NATIONAL TRANSPORTATION SAFETY BOARD Office of Aviation Safety Washington, D.C. 20594

August 11, 2011

ADDENDUM 1

SURVIVAL FACTORS GROUP FACTUAL REPORT OF INVESTIGATION

I. <u>ACCIDENT</u> : DCA11IA040

Location	:	: New Orleans, Louisiana,			
		Louis Armstrong International Airport (MSY)			
Date	:	April 4, 2011			
Time	:	07:15 Central Daylight Time			
Aircraft	:	Airbus A320-200			
Operator	:	United Airlines, Flight 497, Registration N409UA			

II. SURVIVAL FACTORS GROUP

Group Chairman	:	Cynthia Keegan National Transportation Safety Board Washington, D.C.
Member	:	Oscar Fernandez United Airlines San Francisco, CA
Member	:	Candace Kolander Association of Flight Attendants (AFA) Washington, DC
Member	:	Bruce Peleschak International Brotherhood of Teamsters Flight Safety (IBTSF) Chicago, IL
Member	:	Beau Morrow FAA Fort Worth, TX
Member	:	Ben Turner AmSafe Anaheim, CA

III. 1.0 Examination of 1R and 2L Emergency Evacuation Slide/Rafts

Air Cruisers shipping department received UAL flight 497 slide/rafts in their New Jersey Service Center on April 7, 2011. On June 1, 2010, the Survival Factors Group with the technical assistance of Mike Kret and Paul Lacy (Air Cruisers, Inc.), convened at Air Cruisers, in Wall Township, NJ, to examine the 1R and 2L emergency evacuation slides. See Attachment 3 for photographs of the slide/raft examinations.

1.1 <u>1R Emergency Evacuation Slide/Raft</u>

The 1R emergency evacuation slide and pack board were removed from the shipping crate and examined on the shop floor. Figure 1 shows a diagram of the A320 emergency evacuation slide/raft nomenclature highlighting the location of the sea anchor.



Figure 1. A320 Slide/Raft

The lacing cover cable was inspected and no damage was found. Remnants of safety wire were found at the slide release disk, as was designed to occur when the lacing cover releases from the packboard. The spacing between the lacing covers was in accordance with the OEM packing instruction. The mooring line, normally stored inside the girt was found completely out of the girt and the full length of the line was unraveled. All frangible links except for the frangible links at the toe end of the slide released.

The part numbers on the links that did not release were: C19347-102. The part numbers on the outboard links at the sill end of the slide that had released were both C19347-107, and the center frangible link at the sill end of the slide, which also released, was part number C19347-106. The cross link located at the sill end of the slide at each outboard end of the slide had released and contained part number: C19347-119. Figure 2 shows the locations of the frangible links on the A320 slide/raft.



Figure 2. A320 Emergency Evacuation Slide/Raft Frangible Link Locations

The sea anchor pouch is mounted on the forward side of the 1R slide/raft and is attached to the slide with a plastic coated stainless steel cable mounted to a fabric loop attached about 12 inches below the sea anchor pouch. The 1R sea anchor cable measured 42.8 inches long. Photograph 1 shows the location of the sea anchor pouch.



Photograph 1. Sea Anchor Pouch

Five of the 6 pouch snaps designed to secure the sea anchor were found unsnapped. The snap closest to the sill end of the slide was the only snap that remained snapped. The sea anchor stainless steel cable was found routed through the pouch at the sill end of the pouch and secured by the single snap that remained snapped. The sea anchor and sea anchor line had separated from its pouch and the sea anchor line (similar to the mooring line) ran beneath the slide/raft, wrapped around the inflation bottle gage lead and tube and across the bottom of the slide/raft to the aft aspirator. The sea anchor and remaining sea anchor line were ingested in the aft aspirator.

Pressure was applied to the upper chamber of the slide through the forward aspirator. The upper tube fully inflated and held pressure. Pressure was applied to the aft aspirator and the lower tube fully inflated. A notable pressure leak was observed from the aft aspirator flapper valves, and the lower tube gradually lost pressure.¹The ingested sea anchor and sea anchor line were removed from the aft aspirator and measured. The portion of sea anchor line that was ingested in the aspirator measured approximately 165 inches long from the aft aspirator to the sea anchor. A knot in the sea anchor line was present at about 2/3 of the length of the line and measured approximately 12 inches after the knot was released.² The heaving line remained attach to the slide (above the sea anchor pouch) and the hook knife (for cutting the mooring line) was contained in its pouch.

The manual inflation handle remained Velcroed to the girt. The manual inflation cable was routed correctly through the grommet and the girt sleeve. The quick disconnect (barrel) nut remained attached to the manual inflation handle. The girt was intact and the ditching handle remained secured inside the girt flap. The inflation cable contained part number 22C22850-4. The inflation hoses were properly routed and positioned from the inflation bottle to the forward and aft aspirators. The check valves for each aspirator were properly oriented. Both manual inflation/deflation valves mounted on the upper and lower inflatable chambers near the sill end of the slide were found in the closed positions.

The 1R emergency evacuation slide/raft contained the following information:

MR # 25613-002 Serial # A5770 TSO C-69a, & DGAC QAC 143 Mfg Date: 09-93 Fwd Aspirator Part # 60322-105 Fwd Aspirator Serial #[None] Aft Aspirator Serial #[None] Aft Aspirator Serial # A6359 Bottle S/N: 751-3676 Mft 12/06 Tested 1/2010

¹ The amount of pressure loss could not be measured at the time of the examination.

² The sea anchor and line designed total length is 25 feet minimum.

1.2 <u>2L Emergency Evacuation Slide/Raft</u>

The 2L emergency evacuation slide/raft and pack board were removed from the shipping crate and examined on the shop floor.

The lacing cover cable was inspected and found intact. Remnants of safety wire were found at the slide release disk as designed to occur when the lacing cover releases from the packboard. The spacing between the lacing covers was in accordance with the OEM packing instruction. The mooring line remained intact inside the girt. All frangible links separated as designed. The sea anchor and sea anchor line remained intact inside the pouch which was completely snapped. The sea anchor plastic coated stainless steel cable measured 42.8 inches in length. The sea anchor line measured 24 feet 3 inches in length. When snapped and unsnapped the (6) sea anchor pouch snaps were noticeably stronger than the snaps on the 1R slide/raft sea anchor pouch. The sea anchor was removed and verified to have been stowed in accordance with the Aerazure folding procedures. The heaving line remained attached to the slide (above the sea anchor pouch) and the hook knife was contained in its pouch.

The manual inflation handle remained Velcroed to the girt and the inflation cable was routed correctly through the grommet. The quick disconnect" (barrel) nut remained attached to the manual inflation handle. Inflation cable part number was 22C22850-4. The girt was intact and the ditching handle remained secured inside the Velcroed girt flap. The manual inflation/deflation valves were found closed. The inflation hoses were properly routed from the inflation bottle to the forward (upper chamber) and aft (lower chamber) aspirators. The A320 slide/raft aspirator check valves are designed so that they can only be installed in the correct flow position. The check valves for each aspirator were properly oriented.

The forward aspirator was compressed such that its inlet was not concentric and the flappers would not fully close. One flapper closed to within 1/2 inch of the seated rim of the aspirator, and the other flapper closed to within 3/4 inches of the seated rim. Pressure was applied to the forward aspirator and the lower tube fully inflated, but quickly lost pressure through the unsealed aspirator flapper valve. The forward aspirator was disassembled, and the lower aspirator mixing tube was dented. The aspirator housing inlet diameter was measured at two different locations. 4.7 inches across the flapper valve hinge, and 4.93 inches parallel to the flapper valve hinge. Photograph 2 shows the difference between the 2L forward and aft aspirators inlets.



Photograph 2. Comparison of aspirator chamber diameters. Note: forward aspirator (on left) and aft aspirator (on right)

The aft aspirator was intact. Pressure was applied to the upper chamber of the slide through the aft aspirator. The upper chamber of the slide fully inflated and held pressure. The aft aspirator measured 4.8 perpendicular to the flapper valve hinge and 4.85 parallel to the flapper valve hinge.

The following information was recorded from the 2L emergency evacuation slide/raft:

MR # 25612-022 Serial # 5744 Mfg Date: 07-93 Complies with TSO c69a & DGAC QAC 143 Fwd Aspirator Part #60322-103D Fwd Aspirator Serial #C5045 Aft Aspirator Part #60322-108D Aft Aspirator Serial # A6304 Bottle S/N, 751-4495 Mft 03/08 Tested 07/10

See Attachment 4 for the Am Safe overhaul records for the 1R and 2L slide/rafts.

2.0 <u>Slide/Raft Folding and Packing Information</u>

UAL contracts with Am Safe, Anaheim, California (an FAA approved repair station) to perform repair and overhaul UAL's A320 slide/rafts. The United Airlines Joint Document titled "Forward and Aft Slide/Raft A320, D30664-series, and D30665-series" details the UAL required packing and folding procedures, for Am Safe and specifies the use of Air Cruisers manual CE-40-25-61-02-VM (Air Cruisers CMM 25-61-20) folding and packing procedures. The Joint Document supplements and takes precedence over the OEM (Aerazure) slide/raft folding and packing instructions. Section 7 "Assembly", subsection D. "Special notes during slide/raft Assembly Packing or Folding" of the United Airlines Joint Document states:

- (1) Refer to the corresponding Folding Procedures of the slide/raft assembly:
 - (a) Air Cruisers P-11921 (FWD door slide/raft)
 - (b) Air Cruisers P-11915 (AFT door slide/raft)
- (2) Ensure the inflatable pack remains tightly rolled and compressed between the bottle and the aspirator.

(3) Make sure that the distance or space between the upper lacing cover grommet strip edge and the lower lacing cover grommet strip edge is uniform along the entire length and such distance must be within $\frac{1}{2}$ inch of the lower limit as specified in the Folding Procedure.

NOTE: This UAL limit is more conservative than the OEM CMM limits.

3.0 Prior A320 Sea Anchor Ingestions

Air Cruisers representatives informed the Survival Factors Group that they previously experienced the ingestion of a sea anchor during the inflation/deployment of an A320 emergency evacuation slide/raft (Part number D03664-309, Serial number 00083) during a June 19, 2010 acceptance test procedure (ATP.) According to Air Cruisers representatives, as the A320 slide/raft deployed and unfolded the aspirator (opposite the sea anchor side of the slide/raft) contacted the snapped sea anchor pouch, opened the pouch during the slide/raft deployment and released the sea anchor which then ingested into the aspirator. Air Cruisers is in the process of designing a revised closure for the sea anchor pouch that incorporates a Velcroed closure instead of a snapped closure. Attachment 5 of this report includes photographs of the existing and revised Air Cruiser A320 evacuation slide/raft sea anchor pouch closure.

3.1 Sea Anchor Pouch Snaps

The snaps for the A320 slide/raft sea anchor pouch are a socket and stud design in accordance with military specification MS27982. Dimensions were taken at each snap socket and each snap stud on the 1R and 2L slide/raft sea anchor pouch. The snap fastens into a socket designed to the dimensions shown in Figure 3.



Figure 3. MS27982 Snap Socket Design Dimensions

The height of the socket lip is designed to be formed to 3/32 (.0937.) The 1R sea anchor pouch snap socket lip measured an average of .100 inch, and the 2L pouch snap socket lip measured an average of .0920 inch. Because the design of the MS27982 socket creates a flexible receptacle for the snap stud the formation of the 3/32 lip around the diameter of the socket can result in variable socket inside (ID) diameters. Therefore, each socket ID was measured on each snap on the 1R and 2L slide/raft sea anchor pouch. Table 1 below shows the dimensions recorded at each socket with snap position 1 corresponding to the toe end of the slide, and position 6 corresponding to the sill end (closest to the heaving ring) of the slide:

Snap Position	Slide Pouch	1	2	3	4	5	6
Socket	1R pouch	.150	.151	.152	.152	.148	.148
(variable)	2L pouch	.148	.150	.148	.146	.148	.152
Stud diameter	1R pouch	.154	.154	.154	.154	.154	.154
.156 inch	2L pouch	.154	.154	.154	.154	.154	.154

Table 1. 1R and 2L Sea Anchor Pouch Snap Socket and Stud Dimensions

Each snap stud was required to be 5/32 (.156) inch diameter and 3/32 (.094) inch long. The 1R slide/raft pouch snap stud measured an average of .156 long, and the 2L slide/raft pouch snap stud varied between .166- .191 inch long. Figure 4 shows the design dimensions for the MS27982 snap stud.



Figure 4. MS27982 Snap Stud Design Dimensions

See Attachment 6 for a copy of MS27982, Rev D, dated October 21, 1984.

Cynthia L. Keegan Sr. Survival Factors Engineer

Attachments

- 3. Photographs of the slide/raft examination
- 4. AmSafe overhaul records for the 1R and 2L slide/rafts
- 5. Photographs of Air Cruiser A320 Revised Evacuation Slide/Raft Sea Anchor Pouch Closure
- 6. MS27982 Snap Stud Military Specification