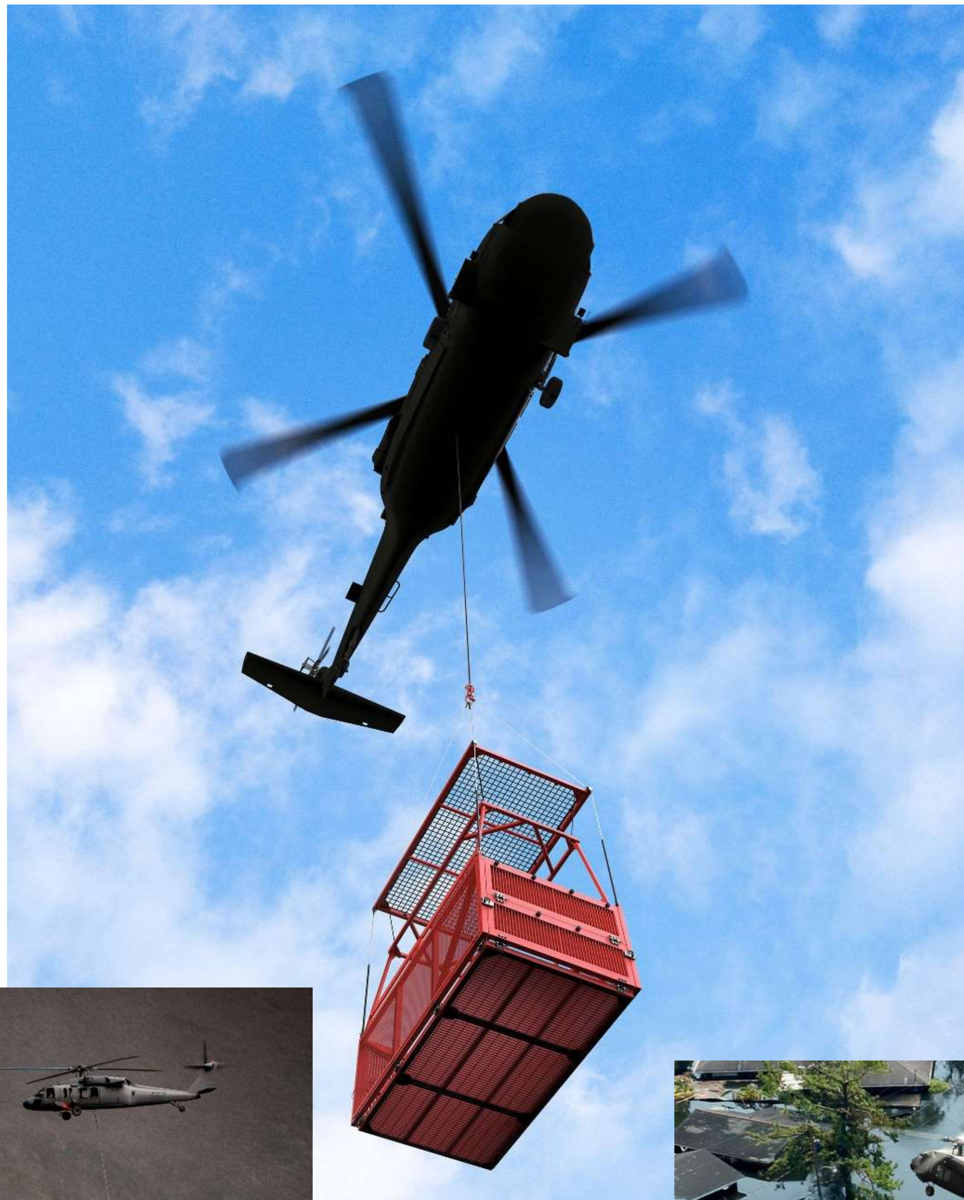
Heli-Basket® HB2000 Capabilities



Helibasket LLC Briefing Goals

PRIMARY: To present United States Army and Air Force documented Heli-Basket® evaluation data (documents incorporated below) that supports an upgrade to the current AWR to include rescue operations, which will allow the Heli-Basket® to better accommodate the Joint Chiefs of Staff Universal Joint Task List requirements.

SECONDARY: To offset further Heli-Basket® rescue evaluations by acknowledging that the quality and depth of the existing military evaluations is sufficient to approve the Heli-Basket® for disaster-mitigation responses.

Heli-Basket® History

- **1992:** Initially developed as a stable, no-spin external load transport device
- **1994:** Heli-Basket® US Utility Patent issued for an *"Aerodynamically Stabilized, Collapsible Personnel and Cargo Basket for Helicopters"*
- **2002:** US Congress approves NDAA funds for the Heli-Basket® as a rescue and utility device for Army National Guard Aviation
- **January – May 2003:** A detachment of the 1/150th GSAB (NJ Army National Guard Aviation) deployed with their Heli-Basket® to Panama in support of the New Horizons Exercise. AAR characterized the HB2000 as "indispensable" in the movement of personnel and support equipment, and recommended all future aviation support missions have at least one Heli-Basket® (document incorporated below)
- **30 May 2003:** A live load restricted Air Worthiness Release was issued for the Heli-Basket® HB2000 and long line remote hook system for Utility use only
  NOTE: *The live load restriction was a singular and unsubstantiated concern/opinion. The Heli-Basket® has never failed any rescue or utility evaluations, national or international, military or commercial.*
- **2014:** The Heli-Basket® was used as part of a demonstration of Lockheed Martin/Kaman UAV capabilities
- **2022:** PZL/Sikorsky purchase 12 Heli-Basket® HB2000 units
- **2023:** Helibasket LLC became AS9100D Certified, and DEVCOM begins writing a MIL-SPEC for the Heli-Basket ®
- **2024:** The HB2000 is under current review by the USAF and US Army to upgrade the AWR to include Live Loads

Current Status

- Meetings in 2023 with Colonel Schilleci at NGB HQ and Colonel Santiago G-3 at DAMO Aviation at the Pentagon recommended briefing Mr. Charles Strowbridge at the Utility PM office in Huntsville to upgrade the current Heli-Basket® AWR to include Live Loads
- As a result of the briefings, Mr. Cory Kroelinger at DEVCOM was tasked with acquiring the MIL-STD for Live External Attached Loads (LEAL)
- Sikorsky/PZL have approved the Heli-Basket® HB2000 as a recognized accessory for their S-70M Helicopter, and Helibasket LLC is in the process of delivering 12 Heli-Baskets® to support their delivery of helicopters to Romania
- The requirements listed in the Joint Chiefs of Staff Universal Joint Task List (UJTL), outlined below, identify numerous capability requirements for “an adequate capability” for search and rescue, humanitarian assistance and disaster relief that the Heli-Basket® fulfills

Short-Haul Multi-Person Rescue

The main capability of the Heli-Basket® is its capacity to perform **Short-Haul Multi-Person Rescue** operations for the recovery of up to 15 people in a single lift cycle.

Short-Haul Multi-Person Rescue is built around the concept of rescuing large numbers of people and moving them out of immediate danger to a place of relative safety, instead of hoisting one or two people at a time into the helicopter via a winch. In the case of maritime SAR, this might be to the closest ship or vessel, or in the case of a high-rise building or roof rescue, it might simply be to the top of an adjacent building, or to the ground where they can be given attention or transported to a hospital or other shelter.

Unlike the current winch-based rescue technologies in use, such as Stokes Litters, Helicopter Rescue Baskets and Sproule Nets, the Heli-Basket® provides the ability to rescue more people in fewer lift cycles, from locations where landing a helicopter is impossible or too dangerous to risk further lives, or in situations where doing so requires too much time or fuel.

Additional Logistical Benefits

The Heli-Basket structure exceeds all national and international standards for a rescue device, and is aerodynamically stable regardless of load placement, helicopter type, air speed or maneuver. With available long lines and remote hooks, confined areas become accessible.

These simple, unique characteristics open the Heli-Basket® up to other logistical uses, such as FARPS for fuel and rearmament. Critical cargo, such as medical supplies and water, is not impacted by net compression or having to be tossed out from a helicopter cabin.

Note: Any load placed symmetrically or asymmetrically in the Heli-Basket® is an approved load, making it an ideal logistical tool.

The Heli-Basket® is a tested, significant multiplier for Force Development and Logistics Sustainment, and meeting UJTL requirements.

The HB2000 Heli-Basket® system is approved by:

- US Army
- US Air Force
- US Navy
- USCG
- USFS
- Lockheed-Martin
- Sikorsky/PZL
- Kaman Aerospace
- Erickson Aviation
- Columbia Helicopters
- Qatar
- Papa New Guinea
- Israel Defense Forces
- Tokyo Fire Department

Incorporated Documents

- **New Jersey Army National Guard:** *"1/150th General Support Aviation Battalion (GSAB) Heli-Basket After Action Review"* (August 3, 2003)
- **DAMO-AV:** *"Testing for Helibasket HB2000 to Allow National Guard Aviation Units to Move Personnel During Emergency Evacuations"* (January 25, 2008)
- **United States Army Forces Central Command (USARCENT) (ARCENT) Coalition Forces Land Component Command (CFLCC):** ARCENT/CFLCC Flight Regulations and Aviation Standardization Program (April 11, 2006)
- **Joint Chiefs of Staff:** *"Universal Joint Task List (UJTL)"* (January 12, 2024)
- **AFSOC Project:** *"HB2000 Heli-Basket Operational Utility Evaluation"* (June 2006)
- **Air Force Research Laboratory:** *"Evaluation of a Helicopter Rescue Basket for Safe Human Carriage"* John A. Plaga (August 2, 2006)
- **U.S. Army Natick Soldier Research, Development and Engineering Center Aerial Delivery Engineering Support Team:** *"Final Report: Foreign Comparative Testing S.P.I.E.S vs. Heli-Basket® vs. AirTEP (Unclassified)"* (February 25th, 2011)
- **Acquisition Directorate, U.S. Coast Guard:** *"Maritime Mass Rescue Interventions; Availability and Associated Technology"* (December 2010)

NEW JERSEY ARMY NATIONAL GUARD
1/150th GENERAL SUPPORT AVIATION BATTALION
TRENTON-MERCER AIRPORT, 152 SCOTCH ROAD
WEST TRENTON, NJ 08628-1389

3 August 2003

MEMORANDUM FOR Precision Lift Inc., 4765 Hwy 89, Monarch, MT 59463

SUBJECT: 1/150th General Support Aviation Battalion (GSAB) Heli-Basket After Action Review

1. A Detachment from the 1/150th GSAB deployed to Panama in support of a New Horizons Exercise from January through May 2003. Although the primary mission was 24 hour Casualty Evacuation, the UH-60 Blackhawk flight crews of the GSAB also provided medium lift support to the New Horizons Task Force Commander. Precision Lift's Heli-Basket proved to be an indispensable asset in the execution of the lift missions. I strongly recommend all future Aviation support given to New Horizons include at least one Heli-Basket.

2. The New Horizons mission was comprised of six two week rotations. During the second and forth rotations Medical Readiness Training Exercises (MEDRETE) were conducted. At four different remote villages doctors, nurses and other health care providers treated thousands of host nation patients. Due to the remote nature of these villages most of the MEDRETE supplies had to be transported via helicopter.

3. The relatively short duration of the rotations increased the need for expedient delivery of the MEDERETE supplies. The Heli-Basket proved to be a vital tool in successfully executing the Task Force Commander's mission taskings.

4. The nature of the Heli-Basket reclassified the external loads, thereby relieving the ground unit of having to certify sling sets. This is significant when analyzed in conjunction with the time constraints present during most field problems. Ground units habitually fail to train their people in Air Assault, Path Finder and Sling Load Inspector courses. This creates a conflict when these units request lift support requiring external loads. Bottom-line, the Heli-basket removed the constant challenge of getting the required support from the ground unit to certify the sling loads.

4. The 1/150th Detachment deployed to Panama with one Heli-Basket hoping that the Air Worthiness Release (AWR) regarding its use would be approved during the deployment. While only in-country for nine days, the Detachment received an official tasking to support a U.S. State Department mission near the Colombian border. A group of Right-wing guerrillas attacked a Panamanian border village causing the villagers to flee to a neighboring town. The more than 500 refugees forced the Panamanian Government to declare a state of emergency and ask for U.S. assistance.

5. Two of the 1/150th Blackhawks flew to the site and began "daisy chaining" more than 16,000 pounds of food and medial relief supplies into the village. Without an approved AWR for the Heli-Basket we were unable to use it to execute the mission. We were forced to internally load all of the relief supplies as well as rig an external load of four 2 ½ ton truck tires. The time spent rigging the external load notably slowed our initial response time. More importantly, we could only travel at 80 KIAS with the external load of tires. This greatly increased our overall travel time to the village. Also, while at the forward refueling point the sling-set rig of tires became tangled which caused an additional delay and greater loiter time on the ground.

6. The Heli-Basket would have allowed us to quickly load-up the truck tires upon notification of the mission. In addition, the Heli-Basket would have enabled us to fly an indicated airspeed of 110 knots with the external load of tires secured within the basket. This would have greatly reduced our overall travel time. There is no doubt that the Heli-basket would have facilitated our execution of the mission.

SUBJECT: 1/150th General Support Aviation Battalion (GSAB) Heli-Basket After Action Review

7. The AWR was approved a month after the above mentioned mission. Thereafter, we were able to utilize the Heli-Basket in order to provide lift support to the Task Force MEDRETE and Engineer personnel. Overall we moved approximately 20,000 pounds of supplies from the Task Force Basecamp to the remote work sites using the Heli-Basket. Whether moving medical supplies or Engineer equipment, the Heli-Basket proved to be a relevant, reliable and a durable tool throughout the New Horizons Exercise. So much so that we have added this device to our UH-60 mission packing list to be included on all future deployments.

8. Chris Croff and John Tollenaere asked if we could include a list of ideas that we thought would enhance this device. The following list represents the input from several of the end-users who utilized the Heli-Basket in Panama:

a) The ground units experienced great difficulty getting their equipment off of the Heli-Basket at the remote work sites. Because of the inaccessibility of the sites, no forklifts or HUMMV's were available to pull the various boxes and equipment out of the basket. If rollers could be added to the existing floor and gate as an add-on device it would allow for both easy off and on-load. Perhaps the rollers could clip on or be pinned to the floor so they could be removed if not needed for a particular load.

b) Several of the forklift drivers trying to load the basket at the Basecamp were inexperienced. With only one basket in-country we were concerned about possible damage during the load-up process. If you had pre-fabricated pallets specially designed for your basket's dimensions it would allow the ground unit to load it and then drive it into the basket, maximizing available cubic footage. These pallets could be designed with holes along the bottom for the forks so to expedite the loading process similar to ISU-90 containers.

g) When the gate is dropped in order to load cargo it may be advantageous to enable the user to remove the gate with sturdy quick disconnects. The gate could then be removed during loading and allow the forklift driver to place the load deeper into the basket.

c) Olive drab, tan and black color options would be ideal for tactical field environments.

d) We used cargo tie-down straps to secure most of our loads. When the basket was full we had a difficult time hooking the straps to the basket. Secured "D" ring fittings placed around the basket interior at the structural strong points would make securing the cargo strap hooks easier. Similar to a UH-60 cargo area, the more tie-down rings the better.

e) The joints that have cotter pins could be improved. These pins all require inspection and taping prior to each load. If an improved quick release pin (similar to locking devices for arming racks) could be installed perhaps it would remove the need to tape all of the cotter pin connections prior to each load.

f) Following extended usage we see the potential for the plastic netting (ceiling) on the top of the basket to tear. Would it be possible to configure the basket so to remove the netting if it was not needed?

9. We appreciate the opportunity to provide you feedback on your fabulous product. We look forward to using our Heli-Baskets during our scheduled rotation in Kosovo in January 2005. I commend you on your invaluable product as well as on the professionalism and dedication of your employees. It has been a pleasure working with your firm and I look forward to continuing the interaction between our two organizations as we move ahead.

JOSEPH E. ROUGHNEEN
CPT, AV, NJARNG
Detachment Commander / S-1

DEPARTMENT OF THE ARMY
Office of the Deputy Chief of Staff, G-3/5/7
400 Army Pentagon
Washington, DC 20310-0400

REPLY TO
ATTENTION OF:

DAMO-AV

JAN 25 2008

MEMORANDUM THRU

COMMANDER, ARMY MATERIEL COMMAND, FORT BELVOIR, VA 22060
COMMANDER, U.S. ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND, ABERDEEN PROVING GROUNDS, MD 21005

FOR U.S. ARMY NATICK SOLDIER RESEARCH, DEVELOPMENT AND ENGINEERING CENTER (NSRDEC), (AMSRD-NSN-WP-D DIRECTOR, WARPADD), NATICK, MA 01760-5017

SUBJECT: Testing for Helibasket HB2000 to Allow National Guard Aviation Units to Move Personnel during Emergency Evacuations

1. References.

a. Memorandum, NGB-AVS, 4 Dec 07, subject: NGB Endorsement of the Kentucky Request for Approval to Conduct Personnel Recovery/Rescue (PRR) Operations and Training Utilizing the HB2000 Helibasket with H-60 and H-47 Helicopters.

b. Letter from Senator Lindsey Graham to BG Mundt, Director of Army Aviation, 24 Sep 07, subject: Request for Update on Live Load Certification for the Helibasket.

c. Memorandum, AMSSB-RAD-AD, 30 May 03, subject: Helicopter Slingload Certification HB2000 Helibasket System.

d. Telephone Conference between HQDA G-3/5/7 Aviation Directorate, NSRDEC, and National Guard Aviation Safety, 28 Nov 07, subject: Initial Test Coordination.

2. Request that the Natick Soldier Center conduct additional testing on the Helibasket HB2000 to determine if the basket is safe and effective for the emergency movement of personnel during emergency evacuations. Your previous testing in 2003 validated that this basket was safe for cargo slingload operations. We understand that your test team is now determining the necessary test procedures, based on the Nov 07 telephone conference between the NSRDEC, the Aviation Directorate, and the National Guard Bureau to accomplish this testing. Request that you use the procedures that the National Guard has developed in the enclosed memorandum as the baseline for the test.

DAMO-AV
SUBJECT: Testing for Helibasket HB2000 to allow National Guard Aviation Units to Move Personnel during Emergency Evacuations

3. The goal is to have approved procedures published in sufficient time for the National Guard to conduct live-load training prior to the height of the hurricane season. The National Guard is prepared to provide helicopters and aircrews in support of this testing this spring. Further, the National Guard has agreed to provide necessary funding to complete the tests.

4. The HQDA G-3/5/7 POC for this testing is LTC Howard Arey, HQDA G-3/5/7 Aviation Directorate, at comm: (703) 693-3572, or email: howard.arey@hqda.army.mil.

JAMES D. THURMAN
Lieutenant General, GS
Deputy Chief of Staff, G-3/5/7

Encl
- National Guard request and draft basket procedures

CF:
Director of Army Aviation
National Guard Bureau (NGB-AVS)

2

ARCENT/CFLCC (US Army) Regulation 95-1
ARCENT/CFLCC (USAF) Pamphlet 11-202(I)
ARCENT/CFLCC (USN) Instruction 3710.7A

United States Army Forces Central Command (USARCENT) (ARCENT)
Coalition Forces Land Component Command (CFLCC)

Interservice Publication (IP):
Aviation

ARCENT/CFLCC Flight Regulations and Aviation Standardization Program

Headquarters
United States Army Forces Central Command
Coalition Forces Land Component Command
Camp Arifjan, Kuwait
APO AE 09306
11 April 2006

UNCLASSIFIED

d. The CG, ARCENT/CFLCC (ATTN: CFLCC C-3 AVN), Camp Arifjan, Kuwait, APO AE 09306 shall be informed of any FEB resulting in adverse personnel actions conducted IAW this paragraph (reference AR 600-105).

4-11. Synthetic Flight Training System (SFTS) requirements. *UAS simulator training requirements are delineated in AR 95-23, para. 4-11. SFTS requirements for conventional aircraft aircrews are IAW this paragraph; AFI 11-202V3, para. 5.13; and OPNAVINST 3710.7, para. 11.6, and appendix K.*

a. Active and RC rotary-wing aviators must use the SFTS for their primary aircraft.

b. Annual training requirements are outlined in the appropriate ATM/*Flight Manual*.

c. SFTS requirements may be prorated per the TC 1-210/*AFI 11-202V2*.

d. For aviators whose primary aircraft does not have a compatible simulator (see table 4-1), annual SFTS requirements will be determined by the commander. A maximum of six hours semiannually may be credited toward rotary-wing aviators flying hour minimums in a non-compatible SFTS device. Helicopter SFTS simulators are listed in table 4-1.

Table 4-1
Synthetic flight training system

Designation	Compatible Aircraft
UH-1 Instrument Flight Trainer, SFTS device 2B24	UH-1
CH-47 Operational Flight Trainer, SFTS device 2B31	CH-47
UH-60 Operational Flight Trainer, SFTS device 2B38	UH-60
AH-64 Combat mission simulator, SFTS Device 2B40	AH-64
AH-64 Cockpit Weapon Emergency Procedures Trainer (CWEPT)	AH-64
AH-64D Longbow Crew Trainer (LCT) SFTS Device 2B64	AH-64D
Aviation Combined Arms Tactical Trainer (AVCATT)	None. Commanders may authorize a maximum of six hours semiannually to be credited toward rotary-wing aviators flying hour minimums per configuration of the device (AH-64A, AH-64D, UH-60, OH-58D, CH-47).

e. Fixed-wing aviators (primary aircraft) may receive up to six flight hours credit toward ATM requirements utilizing a compatible simulator. DES, in coordination with OSAC and USARC, will publish and maintain a current list of compatible fixed-wing simulators that meet this requirement.

4-11.1 Heli-Basket™ operations.

a. References to Heli-Baskets in this regulation are specific to those personnel extraction apparatuses designed and manufactured by Precision Lift, Inc., and those like devices that have been certified for Personnel Recovery (PR)/Rescue operations for contingency and/or humanitarian relief operations. This does not include stokes litters and the related family of medical/air ambulance extraction devices. This paragraph does not apply to the use of Heli-Baskets for cargo carrying operations.

b. Heli-Basket operations for PR/Rescue may only be performed by those organizations that:

(1) Have developed an SOP for the operation of the device;

(a) SOPs developed for the use of the Heli-Basket for PR/Rescue shall clearly delineate the specific methods of communication between service members in the device, and crewmembers on board the aircraft;

(b) mission abort/jettison criteria/jettison procedures for the device;

(c) specific mission, crew, and passenger briefing instructions/criteria (see paragraph 2-7); and

(d) have a copy of a DoD- or Service-issued Air Worthiness Release (AWR) for the device on file, and posted to the aircraft logbook.

(2) have developed 3000-series tasks that clearly denote the tasks, conditions, and standards for the use of the device; and

(3) are performing training or actual emergency missions with the device.

c. Any use of the Heli-Basket that involves transporting personnel (service members or otherwise) shall be automatically assessed as Extremely High Risk (EHR); and, each such mission shall only be approved IAW paragraph 2-14 above. When using the electric long line, transport of personnel is not authorized.

Note: *This approval may be telephonic, via facsimile (fax) or other electronic means, or in-person, but may not be waived or delegated.*

d. Joy rides and morale flights are specifically prohibited with the Heli-Basket, and operations with the device shall be limited to:

(1) Those training flights required to satisfy the requirements of the DA Form 7120 (Commander's Task List [CTL]) for those crewmembers involved; and

(2) actual emergencies, involving a risk of life, limb or sight.

e. Training for Heli-Basket operations should entail the use of other jettisonable slingload training devices to the greatest extent possible, and use of the Heli-Basket itself (with personnel) limited to that deemed essential to attaining and maintaining currency with the 3000-series tasks denoted on the CTL.

f. Use of the Heli-Basket shall be considered a "last resort", and exercised only after all other options have been exhausted for personnel extraction (for instance, selection of another Landing Zone (LZ)/Pickup Zone (PZ) for landing of the aircraft), or when the need to extract multiple personnel simultaneously is necessary due to exigent circumstances.

g. Personnel insertion missions are not authorized using the Heli-Basket as a matter of convenience. There must be a valid operational requirement to insert personnel or equipment to an emergency scene (e.g. insert medical/rescue personnel and equipment to the scene of a natural disaster where a helicopter cannot land).

4-12. Civilian flight time for Reserve Component (RC) aviators. Civilian flight time or tasks may be credited toward the ATM requirements of RC aviators at the commander's discretion.

a. Tasks performed in Army aircraft by civilians will be credited toward applicable ATM requirements.

b. Commanders may give credit for tasks performed in civilian aircraft if the tasks are similar in all respects to the ATM task requirements.

c. Flight time acquired in Army aircraft by RC aviators while employed by the Government, or flight time acquired in civilian aircraft will not be used as the following:

(1) Training instead of Unit Training Assemblies (UTAs);

(2) Additional Flight Training Periods (AFTPs); or

(3) entitlement to Aviation Career Incentive Pay (ACIP), total operational flying duty credit, or retirement points.

4-13. Additional Flight Training Periods (AFTPs).

a. The AFTP program allocates AFTPs for RC aircrews and Flight Surgeons to reach and maintain required levels of proficiency. All RC aviators, Flight Surgeons, and non-rated crewmembers in aviation service may take part in the AFTP program. The program will be per AR 140-1 (Army Reserve, Mission, Organization, and Training).

Universal Joint Task List

> *"The Universal Joint Task List (UJTL) is the authoritative menu (or library) of all approved joint tasks required for planning, readiness reporting, training and exercises, lessons learned processing, and requirements…*
>
> *…The UJTL Program serves as a foundation for joint planning, readiness reporting, joint training, joint capabilities-based planning, education, joint force development, and joint operations…*
>
> *…Each individual UJT in the UJTL is an action or activity assigned to a unit or organization to perform a specific function and/or* ***to provide a capability or resource****."*

The UJTL contains tasks mentioning *"Search and Rescue"*, *"Disaster Relief"*, *"Evacuation"* and *"Humanitarian Assistance"* in dozens of instances. It is clear that these issues are of concern to all branches of the United States Armed Forces, as well as the international bodies that utilize the UJTL as a blueprint for their task lists.

The Heli-Basket's® capacity to perform Short-Haul Multi-Person Rescue operations provides an additional **capability and resource** to complete many of the tasks listed in the UJTL.

The following are some examples of tasks for which the Heli-Basket® can provide an additional capability for completion:

SN 3.4.9 Manage Personnel Recovery (PR)

Priority: Routine

Approval Date: 24-Aug-2023

Description: Provide personnel recovery (PR) capability across the competition continuum.

TA 5.8 Support National Special Security Event (NSSE)/Special Event

Priority: Routine

Approval Date: 16-Jun-2021

Description: Provide Department of Defense (DOD) resources in support of the primary federal agency's conduct of events that may be the target of terrorism or other criminal activity.

OP 6.2.6 Conduct a Noncombatant Evacuation Operation (NEO)

Priority: Routine

Approval Date: 30-Jun-2022

Description: Evacuate noncombatants from a threatened area abroad to safe havens or to the United States.

ST 8.2.3 Coordinate Foreign Humanitarian Assistance (FHA)

Priority: Routine

Approval Date: 19-Jul-2021

Description: Anticipate and respond to requests for foreign humanitarian assistance (FHA).

OP 8.5.5 Coordinate Search and Rescue (SAR)

Priority: Routine

Approval Date: 24-Aug-2023

Description: Coordinate search and rescue (SAR) assets for a broad range of SAR operations.

AFSOC PROJECT 2005-063

HB2000 HELI-BASKET OPERATIONAL UTILITY EVALUATION (OUE)

FINAL REPORT

JUNE 2006

AIR NATIONAL GUARD AIR FORCE RESERVE COMMAND
TEST CENTER
1600 EAST SUPER SABRE DRIVE, BUILDING 10
TUCSON, ARIZONA 85706-6081

Prepared by: BRADLEY B. SEXTON, Lieutenant Colonel, USAF
Project Manager

Reviewed by: RONALD M. MOORE, GS-14
Director of Test

Approved by: JOHN E. MOONEY, JR., Colonel, USAF
Commander

SYSTEM DESCRIPTION

The HB2000 Heli-Basket System is a helicopter sling-loaded cargo or personnel basket capable of carrying 4,500 pounds of cargo or 15 seated people. The metal basket is attached to a 120-foot-long cable underneath the aircraft, and measures 8.5 feet long by 4.5 feet wide by 3.25 feet high. The manufacturer, Precision Lift, Inc., promotes the Heli-Basket for a variety of uses including personnel rescue and resupply disaster relief. The device can be used as a rescue tool for mass personnel recovery where the need is extremely urgent, the helicopter is unable to land, or a rescue hoist recovery too time-consuming. The Heli-Basket's rigid metal frame provides protection for critical cargo from cargo net compression and the ability to place aerodynamically unstable items inside the basket. A photograph of the Heli-Basket is at **Figure 1**.

Figure 1. Heli-Basket.

EXECUTIVE SUMMARY

1. PURPOSE AND BACKGROUND. The Air National Guard Air Force Reserve Command Test Center (AATC) conducted this operational utility evaluation (OUE) to determine if the Precision Airlift, Inc., HB2000 Heli-Basket can be certified for human carriage. This Congressionally-mandated equipment was bought for both the Army National Guard (ARNG) and Air National Guard (ANG). The United States Army Soldier Systems Center (Natick Laboratories) accomplished extensive structural and flight testing resulting in certification of the Heli-Basket for cargo carriage. ANG rescue wings have identified a Homeland Defense requirement to provide short-range "water rescue" and "high-rise building" emergency human carriage capability using the Heli-Basket. This OUE was conducted at, and supported by, the 106th Rescue Wing (RQW), Francis Stanley (F.S.) Gabreski Air Guard Station (AGS), Suffolk County (CO) Airport, New York, from January through March 2006.

2. RESULTS AND CONCLUSIONS. The HB2000 Heli-Basket is satisfactory for human carriage certification. This test addressed two critical operational issues (COI):

a. COI-1. Is it operationally safe to use the Heli-Basket for human carriage? **Resolved satisfactory**. The Heli-Basket strength and flight stability were previously tested and certified by the U.S. Army's Natick Laboratories. During Phase I of this test, instrumented manikins were flown at various altitudes from sea level to 9,000 feet and airspeeds from hover to 100 knots indicated airspeed (KIAS). The basket was landed with the manikins aboard in various configurations of weight, with or without floats, on both grass and pavement. The instrumented manikin force data were then analyzed by computer physiological modeling. These data indicated humans would not sustain bodily harm or injuries in any of the flight regimes tested. Phase II sorties carried one pararescue man and two volunteer passengers at increasing airspeeds from hover to 40 KIAS and altitudes from sea level to 500 feet. At no time did any Heli-Basket occupant experience any problems or become uncomfortable.

b. COI-2. Are there any additional operational procedures not previously identified during U.S. Army testing? **Resolved satisfactory**. No differences in flight stability or strength from the Army's testing were observed. However, the Army was simply certifying for cargo carriage and did not accomplish everything the ANG requires for human carriage. One of the additional items for carrying people is a redundant safety device called the heli-strap which will catch the basket if it were inadvertently released from the cargo hook. While Natick Laboratories tested the strength of the heli-strap, it was not required to be used for cargo flights. ANG aircrews qualitatively assessed the redundant safety features of the heli-strap and their ability to intentionally jettison the load with it attached and foresaw no problems.

Additional testing and inspection criteria were also necessary for maintaining personnel safety and rescue equipment. The Heli-Basket will need to be included in Technical Order (TO) 00-25-245, *Testing and Inspection Procedures for Personnel Safety and Rescue Equipment*.

3. RECOMMENDATION. AATC recommends the HB2000 Heli-Basket be certified for human carriage of seated personnel in the configuration tested (120-foot line), included in TO 00-25-245, AFI 11-2HH-60V3, HH-60 *Operations Procedures,* AFTTP 3-3.24, *Combat Aircraft Fundamentals* –HH60G and added to the HH-60G list of approved equipment.

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ABBREVIATIONS, ACRONYMS, AND DEFINITIONS

AATC	Air National Guard Air Force Reserve Command Test Center
ADAM	Advanced Dynamic Anthropomorphic Manikin
AFB	Air Force base
AFI	Air Force instruction
AFRL	Air Force Research Laboratory
AFSOC	Air Force Special Operations Command
AGS	air guard station
ANG	Air National Guard
ARNG	Army National Guard
COI	critical operational issue
F.S.	Francis Stanley
HSL	helicopter sling load
KIAS	knots indicated airspeed
LOIS	Lightest Occupant in Service
NGREA	National Guard and Reserve Equipment Account
OGE	out of ground effect
OUE	operational utility evaluation
PJ	pararescue jumper
RQS	rescue squadron
RQW	rescue wing
TO	technical order
TS	test squadron

SECTION I – PURPOSE AND BACKGROUND

1.0 PURPOSE. The Air National Guard Air Force Reserve Command Test Center (AATC) conducted this operational utility evaluation (OUE) to determine if the Precision Airlift, Inc., HB2000 Heli-Basket can be certified for human carriage. This Congressionally-mandated equipment was bought for both the Army National Guard (ARNG) and Air National Guard (ANG). Distribution of the approximately 100 units was completed in 2001. The United States (US) Army Soldier Systems Center (Natick Laboratories) completed extensive structural and flight testing in 2003, resulting in certification of the Heli-Basket for cargo carriage. ANG rescue wings have stated a Homeland Defense requirement to provide short-range "water rescue" and "high-rise building" emergency human carriage capability using the Heli-Basket. This OUE was conducted at, and supported by, the 106th Rescue Wing (RQW), Francis Stanley (FS) Gabreski Air Guard Station (AGS), Suffolk County (CO) Airport, New York, from January through March 2006.

1.1 AUTHORIZING DIRECTIVE. The authority for this test was Air Force Special Operations Command (AFSOC) project order 2005-063, 3 August 2005.

1.2 BACKGROUND. Helicopters utilize a number of personnel rescue devices, such as the Stokes litter or forest penetrator, to retrieve people from areas where a landing is unsuitable, such as recoveries from marsh, water, or high-rise buildings. These devices are limited in the number of people that can be extracted at one time and, therefore, increase the amount of time necessary to carry the maximum load the helicopter has available. The Heli-Basket is intended as a quick entry device for up to 15 people that can be carried to a triage area, suitable landing site, or down to ground-level from a tall building. This Congressionally-mandated equipment was bought for both the ARNG and ANG through National Guard and Reserve Equipment Account (NGREA) appropriations. The United States Army Soldier Systems Center (Natick Laboratories) did extensive structural and flight testing and certified the Heli-Basket for cargo carriage (*Helicopter Sling Load [HSL] Certification HB2000 Heli-Basket System*, 30 May 2003). The ANG Requirements Office requested AATC evaluate the Heli-Basket for live carriage (*AATC Support to Assess Feasibility of Heli-Basket for Human Carriage*, 7 July 2005). This OUE was approved by Air Force Special Operations Command (AFSOC) and assigned a project number without a ranked priority (*TEST ORDER, Operational Utility Evaluation [OUE] of the HB2000 Heli-Basket*, AFSOC Project 2005-063, 3 August 2005).

1.3 TEST TEAM, LOCATION, AND DATES. A test team made up of members from the 106 RQW, F.S. Gabreski AGS, Long Island, New York; the 746th Test Squadron (TS), Holloman AFB, New Mexico, which normally does ejection seat sled testing; the Air Force Research Laboratory (AFRL) Human Effectiveness Directorate, Wright-Patterson AFB, Ohio; Headquarters AFSOC; Headquarters ANG; and AATC conducted this OUE. Test team members are listed in **Table 1-1**. Testing of the HB2000 Heli-Basket was conducted in two phases: Phase I - data gathering by instrumented manikins, F.S. Gabreski AGS, Long Island, New York, 9-13 January 2006, followed by computer physiological modeling at AFRL, Wright-Patterson AFB, Ohio; and Phase II - carrying personnel, F.S. Gabreski AGS, Long Island, New York, 27 February-2 March 2006.

Table 1-1. Test Team Personnel.

NAME	TITLE/FUNCTION	ORGANIZATION	EMAIL ADDRESS	DSN
Lt Col Sexton	Project Manager	AATC/DOM	bradley.sexton@aztucs.ang.af.mil	844-6921
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Mrs. Baker	Project Officer	746 TS/TGGIT	susan.baker@46tg.af.mil	349-1368
Mr. Gros	Project Officer	746 TS/TGGIT	timothy.gros@46tg.af.mil	349-1368
Mr. Hill	Project Officer	746 TS/TGGIT	robert.hill@46tg.af.mil	349-1368
Mr. Plaga	Project Officer	AFRL/HEPA	john.plaga@wpafb.af.mil	785-1166
Maj Finerty	Project Officer	ANG/A5R	christopher.finerty@ngb.ang.af.mil	372-3512
Mr. Massey	Project Specialist	AATC/Advancia Corporation	robert.massey.ctr@aztucs.ang.af.mil	844-6911

1.4 CLASSIFICATION STATEMENT. This test was UNCLASSIFIED and the documentation contains no classified information. The Heli-Basket is intended for peacetime operations.

1.5 RELEASE OF INFORMATION. Requests for release of information to contractors or other government agencies must be through the Defense Technical Information Center and be approved by AFSOC/A5. Authority to release to the news media or general public any information regarding this project rests with the AATC Commander as coordinated with National Guard Bureau/PA and AFSOC/PA.

SECTION II – OUE DESCRIPTION

2.0 SCOPE AND METHOD. The Heli-Basket was tested in two phases. Phase I used only instrumented manikins which recorded accelerations at various speeds up to the 100 knots indicated airspeed (KIAS) maximum certified for a fully loaded Heli-Basket during Army testing by Natick Laboratories. Following test data collection, AFRL ran the data through its physiological models and certified that a human would not have been injured under the same conditions. Phase II sorties carried one pararescue jumper (PJ) and two volunteer passengers at increasing airspeeds from hover until reaching 40 KIAS. At no time did any PJ or selected volunteer become uncomfortable with the Heli-Basket deck angle or any other factor not previously detected by the manikins. **Table 2-1** is a test summation matrix.

Table 2-1. Test Summation Matrix.

TEST		DESCRIPTION	COI
MISSION	SORTIES		
Phase I	4	Flight profiles up to maximum speed (100 KIAS) certified for the Heli-Basket	1, 2
Phase II	4	Flight profiles up to 40 KIAS or PJs become uncomfortable with Heli-Basket deck angle	1, 2
TOTAL	**8**		

2.1 PLANNING CONSIDERATIONS AND LIMITING FACTORS.

2.1.1 Planning Considerations:

a. Army testing and ARNG use has shown the Heli-Basket to be a very stable platform at all speeds. The Army National Guard presently uses the Heli-Basket routinely in cargo carriage operations. The ANG has accepted the Natick Lab certifications (*HSL Certification HB2000 Heli-Basket System*, 30 May 2003) of the basket using the 120-foot long line to 100 KIAS when fully loaded to 4,500 pounds, and to 120 KIAS when empty. The Heli-Basket successfully completed Army testing of the ultimate strength of the basket, long line, and heli-strap previously.

b. When used for live carriage, an additional safety device called the heli-strap is necessary to prevent inadvertent release of the Heli-Basket. Normal sling load operations allow jettison of the load with the push of a single button, either the emergency jettison (**Figure 2-1**) or the normal release switch (**Figure 2-2**). The heli-strap provides redundant safety, preventing accidental jettisoning from a single system failure and allows the basket to be safely lowered to the ground. This device must be manually released (**Figures 2-3** and **2-4**) prior to intentionally jettisoning the Heli-Basket.

WARNING: DO NOT USE THE ELECTRIC LONG LINE WITH LIVE CARRIAGE IN THE HELI-BASKET. The electric long line will bypass the redundant safety added by using the heli-strap.

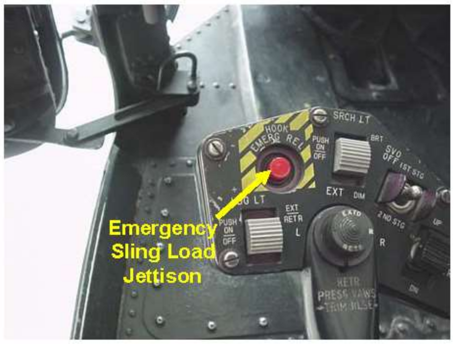

Figure 2-1. Emergency Sling Load Jettison.

Figure 2-2. Normal Sling Load Release.

Figure 2-3. Heli-Strap Bottom View.

Figure 2-4. Heli-Strap Top View with Manual Release.

2.1.2 <u>Limiting Factors</u>. During Phase II, the wind chill factor could have become a limiting condition when flying personnel. Research shows all available wind chill charts are for exposed skin. The test personnel who flew in the basket were wearing appropriate winter clothing and, therefore did not directly expose their skin to the wind. The personnel in the basket were in constant communication with the helicopter flight crew.

SECTION III – RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

3.0 SUMMARY. The HB2000 Heli-Basket is suitable for certification for human carriage.

3.1 COI-1. Is it operationally safe to use the Heli-Basket for human carriage? **Resolved satisfactory**. The Heli-Basket strength and flight stability were previously shown and certified by the Army's Natick Laboratories. During Phase I of this test, instrumented manikins were flown at various altitudes from sea level to 9,000 feet and airspeeds from hover to 100 KIAS. The basket was landed with the manikins aboard in various configurations of weight, with or without floats, on both grass and pavement. The instrumented manikin force data were then analyzed by computer physiological modeling. These data indicated humans would not have sustain bodily harm or injuries in any of the flight regimes tested. Phase II followed, carrying one pararescue man and two volunteer passengers per flight at incrementally increasing airspeeds from hover to 40 KIAS. At no time did any Heli-Basket occupant experience any problems or become uncomfortable with the flights.

3.1.1 Method. This test was conducted in two phases. Prior to starting the test, AATC funded one of the original Army National Guard Heli-Basket test pilots to conduct spin up training for the 106 RQW flight crews. During the test, the Heli-Basket was flown in the exact same configurations previously certified by Army's Natick Laboratories and practiced during spin up training. That configuration was the basket with the 120 foot long line. The long line was the only real difference for the ANG crews between carrying the Heli-Basket and any other sling load operation. All sling load guidance and out of ground effect (OGE) power margins stated in Air Force Instruction (AFI) 11-2HH60V3 were observed at all times. During Phase I, the Heli-Basket was flown with two instrumented manikins collecting force data. One manikin, LOIS (Lightest Occupant in Service), represented a small passenger while the second manikin, ADAM (Advanced Dynamic Anthropomorphic Manikin), represented a large passenger. Data were collected in flight up to the maximum 100 KIAS when fully loaded. The manikins were also used to measure forces in a series of liftoff and set downs from both hard and soft surfaces. One aircraft was flown on four sorties totaling 2.9 flying hours to fulfill this requirement. The Air Force Research Laboratory Human Effectiveness Directorate used that data in its physiological computer modeling and certified there was a very low probability of any injuries. As the Heli-Basket increases speed its deck angle in relation to the horizontal increases. Phase II carried people starting at hover and increased airspeed incrementally to 40 KIAS to ensure the deck angle never reached a point that would be uncomfortable to the occupants. Pararescue men and passengers were encouraged to make comments on anything not detected by the manikins. One aircraft was flown on a single 1.5 hour sortie that included lifts of three separate groups of personnel in the Heli-Basket. All flights for both Phases I and 2 were flown from the 106 RQW home airfield of F.S. Gabreski AGS. The flight area was free of significant high obstructions and had close access to a divided highway or the airfield where the basket could be put down quickly if necessary (**Figure 3-1**).

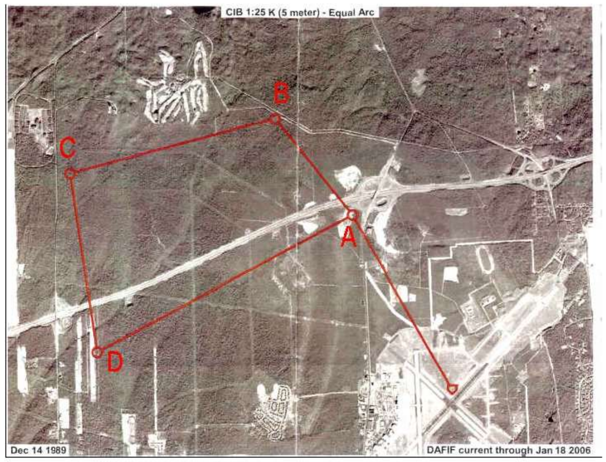

Figure 3-1. F.S. Gabreski AGS Test Area.

3.1.2 Results and Conclusions.

3.1.2.1 MOE 1-1. Manikin Injury Analysis.

3.1.2.1.1 MOP 1-1-1. Manikin Acceleration Analysis. **Evaluation criterion:** Physiological computer models run with the force data gathered during manikin testing must show a human would not have been injured before that speed can be tested with personnel. **Met criterion.** Data collected during Phase I included manikin chest accelerations and rotational rates, Heli-Basket Euler angles and velocities, and video documentation. Physiological computer models using the data gathered during manikin (**Figure 3-2**) testing showed a human would have a very low probability of being injured. [For additional information see *Data and Analysis Report for THE HELI-BASKET*, February 2006, Biomedical Branch Human Effectiveness Directorate Air Force Research Laboratory, Wright-Patterson AFB OH.]

Figure 3-2. LOIS & ADAM Manikins.

3-2

3.1.2.2 MOE 1-2. Human Flight Analysis.

3.1.2.2.1 MOP 1-2-1. PJs' assessment of in-flight forces. **Evaluation Criterion:** Qualitative assessment of in-flight forces felt while flying in the basket. The test began at very slow speeds and became progressively faster until reaching 40 KIAS or a speed at which the PJs thought was appropriate, whichever was less. **Met Criterion.** Each pararescue man and volunteer passenger qualitatively assessed in-flight forces felt while flying in the basket and reported no problems as the speed was progressively increased from hover (**Figure 3-3**) to 40 KIAS.

Figure 3-3. Heli-Basket Zero Airspeed.

3.1.2.2.2 MOP 1-2-2. PJs' assessment of in-flight Heli-Basket deck angle. **Evaluation Criterion:** Qualitative assessment of Heli-Basket deck angle while flying in the basket. The test began at very slow speeds and became progressively faster until reaching 40 KIAS or a speed at which the PJs assessed the deck angle had reached the limit of what should be flown with untrained passengers. **Met Criterion.** Each pararescue man and volunteer passenger qualitatively assessed the Heli-Basket deck angle while flying in the basket as the speed progressed from the hover until reaching 40 KIAS (**Figure 3-4**) and reported no problems.

Figure 3-4. Heli-Basket 40 KIAS.

3.1.3 Recommendations.

a. Certify the Heli-Basket for live carriage.

b. Include the Heli-Basket in the list of approved HH-60G equipment.

c. Add the Heli-Basket maintenance and inspection criteria to TO 00-25-245.

3.2 COI-2. Are there any additional operational procedures not previously identified during Army testing? **Resolved satisfactory**. No differences in flight stability or strength from the Army's testing were observed. However, the Army was simply certifying for cargo carriage and did not accomplish everything required for human carriage. One of the additional items for carrying people is a redundant safety device called the heli-strap which will catch the basket if it were inadvertently released from the cargo hook. While Natick Laboratories tested the strength of the heli-strap, it was not required to be used for cargo flights. ANG aircrews qualitatively assessed the redundant safety features of the heli-strap and their ability to intentionally jettison the load with it attached and foresaw no problems. Additional testing and inspection criteria were also necessary for maintaining personnel safety and rescue equipment. The Heli-Basket will need to be included in Technical Order (TO) 00-25-245, *Testing and Inspection Procedures for Personnel Safety and Rescue Equipment.*

3.2.1 Results and Conclusions.

3.2.1.1 MOE 2-1. Flight Crew's Assessment of Heli-Basket Emergency Release.

3.2.1.2 MOP 2-1-1. Flight crew's qualitative assessments of Heli-Basket jettison. **Evaluation criterion:** Qualitative assessments by the flight crew of jettison procedures with the heli-strap connected. No actual release was planned nor was any expendable asset available for test release. **Met Criterion.** Each crew was asked to evaluate the jettison procedures with the heli-strap connected. The pilot's normal release on the cyclic was disabled by leaving the arming switch on the cargo hook control panel in the safe position (**Figure 3-5**) to decrease the chances of inadvertent release. An intentional jettison (if necessary) would be performed by the flight engineer pulling the manual release on the heli-strap and then manually releasing the sling load hook. Any problems with the manual release of the hook would lead to the flight engineer arming the normal sling load release for the pilots or the use of the emergency sling load jettison switch. No actual release was planned or performed for this test. An analysis of floor loading caused by the heli-strap was performed by Sikorsky. The analysis concluded that any time the heli-strap caught more than 822 pounds, some minor damage to the helicopter floor at the outside edges by the door guides would occur. The probability of the heli-strap actually being required to catch an inadvertent release is extremely unlikely. Precision Lift, Inc., attended the Heli-Basket testing as a technical advisor and was advised of the Sikorsky analysis of the HH-60G floor strength and potential damage in the extremely unlikely event a heli-strap were required to catch an inadvertent release of the Heli-Basket. The company intends to develop an inexpensive bracket which would spread the load along the edge of the helicopter floor over a wider area and prevent any damage. Although the use of the heli-strap would be a very rare occurrence, consideration should be given to procuring this bracket when it becomes available.

Figure 3-5. Cargo Hook Control Panel.

3.2.1.3 MOE 2-2. Flight Characteristics.

3.2.1.4 MOP 2-2-1. Flight crew and PJs qualitative assessments of any anomalies noted. **Evaluation Criterion:** Qualitative assessments by the flight crew of any anomalies noticed or any differences from procedures previously reported in Army testing. **Met Criterion.** Flight crews, PJs, and volunteer passengers all qualitatively assessed the Heli-Basket for any anomalies noticed or any differences from procedures previously reported in Army testing by Natick Laboratories. None were found.

3.2.2 Recommendations. Consider procuring the load spreading bracket for the heli-strap when it becomes available.

3.3 RECOMMENDATIONS. Due to the transition of HH-60s from AFSOC back to ACC, recommended offices of primary responsibility are not provided:

a. Certify the Heli-Basket for live carriage of seated personnel in the configuration tested (120-foot line).

b. Include the Heli-Basket in the list of approved HH-60G equipment.

c. Add the Heli-Basket to TO 00-25-245, *Testing and Inspection Procedures for Personnel Safety and Rescue Equipment*.

d. Consider procuring the load spreading bracket for the heli-strap when it becomes available.

e. Add the Heli-Basket to AFI 11-2HH-60V3, HH-60, *Operations Procedures*.

f. Add the Heli-Basket to AFTTP 3-3.24, *Combat Aircraft Fundamentals—HH60G*.

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13. ABSTRACT (Maximum 200 words)

The Air National Guard Air Force Reserve Command Test Center (AATC) conducted an operational utility evaluation of the HB2000 Heli-Basket to certify for live carriage under the HH-60G helicopter. The test was conducted at, and supported by the 106th Rescue Wing.

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Evaluation of a Helicopter Rescue Basket for Safe Human Carriage

John A. Plaga
Air Force Research Laboratory

<u>Abstract</u>: Background: Expeditious aerial evacuation of civilians with helicopters is limited by the inability to extract more than one person with a helicopter rescue hoist. The small cabin size also limits the number of evacuees (5-6) to be carried to safety on each flight, and often results in long-term separation of families. A 15 person capacity helicopter rescue basket (Precision Lift Heli-Basket HB-2000) was recently provided to US Army Guard and Air Guard HH-60 helicopter units through a Congressional plus-up. Objective: Evaluate the Heli-Basket during flights while tethered to an HH-60 to determine the potential of injury to the occupants during all phases of flight (take-off, transport, and landing). Methods: A large and a small anthropomorphic manikin were placed in the Heli-Basket along with instrumentation to measure manikin and basket accelerations, rotations, velocity, and heading. Tests were supported by the 106th Rescue Wing (RQW), F.S. Gabreski Air National Guard, Long Island, New York. Data were analyzed against injury criteria to determine the probability of injury during several test flights. Results/Conclusions: The Heli-Basket was relatively stable, and analysis indicated that there was minimal probability of injury during all phases of flight.

<u>Purpose</u>: The purpose of this study and analysis is to determine if the Precision Airlift, Inc. Heli-Basket HB2000 can be certified for human carriage. This Congressionally mandated piece of equipment was bought for both the Army and Air National Guard. The US Army Soldier Systems Center (Natick Laboratories) did extensive flight testing and certified the Heli-Basket only for cargo carriage. The Air National Guard (ANG) Rescue Wings have articulated a Homeland Defense requirement to provide short range "water rescue" and "high rise building" emergency human carriage capability using the Heli-Basket.

<u>Objectives</u>: The following are the objectives of the study:

a. To determine if the Heli-Basket is safe for human carriage

b. To define the operational limits of the Heli-Basket for human transport

<u>Test Overview</u>: The Air National Guard Air Force Reserve Test Center (AATC) managed the test program which was conducted at, and supported by, the 106th Rescue Wing (RQW), F.S. Gabreski ANGS Suffolk CO., New York. These tests were part of the first of two test phases for this system, which consisted of flight profiles flying instrumented manikins in the Heli-Basket at various speeds, altitudes, and test configurations. Data collected during these tests included manikin chest acceleration and rotational rates, Heli-Basket Euler angles and velocities, and video documentation data. The data were analyzed to certify that a human passenger would not have been injured throughout the various flight profiles.

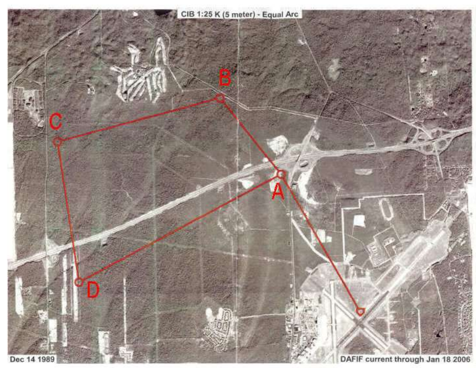

Figure 1. Flight Route

A total of five sorties were flown at various flight conditions to evaluate the stability and acceleration safety of the Heli-Basket. Three phases of flight were examined for stability and acceleration safety of the Heli-Basket: flights encompassing rectangular circuits, landings, and takeoffs. The flights through the circuits (Figure 1) were conducted at air speeds of approximately 20, 40, 60, 80, and 100 knots, with various payload configurations (Figure 2) including a 103-lb Lightest Occupant In Service (LOIS) manikin and a 218-lb Large Advanced Dynamic Anthropomorphic Manikin (ADAM) manikin. The manikins were secured in the basket with lap belts. The takeoffs and landings were either on a hard surface such as concrete or a soft surface such as grass. For a description of each test condition or "cell", see Table 1 below.

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Figure 2. Test Setup

Table 1. Test Cells

Cell	Velocity (KEAS)	Floats	Altitude (feet agl)
A	20	NO	500
B	40	NO	500
C	60	NO	500
D	80	NO	500
E	100	NO	500
AF	20	YES	500
BF	40	YES	500
CF	60	YES	500
BF1	40	YES	9000
CF1	60	YES	9000
LG	0		Landing Grass
TG	0		Take Off Grass
LC	0		Landing Concrete
TC	0		Take Off Concrete

Data Processing: Data collected during the flights included manikin accelerations and angular rates using the LOIS-manikin-mounted digital Data Acquisition System (DAS), Heli-Basket position and velocities using an Embedded GPS/INS (EGI) system, and standard digital video from a camera mounted in the Heli-Basket, pointing at the manikins. Each of these three systems had its own timing system which had to be correlated against each other. The DAS had a time reference with respect to the triggering of data collection as well as an IRIG time (days, hours, minutes, and seconds) with respect to GMT. The EGI system logged the data against day-seconds, which is the number of seconds that have passed since the beginning of the current day at the Prime Meridian (GMT). The video digital time display was synchronized to an atomic clock, but to local time (GMT – 5). The data on the DAS were collected at 1000 Hz, and on the EGI at 16 Hz for periods up to 52 minutes. This resulted in large amounts of data from each sortie for a variety of test conditions. In order to make the data manageable and to easily identify discrete test conditions, data were parsed out of the total data set from each of the five sorties and organized into discrete test numbers and test conditions (Table 2).

Table 2. Text Matrix

Test	Cell	Vel. KEAS	Payload	Float	Alt. feet	Sortie
1	TG	0	LOIS	NO	0	1
2	A	20	LOIS	NO	500	1
3	B	40	LOIS	NO	500	1
4	LG	0	LOIS	NO	0	1
5	TG	0	LOIS	NO	0	1
6	LG	0	LOIS	NO	0	1
7	TG	0	LOIS	NO	0	1
8	LG	0	LOIS	NO	0	1
9	TG	0	LOIS	NO	0	1
10	LG	0	LOIS	NO	0	1
11	TG	0	LOIS	NO	0	1
12	TG	0	LOIS	NO	0	2
13	C	60	LOIS	NO	500	2
14	C	60	LOIS	NO	500	2
15	D	80	LOIS	NO	500	2
16	D	80	LOIS	NO	500	2
17	E	100	LOIS	NO	500	2
18	E	100	LOIS	NO	500	2
19	LC	0	LOIS	NO	0	2
20	TC	0	LOIS	NO	0	2
21	LC	0	LOIS	NO	0	2
22	TC	0	LOIS	NO	0	2
23	LG	0	LOIS	NO	0	2
24	TG	0	LOIS	NO	0	2
25	LG	0	LOIS	NO	0	2
26	TG	0	LOIS	NO	0	2
27	LG	0	LOIS	NO	0	2
28	TG	0	LOIS	NO	0	2
29	LC	0	LOIS	NO	0	2
30	TC	0	LOIS	YES	0	3
31	AF	20	LOIS	YES	500	3
32	BF	40	LOIS	YES	500	3
33	CF	60	LOIS	YES	500	3
34	CF	60	LOIS	YES	500	3
35	CF1	60	LOIS	YES	9000	3
36	BF1	40	LOIS	YES	9000	3
37	TC	0	L+A+B	YES	0	4
38	CF	60	L+A+B	YES	500	4
39	CF	60	L+A+B	YES	500	4
40	BF	40	L+A+B	YES	500	4
41	AF	20	L+A+B	YES	500	4
42	LC	0	L+A+B	YES	0	4
43	TC	0	L+A+B	NO	0	5
44	LC	0	L+A+B	NO	0	5
45	TC	0	L+A+B	NO	0	5
46	LC	0	L+A+B	NO	0	5
47	TC	0	L+A+B	NO	0	5
48	LC	0	L+A+B	NO	0	5
49	TC	0	L+A+B	NO	0	5
50	LC	0	L+A+B	NO	0	5
51	TC	0	L+A+B	NO	0	5
52	C	60	L+A+B	NO	500	5
53	B	40	L+A+B	NO	500	5
54	LC	0	L+A+B	NO	0	5

*L+A+B = LOIS + ADAM + Ballast

Takeoffs and Landings: The takeoffs and landings were treated as discrete events, so the DAS and EGI data were time shifted so that the event (takeoff or landing) occurred at time = 0. The data from the takeoffs were processed from 2 seconds prior to the liftoff to 8 seconds after liftoff, and the data from landings were processed from 6 seconds prior to landing to 4 seconds after landing. The DAS data were filtered at 200 Hz and reduced to an output rate of 500 Hz, and the EGI data were processed using no filtering and the native 16 Hz sample rate.

These data were analyzed against impact injury criteria that were developed primarily for ejection seat evaluation and crash load analysis using AnalyzeTest Version 0.0.18 software that was developed in-house (AFRL/HEPA). The injury criteria included the Dynamic Response (DR) model for 5 axes (+/-X, Y, +/-Z), Multi-axial Dynamic Response Criteria (MDRC), and analysis of a moving average on the chest accelerations. The limits for the DR and MDRC correspond to approximately 0.5% probability of injury, and each of these criteria are shown in Table 3 below along with the extrema values from all of the tests conducted.

The analysis from the tests indicates that the accelerations encountered during takeoffs and landings result in a minimal probability of injury due to the acceleration. Further analysis of the injury results using a One-way ANOVA were conducted to determine if there were statistically significant differences between test variables such as the manikin size, landings on concrete versus grass, effect of total weight, etc (Table 4).

Table 3. Injury Limit Criteria and Test Results

Injury Criteria	Limit		Test Data	
	Min	Max	Min	Max
DRX	-28	35	-3.06	3.28
DRY	-15	15	-3.67	4.04
DRZ	-13.4	15.2	-2.70	5.77
MDRC	N/A	0.8		0.35
Chest X (g)	-35	35	-2.21	3.13
Chest Y (g)	-15	15	-2.62	1.54
Chest Z (g)	-20	25	-0.92	7.98
Chest Resultant (g)	N/A	25		8.24

The results of the statistical analysis of the MDRC and Resultant Chest Acceleration (Table 4) indicate that there is a greater probability of injury when landing on concrete versus grass ($p = 0.0214$), and that there is a greater probability of injury when landing with a heavy load versus a light load ($p = 0.0072$). The effect of the

Table 4. Injury Limit Statistical Results

Effect	Conditions	p	Cell	MDRC Mean	MDRC Std.Err.	Resultant Mean	Resultant Std.Err.
Grass/Concrete	LOIS Only, Landing Only	0.0214	Grass	0.12	0.026	2.23	0.66
			Concrete	0.24	0.023	5.11	0.58
Weight Effects, Landing	LOIS Only, Landing Only	0.0072	Light	0.14	0.021	2.86	0.59
			Heavy	0.27	0.028	5.50	0.76
Weight Effects, Takeoffs	LOIS Only, Takeoffs Only	0.0624	Light	0.10	0.007	1.64	0.16
			Heavy	0.10	0.010	2.02	0.23
Manikin Effects	Concrete Only	0.0498	LOIS	0.17	0.021	3.51	0.46
			L-ADAM	0.16	0.026	2.54	0.56
Takeoff versus Landing	LOIS Only	0.0013	Takeoff	0.10	0.015	1.77	0.37
			Landing	0.19	0.016	3.85	0.40

Table 5. Heli-Basket Stability Indices

	Velocity (knots)	20	40	60	80	100
Average Pitch Angle (deg)	LOIS	-8	-24	-39	-48	-52
	LOIS Float	-2	-31	-49		
	LOIS/ ADAM		-23	-33		
	LOIS/ ADAM/ Float	-11	-18	-25		
Average Roll Angle (deg)	LOIS	4	18	36	44	51
	LOIS Float	1	14	29		
	LOIS/ ADAM		-11	-15		
	LOIS/ ADAM/ Float	-4	-6	-13		
Max Heading Oscillation +/- (deg)	LOIS	30	10	18	15	17
	LOIS Float	140	70	13		
	LOIS/ ADAM		8	10		
	LOIS/ ADAM/ Float	50	40	4		

payload weight on the probability of injury during takeoffs was not statistically significant (p = 0.0624). Analysis of the accelerations seen on the heavier manikin (Large ADAM) and the small manikin (LOIS) indicates that a smaller occupant has a slightly greater probability of injury than a large occupant (p = 0.0498). The statistical analysis also indicates that there is a greater probability of injury during the landing than during takeoff (p = 0.0013). However, it should be noted that the injury analysis for even the worst-case tests were well below the established injury limits.

Analysis of Circuit Flights: Data were also extracted from each circuit for each test condition. Flying a complete circuit could take up to 18 minutes to complete depending on the speed of the test. The data from both the DAS and EGI were converted to day-seconds and the DAS data were filtered at 20 Hz and reduced to 40 Hz, and the EGI data were again kept unfiltered and at the native sample rate of 16 Hz. The trim and stability were evaluated by examining the pitch and roll average angles and deviation or oscillation in the Heli-Basket heading (Table 3) and by examining the test videos.

As one would expect, the greater the velocity, the greater the magnitude of the trim angles. Note that although the roll angles change with velocity, this is due to the fact that the Heli-Basket yaws during flight, and as the velocity increases, the basket lags behind the helicopter resulting in an apparent roll angle. The effects of velocity, payload, and the flotation devices on the average pitch and roll angles are illustrated in Figures 3 and 4 below. These figures indicate that as the velocity increases to 100 knots, the pitch and roll angles increase to -52 and 51 degrees respectively. The figures also indicate that the addition of the flotation devices to the low weight conditions (LOIS alone) reduces the yaw during flight, thereby resulting in the system increasing in pitch but decreasing in roll. Increasing the weight by the addition of the Large ADAM and 600 lbs of ballast tends to reduce the magnitude of the pitch and roll trim angle.

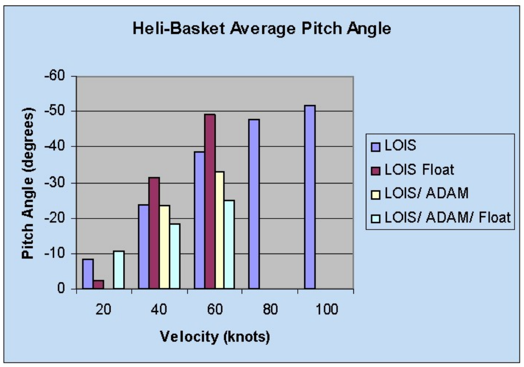

Figure 3. Heli-Basket Average Pitch Angle

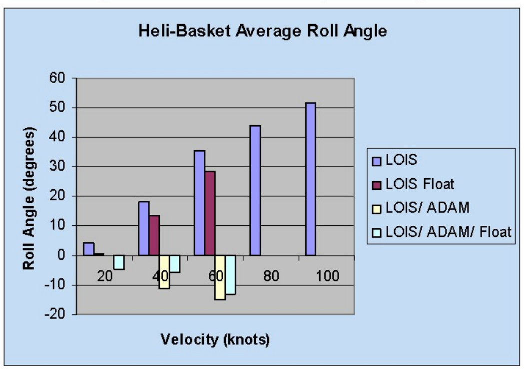

Figure 4. Heli-Basket Average Roll Rate

Examination of the data collected on the Heli-Basket during the flights through the rectangular circuits indicates that the Heli-Basket is extremely stable with a few exceptions (Figure 5). The Heading Oscillation in Table 5 shows the relationship between the test conditions and the peak-to-peak oscillation angles. In general, the Heli-Basket had minimal rotational oscillations during flight, with typical rotations limited to +/- 10 degrees in pitch and roll, and +/- 25 degrees in yaw (heading), with low rotational rates typically less than 15 degrees per second. However, the lightweight configuration (a single 103-lb manikin) with the flotation system produced greater rotations and higher rates, especially at 20 knots. In this configuration, the Heli-Basket headings varied by +/- 140 degrees (Figure 6) with rates up to 41 degrees per second (Figure 7). As the velocity increased to 40 knots, the yaw oscillations decreased to +/- 50 degrees. While there is no evidence that these rates can directly result in injury to humans, the frequency of these oscillations (approximately 0.17 Hz, or 1 cycle every 6 seconds as determined by FFTs), can result in motion sickness within a few minutes of flight. In general, increasing airspeed, payload weight, or removal of the flotation system results in a much more stable system.

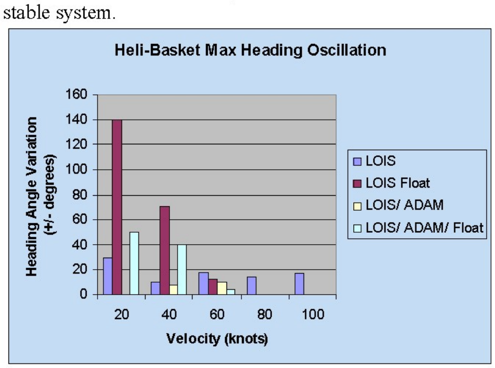

Figure 5. Heli-Basket Maximum Heading Oscillations

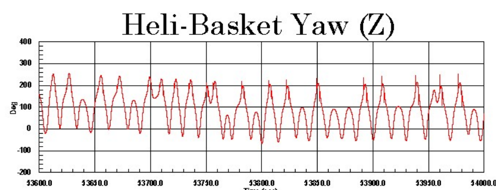

Figure 6. Test 31 Heli-Basket Yaw Data

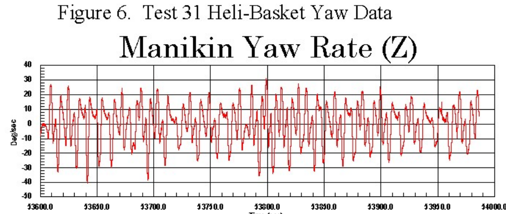

Figure 7. Test 31 Manikin Yaw Rate Data

Additional Considerations: Although a variety of configurations were tested, it is never possible to examine every variable. The flight testing focused on the typical flight regimes envisioned for use with the Heli-Basket with additional examination of high altitude flights that may be encountered during mountain rescues. The flights were flown by only three different pilots, in

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good weather conditions (sunny, low winds, 40-50 °F), which provided a limited variation in the effect of pilot performance. But even with uncertainties of pilot performance, the probability of injury due to accelerations was extremely low.

Summary: Examination of the data collected during the Heli-Basket testing conducted 10-12 January 2006 indicates that there is a very low probability of injury to human occupants due to the acceleration environment. Flights with low payloads using the flotation system are less stable at low speeds, but there is no evidence that this will pose additional risk to the occupants other than possible motion sickness. Increase in air velocities tended to make the system more stable and increase the Heli-Basket's pitch and yaw angles, especially at velocities greater than 60 knots. Although these higher angles should not change the probability of injury, they may result in distress to naive civilian rescuees. Higher altitudes had no discernable effect on the stability of the system. The overall results of the testing of the Heli-basket system indicate that there is minimal probability of injury to human occupants.

About the Author: John Plaga is a research aerospace engineer who has been with the Biomechanics Branch of the Human Effectiveness Directorate, Air Force Research Laboratory for 17 years. He has been involved in escape system research since his graduation from The Ohio State University in 1989. His research projects have included flow stagnation concepts, windblast deflection studies, biomechanics of helmet-mounted displays, development of ejection seat instrumentation systems, studies of ejection seat dynamics, investigation of the Russian K-36 ejection seat, investigation of the implications of women in combat aircraft, and effects of downwash on pararescuemen.

Disclaimer: The findings and conclusions in this report/presentation have not been formally disseminated by the Air Force and should not be construed to represent any agency determination or policy.

U.S. Army Natick Soldier Research, Development and Engineering Center Aerial Delivery Engineering Support Team

Final Report:
Foreign Comparative Testing
S.P.I.E.S vs. Heli-Basket® vs. AirTEP
(Unclassified)

February 25th, 2011

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1.0 Introduction

The US Army Program Manager Special Operations Forces Survival Systems (PMSSS), located at the US Army Natick Soldier Systems Center in Natick, MA, is interested in attaining usage of the Airborne Tactical Extraction Platform (AirTEP). To this end, they have recruited the Aerial Delivery Engineering Support Team (ADEST) of Natick Soldier Research, Development, and Engineering Center (NSRDEC) to develop and execute a plan for acquiring a Safety Release (SR) for testing. Funding was most practically available through a Foreign Comparative Test (FCT) program.

Several years ago, the Heli-Basket® underwent certification for carrying cargo. At that time it was identified that NSRDEC did not have the authority to certify systems for the carriage of live loads. No Department of Defense organization was recognized. It was decided to include Heli-Basket® in this program to further the supportive evidence of its usability.

The scope of this program was intended to compare the AirTEP and Heli-Basket® to the currently fielded Special Patrol Insertion/Extraction System (SPIES). Several other systems exist in the Department of Defense inventory, SPIES most closely compares to the two systems in question. Research into the requirements and authorizing agency for Human External Load (HEL) systems resulted in none available. This document will expand the scope to identify requirements that should be adhered to and presenting an argument that the Department of Defense should have an engineering agency with this proponency.

2.0 System Descriptions

2.1. SPIES [1]

The Special Patrol Insertion/Extraction System was developed as a means to insert and/or extract, by helicopter, reconnaissance teams from water or rough terrain conditions. The SPIES is designed to be used only in situations where helicopter landings are impractical since it would normally be faster and safer for helicopters to land and make the insertion/extraction when the terrain and/or tactical situation permitted.

SPIES consists of a 2-in-1 type braided nylon rope, one-inch in diameter and 120-feet long, a nylon harness assembly for each man who is to be suspended from the rope, two 9-foot-long cargo suspension slings, and four Type IV quick release link assemblies. A double tapered eye splice is constructed at each end of the rope. The tapered eye, used for attaching the rope to the helicopter, is encapsulated in polyurethane for protection from abrasion. The rope itself is coated with a nylon solution that provides abrasion protection. There are ten separable D-Rings inserted through the core of the rope; the rings are located in pairs on opposite sides, spaced one foot apart and 7-feet from center to center of the succeeding pair, starting 7-feet from the lower (bottom) end. Four additional D-rings can be safely added to the rope if needed to provide carrying capacity for 14 men (not to exceed 5,000 pounds). In the event a rope of greater length is required, a second SPIES rope can be attached to the first rope by a Type IV link, thus effectively doubling the total rope length. Men would be carried on the lower rope only. SPIES rope has a tensile strength of 24,000 pounds with a maximum load of 5,000 pounds.

Each harness is equipped with leg straps that are connected with parachute harness ejector snaps and quick fit parachute V-rings; a reversible quick fit adapter is used for the chest strap. A 20-inch strap is connected to the crossover portion of the back strap which, in turn, attaches to a D-ring on the rope using a mountain piton (rappelling-type) snap link. A backup for normal attachment of the rappelling snap link on the D-ring consists of a 12-foot length of rope (3-strand 7/16 inch diameter fiber rope, MIL-P-1688, NSN 4020-00-931-8793) and an additional rappelling snap link. In service, the rope is doubled and secured around the user's chest with a bowline knot, and the snap link is connected to the opposite D-ring. The backup attachment is intended for use in training exercises.

Cargo suspension slings and Type IV quick release link assemblies are used to create a secondary suspension system. The primary means of support is to connect the upper end of the rope to the cargo hook. Slings are passed through the upper eye splice and anchored inside the helicopter. For a UH-60, both slings are connected end-to-end with the Type IV links to form a continuous loop that passes through the cargo space. CH-47 rigging requires the loose 4 ends of the slings to be connected to cargo deck rings with the Type IV links.

2.2. Fast Rope Insertion/Extraction System [1][2]

The Fast Rope Insertion/Extraction System (FRIES) was developed as a means to insert and/or extract, by helicopter, air assault units into or from rough terrain conditions. The FRIES is designed to be used only in situations where helicopter landings are impractical since it would normally be faster and safer for helicopters to land and make the insertion/extraction when the terrain and/or tactical situation permitted.

FRIES consists of a braided polyester rope 1-3/4 inch in diameter and 60, 90, or 120 feet long, a nylon harness assembly for each man who is to be suspended from the rope, and FRIES bars. A double tapered eye splice is constructed at one end of the rope. The tapered eye is used for attaching the rope to the helicopter. Two secondary ropes (9/16 inch diameter) are woven into the main rope, one white and one black. Riders will connect to the both ropes. The black is their primary means of support. The white ropes acts as a fall arrest. The harnesses worn by each rider contain two lanyards with carabineer connections. Each rope has stations to support 6 riders with a maximum 1,500 pounds per rope. Main rope has a breaking strength of 35,000 pounds while the extraction loop ropes break at 9,000 pounds.

FRIES has its own suspension points called FRIES bars. For operation, FRIES bars need to be installed into the various aircraft. UH-60 Blackhawks can accept 2 bars for a total extraction capacity of 12 riders and/or 3,000 pounds. CH-47 Chinooks can have one forward rope and two aft ropes. The three ropes provide for a maximum transport of 18 riders and/or 4,500 pounds.

2.2.1. Aviation Engineering Directorate [3]

In 2006, Aviation Engineering Directorate (AED) issued an updated Airworthiness Release (AWR) for the FRIES. Within the AWR, AED states that this only permits use of the system with the prescribed helicopter. It expressly denies any support of human carriage within the auspices of the AWR program.

2.3. Forest Penetrator

Little detailed information has been found regarding the Forest Penetrator. Skimming details from multiple (unreferenced) sources builds the following description. The Forest Penetrator contains a metal construct of three seats on a center post. Each of the seats is spring loaded such that with no riders they will collapse upward. When closed, the system is very tightly packed with a pointed bottom. Its weight and shape permit it to drop cleanly through dense forest canopy. Each seat is intended to recover a single rider. This system has a maximum capacity of three riders. Suspension rope, maximum rider weight, and connection point details are unidentified.

2.4. AirTEP [4][5]

The Airborne Tactical Extraction Platform is a product of Escape International (a French company) and is being marketed in the United States by Aerial Machine and Tool Corporation of Vesta, VA. It was developed as a means to extract, by helicopters, refugees of disasters from water or rough terrain conditions. The AirTEP is designed to be used only in situations where helicopter landings are impractical since it would normally be faster and safer for helicopters to land and make the extraction when the terrain and/or tactical situation permitted.

The AirTEP consists of an 82 foot long polyamide rope, an automatically opening platform for carrying up to 10 people, descent control mechanism, and 10 safety belts. A double tapered eye splice with steel eye reinforcement is constructed at each end of the rope. One eye is used for connecting to the aircraft, while the other is the attachment point for the platform. The descent control mechanism is intended to lower the platform and rope in such a manner as to prevent the risk of rebound. After the controlled descent portion, the rope is removed from the control mechanism and the platform free-falls the remaining distance. The snatch force, when the rope reaches full extension, unlocks the closed platform. In its open state, five webbing wedges provide a riding surface for the evacuees. Each wedge is sized to fit two persons. Two safety belts are associated with each platform wedge to help retain the evacuees. A maximum of 3,306 pounds can be carried on the platform with the rope having a 34,845 pounds breaking strength.

2.5. Heli-Basket® [6][7]

The HB2000 Heli-Basket® System is a helicopter sling-loaded cargo or personnel basket capable of carrying 4,500 pounds of cargo or 15 seated people. It is manufactured by Precision Lift, Inc located in Seneca, SC. The metal basket is attached to a 120-foot-long cable underneath the aircraft, and measures 8.5 feet long by 4.5 feet wide by 3.25 feet high (various other rope lengths are available). The manufacturer, Precision Lift, Inc., promotes the Heli-Basket® for a variety of uses including personnel rescue and resupply disaster relief. The device can be used as a rescue tool for mass personnel recovery where the need is extremely urgent, the helicopter is unable to land, or a rescue hoist recovery is too time-consuming. The Heli-Basket®'s rigid metal frame provides protection for critical cargo from cargo net compression and the ability to place aerodynamically unstable items inside the basket. The strength of the suspension cable has been rated at 42,985 pounds based on testing performed by NSRDEC during certification.

2.5.1. Department of Defense History

The Heli-Basket® was added to this program due to it already having a history with the Department of Defense (DoD). Below is a brief review of this history.

2.5.1.1. Helicopter Sling Load Cargo Certification [7]

In 2003, ADEST answered a congressional request to provide helicopter sling load certification of the Heli-Basket®. This effort evaluated the strength and flight characteristics of the system. The result was authorization for the Department of Defense to utilize the Heli-Basket® to transport non-live loads ranging from 640 to 5,100 pounds.

Testing did not include the Precision Lift, Inc's electric long line. Nor did it provide for use of the systems non-electric long line for use with other sling load rigging. At the time of testing, it was determined that neither NSRDEC nor the AED could authorize the use of systems for transporting live loads. Therefore, the HSL authorization was limited to non-live loads.

2.5.1.2. Army Role of Heli-Basket® [8][9][10][[11][12][13][14]

The congressional request for Heli-Basket® certification included use as a HEL system. After the HSL cargo-only certification was issued, the topic of live loads was further pursued. Following is a brief synopsis of significant communications identified pertaining to this topic:

24 SEP 2007 – Senator Lindsey O. Graham requests an update from Headquarters Department of the Army on the effort to certify the Heli-Basket® for live loads.

3 DEC 2007 – Brigadier General Stephen D. Mundt from the Dept of the Army's Office of the Deputy Chief of Staff (G-3/5/7) informed Senator Graham that there will be further testing for Human use in spring 2008. The letter refers to the testing as being required to meet the more stringent human load requirements. This letter does not refer to where those requirements are published nor does it indicate which agency was performing the testing.

25 JAN 2008 – Lieutenant General James D, Thurman from the Dept of the Army's Office of the Deputy Chief of Staff (G-3/5/7) produced a Memorandum for the US Army NSRDEC requesting they conduct additional testing on the Heli-Basket® to determine its safety for use during emergency evacuations. The testing was to be performed in conjunction with and funded by the Army National Guard.

26 MAR 2008 – Colonel Kenneth Lassus of the US Army Materiel Command Office of the Command Counsel issued a Memorandum non-concurring with the expanded test effort. One of the key points of the memorandum is that NSRDEC does not have the authority to certify HEL devices and will not without a change to the command's charter. This letter also references the US Army Central Commands Area of Responsibility to use such devices during relief missions.

7 JUL 2008 – Senator Lindsey O. Graham requests a further update of the status of live load certification.

31 JUL 2008 -- Lieutenant General Craig R. McKinley of the Department of the Army and the Air Force, National Guard Bureau, replies indicating the Heli-Basket® was tested and deemed safe for human carriage. The certification effort continues, but, there is no mention of by whom.

3 AUG 2008 – Major General Robert Lennox from the Dept of the Army's Office of the Deputy Chief of Staff (G-3/5/7) expresses that the Army has enough capacity for rescue with hoists. He explains that the Army believes there is less risk involved with the hoist.

2.5.1.3. US Air Force Testing and Evaluation [13][15][16]

As indicated by Lieutenant General McKinley (31 JUL 2008), testing has been done on the Heli-Basket®. In 2006, the Air National Guard conducted instrumented flight evaluations of the Heli-Basket®. Data was submitted to the Air Force Research Laboratory for evaluation by a human threshold tolerance expert. Mr. Plaga reports that the accelerations recorded are within the limits of human tolerance. Further discussion of safety requirements results suitability for human carriage by the Heli-Basket®. The reports admit that certain controls need to be implemented and these would be the responsibility of the crews rather than imposed onto the equipment.

3.0 Requirements

At the commencement of this program, a great deal of time was spent trying to identify who should be performing this effort and to what standards. Part of the results is provided as a historical record for Heli-Basket®. Other information uncovered indicates that there are no standard military performance specifications for HEL systems. Requirements are generated on an as needed basis.

3.1. Authorizing Agencies [1][11][17][18][19]

Identification of an agency within the Army with the proponency to authorize the use of HEL's should lead to performance documentation. However, the authorizing agencies appear to be on an "as needed" basis. As provided by Col Lassus, Headquarters of the Department of the Army assigns responsibilities. US Army Central Command has been authorized the responsibility to use HEL for personnel rescue operations and training during relief missions. ARCENT/CFLCC 95-1 may authorize "peace-time" training, no copy of this document was attained.

USSOCOM MANUAL 350-6 is a compilation of procedures for utilization of Infiltration/Exfiltration systems. By definition, these systems are HEL systems. This document only covers use of such systems by Special Operations forces. No other document has been identified for conventional forces even though USSOCOM MANUAL 350-6 identifies United States Army Special Operations Command as having the proponency for FRIES for conventional forces. FM 3-05.210 is a Special Forces field manual which identifies missions that support Special Operations. Within this list is infiltration and exfiltration. No documents have been identified that specify whether exfiltration is considered a "special operations only" maneuver.

In the final report for FRIES testing, the US Army John F. Kennedy Special Warfare Center and School (USAJFKSWCS) is identified as the organization to contact for final system type classification.

3.2. Performance Specifications [20]

The nature of this program is to perform a comparative study. There needs to be a baseline of comparison. For the scope of this test, Federal Aviation Administration (FAA) regulations are accepted as the primary design criteria. Other characteristics are extracted from performance restrictions of active systems.

The US Army Safety Center has a Fall Protection Program. This program inherits a significant amount from Occupational Safety and Health Administration (OSHA) regulations. Although not directly applicable since these are related to working surfaces and HEL's are intended for transport, defined features should be applied.

3.2.1. Army Fall Protection Program [21]

29 CFR 1910 requires the use of guard rails, safety nets, or personnel fall arrest systems when personnel will be greater than 4 feet above the next lower supportive surface.

Guard Rails: 42 +/-3 inches high
- Constructed of posts, top rails, mid rails, and toe boards
- Top rail: 2x2x3/8 inch structural steel; 200 pounds lateral strength minimum
- Mid rail: 150 pounds lateral strength minimum

Personnel Fall Arrest
- Minimum system strength 5,000 pounds – Anchor points, connectors, lanyards (belts)
- Lanyard: synthetic rope/webbing ½ in effective diameter

3.2.2. Federal Regulations

Within the Federal Regulations, 14 CFR 27 and 29 pertain to helicopters. They differ by helicopter size. For HEL's, the requirements are the same. Only 14 CFR 27 will be referenced.

14 CFR 27.865 External Loads: connection points and devices for carriage of human loads must meet a minimum static load factor of 3.5 times their defined maximum loading.

Human carrying devices require a secondary jettisonable connection point. Jettison must be independent of primary.

14 CFR 133.35 Carriage of Persons: Restricts who may fly on the HEL

14 CFR 133.45 Operating Limitations: Emergency release must require two distinct actions

3.2.3. Operational Restrictions [1][19][22][23]

Other operational restrictions have been issued for existing systems. These restrictions should be standard for HEL's.

Airspeeds should be restricted to 80 knots (indicated); 50 knots for cold weather operations
Maximum angle of bank of 30°
Do not operate under conditions to impart greater than a 1.8 G loading (restricted to 1.3 G's during testing)
Maximum personnel flight time should be limited to 20 minutes during training

4.0 Comparison to Requirements

4.1. SPIES

Maximum Capacity of 5,000 pounds
Primary anchor is cargo hook on the UH-60 and nylon web slings are secondary support:
UH-60 cargo hook is rated for 8,000 pounds (min 5.9 LF)
8,000*5.9/5,000 = **9.4 Safety Factor**
SPIES Rope: 24,000 pounds breaking strength
24,000/5000 = **4.8 Safety Factor**
Slings, 2 loop Type IV: 44,500 pounds when arranged in loop
44,500*2/5,000 = **17.8 Safety Factor**
Primary anchor and secondary support on the CH-47 are nylon web slings:
4 CH-47 cargo deck rings rated for 5,000 pounds each
5,000*4/5,000 = **4.0 Safety Factor**
SPIES Rope: 24,000 pounds breaking strength
24,000/5,000 = **4.8 Safety Factor**
Slings, 2 loop Type IV: 44,500 pounds when arranged in an 'X' pattern
44,500*4/5,000 = **35.6 Safety Factor**

4.2. AirTEP [4]

Maximum Capacity of 3306 pounds
Primary anchor is cargo hook and nylon web slings are secondary support:
UH-60 cargo hook is rated for 8,000 pounds (min 5.9 LF)
8,000*5.9/5,000 = **9.4 Safety Factor**
CH-47 cargo hook: 17,000 pounds (min 5.9 LF)

17,000*5.9/5,000 = **20.0 Safety Factor**
AirTEP Rope: 34,845 pounds breaking strength
34,845/5,000 = 6.9 Safety Factor
Slings, 2 loop Type IV: 44,500 pounds when arranged in loop
44,500*2/5,000 = **17.8 Safety Factor**

Slings, 2 loop Type IV: 44,500 pounds when arranged in an 'X' pattern
44,500*4/5,000 = **35.6 Safety Factor**
Safety Belts rated for 550 pounds with a 9,000 pound breaking strength
9,000/550 = **16.3 Safety Factor**

4.2.1. Manufacturer Data [25][26]

Two reports provided by the manufacture, indicate that each triangular section was designed to 11,000 lbs and tested to 4,400 pounds. Given a maximum loading to 3,306 pounds and assuming an even distribution: 4400/(3306/5) = **6.7 Safety Factor**. Other Cycle testing results in greater confidence in this devices strength.

4.2.2. Primary to Secondary Support [24]

Testing performed at NSRDEC resulted in a 2.29 G build up on the system as the AirTEP falls from the primary support onto the secondary when at minimum loading. At maximum load, the increase never exceeds 1.7 G's. This puts the transfer well within the FAA requirement of 3.5 G's.

The manufacturer provides a secondary restraint system. However, no initial data could be provided as to the shock loading primary to secondary transfer would create. It was decided to use the cargo slings as used with SPIES to limit resources required for this effort.

4.2.3. Miscellaneous

Features of the AirTEP include the flexible net surface and Safety Belts for each rider. Load placed on the nets will flex it to somewhat conform to the shape of the load. The perception of a rider is that they are not just sitting onto of a surface. Flexing will provide for a shallow divot in which the rider will be sitting. Additionally, the Safety Belts restrict movement to prevent the rider form falling off the edge.

4.3. Heli-Basket® [6]

Maximum Capacity of 4500 pounds
Primary anchor is cargo hook and nylon web slings are secondary support:
UH-60 cargo hook is rated for 8,000 pounds (min 5.9 LF)
8,000*5.9/5,000 = **9.4 Safety Factor**
CH-47 cargo hook: 17,000 pounds (min 5.9 LF)
17,000*5.9/5,000 = **20.0 Safety Factor**
Heli-Basket® Rope: 42,985 pounds breaking strength
42,985/5,000 = **8.6 Safety Factor**
Cable harness: 16,300 pounds/leg
16,300*4/5,000 = **13.0 Safety Factor**
(convergence angle ignored)
Slings, 2 loop Type IV: 44,500 arranged in loop
44,500*2/5,000 = **17.8 Safety Factor**
Slings, 2 loop Type IV: 44,500 arranged in cross
44,500*4/5,000 = **35.6 Safety Factor**

4.3.1. Manufacturer Data [27]

Reports provided by the manufacturer indicate that the Heli-Basket® was designed for 3.75 G's. All analysis provided indicates the components are sized appropriately.

4.3.2. Primary to Secondary Support [24]

Testing performed at NSRDEC resulted in a 4.9 G build up on the system as the Heli-Basket® falls from the primary support onto the secondary when at minimum loading. At maximum load, the increase never exceeds 3.1 G's. This puts the transfer well within the FAA requirement of 3.5 G's.

The manufacturer provides a secondary restraint system. However, no initial data could be provided as to the shock loading that the primary to secondary transfer would create. It was decided to use the cargo slings as used with SPIES to limit resources required for this effort.

4.3.3. Miscellaneous

Features of the Heli-Basket® include side-walls to help prevent riders from falling out. Draft procedures indicate for the riders to sit. In this manner, the side walls would act as backrests providing considerable fall protection. Side wall strength has not been tested. This was not a requirement identified by the manufacturer. Since, the US Army does not have a definite set of criteria, it was decided to forego this testing. Once requirements are positively identified, side wall strength should be revisited prior to use.

5.0 Performance [28][29]

5.1. AirTEP vs. SPIES

Testing results indicate the AirTEP performs similarly to the SPIES during flight. Both systems maintain a consistent 90° lateral angle with a minimal trail angle during all maneuvers. Decelerations do not cause a significant amount of over-swing.

AirTEP out performs SPIES in stability. Where SPIES riders need to be trained to "fly" the system, AirTEP appears inherently stable due to its design. Additionally, AirTEP does not require harnesses leading to more physical comfort on the rider. As no humans were flown during this effort, psychological discomfort cannot be commented on.

SPIES is intended as solely a military system. Significant training needs to go into ensuring the safety of the riders. AirTEP should be a good replacement for SPIES. As the system is functionally a platform, AirTEP will also be appropriate for the rescue of civilian personnel.

5.2. Heli-Basket® vs SPIES

Testing results indicate that Heli-Basket® is an inferior device to SPIES for military operation. Heli-Basket's large cross-sectional area tends to impart greater energy into its system. This can be controlled by limited air speed. Once this is done, the operational applicability of Heli-Basket® is reduced.

Heli-Basket® offers greater comfort than SPIES. The ability to sit inside the box should give the rider the sense of a safe enclosure. Also, the need for harnesses is eliminated and the system does fly very stable.

6.0 Recommendations

Based on the research and evaluations performed, the following recommendations are proposed:

1. The AirTEP is suitable as an alternative for SPIES. Operational procedures, testing, and training should be conducted. For units that would use SPIES, USAJFKSWCS must be contacted for permission to field the system.
   a. Testing should include non-live load, tight quarter extraction such as lifting through trees. Based on observed results, tight quarter extraction should be repeated with live personnel.
   b. Procedures should be in accordance with all the assignments and responsibilities defined by USSOCOM 350-6

2. Heli-Basket® use should be restricted to rescue operations only. Increased airspeeds affect unfavorable flight conditions.

a. Additional strength testing should be conducted once a set of US Army standard requirements are established. Specifically, the side walls need to be evaluated for safety.
b. Procedures should be in accordance with all the assignments and responsibilities defined by USSOCOM 350-6

3. If the US Army is to have these Human External Load devices in their inventory for use during missions, Special Operations Command and/or US Army Training and Doctrine Command should pursue their analysis and requirements processes.

4. The US Army has responsibilities which include support of the Department of Interior and State Department for humanitarian relief and catastrophe recovery operations. During these periods, ARCENT has the responsibility to authorize use of and training with HEL's. Outside of these periods there are no policies to allow conventional units to train. Therefore, they will not be ready when needed. It is strongly recommended that item managers, authorizing agencies, and regulations for use be established for conventional forces to train and prepare.

5. If regulations to control design and construction of HEL's for US Army use are to be established, commercial specifications should be used as a base. Occupational Safety and Health Administration policies direct construction of human positioning platforms in accordance with ANSI A92.2. HEL's are not intended for long-term support, nor do they act to position individuals. However, positioning platforms are a close analogy. Additionally, Federal Aviation Administration regulations include important performance details. Other sources may be available.

6. Current operations with SPIES use Nylon webbing slings as a secondary support system. The slings are connected to each other or the air-craft with Type IV connector links. FAA requires the secondary system to be jettisonable. Although, SPIES was not developed to FAA standards, there is a procedure in place for jettisoning the secondary support if needed. This process includes rigging a wood block below the restraint system so an axe can be utilized to cut the webbing. In times of duress, it does not seem reasonable to expect an individual to be able to effectively wield an axe. It is strongly recommended to revise the design of the secondary restraint. Systems provided by the manufacturer may be considered. Multi-ring releases have been shown to be able to support significant loads while providing a low release force. This force is applied via a ripcord. A more "user-friendly" and condition relative method should be established.

7.0 Conclusions

Human External Load systems are used in various industries, including military. New systems should be permitted to expand the US Army's capabilities. To that end, proper leadership and administration should be established to ensure this mission is being performed as safely and responsibly as possible.

AirTEP is a stable flying platform that should be adopted by the military as an alternative system to SPIES. It is recommended that this system be authorized for live load to further evaluate its operational adequacy.

Heli-Basket® lacks performance that may be needed in a non-peacetime scenario. It would not be a suitable alternative to SPIES. However, as the US Army has the responsibly to support other agencies, Heli-Basket® is suitable for multi-person rescue. It is recommended that units be given the authority to train with such equipment to ensure their readiness and preparedness when such a support effort arises.

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Acquisition Directorate

Research & Development Center

Maritime Mass Rescue Interventions; Availability and Associated Technology

Final Report

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Homeland Security

Maritime Mass Rescue Interventions; Availability and Associated Technology

Company: Precision Lift, Inc **Equipment Name: HELI-BASKET HB2000**

Description: The Heli-Basket External Air Transport (EAT) system is a metal frame basket specifically designed to transport cargo or personnel under a helicopter using standard sling load equipment, technology, tactics, techniques, and procedures. The Heli-Basket HB2000 is capable of carrying 15 seated people and the HB1000 is capable of carrying 6 people. The metal basket is attached to a 120-foot-long braided polyester cable underneath the aircraft.

Figure D-17. Heli-Basket HB2000.

Physical Characteristics

Length Stored (ft):	8.9	Length Deployed (ft):	8.9	Capacity People:	15
Width Stored (ft):	4.9	Width Deployed (ft):	4.9	Capacity Payload:	4500 lbs
Height Stored (ft):	8.4	Height Deployed (ft):	8.4		
Weight Stored (lbs):	640.0				

LifeCycle Cost

Acquisition Cost (each):	$32,895	Planned Annual Maint Hrs:	
Service Life:	> 10 years	MTBO:	5 year recertification

Operational Characteristics

Transport Requirements: It is the vendor's opinion that the Heli-Basket® or First Responders Module could be deployed by parachute from the aft ramp of a fixed wing aircraft. The HB2000 has been approved for all DOD helicopters for utility use. The Heli-Basket® was approved for sea rescues and deck use by the US Navy during Kaman Aerospace's Vertical Replenishment contracts. The Heli-Basket® with flotation was tested in Atlantic seas by the USAF.

Delivery Methods: The Heli-Basket® can be used with either the long line attached to a Helicopter or attached to the cable from a winch and lifted to safety on high free-board vessels.

Flotation: The Heli-Basket® has bomb blast resistant flotation kit that form fits into the long sides. The kit will float the Heli-Basket® and 900lbs.

Company: Precision Lift, Inc **Equipment Name: HELI-BASKET HB2000**

Table D-17. Heli-Basket HB2000 characteristics.

Y	N	N/A	UNK	
				Transportation and Stowage
Y	**N**	**N/A**	**UNK**	
X				Air deployable – rotary wing
	X			Air deployable – fixed wing
X				Vessel deployable – ship/cutter (crane or hoist)
	X			Vessel deployable – boat (over the side)
	X			Land deployable – e.g., from a cliff, remote area
	X			Lightweight – can be carried by 1 or 2 people
X				Easily/conveniently stowed
X				Capable of being stowed in multiple environments (w/o climate control)
				Deployment
Y	**N**	**N/A**	**UNK**	
		X		Self righting or reversible
		X		Activation by rescues/survivors
		X		No inadvertent auto-inflation (e.g. not water activated - restriction on helos)
X				Non-collapsing/rigid construction once deployed
		X		Inherent buoyancy (undeployed)
X				Inherent buoyancy (deployed) *(with optional kit)*
			X	Simple operation - only 1 or 2 steps
X				Few moving parts
			X	Instructions with international signage
X				Device can be lifted with survivors on board
				Physical Characteristics
Y	**N**	**N/A**	**UNK**	
X				Multiple sizes to fit different delivery platforms & capacities
X				Low freeboard or ramp/platform
X				Victims ability to rescue other victims (assist disabled survivors)
		X		Minimal Leeway
		X		High visibility (day/night)
		X		Radar reflectivity
X				Abrasion resistant
X				Shock/Impact resistant
X				Puncture resistant
X				Chemical resistance
X				Heat resistant (fire)
X				Vessel condition does not defeat device (effective for use onboard a casualty/disaster or challenging vessel conditions)
				Maintenance
Y	**N**	**N/A**	**UNK**	
X				Long shelf life
X				Minimal maintenance - easy - low cost – infrequent
				Life Support
Y	**N**	**N/A**	**UNK**	
		X		Short Term (<24 hrs)
		X		Medium Term (24-48 hrs)
		X		Long Term (>48 hrs)
		X		Arctic Survival
		X		Tropical Survival
		X		High Sea State

