AA2020-1

AIRCRAFT ACCIDENT
INVESTIGATION REPORT

EXCEL AIR SERVICE INC.
J A 3 5 0 D

February 27, 2020

Japan Transport Safety Board

The objective of the investigation conducted by the Japan Transport Safety Board in accordance with the Act for Establishment of the Japan Transport Safety Board and with Annex 13 to the Convention on International Civil Aviation is to determine the causes of an accident and damage incidental to such an accident, thereby preventing future accidents and reducing damage. It is not the purpose of the investigation to apportion blame or liability.

TAKEDA Nobuo
Chairman
Japan Transport Safety Board

Note:

This report is a translation of the Japanese original investigation report. The text in Japanese shall prevail in the interpretation of the report.

AIRCRAFT ACCIDENT INVESTIGATION REPORT

DAMAGE TO AIRFRAME IN DITCHING
EXCEL AIR SERVICE INC.
EUROCOPTER AS350B3 (ROTORCRAFT), JA350D
ON THE SEA NEAR 41 KM NORTHWEST OF
NAHA AIRPORT, JAPAN
AROUND 15:26 JST, JUNE 7, 2018

January 31, 2020
Adopted by the Japan Transport Safety Board

Chairman	TAKEDA Nobuo
Member	MIYASHITA Toru
Member	KAKISHIMA Yoshiko
Member	MARUI Yuichi
Member	MIYAZAWA Yoshikazu
Member	NAKANISHI Miwa

1. PROCESS AND PROGRESS OF THE AIRCRAFT ACCIDENT INVESTIGATION

1.1 Summary of the Accident	On Thursday, June 7, 2018, a Eurocopter AS350B3, registered JA350D, operated by Excel Air Service Inc., ditched near 41 km northwest of Naha airport while flying for Aguni airport after take-off from Naha airport, and sank in the sea. The pilot was seriously injured.
1.2 Outline of the Accident Investigation	Upon receipt of the occurrence of the accident, the Japan Transport Safety Board designated an investigator-in-charge and one investigator on June 8, 2018 to investigate this accident. An accredited representative of the French Republic, as the State of Design and Manufacture of the helicopter involved in this accident, participated in the investigation. Comments were invited from parties relevant to the cause of this accident and the Relevant State.

2. FACTUAL INFORMATION

2.1 History of the Flight	According to the statement of the pilot of the helicopter, ATC radar track record and information from Ministry of Defense and Japan Coast Guard, the history of the flight is summarized as follows: A Eurocopter AS350B3, registered JA350D, operated by Excel Air Service Inc., took off from Naha airport on June 7, 2018 at 15:14 JST (JST: UTC+9 hours; unless otherwise noted, all time are indicated in JST in this report on a

24-hour clock) for Aguni airport to transport the aircraft with a pilot alone on board sitting in the right pilot's seat.

While flying near about 38 km northwest of Naha airport around 15:23 using Heading Hold and Altitude Hold functions of autopilot (hereinafter referred to as "AP") at a heading of about 310 °, an altitude of about 1,000 ft, and an air speed of about 110 kt, the helicopter turned from 310 ° to 330 ° using heading selector knob of HSI*1.

Figure 1: Estimated flight route

Around 15:25, while flying with visually recognizing Aguni Island, the pilot instantaneously halted veering to the right by applying the left rudder pedal because he heard warning sounds (gong sounds), and simultaneously confirmed red GOV*2 warning light illuminating and an abrupt veering to the right. Furthermore, because the pilot confirmed a reducing number of rotation (hereinafter referred to as "NR") of the main rotor, he switched off AP using master release button of the cyclic stick (as detailed in 2.8 (3)) by slightly pulling backward the cyclic stick with slightly lowering the collective pitch lever (hereinafter referred to as "CP") in an attempt to maintain NR. After confirming that NR indicator showed around 370 rpm in warning control range (yellow arc line: between 320 and 375 rpm), the pilot operated emergency control in case of governor failure. The pilot shifted the twist grip (as detailed in 2.8 (2)) to manual operation and turned it to the left; however, the pilot was unable to position NR in normal control range (green arc line: between 375 and 394 rpm), and the altitude of the helicopter kept going down. The pilot recognized that the engine output could be maintained to some extent because low rotation warning of NR (sounds that continuously keep ringing at 310 Hz when NR has become 360 rpm or less) was not activated and NR was stabilized at around 370 rpm. The pilot then operated the twist grip confirming NR and maintaining attitude of the airframe by looking outside; however, he was unable to confirm the status of other warning lights and engine indicator. The pilot confirmed that the speed decelerated down to about 100 kt during the operation, and in parallel with increase of descent rate, he felt that CP and the cyclic stick became heavy as in the case that hydraulic system was off.

The pilot turned the twist grip only to the left paying attention to avoid an excessive NR, but was unable to increase NR.

Because the helicopter did not stop descending and came as close as about 300 ft to the sea surface, the pilot made a decision to ditch at this time. At

*1 "HSI (Horizontal Situation Indicator)" denotes a horizontal position indicator that gathers various information needed for navigation and displays such information in a single indicator.

*2 "GOV (governor)" denotes a sensing device that senses the rpm of main rotor and engine and automatically controls fuel flow in order to keep main rotor rpm constant (see 2.8 (1)).

	15:25:30, the pilot sent distress message and manually activated emergency locator transmitter (ELT). The pilot thereafter strongly pulled the cyclic stick to decelerate for ditching and extended an emergency float (a float that extends by nitrogen gas in case of emergency ditching and is hereinafter referred to as "the Emergency Float") at about 50 kt. The helicopter came near to the sea surface in 10 to 20 seconds after sending the distress message, and ditched at the speed of 20 to 30 kt without performing a sufficient deceleration. The helicopter immediately sank to the level of the pilot's seat. The pilot unfastened shoulder harness and seat belt while dipped in the sea, escaped from the helicopter without putting on a life jacket equipped in the lower part of the right pilot's seat. And he was grabbing the Emergency Float disconnected from the landing devices of the helicopter, and was waiting to come for rescue. A rescue helicopter of Air Self-Defense Force, which was drilling nearby and received the distress message, arrived near the accident site around 15:39 and found the pilot on the sea. The helicopter had already sank in the sea at this time. The pilot was rescued by the rescue helicopter and was taken to the hospital in the city of Naha via Naha airport around 16:20. When the rescue helicopter arrived at the accident site, it received a weak ELT signal near the site where the helicopter had sank, which became not receivable during the rescue activities. Around 16:22, an aircraft of Japan Coast Guard arrived near the accident site for searching floating wreckage and found no oil floating. From around 17:22 till around 19:00, a patrol ship of Japan Coast Guard gathered floating wreckage. Japan Coast Guard did not receive ELT signal from the helicopter. The place of the occurrence of the accident was on the sea near 313° and 41 km away from Naha airport (26°27' N, 127°27' E) and the time of the occurrence was June 7, 2018 around 15:26.
2.2 Injuries to Persons	Pilot: Seriously injured
2.3 Damage to Aircraft	Extent of damage to the helicopter: Supposed to have been destroyed from floating wreckage gathered because the airframe sank in the sea. ● Landing gear: The attached section of forward float of the right skid was fractured, and float was fractured and detached. ● Lower part of fuselage: Under cowl was fractured. ● Aft fuselage on the left: Cargo room door was destroyed. Damage to all the rest could not be identified because the airframe had sank in the sea.  Figure2: JA350D parking on the ground

2.4 Personnel Information	Pilot Male, Age 46 Commercial pilot certificate (Rotorcraft) December 15, 1997 Specific pilot competence Expiry of practicable period for flight: June 14, 2019 Type rating for single-turbine (land) July 14, 1998 Class 1 aviation medical certificate Validity January 20, 2019 Total flight time 3,474 hours 01 minutes Total flight time in the last 30 days 23 hours 15 minutes Total flight time on the type of aircraft 1,887 hours 40 minutes Total flight time in the last 30 days 23 hours 15 minutes
2.5 Aircraft Information	(1) Aircraft Type Eurocopter AS350B3 Serial number 3467 Date of manufacture November 26, 2001 Certificate of airworthiness No. TO-29-526 Validity February 27, 2019 (2) Engine Type Safran Helicopter Engines ARRIEL 2B Serial number 22240 Date of manufacture April 28, 2001 Total flight times 3,832 hours 9 minutes (3) Maintenance History The helicopter had been maintained in accordance with maintenance manual of the manufacture of the helicopter. According to the maintenance record of the helicopter, there occurred no malfunction or defect related to GOV warning or hydraulic system. (4) Weight and Balance When the accident occurred, the weight and balance of the helicopter are estimated to have been within the allowable ranges. (5) Floating Wreckage Gathered Pieces of the airframe and objects loaded on board, which were gathered in the sea near the accident site, were as follows: (i) five Emergency Floats (ii) cowling on the lower part of the fuselage, cargo room door and rear seat cushion (iii) life boat, life jacket, sun visor, head set earmuffs, pilot's carry-in bag and regular maintenance check sheet

<table>
<tr><td></td><td> 

Figure 3: Floating wreckage gathered</td></tr>
<tr><td>2.6 Meteorological Information</td><td>(1) Aeronautical weather observations for Aguni airport located about 22 km northwest of the accident site around the time of the accident were as follows:
15:00 Wind direction: 110 °, Wind velocity: 6 kt, Prevailing visibility: 10 km or more
Cloud: Amount FEW, Type unknown, Cloud base 600 ft
Amount FEW, Type unknown, Cloud base 3,000 ft
Amount SCT, Type unknown, Cloud base unknown
Temperature 30 °C, Due point 26 °C,
Altimeter setting (QNH) 29.80 inHg
(2) According to the pilot, waves in the sea were calm with no wind near the rescue site.</td></tr>
<tr><td>2.7 Accident Site Information</td><td>The water depth near the sea where the helicopter sank is about 700 m and the helicopter has not been salvaged.</td></tr>
<tr><td>2.8 Additional Information</td><td>(1) GOV Warning and Emergency Control
The helicopter is equipped with an engine which has a governor function, which maintains NR in a normal control range (green arc line) of 375 to 394 rpm by automatically controlling Pump and Metering Unit Assembly by Engine Electronic Control Unit, and in the event that governor failure including sticking of metering valve in the Pumping and Metering Unit Assembly or malfunction of engine control system has occurred, GOV warning light (red) illuminates simultaneously with warning sounds (gong sounds) ringing, and the fuel flow is fixed at the value before the failure has occurred.</td></tr>
</table>

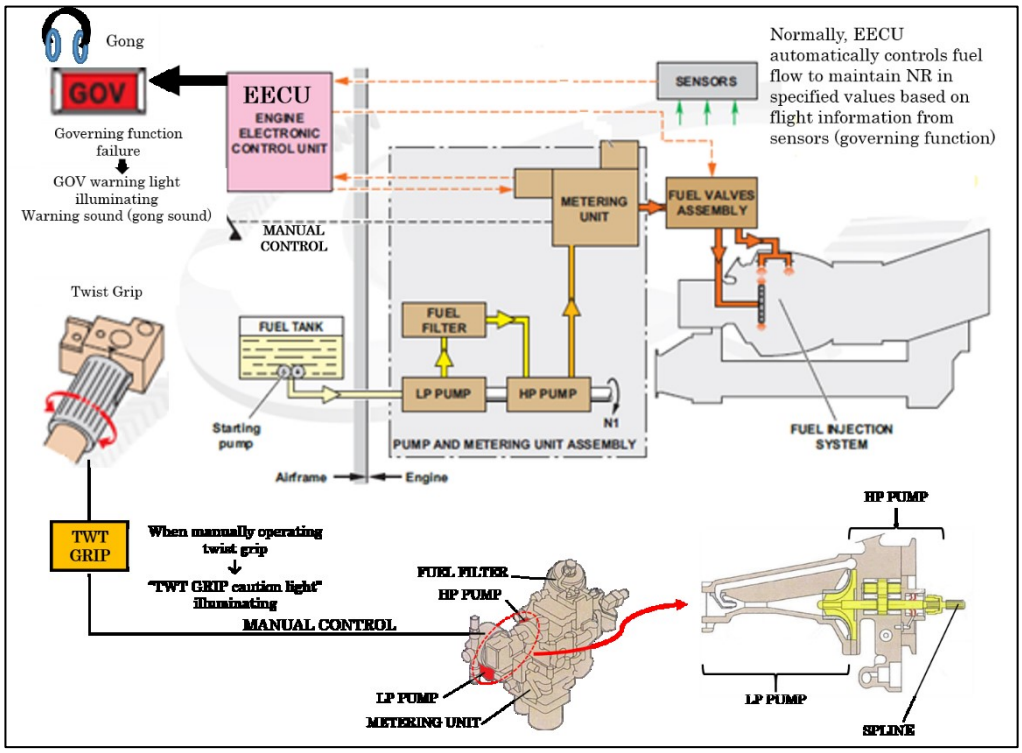

Figure 4: Pump and metering unit assembly (governor system)

Flight manual of the helicopter contains following descriptions with regard to the emergency control procedures when GOV warning has been activated: (excerpt)

In the event of engaging in MANU Mode*3 or governor failure

– Fuel flow is fixed at the value before the failure.

Pilot actions

– *Check flight parameters.*
– *Maintain NR in green range.*
– *Unlock the FLIGHT detent (VOL), the fuel flow can be modified by turning the twist grip:*
  - *to the left to increases fuel flow*
  - *to the right to decreases fuel flow*
– *Only apply small amplitude adjustments, synchronized with the collective pitch control in order to maintain NR in the green range.*
– *Fly the approach at 40 kt and adjust the fuel flow rate to maintain NR within the upper section of the green range. Slowly reduce the speed if necessary adjust the fuel flow rate slightly on the twist grip to maintain NR within the green range.*

  On final approach, when the collective pitch is increased on reaching the hover, let the NR drop for touchdown. After touchdown, reduce the fuel flow rate before lowering collective pitch.

Note 2: in all cases, the NR must be controlled so that the MAX NR alarm is never activated.

*3 "MANU (Manual) Mode" denotes fuel flow adjustments by Emergency Throttle Control at the time of governor failure.

(2) Twist Grip

Twist grip is a rotation-typed grip positioned at the tip of CP. Normally, NR is automatically adjusted by Engine Electronic Control Unit at FLIGHT Detent*4 position. Unlocking FLIGHT Detent and subsequently turning twist grip enable the fuel flow to be adjusted manually as shown in Figure 5. TWT GRIP caution light (amber color) illuminates when FLIGHT Detent is unlocked, which indicates that manual control by the twist grip is feasible.

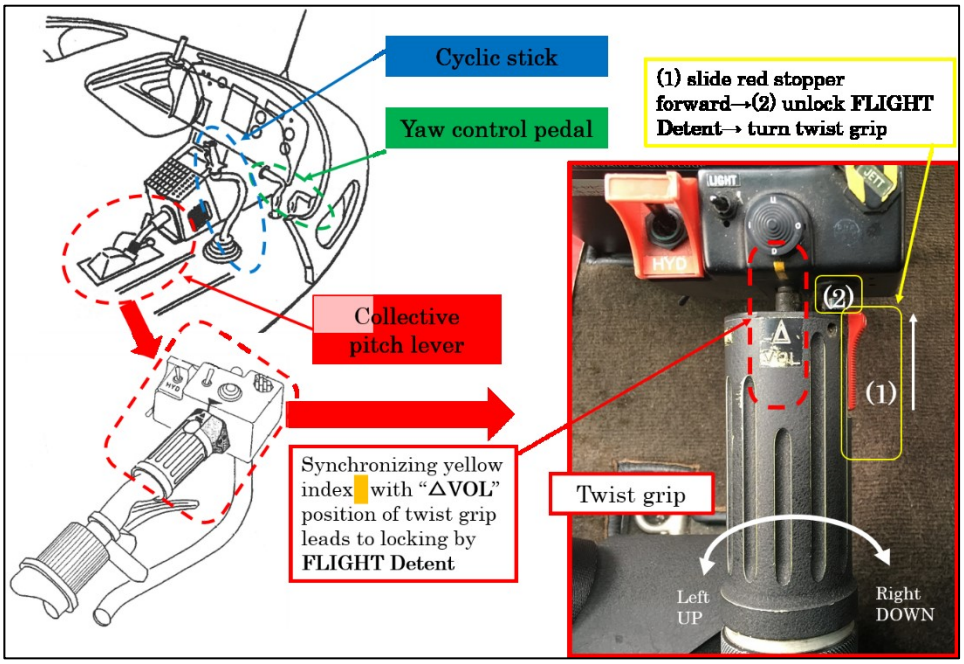

Figure 5: Twist grip control

(3) Functions of AP

AP equipped in the helicopter controls three axes (pitch, roll and yaw) and is capable of holding attitude of the airframe, air speed and pressure altitude selected by a pilot and heading direction selected by heading selector knob. Pitch and roll channels have Artificial Load System and are switched on or off by trim release switch in the control console. Status of AP mode in use can be confirmed in the AP monitoring panel.

*4 "FLIGHT Detent" denotes a detent that prevents mistaken closure of throttles.

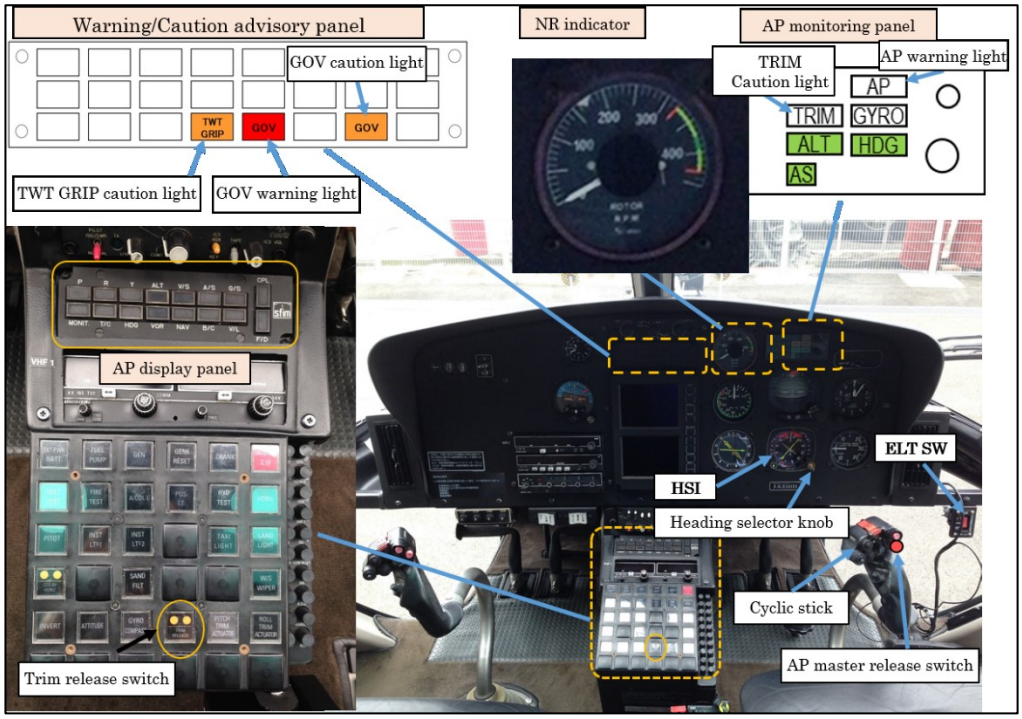

Figure 6: Pilot's seat and AP display of the helicopter

(4) Output Required for Level Flight

Measurement of the output required for level flight using flight training device of AS350B3e, which has performance equivalent to the helicopter, under the flight condition at the time of occurrence of malfunction, is shown in Figure 7 below.

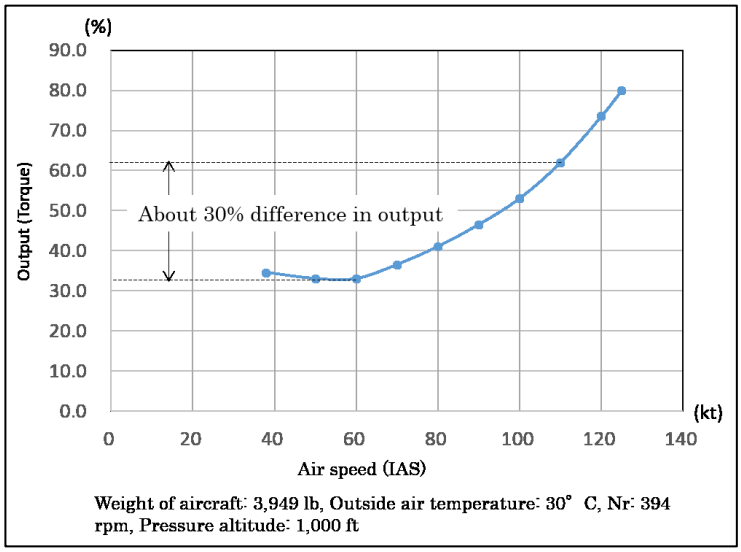

Figure 7: Output required for level flight

(5) Emergency Equipment

The helicopter was equipped with life jackets (for six adults and three children) and a rescue boat capable of boarding six persons. The pilot did not wear a life jacket.

(6) Emergency Float

Individual addendum to the flight manual of the helicopter contains descriptions with regard to emergency control procedures in case of ditching

	using emergency float as follows: (excerpt) ● *Ditching at 10 kt or less is recommended.* ● *Ditching must be as horizontal as possible.* ● *Ditching with power on requires deceleration to 5 kt or less before lowering the collective lever after ditching.* (7) Governor or Fuel Control Failure Helicopter Flying Handbook of FAA (FAA-H-8083-21A 11-21 on page 151) describes with regard to governor or fuel control unit failure as follows: *If the governor or fuel control unit fails, any change in collective pitch requires manual adjustment of the throttle to maintain correct rpm. In the event of a high side failure, the engine and rotor rpm tend to increase above the normal range. If the rpm cannot be reduced and controlled with the throttle, close the throttle and enter an autorotation. If the failure is on the low side, normal rpm may not be attainable, even if the throttle is manually controlled. In this case, the collective has to be lowered to maintain rotor rpm. A running or roll-on landing may be performed if the engine can maintain sufficient rotor rpm.* (8) Emergency Control Training by the Pilot for the Case of GOV Warning Light Illuminating The pilot had not experienced training of emergency control for the case of governor warning light failure, and had verbally confirmed the procedures simulating the failure in regular training. Besides, the pilot had experienced small adjustments of the twist grip in the right direction caused an abrupt reduction of NR when he was manually operating the governor on the ground.

3. ANALYSIS

3.1 Involvement of Weather	None
3.2 Involvement of Pilot	Yes
3.3 Involvement of Aircraft	Yes
3.4 Analysis of Findings	(1) Estimated Causes of the Malfunction of the Aircraft From the maintenance history of the helicopter and the statement of the pilot, it is probable that the helicopter did not have any abnormality until GOV warning was activated. It is somewhat likely that the engine of the helicopter was not shut down, but was under low output condition because the abrupt veering to the right along with GOV warning illuminating and the reduction of NR occurred during the flight using AP, and the pilot was able to maintain NR at around 370 rpm by slightly lowering CP. It is probable that, when GOV warning is activated, the possibility of occurrence of the NR reduction and right veering is low because the fuel flow is fixed at the value before the occurrence of failure in the event of simply sticking of metering valve or malfunctioning of engine control

system. To the contrary, in the event of malfunction of low pressure pump or high pressure pump in Pump and Metering Unit Assembly, it is probable that the engine output is reduced and veering to the right occurs due to reduced fuel flow. It is somewhat likely that the engine output did not follow manual operations of the twist grip because the malfunction hindered sufficient adjustments of fuel flow. However, it could not be determined in which section of the aircraft the malfunction occurred and what caused it because the helicopter sank in the sea and the record of the engine data could not be obtained.

(2) Situation of Airframe and Emergency Control the Pilot Took after Occurrence of the Aircraft Malfunction

It is probable that NR was not recovered to the normal operation range and the altitude of the helicopter was lowered although the pilot commenced emergency control after GOV warning of the helicopter.

It is probable that the pilot continued operating the twist grip for emergency control maintaining an air speed of about 100 kt based on the recognition that the output was maintained to some extent because NR was stabilized at around 370 rpm after GOV warning light was illuminated.

It is somewhat likely that unsuccessful recovery of NR by the pilot was attributable to the malfunction of the fuel flow system, which prevented NR from following, although he turned the twist grip only in the left direction paying his attention to a possible excess of NR. Besides, it is somewhat likely that the engine output was too insufficient to rotate the main rotor maintaining the speed and to restore NR.

Maintaining NR in a normal operation range (green arc line) requires confirmation of flight parameters in emergency control and subsequent operations in accordance with such parameters, and it is possible that NR would be easy to maintain by extra output brought about by deceleration, if in cruising flight. Figure 7 shows about 30% difference by comparing an air speed of 110 kt with 60kt, which is close to the best climb rate speed. From this, it is somewhat likely that it was feasible to maintain level flight by maneuvering deceleration at first, as far as reduction of the output was within about 30%, and even in the situation of more reduced output, emergency control could have been performed with more time available to do so.

It is probable that the pilot decided to ditch for emergency, sent distress message in a short period of time with operating deceleration, extended the Emergency Float, manually activated ELT and operated emergency ditching; however, due to the late descending operation, the helicopter ditched at an air speed of 20 to 30 kt and at an excessive descent rate.

Due to this, it is highly probable that the helicopter sank in the sea with the Emergency Float and the airframe damaged.

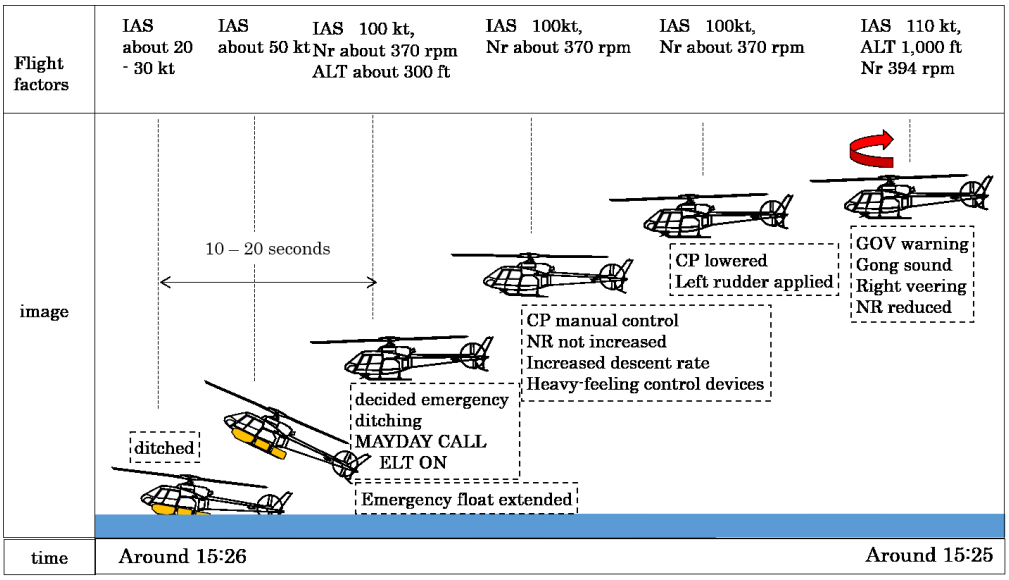

Figure 8: From GOV warning activation to ditching of JA350D

(3) Increased Workload during Emergency Control

With regard to the pilot's feeling that CP and the cyclic stick became heavy during the descending, it is somewhat likely that trim release switch was not turned off when AP was switched off by release switch of the cyclic stick, which caused load of trim actuator in Artificial Load System to remain, there occurred an aerodynamic affect associated with the change in attack of angle of the main rotor blades, or there occurred failure in hydraulic system; however, probable causes could not be determined.

(4) Preventive Measures in Similar Cases

(i) In the event of failure of fuel flow function of engine, it is important to give the highest priority to the control in accordance with flight parameters, to properly judge increase or decrease of NR, and to get familiarized with manual control of emergency control throttle.

(ii) The Emergency Float is considered effectual when a stable ditching can be performed. On the other hand, it is necessary that all of crew members on board wear life jackets when helicopters fly over the sea beyond autorotation distance from the land because it is predicted that a stable ditching is difficult to perform in the event of emergency ditching, and time for evacuation and space for wearing life jackets are limited.

4. PROBABLE CAUSES

In this accident, it is probable that NR of the main rotor was reduced during the flight and flight altitude became unable to maintain, which led to ditching at the excessive speed and descent rate and caused damage to the airframe, followed by sinking.

It is somewhat likely that the reduced NR of the main rotor was caused by some kind of malfunction occurring with engine system; however, it could not be determined in which section of the engine malfunction occurred and what caused it.

5. SAFETY ACTIONS

After the accident, the operator has implemented following measures:

(1) Special training to pilots (ground school training and practical navigation training) to be implemented includes following;

- special training related to emergency procedure for fuel supply system
- training related to emergency procedure for fuel supply system that has become mandatory from optional in regular training
- ground school training to get familiarized with use of Emergency Equipment as well as evacuation training from the sea

(2) Amendment of Operation Manual related to ways to guide passengers in emergency evacuation.

(3) Collecting the latest information on malfunctions from aircraft manufactures and taking courses hosted by engine manufacturers to make the best use of what has been learned for enhancing quality of maintenance.

(4) Introduction of following equipment;

- multi-engine aircraft for navigation to isolated islands and installation of emergency float
- installation and flight operation with wearing life jackets that are possible to put on during the flight

6 RECOMMENDATIONS

6.1 Recommendation to Minister of Land, Infrastructure, Transport and Tourism

In this accident, it is highly probable that the helicopter, when ditching for emergency, ditched at an excessive descent rate and sank in the sea having damage to the Emergency Float and the airframe. The pilot, who did not put on a life jacket, was waiting for rescuers to come grabbing the Emergency Float in the sea, and he was found and rescued by a rescue helicopter about 13 minutes after the ditching.

It is necessary to sufficiently reduce speed and descent rate of aircraft in order to let the Emergency Float function in an effectual manner and to perform a stable ditching. It is predictable that, under the situation where such conditions is not met as in the case of this accident, a stable ditching is difficult to perform and crew members do not have enough time to exit after putting on life jackets.

In view of what is stated above, pursuant to the provision of Article 26 (1) of Act for Establishment of the Japan Transport Safety Board, the Japan Transport Safety Board recommends Minister of Land, Infrastructure, Transport and Tourism to take measures described below in order to prevent aircraft accident and to mitigate damage in the event of occurrence of aircraft accident.

Civil Aviation Bureau of Ministry of Land, Infrastructure, Transport and Tourism is to consider to request aircraft operators that all crew members on board wear life jackets when helicopters fly over a water area beyond the autorotation distance from the land.