INCIDENT

Aircraft Type and Registration:	AW169, G-UNIB	
No & Type of Engines:	2 Pratt & Whitney Canada PW210A turboshaft engines	
Year of Manufacture:	2022 (Serial no: 69152)	
Date & Time (UTC):	21 February 2023 at 0800 hrs	
Location:	Humberside Airport, North Lincolnshire	
Type of Flight:	Hoist operations	
Persons on Board:	Crew - 3	Passengers - 4
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Hoist hook and 20 cm of cable severed from hoist	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	55 years	
Commander's Flying Experience:	5,440 hours (of which 490 were on type) Last 90 days - 50 hours Last 28 days - 25 hours	
Information Source:	Aircraft Accident Report Form submitted by the commander plus further enquiries by the AAIB	

Synopsis

During aircraft pre-start procedures, one of the passengers reported that he had seen something fall from the aircraft. The ground crew subsequently reported that the hoist hook had detached from the hoist cable and fallen to the ground. Although there were no functional, mechanical or electrical problems found with the hoist system, it was possible that procedural drift may have resulted in inadvertent activation of the hoist cut system, severing the hoist cable.

The Operator has stressed to their crews the importance of following the organisation's published aircraft start checklists. They have also amended their checklist to include a more detailed hoist start up sequence which contains the warnings from the aircraft's Rotorcraft Flight Manual external hoist system supplement.

History of the pre-flight operation

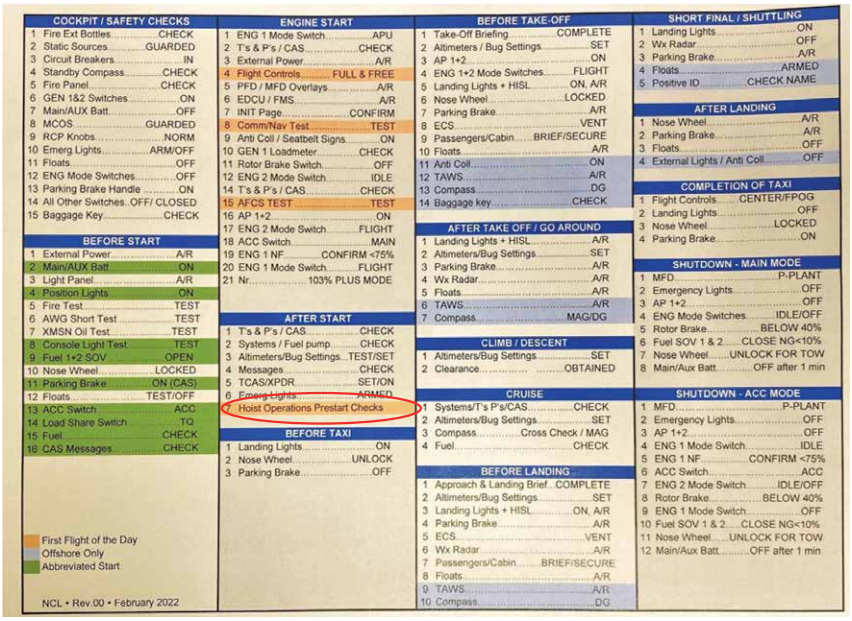
The operator's maintenance organisation had already completed a ground power check and an engine compressor wash procedure before the flight crew began their walk to the aircraft at approximately 0750 hrs. The crew arrived at the aircraft with plenty of time to spare before their scheduled takeoff time of 0800 hrs. The crew consisted of the Pilot Flying (PF) who was also the aircraft commander, the Pilot Monitoring (PM) plus an experienced hoist operator (HO). Their plan was to hoist Helicopter Landing Officers (HLOs) and Wind

Turbine Technicians onto various offshore turbines to undertake repairs and maintenance contracted by an offshore wind farm organisation (Figure 1).

Figure 1

Example pictures of wind turbine hoist operations

The PF proceeded with a 'walkaround' check of the helicopter's external features whilst the PM climbed into the right cockpit seat to begin pre-flight preparations. The HO entered the cabin to assist HLO2, one of two HLOs to be transported that day, to get seated and secure various pieces of equipment. Ground power had already been connected to the aircraft during the previous power check and compressor wash procedure. The PM began his pre-start procedures with the cockpit safety checks listed in company check list document NCL Rev 00 dated February 2022 (company checklist), shown in Figure 2. He reached the engine start procedure but stopped before starting the engines because the PF was still outside the helicopter and had not finished his walkaround check.



COCKPIT / SAFETY CHECKS

1	Fire Ext Bottles	CHECK
2	Static Sources	GUARDED
3	Circuit Breakers	IN
4	Standby Compass	CHECK
5	Fire Panel	CHECK
6	GEN 1&2 Switches	ON
7	Main/AUX Batt	OFF
8	MCOS	GUARDED
9	RCP Knobs	NORM
10	Emerg Lights	ARM/OFF
11	Floats	OFF
12	ENG Mode Switches	OFF
13	Parking Brake Handle	ON
14	All Other Switches	OFF/ CLOSED
15	Baggage Key	CHECK

BEFORE START

1	External Power	A/R
2	Main/AUX Batt	ON
3	Light Panel	A/R
4	Position Lights	ON
5	Fire Test	TEST
6	AWG Short Test	TEST
7	XMSN Oil Test	TEST
8	Console Light Test	TEST
9	Fuel 1+2 SOV	OPEN
10	Nose Wheel	LOCKED
11	Parking Brake	ON (CAS)
12	Floats	TEST/OFF
13	ACC Switch	ACC
14	Load Share Switch	TQ
15	Fuel	CHECK
16	CAS Messages	CHECK

First Flight of the Day
Offshore Only
Abbreviated Start

NCL • Rev.00 • February 2022

ENGINE START

1	ENG 1 Mode Switch	APU
2	T's & P's / CAS	CHECK
3	External Power	A/R
4	Flight Controls	FULL & FREE
5	PFD / MFD Overlays	A/R
6	EDCU / FMS	A/R
7	INIT Page	CONFIRM
8	Comm/Nav Test	TEST
9	Anti Coll / Seatbelt Signs	ON
10	GEN 1 Loadmeter	CHECK
11	Rotor Brake Switch	OFF
12	ENG 2 Mode Switch	IDLE
14	T's & P's / CAS	CHECK
15	AFCS TEST	TEST
16	AP 1+2	ON
17	ENG 2 Mode Switch	FLIGHT
18	ACC Switch	MAIN
19	ENG 1 NF	CONFIRM <75%
20	ENG 1 Mode Switch	FLIGHT
21	Nr	103% PLUS MODE

AFTER START

1	T's & P's / CAS	CHECK
2	Systems / Fuel pump	CHECK
3	Altimeters/Bug Settings	TEST/SET
4	Messages	CHECK
5	TCAS/XPDR	SET/ON
6	Emerg Lights	ARMED
7	Hoist Operations Prestart Checks	

BEFORE TAXI

1	Landing Lights	ON
2	Nose Wheel	UNLOCK
3	Parking Brake	OFF

BEFORE TAKE-OFF

1	Take-Off Briefing	COMPLETE
2	Altimeters / Bug Settings	SET
3	AP 1+2	ON
4	ENG 1+2 Mode Switches	FLIGHT
5	Landing Lights + HISL	ON, A/R
6	Nose Wheel	LOCKED
7	Parking Brake	A/R
8	ECS	VENT
9	Passengers/Cabin	BRIEF/SECURE
10	Floats	A/R
11	Anti Coll	ON
12	TAWS	A/R
13	Compass	DG
14	Baggage key	CHECK

AFTER TAKE OFF / GO AROUND

1	Landing Lights + HISL	A/R
2	Altimeters/Bug Settings	SET
3	Parking Brake	A/R
4	Wx Radar	A/R
5	Floats	A/R
6	TAWS	A/R
7	Compass	MAG/DG

CLIMB / DESCENT

1	Altimeters/Bug Settings	SET
2	Clearance	OBTAINED

CRUISE

1	Systems/T's P's/CAS	CHECK
2	Altimeters/Bug Settings	SET
3	Compass	Cross Check / MAG
4	Fuel	CHECK

BEFORE LANDING

1	Approach & Landing Brief	COMPLETE
2	Altimeters/Bug Settings	SET
3	Landing Lights + HISL	ON, A/R
4	Parking Brake	A/R
5	ECS	VENT
6	Wx Radar	A/R
7	Passengers/Cabin	BRIEF/SECURE
8	Floats	A/R
9	TAWS	A/R
10	Compass	DG

SHORT FINAL / SHUTTLING

1	Landing Lights	ON
2	Wx Radar	OFF
3	Parking Brake	A/R
4	Floats	ARMED
5	Positive ID	CHECK NAME

AFTER LANDING

1	Nose Wheel	A/R
2	Parking Brake	A/R
3	Floats	OFF
4	External Lights / Anti Coll	OFF

COMPLETION OF TAXI

1	Flight Controls	CENTER/FPOG
2	Landing Lights	OFF
3	Nose Wheel	LOCKED
4	Parking Brake	ON

SHUTDOWN - MAIN MODE

1	MFD	P-PLANT
2	Emergency Lights	OFF
3	AP 1+2	OFF
4	ENG Mode Switches	IDLE/OFF
5	Rotor Brake	BELOW 40%
6	Fuel SOV 1 & 2	CLOSE NG<10%
7	Nose Wheel	UNLOCK FOR TOW
8	Main/Aux Batt	OFF after 1 min

SHUTDOWN - ACC MODE

1	MFD	P-PLANT
2	Emergency Lights	OFF
3	AP 1+2	OFF
4	ENG 1 Mode Switch	IDLE
5	ENG 1 NF	CONFIRM <75%
6	ACC Switch	ACC
7	ENG 2 Mode Switch	IDLE/OFF
8	Rotor Brake	BELOW 40%
9	ENG 1 Mode Switch	OFF
10	Fuel SOV 1 & 2	CLOSE NG<10%
11	Nose Wheel	UNLOCK FOR TOW
12	Main/Aux Batt	OFF after 1 min

Figure 2

Aircraft pre-flight, start, flight, landing and shutdown checklists

Whilst waiting for the PF to finish his walkaround, the HO decided to carry out the 'hoist operations pre-start' procedure on the reverse side of the company checklist (Figure 3).

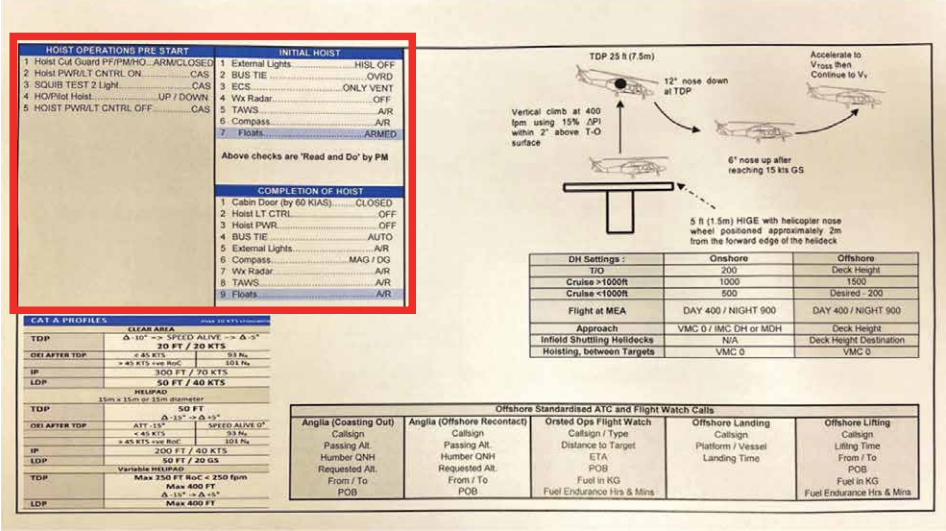


Figure 3

Hoist operation checklists and aircraft operating information

This hoist pre-start procedure required each hoist cable cut switch guard, one on each of the pilot's collective controls and one on the HO's control panel (HO's panel) in the cabin, to be lifted in turn to check that a HOIST CUT ARM caution message appeared on the two Primary Flight Displays (PFDs) and disappeared again once the guards were lowered. This was to be followed by a check of the squib via the HO's panel, with the Hoist Power ON, to ensure the two green squib LEDs illuminated when the squib test button was pressed (Figure 4).

Figure 4

HO control panel showing cut switch guard, squib test button and LEDs illuminated (left) and the panel with the cut switch guard lifted showing the cut button (right)

The HO began by asking the PM to switch on the hoist power (Hoist PWR) and lift the guard of the hoist cut switch on the PM's collective control. Both the PM and the HO verbally

confirmed that a HOIST CUT ARM caution message had appeared on the left and right cockpit PFDs. The PM lowered the guard and both verbally confirmed that the caution messages had disappeared from view.

Once the PF had reached the left cockpit door at the end of his walkaround, the PM asked him to carry out the cut switch guard lift procedure on the left pilot's collective control from his position at the door. The PF lifted the guard and the PM, HO and the PF verbally confirmed the appearance of the HOIST CUT ARM caution on the PFDs. The guard was lowered again and they confirmed the caution messages had disappeared.

HLO1 was at the aircraft, loading and securing equipment into the helicopter's cabin whilst working around the HO. The HO repeated the guard lift process using the HO's panel in the cabin with a similar result. At this point he noticed that the two green LEDs (SQ 1 and SQ 2) on the HO panel were illuminated, but proceeded to press the squib test button, Step 3 in the hoist operations pre-start checklist shown in Figure 3, regardless.

The HLO2 had watched the HO lift the cut guard on the HO panel, although he didn't observe any buttons being pressed, and then noticed something fall from the aircraft's right side by the cabin door. He tapped the HO on the shoulder to tell him what he had seen. About the same time, one of the Ops team also approached the cockpit to let the crew know that the hoist hook had detached from the hoist and fallen to the ground. None of the crew had noticed the hook detach from the hoist cable.

Recorded information

There was no information available from the cockpit voice recorder or the flight data recorder during the period of the incident. However, the following information was determined from the Data Transfer Device (DTD) which had recorded various caution messages sent to the Crew Alerting System (CAS) and displayed on the two PFDs in the cockpit.

On the date of the incident, there were four separate CAS events recorded. The first lasted approximately 7 minutes and recorded the application of ground power. The second event started at approximately 07:41:00 hrs and showed that an engine cranking procedure had occurred which was later confirmed to be for an engine compressor wash. The third of the four events occurred during the incident period. Figure 5 shows the Flight Data Monitoring (FDM) timeline taken from 07:53:00 to 08:18:00 hrs showing the third (Figure 6) and fourth (Figure 7) CAS events.

The third event started at 07:52:49 hrs when the HOIST ON advisory message was activated, confirming that hoist power had been switched on, see Figure 6 expanded event timeline. At approximately the same time, the HOIST CUT ARM and HOIST CABLE FOUL cautions were briefly displayed on the PFDs. In the seconds that followed, a sequence of three HOIST CUT ARM messages were recorded. The data also shows an additional sequence of two caution messages starting at 07:54:15 hrs, with each lasting approximately two seconds. Hoist system power was switched off 36 seconds later at 07:54:51 hrs. The fourth event occurred after the hoist cable had been severed, see Figure 7 expanded event timeline.

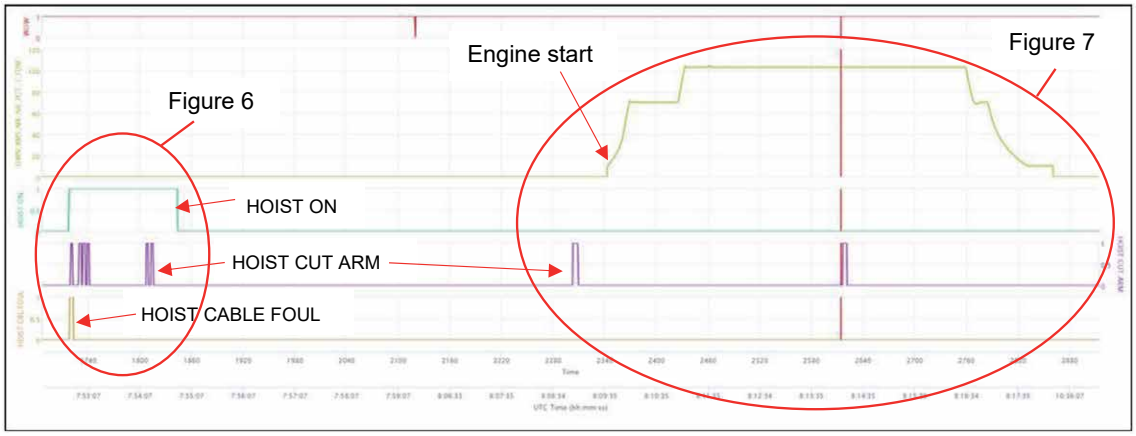


Figure 5

FDM messages recorded by the DTD showing the third and fourth events

Figure 6

Event 3 expanded timeline showing lifting sequence of hoist switch cut guards

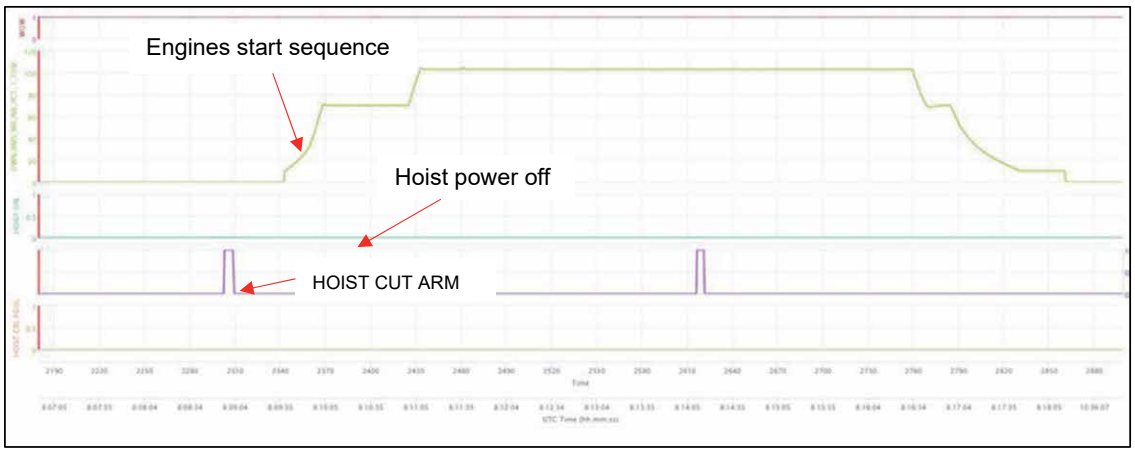


Figure 7

Event 4 expanded timeline - HOIST CUT ARMED cautions before and after engines start

The fourth event began whilst engine 1 was running in APU mode at 08:08:58, during which there was a two second activation of a HOIST CUT ARM caution. The caution occurred again at 08:14:12, but in this case both engines were running and the helicopter's rotors were turning. Both caution activations took place with no power applied to the hoist system. At 08:16:33 both engines were selected to IDLE and then to OFF. CAS recordings ceased at 08:18:15.

Aircraft and hoist information

The incident aircraft, one of two AW169 Leonardo Helicopters, was purchased from new by the Operator in September 2022. The two helicopters were each equipped with a single Goodrich Model 44316 external hoist[1] for lowering personnel onto the platforms of offshore wind turbines to carry out repairs and maintenance. Whilst the Goodrich hoist original equipment manufacturer (OEM) was Collins Aerospace, integration of the hoist onto the aircraft was designed and installed by the aircraft manufacturer. Integration included software to provide cautions on the cockpit PFDs via the CAS when hoist power was applied, cut guards raised or hoist fouling was detected; although there is no PFD warning displayed to the pilots in the event of a cut switch activation. The only warning to the crew that the hoist cable has been cut by the squib is provided by the two LEDs on the HO's panel in the cabin.

The external hoist was specifically designed to meet the Human External Cargo (HEC) regulations[2] necessary to safely raise, hold and lower personnel under a variety of conditions. The hoist system employs an externally mounted, 28 Volt DC electrically powered rescue hoist which utilises a proprietary translating drum cable management system. A Weston style[3] load brake and overload slip clutch[4] provides safe braking mechanisms for the hoist. A secondary shaft locking mechanism that also meets the HEC requirements is employed to improve the level-wind system[5] design. The hoist system includes fault code readouts from the built-in-test system and cable length readouts in both feet or meters on the HO's pendant. The pendant allows the HO to control raising and lowering of the hoist hook and the direction of a searchlight, (Figure 8). The pendant is attached to the hoist system by a coiled electrical cable which allows the HO flexibility to view personnel or equipment suspended from the hoist whilst in flight.

Footnote

1 Manufactured by Collins Aerospace.
2 The definition of HEC is in FAA AC 27/29.865: Human External Cargo (HEC). A person(s) that at some point in the operation is carried external to the rotorcraft.
3 Weston style load brake - Uses the weight of the load to force a friction plate or coned surface against the rotating element. The hoist must be reversed to overcome the holding power of the brake.
4 Overload slip clutch – protects two rotating shafts from damage by slipping when one shaft is overloaded (a friction plate slip-clutch for example).
5 Level-wind system – a method of ensuring the hoist cable is efficiently wound onto the drum as the drum rotates.

Figure 8

External Goodrich hoist assembly after cable had been cut (left) and HO's pendant (right)

To release the winch cable if it becomes fouled and risks the safety of the aircraft, the cable can be cut using the hoist cut buttons located on each pilot's collective control (Figure 9) and the HO's control panel located in the cabin roof behind the headrest of the right pilot's seat.

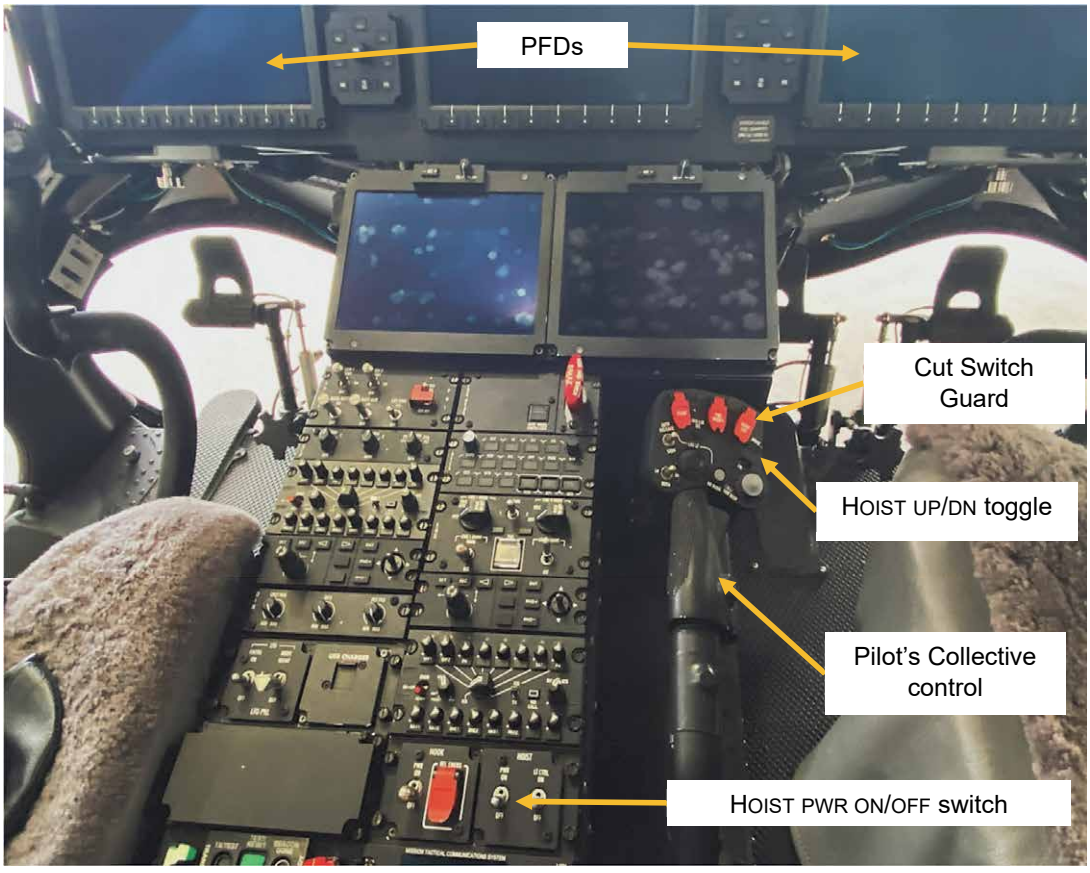


Figure 9

Cockpit showing PFDs, right pilot's collective with cut switch guard plus HOIST UP/DWN toggle button and hoist power switch

To prevent inadvertent activation of the cable cut mechanism, each cut button is shielded by a red cut switch guard which must be lifted before the cut button can be pressed. With the hoist power switched on, lifting the cut guard provides 28 VDC to the cable cut button. When the cut button is pressed, the 28 VDC activates the squib which cuts the cable at the winch point, separating the hook and part of the cable from the aircraft hoist.

Aircraft and hoist examination

The high tensile steel, multistrand hoist cable had been severed approximately 20 cm from the hook assembly (Figure 10). There was no other damage to the aircraft found during the examination.

Figure 10

Hoist hook showing severed cable

After the incident, both squib LEDs on the HO's panel illuminated immediately power was applied to the hoist (Figure 4).

Detailed functional tests were completed on the hoist system but no faults were revealed. Visual inspections were made of both collective controls' hoist cut button wiring connections (Figure 11) but no anomalies were found. The HO's control box was removed and sent to the OEM for examination and functional testing; no faults were discovered.

Out of sequence hoist operations pre-start checks

The company checklist, (Figure 2), begins with 'cockpit/safety checks' followed by a 'before start' checklist and then the 'engine start' procedure. Having started both engines, the checklist then details an 'after start' procedure containing the 'hoist operations pre-start checks' shown in Figure 3.

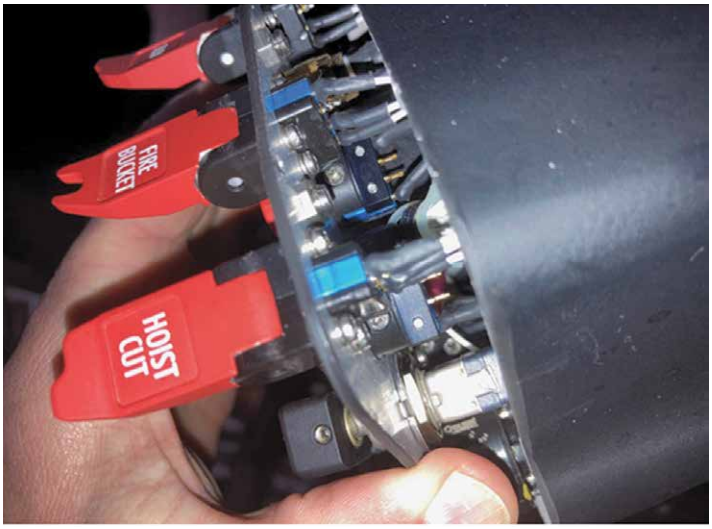


Figure 11

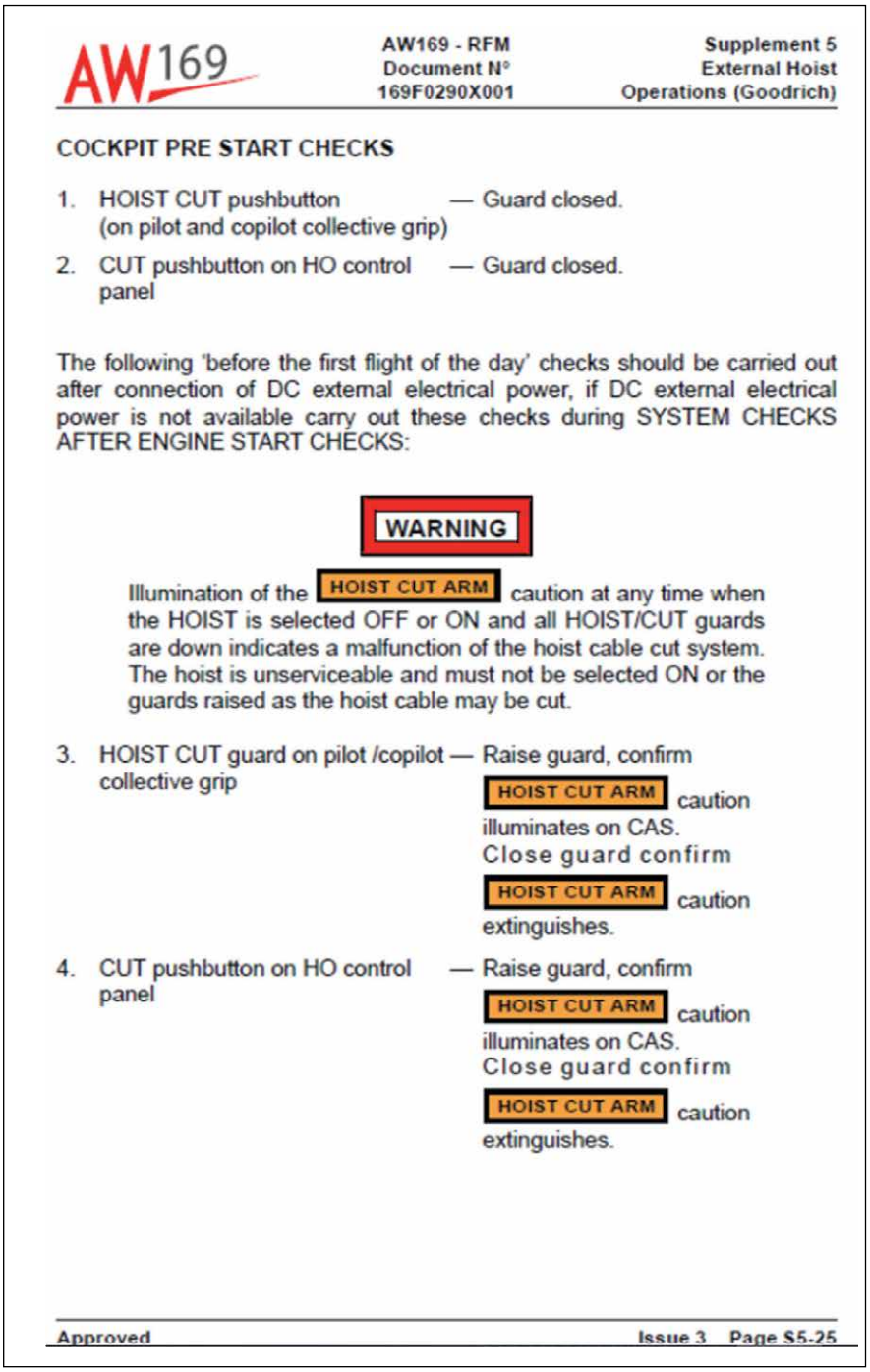
Pilot's collective hoist cut button (1 of 2) wiring visual examination

The crew interrupted the flow of the checklist before starting the engines because the PF was still walking round the aircraft, so the PM and HO decided to carry out the 'hoist operations pre-start checks' before the 'engine start' procedure. However, instead of following the 'hoist operations pre-start procedure,' the HO requested the PM to switch hoist power to ON. The PM recognised that the sequence was not in the usual order but proceeded as requested and switched on the hoist power.

Figure 12 shows a section taken from AW169 Rotorcraft Flight Manual (RFM) Supplement No 5 Section 2, '*Pre-Flight Checks*' issued by the aircraft manufacturer for operations with the Goodrich Rescue Hoist.

RFM Steps 1 to 2 state that the pilots' and HO's hoist cut pushbutton guards should be in the closed position. Step 2 is followed by a warning to ensure that if the HOIST CUT ARM caution is present in the PFDs with all three hoist cut guards closed, a malfunction of the cable cut system is present and the power must not be selected on or the guards raised as the hoist cable cut system may be activated. Note that the hoist power switch should not be selected ON until RFM Step 5 (Figure 13).

The expanded timeline in Figure 6 shows that when the out of sequence hoist power was selected ON, the HOIST CABLE FOUL caution was correctly displayed on the PFDs (step 5 of the RFM), but so was a HOIST CUT ARM caution which may indicate that either a cut switch guard was raised or a fault was present. However, both cautions disappeared from the PFD screens before the next cut guard sequence began, confirming that no system fault was present. Steps 3 and 4 of the RFM required the crew to raise and lower the cut guards in sequence starting with the PM, then the PF and lastly the HO. The three HOIST CUT ARM cautions caused by lifting the switch guards in turn can be seen in Figure 6 beginning a few seconds after the HOIST CBL FOUL and first HOIST CUT ARM cautions had disappeared.



AW169 — AW169 - RFM Document N° 169F0290X001 — Supplement 5 External Hoist Operations (Goodrich)

COCKPIT PRE START CHECKS

1. HOIST CUT pushbutton (on pilot and copilot collective grip) — Guard closed.
2. CUT pushbutton on HO control panel — Guard closed.

The following 'before the first flight of the day' checks should be carried out after connection of DC external electrical power, if DC external electrical power is not available carry out these checks during SYSTEM CHECKS AFTER ENGINE START CHECKS:

WARNING

Illumination of the HOIST CUT ARM caution at any time when the HOIST is selected OFF or ON and all HOIST/CUT guards are down indicates a malfunction of the hoist cable cut system. The hoist is unserviceable and must not be selected ON or the guards raised as the hoist cable may be cut.

3. HOIST CUT guard on pilot /copilot collective grip — Raise guard, confirm HOIST CUT ARM caution illuminates on CAS. Close guard confirm HOIST CUT ARM caution extinguishes.
4. CUT pushbutton on HO control panel — Raise guard, confirm HOIST CUT ARM caution illuminates on CAS. Close guard confirm HOIST CUT ARM caution extinguishes.

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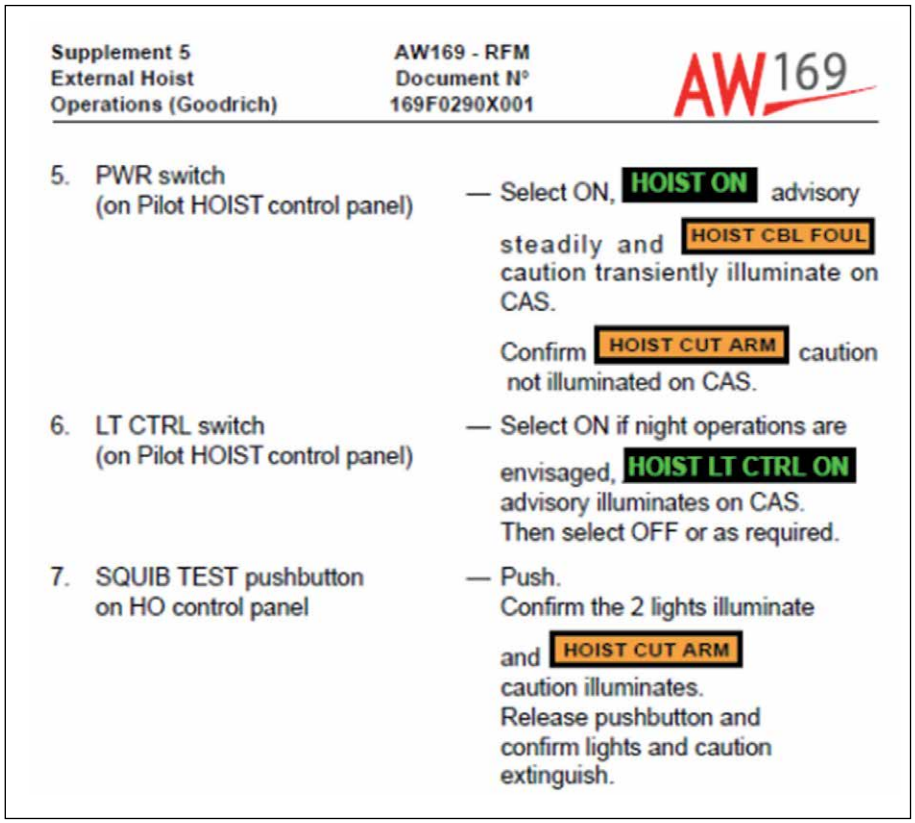
Figure 12

Steps 1 to 4 of the RFM hoist start up procedure



Supplement 5
External Hoist
Operations (Goodrich)

AW169 - RFM
Document N°
169F0290X001

AW169

5. PWR switch (on Pilot HOIST control panel)	— Select ON, HOIST ON advisory steadily and HOIST CBL FOUL caution transiently illuminate on CAS. Confirm HOIST CUT ARM caution not illuminated on CAS.
6. LT CTRL switch (on Pilot HOIST control panel)	— Select ON if night operations are envisaged, HOIST LT CTRL ON advisory illuminates on CAS. Then select OFF or as required.
7. SQUIB TEST pushbutton on HO control panel	— Push. Confirm the 2 lights illuminate and HOIST CUT ARM caution illuminates. Release pushbutton and confirm lights and caution extinguish.

Figure 13

Steps 5 to 7 of the RFM hoist start up procedure

A further two HOIST CUT ARM cautions occurred approximately 12 seconds after the group of three cautions in Figure 6, but the crew were unable to explain the additional guard lifts. From witness statements, it may have been during one of these two guard lifts that the hoist cable was cut. As step 5 in Figure 13 had already occurred out of sequence, the HO proceeded to step 7, but observed that the two squib LEDs were already lit. The squib LEDs are latched ON if a hoist cut switch is pressed and can only be switched off again using a specific maintenance procedure. The LEDs and the HOIST CUT ARM cautions are also illuminated during the squib test procedure but, under no fault conditions, disappear from the PFDs again once the test button is released.

The fourth hoist CAS event shown in Figure 7 occurred once the hoist cable had been cut. After the Captain had left the aircraft to report the incident, the PF was requested to start the engines to ensure there was no residual water remaining in the engines following the earlier compressor wash. During this period, the PF attempted to check the hoist cut CAS messages by raising the cut guard on his collective twice to observe that the appropriate cautions were displayed on the PFDs. The hoist power was not switched on during these additional checks.

Analysis

In the absence of an electrical or mechanical fault or a system anomaly which could have allowed 28 VDC to activate the hoist cut squib without a hoist cut button being pressed, the focus of the investigation was on the sequence of events during the aircraft start-up procedure.

The crew could not explain their exact sequence of cut switch guard raises, why the hoist power was applied out of sequence or why the hoist operations pre-start procedure in the company checklist was not followed in order. Although the pilots were not aware of the AW169 RFM hoist supplement or the warning before Step 3 of the supplement, the HO was aware of the RFM. He checked for the presence of a hoist cut arm caution with all cut guards lowered before proceeding with the cut guard raise and lower sequence.

Soon after the incident, the Operator issued instructions to all their crews that the company procedure must be followed whenever they are preparing the aircraft for operations.

The company start up procedure in Figure 3 contained no mention of checking for the presence of the HOIST CUT ARM caution with all cut guards lowered as stated in the RFM 'SYSTEM CHECKS AFTER ENGINE START CHECKS' (Figure 12). Whilst the application of hoist power is not required until RFM Step 5, there is no mention in the company checklist that Step 1 should be carried out with hoist power OFF. There was also no mention in the company checklist of the warning in Step 5 of the RFM to check for the presence of the HOIST CUT ARM caution when the hoist power is selected ON before continuing with the pre-start checklist.

The company procedures have since been amended to include the requirement to ensure the hoist power is off, all cut guards are lowered and there is no CUT GUARD ARM caution present before proceeding to Step 1. In addition, a warning has been added after Step 2 to ensure the HOIST FOUL caution extinguishes after hoist power is applied and there is no HOIST CUT GUARD caution present on the PFDs before proceeding to Step 3.

Had there been a hoist system fault, the out of sequence activation of hoist power and raising the cut guards whilst a HOIST CUT ARM caution was present could have caused 28 VDC to be supplied to the squib to cut the cable. No such fault was found during functional testing or examination of the wiring connections to the three hoist cut arm switches. As procedural drift occurred throughout the hoist start up process, the possibility that one of the hoist cut buttons was pressed inadvertently instead of the hoist lower/raise toggle, the next step in the company procedure after the squib test, could not be ruled out. The possibility that the squib was activated during the squib test could be ruled out because the squib test electrical current is insufficient to activate the squib. The fact that the LED lights indicating 28 VDC may have already been illuminated before the squib test button was pressed, shows that the hoist cable had been cut before the squib test button was pressed.

Conclusion

Procedural drift caused the crew to deviate from the Operator's aircraft pre-fight, start, flight, landing and shutdown checklists. The risk that the hoist squib could be activated when a CUT GUARD ARM caution message was displayed despite all three cut guards being in the lowered position, was not apparent in the Operator's checklists.

The company checklist did not adequately represent the AW169 RFM external hoist start up procedure and contained no warnings regarding the impact of warning cautions at specific points in the procedures. The Operator has changed the company checklist to address these problems.

No mechanical or electrical or functional faults were found with the hoist system. The possibility that one of the cut buttons may have been inadvertently pushed during the out of sequence hoist startup checks, which caused the squib to activate and cut the hoist cable, could not be ruled out.