where terrain or other mission constraints did not allow the aircraft to land or takeoff safely. The rappel kit was Government Furnished Equipment (GFE) in its entirety. There were multiple brands of rope that were authorized for use during rappel operations. They were all approximately 11 mm in diameter and 120 ft in length with a minimum tensile strength of 3,840 lb. Each rappel rope was attached to two 32 in. long steel attachment cables in the cabin area. The ropes were attached to the cables via snaplinks and a bowline knot. As a safety backup, the rope was also attached to the cabin deck cargo rings via snaplinks and a bowline knot. Each cable was attached to the aircraft floor by carabiner snaplinks. Each rappeller was fitted with a sling, which attached to the rappel rope by a carabiner snaplink. One rappeller was permitted on a rope at any one time. A delay person was utilized to stabilize the rappel rope during rappel operations. A more detailed description of the rappel kit can be found in references 1 and 2.

SPIE

The SPIE kit was utilized as a means to rapidly insert and/or extract a reconnaissance patrol from an area, which did not permit a helicopter to land. The 1 in. diameter SPIE rope had D-rings spliced through it at 1 ft intervals and could be configured to carry up to 14 ropers. Each roper wore a nylon fabric harness that attached to the SPIE rope via a snaplink. A backup for the normal attachment of the snaplink on the D-ring consisted of a 12 to 15 ft sling rope secured with a bowline around the roper’s chest area and attached to the SPIE rope via a snaplink. The harness and safety rope were attached to the SPIE rope through separate D-rings. Two methods were approved for attaching the SPIE rope to the aircraft. The primary method attached the SPIE rope to the helicopter via the cargo hook, two nylon cargo suspension slings, and a type IV link assembly. The secondary method was used when the cargo hook was not installed and utilized four cargo slings and four type IV links. For this testing, the secondary installation method was used. A more detailed description of the SPIE kit may be found in references 1 and 2.

Static Line

The MC-5 Ram Air Parachute had a steerable canopy and was used during static line airborne operations. The main parachute consisted of five major components: the harness assembly, the riser assembly, the deployment bag and static line assembly, the pack tray assembly, and the canopy assembly. A reserve parachute was used in conjunction with the main parachute. The deployment bag was constructed of cotton sateen cloth and was permanently attached to a 15-ft long static line. The static line and deployment bag were recovered by manually pulling them back into the helicopter. The UH-1Y utilized a revised anchor line system from the UH-1N. The UH-1Y anchor line configuration routed a steel cable through the existing deck rings on the cabin floor in the shape of an oval. A more detailed description of static line parachute operations can be found in reference 3.

Free Fall

The current military free fall parachute system was the Ram Air Parachute System (RAPS). The RAPS was a steerable, rectangular style canopy parachute. Parachute deployment may be activated manually via ripcord or automatically via an automatic ripcord release at a preselected pressure altitude. Minimum jump altitude was dependent on jumper weight and jump day pressures and temperatures. A more detailed description of the free fall parachute system can be found in “Military Free-Fall Parachute Tactics, Techniques and Procedures”, reference 4.
The AN/ASC-26 communications package was an installed communications kit utilized for the command and control mission. It had the capability to transmit and receive in the UHF, VHF-AM, and VHF-FM frequency bands, all secured by communications security devices. It consisted of one UHF-AM radio, two VHF-AM/FM radios, four intercockpit communication system control panels, one central control panel, two voice security units, three externally mounted antennas, and the package container complete with all the required electrical connectors to operate with the UH-1Y and the required GFE items. The package was internally mounted in the cabin area forward of the transmission bulkhead. A more detailed description on the AN/ASC-26 communications package may be found in the UH-1N Tactical Manual, reference 5.

3. TEST PLANNING PROCESS

The test planning process began by determining who would participate in this specialized test. The H-1 Upgrades program determined it necessary to only seek a Developmental Test (DT) certification rather than pursuing a Developmental and Operational Test (OT) certification simultaneously due to schedule restraints. Therefore DT test support personnel were chosen from Reconnaissance and Amphibious Raids at MCB Quantico and Special Operations Training Group (SOTG) from New River, North Carolina. Reconnaissance and Amphibious Raids added expertise in both HRST and parachute operations as well as providing qualified developmental testers for this test effort. SOTG is the USMC focal point for special ops and their knowledge and personnel were an integral part of the test team. Using both of these groups allowed for support for both the HRST and parachute operations.

Ground testing was conducted well in advance of planned flight tests. This allowed the flexibility to mitigate any issues discovered during ground testing before the start of flight tests. Certified HRST Masters and Jumpmasters were scheduled to travel to NAS Patuxent River, MD in August 2003 prior to flight test events scheduled for November 2003. During the planning phase, the test team determined to conduct the majority of the flight testing at MCB Quantico due to the amount of personnel and equipment required for this testing.

A collaborative effort between the H-1 Upgrades Integrated Product Team (IPT) and personnel from MCB Quantico was undertaken to determine what testing would be required to qualify the UH-1Y. Consideration was given to conducting proper pre-requisite testing prior to proceeding to the next test evolution based on Standard Operating Procedures (SOP) for developmental testing, proper buildup within each test evolution, as well as risk mitigation for each test phase. Risks addressed during the test planning process are listed below:

- Parachute hangs up on helicopter
- Power required exceeds power available during helicopter insertion/extraction (HIE) operation
- Hung roper during fast rope or rappel operations
- Dragging a roper during SPIE operations
- Static line breaking during simulated hung jumper testing
- Mannequin hitting side of cabin or tailboom during simulated hung jumper testing
- Static discharge during retrieval of hung jumper from a hover
- Inadvertent parachute deployment in the cabin

Minimizing procedures were outlined for each of these test hazards. Depending on the test, these procedures were discussed during pre-flight briefings of SOPs, build up in test events, and following required pre-requisite testing. Corrective actions were also addressed in the event the hazard was realized during testing and briefed during the pre-flight briefing.

The final approval of the test plan came from Air Test and Evaluation Squadron Two One (HX-21). An Executive Review Board (ERB) was held to review the test plan with squadron leadership prior to the commencement of tests. The final review ensured that the testing planned was effective and efficiently planned and mitigated risk through thorough planning and adherence to SOPs.

4. GROUND TESTS

Ground tests were conducted on all special mission kits prior to flight tests to evaluate each kit for form, fit, and function on the upgraded UH-1Y platform. This served to identify and document any differences needed in kit installation due to the addition of floor rings rated for higher loads as well as new requirements and capabilities of the UH-1Y. For this testing certified HRST masters were used to gather input for configurations on the UH-1Y as well as their familiarization with the equipment.

Fast Rope

For this evaluation, the gantry was installed on the left hand side of the aircraft along with the Improved Defensive Armament System (IDAS) equipped with a GAU-16 machine gun. A short section of fast rope (approximately 4 ft in length) was installed on the gantry to allow the HRST Masters to assess all aspects of a fast rope configured UH-1Y aircraft. The mounting location of the fast rope gantry of the UH-1Y was located approximately 10.5 in. aft from the previous UH-1N design. In addition to the change in location, the new gantry was designed to be permanently installed, using straps to secure it to the ceiling in the cabin.

The change in location of the fast rope gantry created a snag hazard for fast rope personnel when deploying from the
UH-1Y. Under current procedures, when deploying from the fast rope, personnel swing from the cabin door to face the direction of aircraft travel with their combat gear on their back. When the fast rope personnel swung into position, the lower part of his back came into contact with the forward part of the IDAS. The fast rope gantry installed in the new UH-1Y position did not allow for adequate clearance between the IDAS and mission equipped USMC personnel using the fast rope to deploy from the aircraft. Under current doctrine, the troop insertion/extraction mission is performed armed, necessitating the IDAS and defensive weapons be installed for self-protection. The UH-1Y fast rope gantry is currently under redesign to meet the mission constraints and support the use of defensive armament that will be necessary while deploying USMC personnel. Due to this issue the legacy UH-1N fast rope gantry was utilized for flight test of the fast rope mission. The legacy equipment and location are still usable on the UH-1Y without any modifications to the structure.

SPIE

During the installation of the SPIE kit the HRST masters discovered that two of the tiedown rings in front of the center transmission wall were not installed on the aircraft. These two tiedown rings were required for the SPIE kit installation and would prevent the aircraft from being able to perform the SPIE mission. The rings were installed prior to flight operations to restore the UH-1Y to the original production configuration and are permanently installed on the aircraft.

Rappel

A new cabin deck tiedown ring configuration was evaluated for operational use during rappel operations. The cabin deck tiedown ring installation consisted of a combination of an older, preexisting aircraft deck ring design and a newly designed tiedown ring configuration. The aircraft was rigged for rappel operations in accordance with reference 2 using a combination of old and new deck ring locations to ensure a total of three separate attachment points.

Anchor Line

The anchor line was evaluated for form, fit, and function on the UH-1Y aircraft. The UH-1N configuration consisted of a 3/8 in. steel cable routed through the existing deck rings on the cabin floor in the shape of an oval. This configuration was utilized as a starting point, but modified to also use the 5,000 lb rated floor rings new to the UH-1Y. The configuration was further modified to add load paths to higher rated deck rings for two of the legacy deck rings that were determined as high stress points by NAVAIR Structures (AIR-4.3) and did not meet the new Joint Services criteria to withstand an ultimate load of 5,400 lbs. The final UH-1Y configuration is shown in figure 1 with the exception of the tieback cable being dually, rather than singly, clamped on either end.

The AN/ASC-26 communications package (FM whip antennas and fixture assemblies) was evaluated for maintainability and functionality for use on the UH-1Y. The AN/ASC-26 was a communication package carried in the aft cabin on the UH-1N platform during command and control missions and was intended to be a forward fit installation package on the UH-1Y. The FM whip antennas were intended to be installed on the landing gear forward cross tube just above the skid saddle (one on each side), utilizing a U-bolt clamp. The UH-1N utilizes a round cross tube for this installation. However, the square cross section design of the UH-1Y landing gear cross tube was too large to support the clamping hardware for the base of the antenna, precluding installation of the base antenna mounting bracket. A method for securing the whip antennas to the square UH-1Y crosstube was developed using an alternative attachment brace that allowed for installation of the whip antennas. An Electromagnetic Compatibility Safety of Flight (EMC SOF) test was then conducted on the UH-1Y with the AN/ASC-26 communications package installed. No EMC issues were found during the ground run.

5. FLIGHT TESTS

Flight tests were conducted in the NAS Patuxent River local flying area and MCB Quantico in November 2003. Personnel support from Reconnaissance and Amphibious Raids and Special Operations Training Group from New River, North Carolina were used for HRST and parachute operations.
Fast Rope Operations

The flight evaluation for fast rope operations utilized the UH-1N gantry rather than the UH-1Y gantry design. Fast rope testing was conducted in a buildup fashion in a hover beginning with the deployment of the ropes to determine any adverse effects of the main rotor downwash. This was followed by one roper deploying individually from each side, then one roper simultaneously from each side (two ropers total), then two ropers from each side deployed (four ropers total), and finally three ropers from each side were deployed (one top, one middle, and one at the bottom of each rope for six ropers total). The final evaluation began with an approach to a hover and then deploying three ropers from each side of the aircraft (six ropers total). Each deployment was conducted from a 25 ft AGL hover. No problems were noted during flight tests. Figure 2 shows one roper deploying from each side of the aircraft.

Figure 3 - SPIE Test Event With Six Ropers Deployed

Rappel Operations

The flight evaluation of the rappel kit began with the deployment of ropes in a hover to determine the main rotor downwash characteristics. Next, one roper was deployed individually from each side (two ropers total), followed by deploying one roper simultaneously from each side (two ropers total). The testing continued by deploying two ropers simultaneously from each side (four ropers total). The final test point was a normal approach to a hover and then deploying three ropers from each side of the aircraft (six ropers total). Each deployment was conducted starting with a vertical lift to 500 ft AGL. The aircraft was then flown in a right hand pattern at 70 KIAS and 500 ft AGL back to the zone. The final part of the evaluation consisted of a vertical let down from 500 ft AGL to release the ropers. Figure 4 shows the rappel test event of two ropers deploying simultaneously from each side of the aircraft. The ability to rappel four ropers without being limited by the slim power margin seen on the UH-1N is an enhancing characteristic for the UH-1Y.

Figure 4 - Rappel Test Event With Four Ropers

SPIE Operations

Flight test for the SPIE kit was conducted in a buildup fashion beginning with conducting a pattern around the drop zone with a 200 lb mannequin on the top attachment. Flying with live personnel followed the successful mannequin evolution. The planned buildup required two ropers, four ropers, and finally six ropers to be attached to the SPIE sling. Each event was conducted starting with a vertical lift to 500 ft AGL. The aircraft was then flown in a right hand pattern at 70 KIAS and 500 ft AGL back to the zone. The final part of the evaluation consisted of a vertical let down from 500 ft AGL to release the ropers. Figure 3 shows the SPIE test event with six ropers deployed. Both pilots noted that the only change in the flying qualities of the helicopter between a clean aircraft and an aircraft with a full load of ropers was the amount of torque required for an out-of-ground effect (OGE) hover. The ability to carry six ropers without being limited by the slim power margin seen on the UH-1N is an enhancing characteristic for the UH-1Y.

Static Line Parachute Operations

Static line parachute operations were conducted in a buildup fashion beginning with the deployment of deployment bags or d-bags. Static line bags were deployed from either side of the aircraft at 50, 60, and 70 KIAS to evaluate possible interference with the aircraft. The four bags were then retrieved at 70 KIAS.
Next, the hung jumper test was executed. This test was designed to ensure the aircraft and anchor line system would be able to withstand a “worst case” hung jumper scenario. This is a recently added requirement for static line DT qualification. The UH-1Y was the first helicopter program to perform this testing due to concerns in handling qualities of the aircraft during the mannequin deployment.

To measure the maximum load experienced during the test a load cell was installed between the anchor line and the static line. Hung jumper testing was planned to use a buildup of weighted mannequins from 180 lb to a maximum of 360 lb using the same weight increments as tested on the V-22 program. The evaluation began by pushing a torso mannequin weighing 180 lb from the left side of the aircraft. The peak load reading was 1,634 lb and there was a perceptible left roll when the mannequin reached the end of the line. On the second deployment of the 180 lb mannequin, a load of 1,824 lb was reached and the roll was less perceptible. The mannequin was then reballasted to 200 lb. When the 200 lb mannequin was dropped, a load of 1,770 lb was reached and the static line failed. It was determined through material analysis, the reason for the failure was repetitive loading of the static line and, in future testing, static lines should not be used for multiple hung jumper drops. Due to damage from the static line failure the torso mannequin, with the ability to reballast to achieve various weights, was no longer usable.

To complete hung jumper testing, the data collected during UH-1Y testing was compared to loads seen during the V-22 hung jumper testing. The UH-1Y data was found to be in the scatter of the V-22 data and it was deemed a minimal risk by the test team to continue hung jumper testing at one more weight, higher than what had been previously tested, and thus adjusting the previously agreed upon buildup. The hung jumper testing proceeded with a 300 lb mannequin. On the first mannequin deployment, the peak load was read as 1,117 lb, however, the harness failed. The final evolution for the hung jumper testing was conducted with a 309 lb articulated mannequin. The first deployment recorded a 952 lb peak load and the second a 1,108 lb load. The lower loads seen on the third evolution are attributed to the torso harness used and the use of an articulated mannequin rather than a torso mannequin that absorbed much of the load before it was seen on the static line.

Following completion of the hung jumper testing, parachute equipped mannequins were deployed from each side of the aircraft over the zone at MCB Quantico to determine safe separation from the aircraft. After this successful test evolution, drops with live personnel began. Three sets of jumps were conducted, four from each side (24 total jumpers), with the jumpers in clean and full combat load configurations. Figure 5 shows jumpers exiting the aircraft during the static line testing. The jumpers did not note any issues with separating from the aircraft. The pilots noted a slight aircraft roll (less than 2 deg) associated with jumper deployment, however, the handling qualities of the aircraft were not affected.

**Figure 5 - Static Line Parachute Operations**

**Free Fall Operations**

Free fall jumps were conducted in a buildup fashion beginning with one jumper from each side and continuing with two and three from each side with the jumpers in a minimum combat load configuration. The jumpers did not note any issues with separating from the aircraft. However, the 70-kt airspeed, coupled with a 35-kt wind at altitude, did not provide enough initial speed for them to maintain body stability for the first 1,000 ft of free fall. Another evolution with six jumpers (three from each side) was conducted with the jumpers fully loaded with combat gear. The airspeed for this evolution was 100 KIAS, the jumpers noted that the increased airspeed gave them better body control upon exiting the aircraft. Figure 6 shows the free fall parachute testing with two jumpers exiting the aircraft.

**Figure 6 - Free Fall Parachute Operations**
6. CONCLUSIONS

Special Warfare testing was successfully completed on the UH-1Y. The test planning process effectively identified specific hazards associated with these tests and assigned minimizing procedures to address each hazard. Proper test buildup and pre-requisite testing were also effectively incorporated during the planning process. Lessons were learned in regards to equipment limitations during simulated hung jumper testing, as the UH-1Y was the first helicopter to perform this testing. The UH-1Y effectively performed static line and free fall parachute, rappel, and SPIE operations. However, the UH-1Y fast rope gantry and AN/ASC-26 Communications Package both had integration issues with the UH-1Y. Enhancing characteristics were also noted during this testing that allow for six ropers to be carried on SPIE missions and four ropers to rappel at one time without the limits of the slim power margin seen on the UN-1N. Future testing for the fast rope mission will be necessary when the UH-1Y fast rope gantry has been redesigned and manufactured.

REFERENCES


BIOGRAPHY

Kacie Fleck earned her B.S. degree in Aerospace Engineering from Purdue University, West Lafayette, IN in 2001. She has been working on the H-1 Upgrades flight test team at NAS Patuxent River since July of 2002 as a flight test engineer. She is currently the Lead Planning Engineer for the test team. Prior to working for the Department of Defense, she was employed for The Boeing Company in Everett, WA as an Aerodynamics Engineer for 777 Product Development.