AA2019-8

AIRCRAFT ACCIDENT
INVESTIGATION REPORT

JAPAN COAST GUARD SCHOOL MIYAGI BRANCH
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September 26, 2019

JTSB 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.

Nobuo Takeda
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 DUE TO HARD LANDING
JAPAN COAST GUARD SCHOOL MIYAGI BRANCH
BELL 505 (ROTORCRAFT), JA184A
AT SENDAI AIRPORT, JAPAN
AROUND 14:06 JST, FEBRUARY 27, 2019

August 30, 2019
Adopted by the Japan Transport Safety Board
Chairman Nobuo Takeda
Member Toru Miyashita
Member Yoshiko Kakishima
Member Yuichi Marui
Member Yoshikazu Miyazawa
Member Miwa Nakanishi

1. PROCESS AND PROGRESS OF THE AIRCRAFT ACCIDENT INVESTIGATION

1.1 Summary of the Accident	On Wednesday, February 27, 2019, a Bell 505, registered JA184A, belonging to Japan Coast Guard School Miyagi Branch, with an instructor as a captain and two trainees on board, experienced hard landing while conducting autorotation full landing on the west helipad at Sendai airport and suffered damage to the airframe.
1.2 Outline of the Accident Investigation	The Japan Transport Safety Board designated an investigator-in-charge and one investigator on February 28, 2019 to investigate this accident. An accredited representative and an adviser of Canada, as the State of Design and Manufacturer of the helicopter involved in this accident, and an accredited representative and an adviser of the Republic of France, as the State of Design and Manufacturer of the engine of the helicopter, participated in the investigation. Comments on the draft final report were invited from parties relevant to the cause of this accident and the Relevant States.

2. FACTUAL INFORMATION

2.1 History of the Flight	According to the statements of the instructor as the captain of the helicopter, two trainees and the air traffic controller at local control position of Sendai airport traffic control tower (hereinafter referred to as "the Tower") and the records of the integrated instruments (G1000H manufactured by Garmin Limited), the history of the flight is summarized as follows: The helicopter Bell 505, registered JA184A, belonging to Japan Coast Guard School Miyagi branch (hereinafter referred to as "the School"), which

is an approved training organization for commercial pilots (rotorcraft, land single-turbine), with the instructor sitting in the left pilot's seat, trainee A in the right pilot's seat and trainee B in the center rear seat on board took off from the west helipad at Sendai airport for the basic operation stage training based on the education manual of the School on February 27, 2019 at 13:08 JST (JST: UTC+9 hours; unless otherwise noted, all times are indicated in JST in this report on a 24-hour clock).

The helicopter conducted trainings of air work in the training airspace in the southwest of the airport, and then entered the traffic pattern of the airport for six times touch and go training conducted by trainee A. The fifth and sixth trainings were autorotation power recovery*1 (hereinafter referred to as "Power Recovery"). Wind information reported by the Tower during the touch and go trainings was that wind direction was 120° - 130°, wind velocity was10 - 13 kt and approaching and take-off directions were 120°. The instructor presumed from the wind situation and so on that the

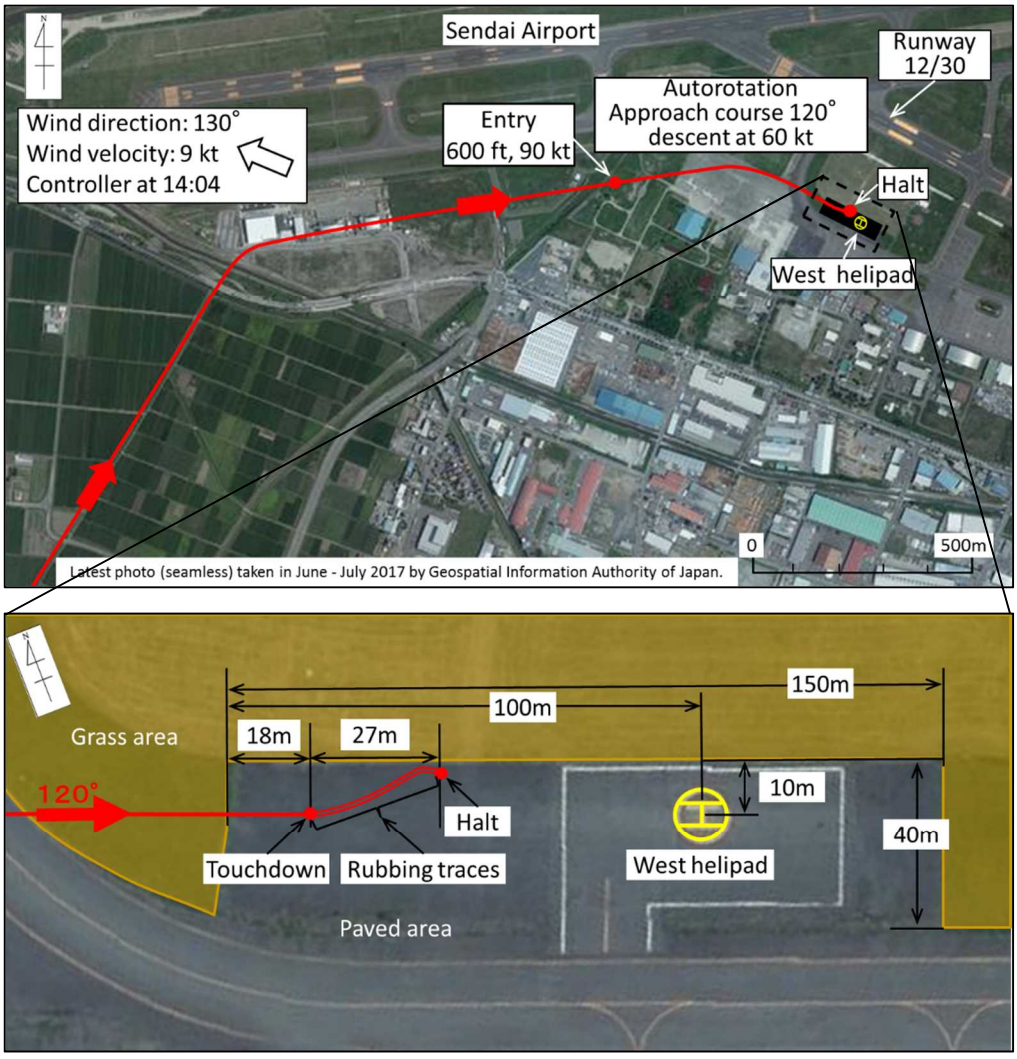


Figure 1: Estimated flight route

*1 There are two different types of the training for "autorotation landing" assuming the case that the engine stops in the airspace; "Power Recovery" that is to approach by autorotation setting the engine idle and then to transfer to hovering setting the engine back to normal flight status when descending to near the ground, and "autorotation full landing (hereinafter referred to as "Full Landing")" that is to touch down setting the engine idle as it is.

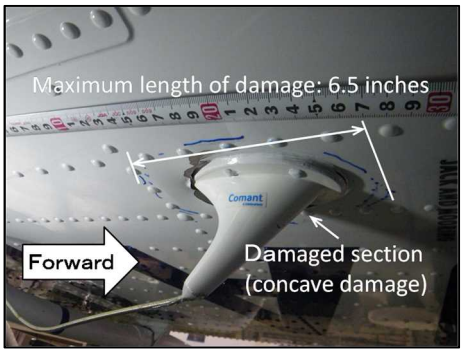
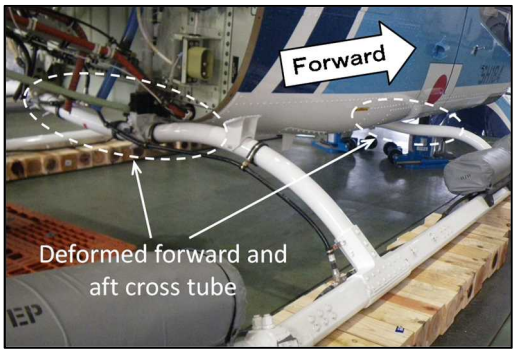
condition was suitable for the opportunity to conduct demonstration flight of Full Landing*[1], which each trainee is obliged to conduct once or more in the basic operation stage.

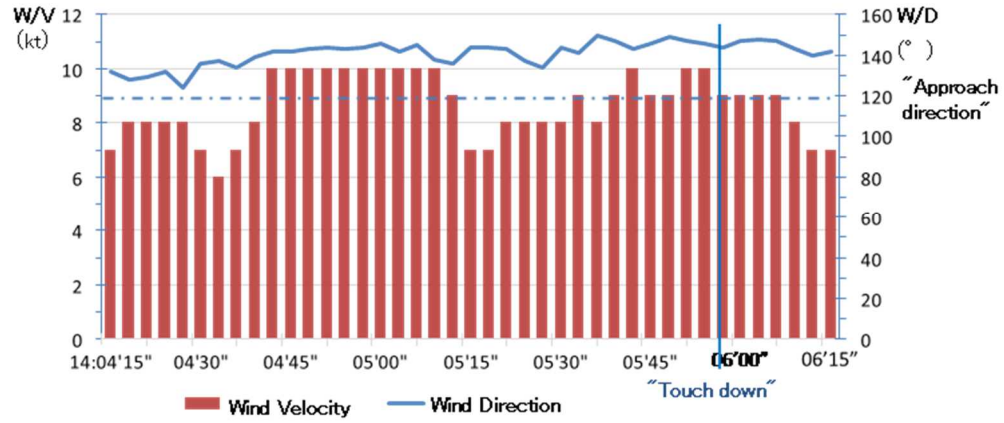
Figure 2: Throttle

The instructor switched the flight control from the trainee A at the west helipad and the helicopter took off to conduct Full Landing on the paved area short of H mark indicating the west helipad. The landing gear of the helicopter is skid type that features smooth sliding performance on paved area, however, on the other hand, poor sliding performance on grass area, which occasionally causes a steep deceleration or shaking during sliding on grass area and could adversely affects the airframe. Besides, because H mark of the west helipad is located in the east side of the paved area, which provides a shorter paved area for approaching in the direction of 120°, the instructor intended to touch down on the paved area short of H mark in order that the helicopter did not enter the grass area even if it slid.

The helicopter entered traffic pattern and received clearance from the Tower on touch and go by autorotation on the west helipad. The wind direction and wind velocity at that time were 130° and 9 kt, respectively. The instructor made an entry maneuvering (maneuver to put throttle switch idle and lower collective pitch control lever (hereinafter referred to as "CPL") to the lowest position) at the point that takes the wind into consideration and slightly raised CPL because lowering CPL to the lowest position increases the number of rotation of the main rotor (hereinafter referred to as "Nr") too excessively. The instructor confirmed speed, Nr and slip indicator when the descent attitude became stabilized. The instructor decided to conduct Full Landing as it was on because the velocity at that time was 60 kt, Nr almost maintained about 100%, there was no sliding and the helicopter was approaching toward the paved area short of H mark.

Though the instructor intended to commence deceleration during the descent at 150 ft above the ground level (AGL) where "MINIMUM" automatically sounds, and the instructor was sure to manage to land by normal maneuvering although the helicopter was around 100 ft AGL due to a slight delay. The instructor felt more sinking, when descending, than he had expected. The instructor maneuvered to moderate flare maneuvering (nose up maneuver to mitigate the descent rate and the speed at touchdown) so that the helicopter did not touch down short of the paved area by reducing the speed too excessively, and then, the helicopter was coming close to the ground before a sufficient deceleration had been obtained. The instructor presumed that the helicopter could not touch down if nose up attitude was kept unchanged, and accordingly, set the nose to horizontal attitude. At the same timing, the helicopter touched down accompanied by a strong impact,

	slid to the left and finally came to a halt slightly pointing to the right. After confirming that two trainees suffered no injury by talking to them, the instructor decided to suspend the training as he realized the helicopter banked to the right, contacted the Tower and shut down the engine. None of three persons on board heard the low rotation alarm, which is designed to sound when Nr becomes below 95% (when the power is off), from flare until touchdown. There was no abnormality at the pre-flight inspection and in-flight. The place of the occurrence of the accident was near the west helipad at Sendai airport (38°08'10" N, 140°55'01" E) and the time of the occurrence was February 27, 2019 around 14:06.
2.2 Injuries to Persons	None
2.3 Damage to Aircraft	Extent of damage to the helicopter: Substantially damaged Antenna mounted to the bottom of the airframe: Damaged (concave damage) Skid (forward and aft cross tube): Deformed  Figure 3: Antenna mounting  Figure 4: Forward and aft cross tube
2.4 Personnel Information	Captain (Instructor) Male, Age 48 Commercial pilot certificate (Rotorcraft) March 30, 2001 Specific pilot competence review validity December 20, 2019 Rating: Land single-turbine March 30, 2001 Flight instructor certificate (Rotorcraft) February 7, 2008 Flight time for flight instruction in the last one year 225 hours 23 minutes Class 1 aviation medical certificate Validity September 27, 2019 Total flight time 2,348 hours 03 minutes Total flight time in the last 30 days 18 hours 13 minutes Total flight time on the type of aircraft 62 hours 23 minutes
2.5 Aircraft Information	(1) Aircraft Type Bell 505 Serial number 65032 Date of manufacture October 10, 2017

	Certificate of airworthiness No. To-30-495 Validity January 30, 2020 (2) Weight and balance When the accident occurred, the weight and balance of the helicopter are estimated to have been within the allowable ranges.
2.6 Meteorological Information	Aeronautical weather observations of the airport at the relevant time of the accident were as follows: 14:00 Wind direction 130°, Wind velocity 10 kt, CAVOK Temperature 7°C, Due point -3°C, Altimeter setting (QNH): 30.22 inHg Besides, instantaneous wind direction and wind velocity observations (on runway 12 side) of the aerodrome at the relevant time of the accident were as follows:  Figure 5: Instantaneous wind direction and wind velocity (Every three seconds from 14:04'15" till 14:06'15")
2.7 Additional Information	(1) Situation at Accident Site The accident site was a flat pavement and nose of the helicopter pointed southeast (about 160°). About 27 m west from there, there were two lines of rubbing trace and its edge was in the direction of 300° from the west helipad and located 18 m from the edge of the pavement (see Figure 1). (2) Procedures for Autorotation Procedures for conducting aircraft training (Japan Coast Guard) contain the description shown in Figure 6. Procedures for Power Recovery are such that aircraft makes entry from the level flight of 600 ft and the speed of 90 kt, approaches at the speed of 60 kt by autorotation, after switching throttle switch to fly (normal flight position; the engine is controlled to adjust the Nr constant even if CPL is moved) at 150 ft AGL maneuvers to decelerate followed by flare maneuvering, halts descent of the helicopter by raising CPL and shifts to hovering. Procedures for Full Landing are same as ones for Power Recovery except for not switching throttle switch to fly and touchdown without shifting to hovering after flare maneuvering.

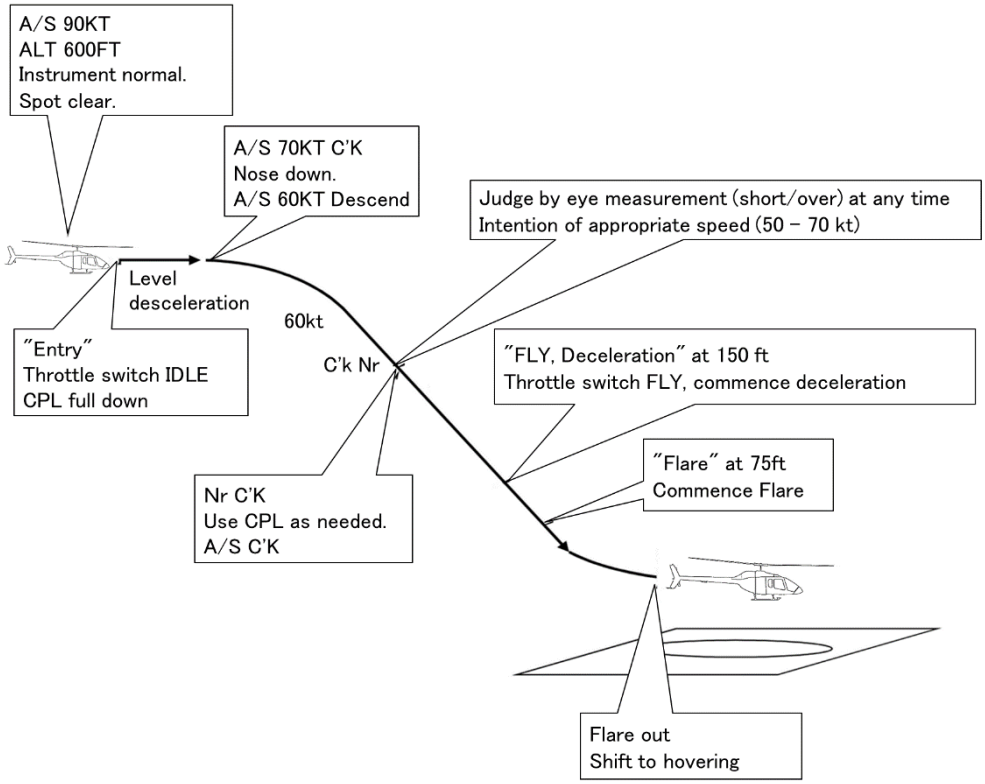


Figure 6: Procedures for autorotation (in case of Power Recovery)

(3) Features of Instruments

The School started to use the Bell 505 helicopter as a training helicopter in March 2018 in addition to the Bell 206 helicopter already in use, and thus, there were two models of the helicopter in use at the time of the accident. According to the instructor, there is almost no difference in the sense of maneuvering between both models, however, 505 model is equipped with the integrated instruments of PFD (Primary Flight Display) on the right and MFD (Multi Function Display) on the left. Speed and altitude are displayed on PFD in the state of scale and in digital numerals that differs in the way of display from previous instruments. At take-off and landing, PSI (Power Situation Indicator), part of PFD, is displayed on MFD. The model also features a function to sound alarm at any altitude AGL as desired and 150 ft AGL was set at the time of the accident.

Figure 7: Bell 206 instruments

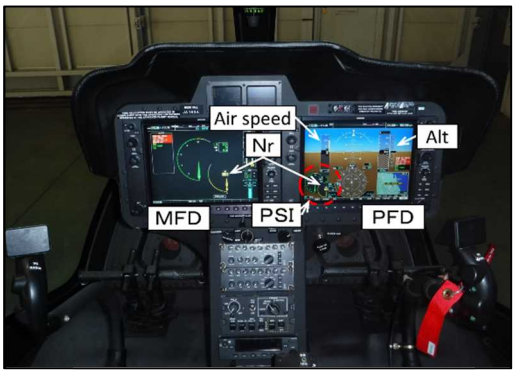


Figure 8: Bell 505 instruments

(4) Footage of Monitor Camera at Apron

Situation at the time of the accident was recorded in the monitor camera set at the apron, sequence photos of which are as shown in Figure 9. The helicopter had 12° nose up at 77 ft AGL 5.5 seconds before touchdown, 15° nose up at 49 ft AGL 4 seconds before touchdown and 23° maximum nose up at 21 ft 2 seconds before touchdown, and then, nose down was commencing followed by touched down in a horizontal attitude.

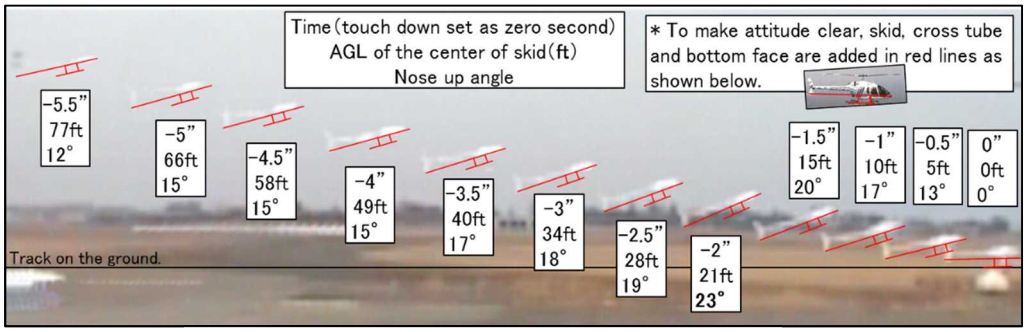


Figure 9: Monitor camera footage set at apron

(5) Analysis of Flight Data Recorded in the Integrated Instrument

According to data recorded in the integrated instruments of the helicopter, it touched down at 14:05:53. Analytical result of the data by the designer and manufacturer of the helicopter was as follows:

a. Forward airspeed (ground speed unknown) at touchdown was about 30 kt.

b. Descent rate at touchdown was 840 fpm, which is excessive as autorotation touchdown.

c. Throttle switch was at idle position at touchdown.

d. Accident flight indicated a low flare altitude compared to autorotation conducted before the accident.

e. At touchdown, Nr was close to 100%, which was not in low rotor rotation.

f. At touchdown, the position of CPL was lower than one expected by normal autorotation.

(6) Training of Instructor

Trainings of the instructor were conducted for one hour or longer per month in conformity with the education manual. The number of Full Landing aggregated 34 times since the first time he conducted in July 2014 until the accident. With regard to the pilot's seat, the left pilot's seat was 20 times, the right pilot's seat was once and 13 times were unknown. As for the helicopter used, the same type of the helicopter was 4 times and Bell 206 was 30 times. Trainings recently conducted were once each in the right pilot's seat of Bell 206 on February 8, 2019 and in the left pilot's seat of the same type of the helicopter on February 6, 2019.

3. ANALYSIS

3.1 Involvement of Weather	None
3.2 Involvement of Pilot	Yes

3.3 Involvement of Aircraft	None
3.4 Analysis of Findings	(1) Situation at Approaching It is highly probable that the instructor sitting in the left pilot's seat intended to conduct Full Landing with the aim to touch down on the paved area short of H mark by seeing Power Recovery the trainee A had conducted twice and presuming that the condition including wind situation was suitable for demonstration flight of Full Landing. It is highly probable that the instructor decided to conduct Full Landing because he confirmed, while descending, the speed, Nr and slip indicator status and the helicopter was approaching toward the paved area short of H mark. (2) Deceleration Maneuvering It is highly probable that the deceleration maneuvering the instructor intended to conduct at 150 ft AGL was commenced at about 100 ft AGL. It is highly probable that the instructor continued Full Landing without canceling the autorotation presuming that the landing was feasible to conduct by normal maneuvering, despite being recognized the delayed commencement of the deceleration. It is probable that this situation judgment by the instructor was not appropriate. It is probable that the alteration of the instruments to the integrated instruments affected very little the delay in commencing deceleration although the integrated instruments have a different way of display from the previous instruments, because the alert sounded at 150 ft at the time of the accident. (3) Flare Maneuvering It is highly probable that the delay in commencing deceleration maneuvering requires more elevated flare than normal to mitigate descent rate before the helicopter comes close to the ground. It is highly probable that the descent of the helicopter did not halt although the flare was continued until it came very near the ground. It is highly probable that the descent the helicopter did not halt was attributable to insufficiently elevated flare. With regard to the flare that was not sufficiently elevated, it is probable that the instructor's view to prioritize the touchdown position over mitigating the descent rate was involved because he presumed that the helicopter would touch down short of the paved area by too excessive deceleration if the flare was elevated. However, it is probable, in this case, that the flare should have been elevated giving priority to halt the descent rather than touchdown position. (4) CPL Maneuvering It is required to raise CPL, no matter if low rotation alarm sounded, to mitigate the impact caused by high descent rate touchdown, however, it is highly probable that CPL of the helicopter was kept at low position. It is probable that this was due to lack of sufficient time to raise CPL because the helicopter, which had been performing flare until it came close to the

	ground, already touched down when the instructor attempted to raise CPL after stop the flare maneuvering. (5) Damage to the Air Frame It is highly probable that the helicopter experienced hard landing led by insufficient deceleration of the descent speed of the helicopter in Full Landing, made deformation of the cross tube, the antenna at the bottom of the helicopter contacted the ground and damaged the outer plate of the antenna mounting portion, and so on. (6) Implementation of Demonstration Flight for Full Landing Full Landing requires a high level of judgment and maneuvering proficiency, and is a curriculum that could cause damage to airframe if it failed, and thus, it needs to be conducted cautiously. However, procedural difference between Full Landing and Power Recovery lies only in either switching throttle switch to fly for hovering or touchdown without switching. Because demonstration flight for Full Landing is to show trainees that the same procedures applied for Power Recovery until close to the ground enable safe landing, it is required to conduct Full Landing in accordance with the procedures. In this accident, it is probable that the instructor continued the maneuvering presuming that the landing was feasible to conduct by normal maneuvering, despite being recognized the delayed commencement of the deceleration. Even in view of the purpose of the demonstration to show the model of maneuver to trainees, it is probable that the instructor should cancel the autorotation when the instructor recognized the deceleration could not be commenced at an altitude according to the prescribed procedure.

4. PROBABLE CAUSES

In this accident, it is highly probable that the helicopter experienced hard landing without stopping its descent speed and damaged the air frame, when the helicopter was executing autorotation Full Landing, because of the delayed commencement of deceleration and improperly subsequent maneuvering.

5. SAFETY ACTIONS

After the accident, the School reconfirmed following items in order to prevent recurrence.

(1) Treatments and confirmation for the instructors on the ground
   a. Procedures and the points to note for autorotation landing*1
   b. Various procedures and the points to note for emergency operations other than autorotation landing
   c. Differences between Bell 206 and Bell 505 and the points to note
   d. Study of similar cases in the past (accidents during autorotation training)

(2) Treatments and confirmation for the instructors in the air (mutual confirmation of flight by instructors on board after completion of (1) described above)
   a. Autorotation landing
   b. Emergency operations other than autorotation landing

c. Differences between Bell 206 and Bell 505

d. Pattern flight and touch and go including autorotation landing

Note: Treatments in a. through c. in above (2) are conducted two hours and twice per instructor mutually by instructors. With regard to d., final confirmation is conducted for each instructor by chief practical instructor.