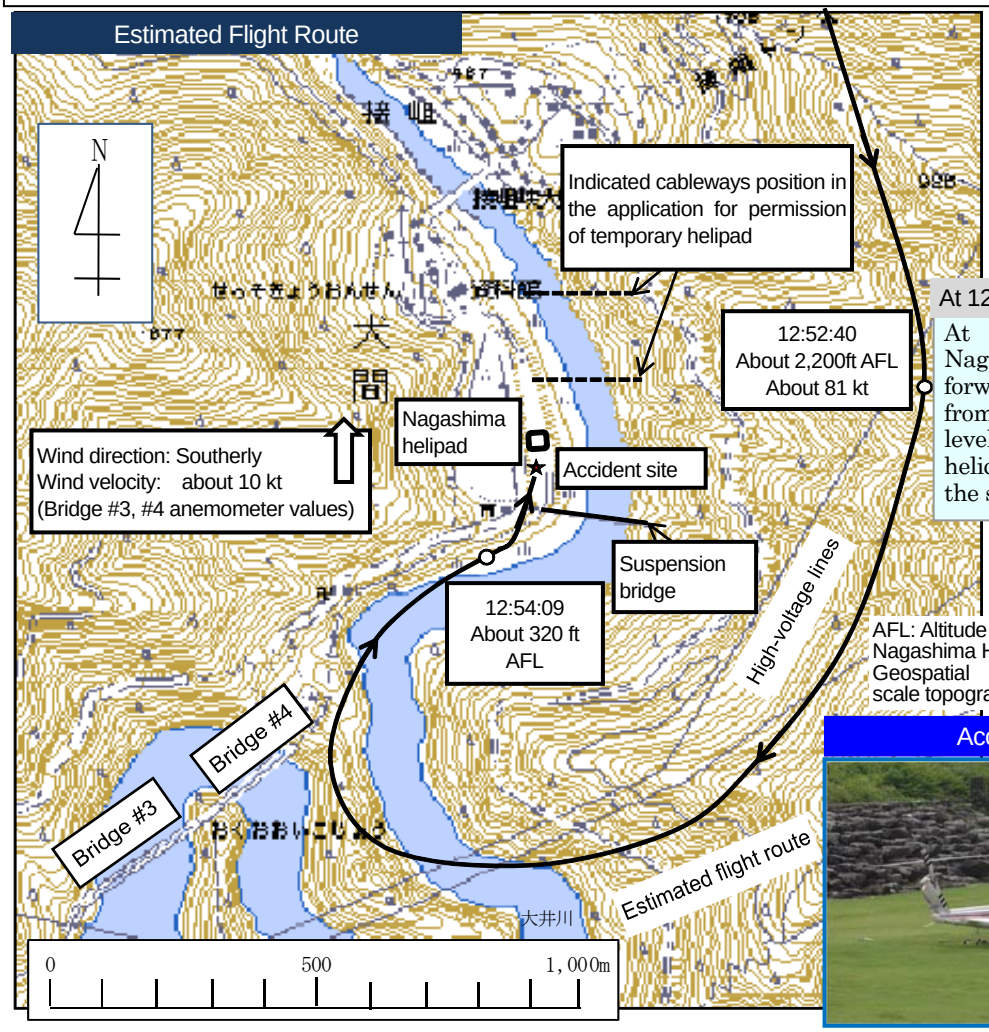
Case 4

Persons on board were injured as a result of hard landing during a high descent rate

Summary: On Friday June 29, 2012 at 12:54 local time (UTC+9 hours), a Bell 412EP, owned by Chubu Regional Bureau, Ministry of Land, Infrastructure, Transport and Tourism (operated by contracted Company A) experienced a hard landing when attempting to land at upstream of Nagashima Dam temporary helipad, Kawanehon-cho, Haibara-Gun, Shizuoka Prefecture. The pilot suffered serious injuries, and one of the passengers suffered minor injuries.
There were eight persons on board, consisting of the pilot, two crews and five passengers.
The helicopter was slightly damaged, but there were no outbreak of fire.

Estimated Flight Route



At 12:52:40

At about 800 m east of Nagashima Helipad, with a forward airspeed of 81 kt and from about 2,200 ft above field level (AFL) of the helipad, the helicopter was descending in the south-southwest direction.

AFL: Altitude above field level of the Nagashima Helipad.
Geospatial Information Authority 1/25000 scale topographic map was used.

Accident Helicopter

Events leading to the Accident

About 10:00

The helicopter made the first landing at Nagashima Helipad. The PIC determined that the wind was calm from the conditions of the surrounding trees and other things. The PIC avoided a southward approach that would pass over hardly visible cableways at the north of Nagashima Helipad, deciding to use a northward approach instead. This was the PIC's first time to land at Nagashima Helipad.

At 11:55

The helicopter took off from Shizuoka Heliport with a pilot and seven persons onboard, and after completing a flight to confirm the situation of damage from natural disaster in the area of Oi River basin, the helicopter began an approach to land at Nagashima Helipad.

The helicopter continued to maintain a high descent rate of about 1,300 ft/min while approaching at a high angle, which corresponds to about 55% of induced velocity.

To next page

Causal Factors of the Accident

Prior to the helicopter's takeoff or landing, it was not prepared to clearly indicate the extents of the heliport, etc. and set up wind direction indicators.

For details, refer to "Management of The Temporary Helipad" (next page)

For the approach at the time of the accident, the pilot determined that the wind was calm just as during the first landing, and he passed through a relatively low area between a suspension bridge and a road from the south, making the approach on a northward route with as shallow a pass as possible.

The pilot probably believed from the condition of the nearby trees, etc. that the wind was not strong, and without having an accurate grasp of the wind conditions, made a northward approach with a tailwind of about 10 kt, passing over an easily-visible suspension bridge.

Making an approach from a comparatively high altitude with a target in front of the unmarked helipad, it is probable that the resulting approach was made at a high angle.

From previous page

12:54:12

The onboard mechanic reported the pilot, "The left side is clear".
While descending from an altitude of about 280 ft AFL with a magnetic course of about 010°, the CP position started to gradually be pulled from about 31%, No.1 engine torque (*1) (TQ1) began increasing from about 12% and TQ2 began increasing from about 5%.

12:54:23

While descending from an altitude of about 40 ft AFL with a magnetic course of about 005°, the CP position was being pulled from about 64%, and both TQ1 and TQ2 were increasing from about 47%.
At this point, the pilot exclaimed "Ah…".

12:54:27

The helicopter bounced once before coming to stop.

The pilot continued to descend at low power output from the base leg (*2) to the final approach, and began to pull the CP position from 15 seconds before touchdown, with the helicopter on a nearly straight- line route.

At 5 seconds before touchdown, although the pilot pulled the CP position to about 56%, a position at which transitioning to a hovering state is normally considered possible, this result could not be achieved, therefore it is highly probable that the pilot continued to pull the CP further, until touchdown occurred with the CP ultimately near its operation limit of about 71%.

It is probable that the cause of the hard landing was not a lateness in the pulling of the CP, on the contrary, there existed a condition in which the power output was increased but there was no increase in main rotor (MR) lift, suggesting the occurrence of VRS (*3).

*1: "Engine torque" refers to the rotational moment generated by engine to drive a rotor, etc. For the helicopter, the engine torque value is noted in %, and if both No.1 Engine and No.2 Engine reach about 60% when both engines are in operation, the mast torque of the main rotor will be near its operating limit of 100%.
*2: A traffic pattern before entering final course (final) established for aircraft taking off from or landing to an aerodrome.
*3 Phenomenon which occurs at certain power output when a helicopter transitions from hovering to vertical descent. When the increased downward airflow velocity induced by main rotors becomes equal to helicopter's descent rate, downwash by main rotors flows upward along circumference of main rotors, resulting in generation of vortex like the donuts, and lead to rapid loss of lift.

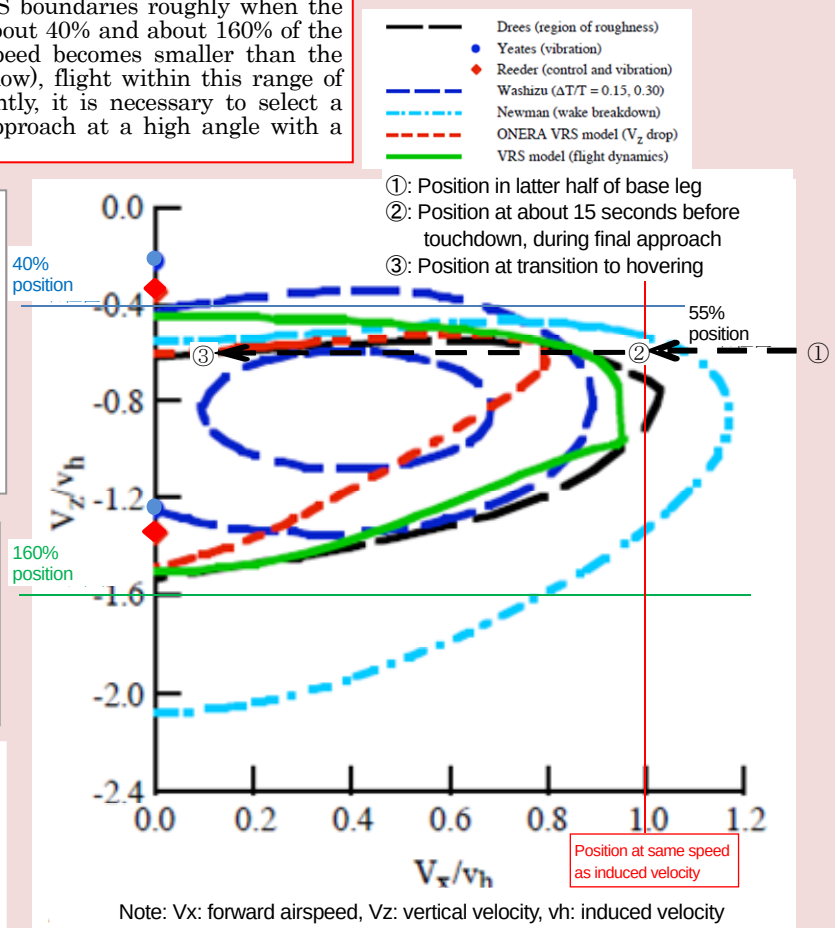
Causes of Entry into VRS Boundaries

Operating in VRS during a landing approach is extremely dangerous because in general cases, a helicopter will not have sufficient altitude to escape it. Therefore, it is critically important to assure that a helicopter does not enter VRS boundaries during a landing approach.
Because it becomes easier to enter VRS boundaries roughly when the descent rate is a large value between about 40% and about 160% of the induced velocity and the forward airspeed becomes smaller than the induced velocity (refer to the figure below), flight within this range of conditions must be avoided. Consequently, it is necessary to select a traffic pattern that does not involve approach at a high angle with a tailwind.

At 37 seconds before touchdown during the latter half of the helicopter's base leg, its forward airspeed was about 30 kt and its descent rate was about 1,300 ft/min. Therefore, the ratio of the helicopter's descent rate to its induced velocity (about 2,360 ft/min: about 23kt) becomes -0.55, and the ratio of the forward airspeed to the induced velocity becomes 1.3, which are **outside of the VRS boundaries** as indicated by ① in the figure.

At about 15 seconds before touchdown the descent rate was about 1,300 ft/min and the forward airspeed was about 22 kt, their ratio to the induced velocities become about -0.55 and about 0.96 respectively, which are **near the entry point of the VRS boundaries** as indicated by ② in the figure.

It is probable that the helicopter's forward airspeed continued to decrease during its high descent rate because it was attempting to land on steep approach path under tailwind conditions.



Note: Vx: forward airspeed, Vz: vertical velocity, vh: induced velocity

Figure: Relationships with VRS Boundaries

From US NASA "STI (Scientific Technical Information) Report Series"

Management of the Temporary Helipad

Prior to the helicopter's takeoff or landing, it was not prepared to clearly indicate the extents of the heliport, etc. and set up wind direction indicators.	It is highly probable that these preparations were not carried out because there was no coordination involving the contracted operator Company A.
The operation supervisor was to coordinate with Chube Bureau's personnel in charge of operation when preparing operation plan, but he failed to request indication of the boundaries of the helipad as well as the setup of windsocks.	The coordination involving these request was somewhat inactive, because the management of the temporary helipad is the responsibility of the Chubu Bureau, and it is possible that this is related to the fact that it is the contractor who would need to make a request to the contractee regarding items for preparation.
The absence of indication for the boundaries of the helipad and the failure to set up windsocks are considered one of factors in this accident.	Because these are fundamental items required for safe operation, there is a necessity to reaffirm their importance and to create a system by which it is sufficiently possible for both operation contractor and contractee to exchange opinions on safety.
The cableways that the pilot had been concerned with during his approach had actually already been removed. If this information had been properly conveyed to him, it is possible that his judgments regarding the approach direction may have been different.	When updating applications, it is necessary to thoroughly confirm whether there are any changes in the application contents from the previous time, and if there is a need for changes, to accurately reflect them in the application contents.

In order to Prevent Recurrence

Following this accident, the Company A implemented safety actions including thoroughly assuring that during update procedures for the temporary helipad, responsible personnel are fully aware of any differences between previous and current application contents, and traveling to offices across the country to carry out the following safety education aimed toward pilots.

1. Settling with Power (synonymous with VRS)
   (1) Summary
   Under conditions where the forward airspeed is the same or less than the induced velocity, if the descent rate becomes 40% or more of the induced velocity, it becomes easier to enter VRS, and considerably more so if the descent rate becomes 60% or more.
   (2) Specific Examples for Models Owned by the Company A
   Bell 412Ep example: Likely to enter VRS with a forward airspeed of 23 kt or less and a descent rate of 935 ft/min or greater; extremely likely with a descent rate of 1,400 ft/min or greater.
   (3) Preventive Measures
   Avoiding a descent at 700 ft/min or greater with a forward airspeed of 25 kt or less.
2. Translational Lift and Ground Effect
   It should be kept in mind that decreasing speed under conditions where ground effects cannot be obtained will require appropriate power output control when translational lift (increase in lift accompanying an increase of inflow air currents to the main rotor generated by forward airspeed of 15 kt or greater) is lost.
3. Other emergency procedures
   Guidelines for collective bounce, dynamic rollover, and loss of tail rotor effectiveness.

Following this accident, the Chubu Bureau implemented the following safety actions.

1. The "Helicopter User's Plan" which is to be prepared by rotorcraft users before operation has been revised so that the newly-defined "Temporary Heliport Pre-Operation Check List" is attached to it for submission to the Disaster Prevention and Relief Division of the Chubu Bureau. This allows advance confirmation among Helicopter Users (Chubu Bureau Internal Office), Operation Division (the Disaster Prevention and Relief Division of the Chubu Bureau), and operation contractors (operating company) to assure that the preparation for operation of temporary helipads (including heliport marking, setup of windsocks and other things) defined in the "Utilization Manual" are properly carried out. Alternative procedures have also been described for items whose preparation may not be feasible. Moreover, it has become possible for the exchange of information regarding the status of preparations, etc. on the target day between the site observer and helicopter to be carried out and confirmed via the Disaster Prevention and Relief Division.
2. Notification of safety actions in writing was made within the Chubu Bureau divisions as well as at Chubu Bureau Internal Office Manager meetings.
3. Safety education regarding the use of helicopters was conducted at opportunities in Chubu Bureau Internal Office Disaster Prevention Representative Division Chief meeting.
4. Safety actions executed after the accident were presented by the Chubu Bureau Disaster Prevention and Relief Division Chiefs at Regional Bureau Disaster Prevention Officer and Division Chief meeting, and provision of information and calls for attention were carried out to other regional bureaus.

The investigation report of this case is published on the Board's website (issued June 28, 2013).
http://www.mlit.go.jp/jtsb/eng-air_report/JA6817.pdf