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INVESTIGATION PARTY SUBMISSION FOR NTSB FILE ERA18MA099 (N350LH)

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REFERENCES

1. Emergency Flotation System Group Factual Report for ERA18MA099, dated September 3, 2019
2. Grip Strength and Hand Force Estimation (Technical Report No: 65-1-2000), Department of Labor and Industries dated May 2000

1.0 INTRODUCTION

On March 11, 2018, an AS350B2 helicopter registered as N350LH and operated by Liberty Helicopters on behalf of NYONair and FlyNYON (jointly referred to hereinafter as “FlyNYON) experienced a perceived engine failure and was forced to make an emergency landing into the East River in New York City. During the water landing, the helicopter rolled to the right, causing the aircraft to capsize.

The float system installed on the helicopter was approved under FAA STC SR00470LA. This STC was issued to Apical Industries, Inc. (d/b/a Dart Aerospace and hereinafter referred to as “Dart”) in 1997 and has been installed on multiple aircraft of this type since then. During the emergency, the pilot initiated the activation of the float system using the cyclic mounted inflation lever. As a result of the NTSB investigation, it was determined that once the pilot initiated the float inflation, there was a disparate amount of pressure that was present between the LH floats and the RH floats.

The Emergency Float System Group focused primarily on investigating the function of the float system during the emergency, with considerations for any malfunctions or defects of the subcomponents.

1.1 SCOPE

The purpose of this document is to provide additional technical details supporting the evidence of the investigation, determine a probable cause for the malfunction of the float system, and provide additional recommendations for continued safety improvements.

2.0 FLOAT SYSTEM DESCRIPTION

2.1 SYSTEM ARCHITECTURE AND FUNCTION

The float system approved under STC SR00470LA consists of six cylindrically shaped inflatable float bags attached to the skid landing gear of the helicopter through aluminum girts bonded to the float bags themselves, and mechanically fastened to the skidtubes using bolts.

The floats are inflated using compressed helium or nitrogen that is stored in two reservoir assemblies. These reservoir assemblies are located in the lower fuselage on the LH and RH side. Each reservoir assembly contains a mechanical inflation valve, with gas flowing from the outlet of the valve, through flexible hoses, and to the inlet check valves of the floats. The hose routing is such that gas is allowed to flow from one side of the system to the other. This hose architecture helps distribute the flow of gas more evenly during a normal activation.

Activation of the system is accomplished by pulling the cyclic mounted inflation lever to its full travel. This lever is connected to a mechanical pull cable that is routed under the floor to a junction box on the LH side of the fuselage. This junction box houses the ends of three cables, with one cable running to the LH reservoir assembly, another to the RH reservoir assembly, and the third cable being routed to the inflation lever. When the lever is pulled, the RH and LH reservoir cables are also pulled. This action initiates displacement of a pull cable at each inflation valve. The displacement of the pull cable results in activation of the valve, which releases the gas into the system.

Once gas flows into the system, the float bags become fully pressurized in a matter of seconds. Once the floats reach a minimum operating pressure, they provide enough buoyancy to keep the helicopter afloat and stable.

2.2 FLOAT INFLATION LEVER

The float inflation lever is designed to provide mechanical advantage for the operator in an ergonomic manner. The overall design is similar to that of a motorcycle or bicycle break lever, with rounded edges and an increased cross section toward the end of the lever. The design intent of the lever is to allow for a single hand operation, with the pilot using the base of the palm and thumb to control the cyclic while using the rest of the fingers to pull the lever to full travel. This design has been used successfully on multiple models, such as the Airbus Helicopters H130, H135, H145 and the Bell 206, 407, and 505.

The design was evaluated by FAA flight test pilots and DERs, and in all cases was determined to comply with the existing airworthiness regulations. Specifically, the inflation lever was evaluated for its ability to perform its intended function and that it did not create any situation that would add a burden to a pilot's workload during an emergency.

Figure 1: Inflation Lever Installed on AS350 Helicopter

Figure 2: Inflation Lever Being Pulled During Inflation

2.3 FLOAT SYSTEM CERTIFICATION

The float system was originally certified through the FAA, using the guidance of the airworthiness regulations and amendment levels equivalent to the certification basis of the basic aircraft. The float system was certified as an emergency float system, and full ditching certification was not requested. At the time of application, the FAA had not released updated guidance on design and approval of floats not certified for ditching. Therefore, the system was designed with interim guidance from the FAA, which stipulated that the forward water entry speed as mentioned in 14 CFR 27.563 would not be required. Therefore, Dart's recommended procedures for water entry included a maximum forward speed of 10 kts during an emergency landing (by way of comparison, ditching certification would have limited a maximum forward speed to 30 kts).

During the certification of the emergency float system, there were failures of the system unrelated to the root causes as it pertains to this accident. Failures are very common in R & D testing and serves to vet and improve the product before public release. The sole purpose of certification testing is to validate the design as such, failures are expected and designs are improved.

It is noteworthy that according to the results of the investigation, the water entry speed during the accident was approximately 22-23 kts, which well exceeded the maximum recommended water entry speed as documented in the Rotorcraft Flight Manual Supplement and approved under the STC.

3.0 INVESTIGATION RELEVANT FINDINGS

3.1 SYSTEM SUBCOMPONENTS

During the investigation, each subcomponent of the float system was inspected to determine if a failure of said subcomponent had occurred, and if that failure had contributed to the overall failure of the float system.

3.1.1 Float Assemblies

The float assemblies were inspected for any damage that would have been present prior to the accident or occurred during the water landing. All of the floats were in good condition, with damage definitively concluded to have occurred as part of the salvage operation.

3.1.2 Pull Cable Assemblies

All of the pull cable assemblies were inspected in detail for kinks, corrosion, and manufacturing defects that could have contributed to failure of the system. The cable leading to the RH reservoir assembly experienced some kinking at the base of the threaded cable fitting. This could have occurred during installation, but this was not definitive given that the cable may have been damaged during the salvage operations.

There was corrosion present near the exposed ends of the steel conduit. This corrosion did not propagate inside the pull cable and was most likely due to the aircraft having been immersed in salt water as a result of capsizing.

3.1.3 Inflation Valve

As part of the investigation, it was discovered that the RH reservoir assembly remained fully charged to the design pressure after the accident. This indicated that the RH reservoir had not released any gas into the system.

The reservoir assembly was removed from the accident helicopter and sent to an independent laboratory for additional evaluation.

Internal scans of the inflation valve showed that the valve remained intact with no damage to any of the mating components. Based on this information, a functional test of the valve was accomplished at Dart's facility in Vista, CA. The result of the test was a successful function of the valve. The inescapable conclusion from this test was that the RH reservoir assembly would have functioned as designed had the valve been activated via actuation of the inflation lever.

3.2 FLOAT SYSTEM FUNCTION

During the course of the investigation, Dart determined that it would be beneficial for operators to have a test tool that could be used to verify the correct installation and rigging of the pull cables as well as to verify that the pull force as experienced by the pilot was within reasonable limits, even though there was no evidence uncovered during the investigation that the pull force required by the pilot in the accident aircraft was above the design limits (30 lbs.). (The 30lbs. design limit on pull force was determined with input from the NTSB and FAA through statistical analysis of Dart employees grip strength and documented results from the Department of Labor's study on 'Grip Strength and Hand Force Estimation'.)

To this end, Dart, along with members of the FAA and NTSB, traveled to ERA Helicopters in Lake Charles, LA to test a prototype of the test tool. The test tool is installed onto the inflation valve and connects directly to the pull cables that are routed from the junction box. The test tool is designed to mimic the friction force that is present in the inflation valve. Two test tools are used for the AS350 design, with each tool being installed on the LH and RH inflation valve.

Once installed, the operator can rig the pull cables according to the STC documentation, and record the pull force at the inflation lever. If the system has been installed properly, actuation of the inflation lever will occur under 30 lbs. with both the test tools on the RH and LH inflation valves registering a successful firing prior to the inflation lever reaching its full stroke.

The conclusion of the testing at ERA was a successful verification of the effectiveness of the test tool in providing immediate feedback on the function of the float system without requiring a full system inflation.

4.0 PROBABLE CAUSE OF FLOAT SYSTEM FAILURE

4.1 PILOT DID NOT FULLY ACTUATE INFLATION LEVER

When a pilot pulls the emergency float inflation lever, there are three basic ways for the pilot to determine that the floats have inflated: (1) he/she hears the loud “pop” sound that accompanies the activation of the reservoir (especially where, as here, the engine is not operating), (2) he/she feels the significant increased drag on the helicopter's operation, and (3) clearly sees that the front floats of each side of the floation system have properly inflated. As mentioned in the pilot testimony, the pilot pulled the inflation lever during autorotation procedures and apparently believed that there was commencement of inflation. Therefore, it is concluded that he prematurely stopped pulling the lever aft and, instead, directed his attention to completion of emergency landing maneuvers.

As noted above, the results of the investigation on the float system subcomponents concluded that each subcomponent was in good working condition free from manufacturing operational defects. The RH inflation valve was found to function properly even after the accident.

It is clear that had the pilot continued to pull the inflation lever to its full travel, then both the LH and RH reservoir assemblies would have been activated, thereby releasing a balanced amount of gas to each side. It is probable that had he accomplished this, the pilot would have had the ability to counteract rolling moments during the water landing – especially had he followed the published procedures and entered the water with a forward speed of not more than 10 kts. While the water entry speed was much higher than the recommended maximum forward speed for float utilization (indeed, more than twice as fast), it is unclear whether the additional speed, combined with the additional drag area from fully inflated floats, would not have introduced other failures.

It is noteworthy that Liberty’s pilots included as part of ongoing training a functional test of the float system. The pilots, including the pilot of the accident helicopter, had previous experience in how to initiate the inflation with instructors stressing that the inflation lever must be pulled full aft followed by a confirmation that the floats have fully inflated. Dart submits that the pilot here failed pull the lever fully and prematurely released the lever before the RH floats had an opportunity to inflate.

5.0 RECOMMENDATIONS

5.1 REVIEW FLOAT SYSTEM TRAINING PROCEDURES

Given that the pilot had previous experience in the proper activation of the float system, but was not able to activate the floats during the time between beginning autorotation and the water landing, it is reasonable to recommend that operators review existing training procedures for float activation.

5.2 DART TO ISSUE SERVICE BULLETIN FOR PILOT ACTIVATION

During the investigation, in conjunction with recommendations from the FAA and NTSB, Dart released a Service Bulletin (SB2018-03) that provided clarification on the proper function of the inflation lever. Specifically, the Service Bulletin instructs pilots that pulling the inflation lever to full travel is the recommended method for ensuring full float inflation.

In support of this Service Bulletin, Dart has also revised the Rotorcraft Flight Manual Supplement for STC SR00470LA to include the information listed above.

It is Dart’s belief that the Service Bulletin may aid in preventing other pilots in the future from not fully pulling the flotation lever and prematurely releasing it without confirmation that the floats have, in fact, fully inflated.

5.3 DART TO ISSUE SERVICE BULLETIN FOR TEST TOOL

Dart has developed a pull cable test tool that will help operators verify the correct installation and function of the float system. A Service Bulletin will be sent to all operators shortly providing instructions to perform a functional test using the test tools within the six months following the date of release of the Service Bulletin. This test will provide feedback to the operator that both RH and LH inflation valves will fire with a single actuation of the inflation lever. It also will allow operators to quantify the amount of force required to pull the inflation lever so as to ensure that the force needed is equal to or less than the 30 lbs limit.