Helicopter Underwater Emergency Breathing Apparatus (HUEBA)  

Offshore Helicopter Safety Inquiry  
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Offshore Safety & Survival Centre  
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Introduction

- Review the rationale for HUEBA
- Review HUEBA equipment and operation
- Identify the hazards and limitations associated with using HUEBA
- Review HUEBA practical
Rationale for HUEBA

2007 world-wide offshore helicopter operational data: (OGP Report 2009)

- Over 9 million passengers
- Over 900,000 flying hours
- 10 accidents
- 5 fatalities

5 year average:
- 16 accidents
- 5.8 fatalities
Rationale for HUEBA

Out of 110 accidents: (Taber & McCabe 2006)

- 69 (63 %) capsized
- 27 remained afloat
- 38 sank
Rationale for HUEBA

Capsize equally likely in both ditching and crash landings: (Cliffords 1996)

- 69% controlled
- 56% limited control
- 65% fly-ins
- 68% uncontrolled
Rationale for HUEBA

83% of UK military fatalities due to drowning with only 17% due to impact injuries (Cliffords 1996)
Rationale for HUEBA

- High incident of capsize = high incident of drowning
- Cause of drowning:
  - Incapacitation due to injury
  - Disorientation
  - Jammed or obstructed exit
- Cold Shock single most important factor limiting escape of an uninjured person
Rationale for HUEBA

Suggested times required to escape from a capsized helicopter are between 40 – 60 seconds (Tipton et al, 1997)

Average breath-hold times: (Cheung et al, 2001)
- 25 C = 37 s
- 16 C = 29.7 s
- 1 C = 15.9 s
- Cold Shock BHTw as little as 6s with average < 20s (CAA Report 2003)

Need to bridge the gap between breath-hold and escape time
Two Solutions

1) Re-breather

* **Survival in the Sea Project (Shell) 1989**
  - Extent underwater survival time
  - Without introducing additional dangers
  - Simple to use

* **Air Pocket® Re-breather**
  - Counter lung, hose, mouthpiece and nose clip
  - Allows respiratory movement
  - Re-breathe 2 to 4 times as long as holding breath
Two Solutions

2) Compressed air
   - Military worldwide
Compressed Air HUEBA

HUEBA - Helicopter Underwater Emergency Breathing Apparatus aka:
- EBS – Emergency Breathing System
- HEED – Helicopter Emergency Egress Device
- HABD – Helicopter Aircrew Breathing Device
- HEBE – Helicopter Emergency Breathing Equipment
- UER – Underwater Escape Re-breather
- STASS – Short Term Air Supply System
- APP – Air Pocket Plus
- SEA – Survival Egress Air
Compressed Air HUEBA

- First HEBE developed in 1975
- Early 1980’s US Navy and Canadian Forces started using ‘Spare Air’
- 1986 Canadian Forces switched to HEED2
- 1990 US Navy switched to US Divers Inc HABD
  - 1994 Canadian Forces switched
- 1992 Royal Navy started using STASS
  - 1993 unit for ordinary passengers P-STASS
- 2000 CAPP starts looking into EBS
  - 2004 selects US Divers SEA LV2
Benefits of HUEBA

HUEBA benefits include additional time to: (CAA Paper 2003/13)
- Overcome panic
- Overcome disorientation
- Release a jammed or snagged seatbelt
- Identify alternate exits
- Cross fuel cell to exit
- Jettison an exit
- Overcome any snagging due to structural damage of the airframe
- Overcome impact injuries
Equipment & Operation

Aqua Lung
Survival Egress Air
(SEA-LV2 Exxon)

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Aqua-Lung EBS

Helicopter Aircrew Breathing Device (HABD)

Survival Egress Air MK (SEA-MK)

Survival Egress Air LV2 (SEA-LV2)

GEN 1

GEN 2

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GEN 3
SEA LV-2 (Exxon) Major Components

- Cylinder stores HP air
  - 21% oxygen & 78% nitrogen
  - 3000 psi
  - 1.5 cubic feet
- 1st stage reduces HP air
  - intermediate pressure 135 (+/- 20 psi)
- Hose delivers air to 2nd stage
- 2nd stage delivers air at ambient pressure
Cylinder

<table>
<thead>
<tr>
<th>Cylinder Specifications</th>
<th></th>
</tr>
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<tbody>
<tr>
<td>Air Volume</td>
<td>1.5 cu/ft / 42.5 liters</td>
</tr>
<tr>
<td>Service Pressure</td>
<td>3000 PSI / 207 BAR</td>
</tr>
<tr>
<td>DOT Test Pressure</td>
<td>5000 PSI / 345 BAR</td>
</tr>
<tr>
<td>TC test Pressure</td>
<td>4500 PSI / 310 BAR</td>
</tr>
<tr>
<td>Aluminum Alloy</td>
<td>6061-T6</td>
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</tbody>
</table>

Cylinder Identification

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1st Stage

- Dial gauge
- Fill port
- On / off knob
- Burst disk

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Hose Assembly

- Swivel adapter
- Hose
  - 28 inches
  - 3/16 I.D.
  - Low pressure
2nd Stage

- Low volume
- Open circuit demand valve
- Indexable mouthpiece
- One-way exhaust valve
- Purge button
Breathing Routine

- Place 2\textsuperscript{nd} stage mouth piece in your mouth and breathe
- If necessary (U/W) clear the second stage
  - Blast method
  - Using purge button
- Inhale first breath cautiously
When to use HUEBA

- Deploy just before submersion
- If unable to deploy prior to submersion
  - Decide whether to escape without HUEBA
    - Deployment could delay escape by 5 to 10 s
  - Deploy and clear HUEBA
HUEBA Limitations

- Intended for use as an emergency egress device
- Limited air supply with endurance depending on:
  - Breathing rate
  - Work rate
  - Water temperature
  - Depth
  - With or without face mask
  - Charge in cylinder
HUEBA Malfunctions

- Leakage or free flow of air from second stage
  - Freeze-up
    - Regulator will freeze open
  - Purge button depressed/stuck
- Flooding 2nd stage
  - Mouth piece
  - Diaphragm
  - Exhaust valve
Direct Effects of Pressure
Boyles Law

"For any gas at a constant temperature, the volume of the gas will vary inversely with the pressure."

<table>
<thead>
<tr>
<th>Depth</th>
<th>Pressure</th>
<th>Gas Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 fsw (10 m)</td>
<td>1 ata (14.7 psia)</td>
<td>1</td>
</tr>
<tr>
<td>33 fsw (20m)</td>
<td>2 ata (29.4 psia)</td>
<td>1/2</td>
</tr>
</tbody>
</table>

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Boyles Law

The following air filled spaces are affected by pressure and density changes:

- sinuses
- ears
- mask
- suit
- lungs

If the pressure in these air filled spaces is not equalized then a barotrauma injury may occur.
Lung Expansion Injuries

Normally caused by

- Holding your breath
- Inflammation and blockage of smaller bronchial passages
  - As a result of a chest cold, asthma, emphysema or bronchitis

Can occur in as little as 1 meter of water
Lung Expansion Injuries

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EXHIBIT/P-00097
Lung Expansion Injuries

There are four principal lung expansion injuries:

- Pneumothorax
- Mediastinal Emphysema
- Subcutaneous Emphysema
- Arterial Gas Embolism (AGE)

Signs & Symptoms occur immediately upon surfacing or shortly (within 15 min) after
Practical Exercises
Practical Exercise Objectives

Demonstrate:

- donning a flight suit with HUEBA equipment
- preflight checks
- deployment and operation of HUEBA equipment
- Breathing actions including
  - Breathe u/w
  - Deploy and clear HUEBA while u/w
  - Deploy and clear HUEBA while inverted u/w
Preflight Checks and Donning

Photo: J Boone
Pre-Breather

- Unlimited air supply
- LV-2 second stage

Photo: J Boone

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Pre-Breather

Practice

- Normal breathing pattern
- Clearing 2nd stage
  - Purge method
  - Blast method
HUEBA Operation

Practice

- Deploying HUEBA
- Normal breathing pattern
- Deploying HUEBA u/w
- Clearing 2nd stage
  - Purge method
  - Blast method

Breathe HUEBA down while u/w

Photo: J Boone
Emergency Breathing System Inversion Chair (EBSIC)

- Designed to provide a controlled way of inverting students
- 4 point harness
- Emergency release
EBSIC

Practice

- Deploying HUEBA
- Normal breathing pattern while inverted
- Deploying HUEBA u/w while inverted
- Clearing 2nd stage u/w while inverted
  - Purge method
  - Blast method
References


Taber & McCabe 92006 SAFE Journal 34(1), 5-10

