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IDEA-0710-68
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18 September 1968

MEMORANDUM FOR: Deputy for Operations, OSA

SUBJECT: Underwater Cockpit Escape Evaluations in the S-1010 PPA

1. Subject evaluations were conducted at the U. S. Navy Physiological Training Facility, Miramar NAS, San Diego, California, on 7, 8 August 1968. Participants were as follows:

[redacted] - Headquarters - R&D
[redacted] Headquarters - Intel
[redacted] Det. G - Personal Equipment
[redacted] David Clark Co. - Project Monitor
[redacted] Det. G - ARO Tech Rep
[redacted] - ARO Corp - Project Engineer
[redacted] LAC - Escape System Engineer
[redacted] LAC - Parachute Tech Rep

2. Purpose of Evaluations: There were three primary purposes in conducting this evaluation program, as follows:

A. To evaluate and develop procedures for emergency egress from the U-2R cockpit in the event of a landing or takeoff accident during carrier operations, which results in the aircraft being submerged with the pilot in the cockpit.

B. To evaluate the S-1010 PPA/U-2R life support equipment, in terms of effects on the emergency situation described above.

C. To evaluate and develop a special egress training program for project pilots involved in U-2R carrier operations.

3. Equipment Used:

A. Trainer Used. The device (called a "Dilbert Dunker") in which the tests were conducted, consisted of a platform approximately 15-20 feet high with rails sloping downward at approximately 35-40° and entering a swimming pool at the deep end (12 ft.). The rails project beyond the edge of the pool and

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enter the water to a depth of approximately one foot. A cockpit mockup with a dummy instrument panel and an ejection seat mounted inside is boarded at the top of the platform. Upon release, the cockpit slides down the rails and impacts the water. Upon water entry, the cockpit is automatically rotated forward and over to an inverted position, with the bottom of the cockpit ending up just slightly above the surface of the water. The occupant is therefore suspended upside-down in the cockpit with his head approximately 4-5 feet below the surface.

B. Life Support Equipment: The evaluations were conducted using a stripped U-2R ejection seat mounted in the trainer, a U-2R type seat/kit emergency oxygen system installed in the seat, a dummy U-2R parachute, and the prototype S-1010 PPA worn by the undersigned as evaluator. The ground egress handle ("scramble handle") on the ejection seat was only tied into the parachute arming lanyard release mechanism for these tests. Normally this handle, when pulled, will release the lap belt, cut the foot cables, and cut the D-ring cables in addition to releasing the parachute arming lanyard. Therefore, for these tests the lap belt had to be manually opened in addition to pulling the scramble handle. The ejection D-ring and foot retraction cables were not installed.

C. Breathing Supply. Compressed air for breathing was used in both the cockpit supply tied into the seat mounted quick disconnect, and the seat kit emergency cylinders tied into the suit emergency oxygen leads.

D. Photographic Coverage. The personnel at the physiological training facility kindly arranged for an underwater photographer to cover the evaluations. Both 16 mm color motion pictures and 35 mm color slides were obtained.

4. Tests Conducted:

A. Preliminary Pool Test was conducted wearing the S-1010 PPA with parachute and seat kit (packed with some bulky items for weight/volume similar to operational kit) attached. Water entry was made from the side of the pool with the visor closed, breathing from the emergency oxygen supply in the kit, but without the flotation garment inflated. The purpose of the test was to evaluate the buoyancy characteristics of the system, without the flotation garment inflated, in terms of the effects on emergency egress from an inverted and submerged cockpit. The complete system, as used in this test, provided a great deal of buoyancy. This buoyancy decreased with time as the seat kit and parachute took on water, but the suit buoyancy still prevented complete submergence. When the visor was opened momentarily, the water pressure forced trapped air from the suit out the open helmet and thus reduced buoyancy further. Even with diver assistance, it was impossible to attain an inverted position under these conditions and therefore could not simulate the condition to be encountered in the "dunker" tests.

B. Cockpit Escape Test #1. Cockpit egress in the first test was planned to be made with both the seat kit and parachute attached to the suit. The planned sequence of steps was to be as follows:

1. After water entry and inversion, check the breathing capability from the ship's supply.

2. Pull the green apple to activate emergency oxygen and manually disconnect from ship's supply to check breathing capability from seat kit.

3. Pull scramble handle, manually open lap belt (only required in test conditions), stand up to release personal leads, and egress over the side of the cockpit.

4. Pull flotation lanyard when clear of the cockpit. Surface while breathing from seat kit supply.

Water impact, inversion and bubbles in the visual field caused a momentary disorientation that resulted in a delay in starting the planned escape sequence. I then started to reach for the "green apple" which was not secured to the PPA as it is with operational suits. As I was experiencing difficulty in locating the green apple, I noted that the upper part of the helmet was filling with water rather rapidly. After another attempt to locate the green apple, I determined that the helmet was filling too rapidly to allow time for the planned sequence to be accomplished.

I therefore pulled the scramble handle to release the parachute arming lanyard, pulled the seat kit handle to release all kit connections (since I wouldn't be able to breathe the emergency air with the helmet full of water), stood up to break all personal leads and egressed over the side of the cockpit and headed toward the surface. I did not activate the flotation device. Upon cockpit egress and heading to the surface, the water in the helmet was now filling the lower half, covering the nose and mouth which necessitated holding my breath. The suit still provided positive buoyancy and upon surfacing, I held onto the side of the cockpit and opened the visor to empty the helmet and breathe. I was unable to determine at this point where or how the water had entered the helmet, so additional preliminary tests were conducted.

C. <u>Pool Test for Helmet Leakage</u>. Following discussions, the most likely point of helmet leakage was felt to be the antisuffocation valve on the lower left side of the helmet shell. To confirm this, I entered the pool fully suited, breathing from a portable LOX supply, without seat kit or parachute, and with the flotation garment uninflated. Holding myself underwater on the ladder in an upright position produced no water entry into the helmet. However, upon pulling myself down the ladder in an inverted position, I could observe water entering the helmet in the region of the antisuffocation valve. This valve was then sealed with tape and water was re-entered in an inverted position with no helmet leakage. I maintained this inverted position, fully submerged for a few minutes and determined that breathing capability was excellent. To determine whether being inverted had shifted trapped air to the lower extremities, I then released the ladder. Suit buoyancy remained primarily in the upper part of the suit/helmet and therefore brought me to the surface headfirst. Therefore, there is no danger of floating feet upwards regardless of the period of time spent inverted in a submerged cockpit. For the remaining cockpit escape tests, the antisuffocation valve was sealed with tape.

D. <u>Cockpit Escape Test #2</u>. Since Escape Test #1 planned procedures were aborted due to helmet leakage, they were evaluated on this second test. The first test had evaluated escape with the parachute and without the seat kit. In test #2 the green apple was pulled as the cockpit impacted the water. Upon inversion, I waited for bubbles to clear and noted that breathing from the ship's supply was satisfactory. The ship's supply leads were then manually disconnected to switch over to breathing from the seat kit. Breathing remained satisfactory. The scramble handle was pulled and the lap belt manually opened. Using my hands on the cockpit rails I stood up, with the kit and parachute attached, to disconnect remaining personal leads (vent hose) and egressed over the side of the cockpit. The combined suit/seat kit buoyancy brought me to the surface, breathing from the kit supply, in an upright seated position with my head well out of the water. I then inflated the flotation garment, opened the visor and pulled the seat kit handle. The released kit floated to the surface. The Koch canopy releases and kit strap side locks were operated to release the parachute. Suit flotation remained satisfactory throughout these procedures.

E. Cockpit Escape Test #3. To simulate a failure of the scramble handle mechanism, the final test was to escape from the cockpit without the seat kit or parachute. In addition, the flotation garment was to be inflated prior to leaving the cockpit to see if egress was possible despite the added buoyancy tending to force the occupant into the seat. This was to evaluate the possible situation of confusion causing the pilot to inflate his flotation garment while still in the cockpit. Specifically, the sequence of procedures were as follows: after water entry, inversion, and checking breathing, the scramble handle was pulled followed by pulling the seat kit handle. The seat kit side strap locks were released and the Koch canopy releases operated. The lap belt was manually opened and the flotation garment was inflated. Using my hands on the cockpit rails and feet against the floor I was able, with considerable effort, to stand up to release personal leads and egress over the side of the cockpit. The inflated flotation garment and suit buoyancy brought me to the surface rapidly, where the faceplate was then opened.

5. Conclusions and Recommendations:

A. Protective Equipment. The S-1010 PPA, in combination with the U-2R seat kit, provides excellent pilot protection for emergencies involving cockpit submergence, either upright or inverted. The anti-suffocation valve of the helmet is being redesigned to allow the pilot to manually close the valve in the event of being inverted underwater where the water pressure on the valve is slightly greater than on the breathing regulator, which allows the valve to open and introduces water into the helmet. Because of the advantages, for any type of carrier operation accident, afforded by the S-1010 PPA, it is recommended that all carrier operation flights be made with the pilot wearing his S-1010 PPA. It is further recommended that, providing there are no visual restrictions, that all carrier landings be made with the visor down and locked and the ship's oxygen supply turned on. This maintains maximum suit protection for any potential accident including ejection, water impact or submergence.

B. Carrier Accident - Recommended Escape Procedures. With the U-2R zero-zero stabilized escape system, ejection is the primary means of surviving an accident where the aircraft is heading overboard with no chance of on-deck recovery. However, if ejection is not initiated prior to the aircraft contacting the water for any reason (i.e., malfunction of escape system or delayed decision by the pilot), cockpit egress would be involved. If the aircraft remained afloat the pilot would follow emergency ground egress procedures, inflate his flotation garment prior to leaving the cockpit, enter the water and swim clear of the aircraft. If the aircraft was submerged and/or inverted, the recommended procedure is to egress from the cockpit with both the seat kit and parachute still attached, as the quickest and safest method. In the event of difficulties encountered in accomplishing these procedures, it is still possible for a well trained pilot to escape leaving both the seat kit and parachute behind.

C. Underwater Escape Training. On the basis of the evaulations conducted, it is recommended that a formal training program on carrier accident/underwater escape be conducted for all project pilots who will be involved in U-2R carrier operations. As the first phase of this training program, the undersigned and [redacted] (INTEL/O/OSA) have developed a briefing/discussion based on the August evaluations and utilizing 16 mm motion pictures and 35 mm slides from that exercise. It is planned to present this information to Detachment G pilots and life support personnel in late September. It is proposed that each pilot to be involved receive "dilbert dunker" indoctrination in early 1969, prior to any U-2R carrier operations.

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ASD/R&D/OSA/[redacted]
Distribution:
Cy 1 - D/O/OSA
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PROPOSED TEST SCHEDULE
UNDERWATER SEAT EJECTION

PRELIMINARY TESTS

Test Sequence No.	
1	Dunk fuselage less seat and catapult to 5 ft. depth and observe leakage and structure. "Dry" run for equipment, cameras etc.

EJECTION TESTS WITH DUMMY

Test Sequence No.	Depth Feet	Cockpit Press. at start of immersion - psi	Immersion Time - min.	Ejection Attitude	Canopy
2	5	.4	1	Normal	ON
3	7.5	Ambient	2	Normal	ON
7	10	.4	2	Normal	ON
8	10	Ambient	1	Normal	OFF
23	5	.4	1	Inverted	ON
21	Dunk fuselage less seat and catapult slowly to 15 ft. level. Observe leakage and structure. Level off if required.				
22	15 or less if required	.4	2	Normal	ON

CANOPY OPENING TESTS - UNDERWATER

Test Sequence No.	Depth Feet	Cockpit Press. at start of immersion - psi	Immersion Time - min.	Release Handle
4	5	.4	1	Cockpit
5	5	Ambient	1	Cockpit
6	5	Worst config. (Tests 4 & 5)	1	External
9	10	.4	1	Cockpit
10	10	Ambient	1	Cockpit
11	10	Worst config. (Tests 9 & 10)	1	External
12	7.5	.4	1	Determine

how difficult to break glass from outside.

NOTE: Cockpit Handle - cockpit handle to be released by remote cable attached to handle.

External Handle - handle to be released by person using underwater breathing apparatus.

CANOPY OPENING TESTS - UNDERWATER
LIVE PARTICIPANT USING UNDERWATER
BREATHING APPARATUS

Test Sequence No.	Depth Feet	Cockpit Press. at start of immersion - psi	Immersion Time - min.
13	3	.4	Upon reaching depth
14	3	Ambient	↓
15	5	.4	↓
16	5	Ambient	↓
17	10	.4	↓
18	10	Ambient	↓
19	15	.4	↓
20	15	Ambient	

NOTE: No instrumentation other than cockpit pressure is planned for these tests. However, test progress may dictate a need.

MRMPA (Maj. Lee) X 33181

SUBJECT: Special Test

1. On 18 March 1964 tests were performed to determine the capability of the MC-3A partial pressure suit to function underwater and provide surfacing capability for the wearer.

2. The test conditions were as follows:

a. Subject wore standard MC-3A partial pressure suit with standard oxygen fittings attached to capstan and breathing pressure leads from F-2400 regulator.

b. Seat kit was attached to subject and one-hundred (100) pounds of lead weights were attached to the seat kit to retain the suited subject underwater.

c. Subject entered the test pool in Bldg. 824 and descended to a depth of eight (8) feet.

3. The results of the test were as follows:

a. The subject breathed without difficulty and no water entered the helmet.

b. Upon release of the one-hundred (100) pounds of lead weights the subject surfaced due to the buoyancy of the suit.

c. Surface flotation was adequate and the subject remained in a satisfactory attitude with respect to the water surface.

4. The following recommendations are made:

a. In the event of a situation which places the suited crewmember under water within an aircraft cockpit, the following procedures should be followed:

(1) jettison canopy

(2) pull green apple

(3) release lap belt

(4) stand up and exhale continously during ascent to surface.

(5) Upon reaching surface disconnect capstan and breathing pressure lines from seat-kit leads.

(6) open face plate after disconnecting capstan and breathing pressure lines.

5. The following comments are considered pertinent:

a. If the canopy is not of the explosive jettison type, it must be broken and the cockpit allowed to fill with water before it can be opened and jettisoned. It is recommended that the green apple not be pulled prior to completing this procedure.

b. In the event that there is a common multiple disconnect on the seat kit, it is recommended that the capstan and breathing pressure lines not be disconnected at this level. These lines whould be disconnected at their attachments to the corresponding suit inlet lines.

c. The characteristics of the oxygen system are such that adequate breathing pressures can be provided for a descent to one-hundred and fifty (150) feet.

William L. Lee Jr.

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