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AIR TRANSPORTATION SAFETY INVESTIGATION REPORT A21O0030

UNINTENTIONAL GEAR-UP LANDING ON RUNWAY

Province of Ontario, Ministry of Northern Development, Mines, Natural
Resources and Forestry
Canadair CL-215-6B11 (Series CL-415), C-GOGH
Sault Ste. Marie Airport, Ontario
02 May 2021

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History of the flight

At 1121¹ on 02 May 2021, the Province of Ontario, Ministry of Northern Development, Mines, Natural Resources and Forestry (OMNRF)² CL-215-6B11 (Series CL-415) aircraft (registration C-GOGH, serial number 2034), departed from Sault Ste. Marie Airport (CYAM), Ontario, on a recurrent training flight with 2 pilots on board. The instructor pilot was seated in the left seat and was the pilot monitoring (PM), while the pilot receiving training was seated in the right seat and was the pilot flying (PF). Before arriving at the aircraft, and once again before starting the engines, the PM briefed the exercises to be flown and the order in which they would be accomplished. Each of the exercises had been practised by the occurrence PF in the OMNRF CL-415 flight simulator in March 2021.

¹ All times are Eastern Daylight Time (Coordinated Universal Time minus 4 hours).

² Recently changed to the Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry. For brevity, the initialism OMNRF will be used throughout this report.

The flight proceeded as briefed, and the aircraft returned to CYAM at approximately 1215 to conduct 3 planned circuits on Runway 12. The final circuit was to include a flapless approach and full-stop landing.

During the final circuit, while the aircraft was approximately mid-downwind, the PF called for Flaps 10 as he would during a normal circuit. The PM reminded him that they were practising a flapless landing and did not extend the flaps. As the PF began to turn for the base leg, he called for the GEAR DOWN, LANDING CHECKS checklist. Although this was the typical location for the GEAR DOWN, LANDING CHECKS call during a normal visual approach, the PM advised the PF to extend the downwind to arrange for a longer final approach. The PF abandoned the turn for the base leg as instructed and flew an extended downwind leg; the landing gear was not selected down by the PM, who began a verbal instruction explaining the method of calculating the appropriate approach path for a flapless landing. While continuing his explanation, the PM told the PF when to make the base turn and there was no subsequent call for the GEAR DOWN, LANDING CHECKS checklist. The approach continued on a typical profile for the flapless configuration. The landing gear aural warning did not activate during the approach given the flapless configuration and throttle lever positions.

At approximately 1228, the aircraft landed on the centreline of Runway 12 with the landing gear retracted. The aircraft came to a stop on the runway surface with the right wingtip float resting on the ground (Figure 1). There was significant damage to the belly of the aircraft and minor damage to each wingtip float.

Figure 1. Photo of the occurrence aircraft after the gear-up landing (Source: Province of Ontario, Ministry of Northern Development, Mines, Natural Resources and Forestry)



Flight crew, aircraft, and weather information

The investigation determined that the pilots were certified and qualified for the flight in accordance with existing regulations. No deficiencies were noted with respect to the certification, equipment, or maintenance of the aircraft, which all followed existing regulations and approved procedures. The flight occurred in daylight visual meteorological conditions, and weather was not considered a factor in this occurrence.

Previous CL-415 unintentional gear-up landing on runway

On 03 April 2009, a CL-415 aircraft operated by the Service aérien gouvernemental du Québec (registration C-GQBG, serial number 2022) was conducting a flapless landing as part of a training flight and landed with the gear retracted at Québec/Jean Lesage International Airport (CYQB), Quebec. The occurrence summary³ noted that the landing gear aural warning did not activate because the throttle settings were higher than the activation threshold of the warning system given the power requirements for a flapless approach.

CL-415 landing gear warning and indication system

As an amphibious aircraft, the CL-415 is equipped with a landing gear indicating and warning system to provide warnings and indications for landings on both land and water. There is a LAND/SEA switch that must be set to match the intended landing surface to ensure that the landing gear aural warning operates correctly.

When the LAND/SEA switch is in the LAND position, the landing gear aural warning activates if the landing gear is not extended with flaps set at 15 or greater, or if the throttles are positioned less than half an inch above the idle stops.⁴ Given the power requirements of a flapless approach,⁵ the throttles typically remain above that position until they are retarded during the landing flare or following touchdown.

The LAND/SEA switch was in the appropriate position (LAND) during this occurrence. The landing gear aural warning system was examined following the occurrence and was found to be operating within the limits prescribed by the maintenance manual.

The airplane flight manual (AFM) includes a caution regarding abnormal procedures that states the following:

When landing with less than 15° of flaps, depending on profile and power required during approach, the landing gear aural warning may not be available to warn the pilots of improper gear configuration. Confirm proper selection of LAND/SEA switch and gear position before landing.⁶

³ TSB Aviation Occurrence A09Q0047.

⁴ This is a mechanical setting that uses a microswitch located within the throttle quadrant. The torque value is reported to be approximately 9% when the landing gear aural warning normally activates.

⁵ The *OMNRF CL-415 SOP—CL-415 Standard Operating Procedures* indicate that a flapless approach at 125 knots with the gear down requires a torque setting of approximately 34%. It is reported that the landing gear position does not significantly affect power requirements during approach for the CL-415. (Source: Province of Ontario, Ministry of Natural Resources and Forestry Air Service – Fixed Wing, *OMNRF CL-415 SOP—CL-415 Standard Operating Procedures*, Revised Original [01 October 2020], Section 10.4: CL-415 Power Settings – For Flight Profiles, p. 10-5.)

⁶ Bombardier Inc., Product Support Publication (PSP) no. 491, *Bombardier 415 Model CL-215-6B11 Airplane Flight Manual* (1994), Revision 48 (30 September 2016), Flap System Failure, p. 05-05-7.

After this caution was added to the AFM in 2015, it was also added to the manufacturer's pilot checklist (PCL) in 2016.⁷ However, it was not replicated in the *OMNRF CL-415 Checklist*,⁸ a document created by the OMNRF to replace the PCL.⁹

Both occurrence pilots were, however, made aware of this caution when it was reviewed during their recurrent ground school in March 2021; they also discussed it during the pre-flight briefing for the occurrence flight.

Operational checklist procedures

During a flight, OMNRF flight crews use the *OMNR CL415 Operational Checklist*, a single-page (front and back) laminated checklist.¹⁰ All items on the operational checklist are normal procedure items copied from the *OMNRF CL-415 Checklist*; the operational checklist is intended to be used during every flight, from start-up to shutdown, and covers normal operations on both land and water, including water bombing operations.

Each section of the operational checklist contains a 2-letter code in parentheses that corresponds to a checklist type, based on how the checklist is to be completed. The 4 checklist types are as follows:

- CR – Challenge and Response
- RD – Read Aloud and Do
- SD – Silently Do
- VA – Vital Action

The CR, RD, and SD checklist types are described in detail in the *OMNRF CL-415 SOP—CL-415 Standard Operating Procedures (SOPs)*, including specific examples detailing each crew member's role while actioning those checklists;¹¹ however, the SOPs do not refer specifically to the *OMNRF CL-415 Checklist*. Although there is no similar description of the VA checklist type,¹² vital action is described in the SOPs as "[c]hecks and drills that are committed to memory."¹³ The GEAR DOWN, LANDING CHECKS checklist in the operational checklist (Figure 2) is labelled as vital action.

⁷ Bombardier Inc., *Bombardier 415 Pilot Check List Model CL-215-6B11*, Revision 6 (13 June 2016), Flap System Failure, p. AP-47.

⁸ The *OMNRF CL-415 Checklist* contains normal operations checklists, aircraft limitations, operating notes, performance charts, and emergency and abnormal procedures.

⁹ Province of Ontario, Ministry of Natural Resources and Forestry, *OMNRF CL-415 Checklist* (01 October 2020).

¹⁰ Province of Ontario, Ministry of Natural Resources and Forestry, *OMNR CL415 Operational Checklist*, Revised Original (01 October 2020).

¹¹ Province of Ontario, Ministry of Natural Resources and Forestry Air Service – Fixed Wing, *OMNRF CL-415 SOP—CL-415 Standard Operating Procedures*, Revised Original (01 October 2020), Section 1.9 Checks, Checklist and Drill: Types of Checks and Drills, p. 1-15.

¹² This was also noted in TSB Aviation Investigation Report A13A0075 involving a Government of Newfoundland and Labrador CL-415 whose SOP at the time of occurrence was identical to the the current OMNRF SOP.

¹³ Province of Ontario, Ministry of Natural Resources and Forestry Air Service – Fixed Wing, *OMNRF CL-415 SOP—CL-415 Standard Operating Procedures*, Revised Original (01 October 2020), Section 1.6 Definitions, p. 1-10.

Figure 2. The GEAR DOWN, LANDING CHECKS checklist as depicted on the operational checklist (Source: Province of Ontario, Ministry of Natural Resources and Forestry, OMNR CL415 Operational Checklist)

GEAR DOWN, LANDING CHECKS (VA)	
RUNWAY (VA)	
1. GEAR	DOWN / 3 GREEN
2. CONDITION LEVERS	MAX
3. FLAPS	AS REQ / 25 WHEN LANDING ASSURED
4. BRAKES	PARKING OFF / PRESS CHECKED
5. NW STEERING PBA	PRESS IN
6. LIGHTS – TAXI / LANDING	AS REQ

The Landing Checks section in the SOPs includes the following statement: “[a]s this check may be done during an especially high workload period it can be carried out from memory and verified with the checklist.”¹⁴ There is no mention of the type of checklist completion that is intended to be used during this verification (CR, RD, or SD).

In an advisory circular published in 2017, the U.S. Federal Aviation Administration describes the manner of checklist completion commonly known as a “flow” as follows:

For most normal procedures on the flight deck, a “flow” is conducted as a sequence of actions done from memory to configure the aircraft and its systems. The flow is followed by a checklist containing a subset of items from the flow that may be the most critical items within that flow and items that confirm the flow was done correctly.¹⁵

Both OMNRF SOP guidance for completing the GEAR DOWN, LANDING CHECKS checklist and the actual practice reported by pilots for completing the VA checklists are consistent with the “flow” method of checklist completion described above.

The SOPs state that “[v]ital action (memory) items require confirmation by the second flight crew member.”¹⁶ This statement seems to apply only to memory items found in the SOPs’ abnormal or emergency procedures. The requirement to confirm vital action items by a second crew member does not appear to apply to the GEAR DOWN, LANDING CHECKS checklist, and it is not required, nor typical, during normal operations at OMNRF.

¹⁴ Ibid., Section 5.9 Landing Checks, pp. 5-5.

¹⁵ Federal Aviation Administration (FAA), Advisory Circular (AC) 120-71B: Standard Operating Procedures and Pilot Monitoring Duties for Flight Deck Crewmembers (2017), Section 5.1.2 Type of List and Manner of Execution, p. 5-1.

¹⁶ Province of Ontario, Ministry of Natural Resources and Forestry Air Service – Fixed Wing, *OMNRF CL-415 SOP—CL-415 Standard Operating Procedures*, Revised Original (01 October 2020), Section 7.4 Checks, Checklists and Drills, p. 7-8.

Confirming the landing gear extension

The SOPs provide guidance on crew actions with respect to landing gear extension. One specific scenario is detailed as follows:

To initiate the extension of the landing gear when it is inappropriate to complete the Landing Check, the PF calls "**Gear Down**". The PM responds by selecting the Landing Gear Lever down and saying, "**Gear Down**". Once the Landing Gear is down and locked the PM should call "**Gear Down Three Green**" [emphasis in original].¹⁷

Note that this procedure does not require confirmation of the gear position by the PF. The SOPs do not expand on the procedure to be used when extending the landing gear as part of the GEAR DOWN, LANDING CHECKS checklist, nor does it offer an example.

The SOPs also provide guidance on the final landing check:

The Final Landing Check is not specifically listed on the checklist and is a continuation/last look of the LANDING CHECK. When the PF calls for "**Flap 25**" the PM will select flaps to **25** and when set call "**Flap 25 Indicating**" and confirm that the landing gear is down "**Landing Gear down and Indicating**" [emphasis in original].¹⁸

The cue for this check is the Flap 25 callout made by the PF, and it is therefore unlikely that the PM would initiate this check during a flapless approach because there would be no call for Flap 25 to trigger the initiation of this check.

No definition of a "continuation/last look" checklist type or procedure is included in the SOPs, and the final landing check outlined above does not appear on the *OMNR CL415 Operational Checklist*.

Crew resource management during airborne training

In a multi-crew aircraft such as the CL-415, pilots must successfully interact with each other, their aircraft, and their environment, using associated checklists and company SOPs to effectively manage threats, errors, or undesired aircraft states that may be encountered.

Airborne training flights can present challenging situations from the perspective of crew resource management for a few reasons, including but not limited to the following:

- The pilot-in-command¹⁹ may be delivering verbal instruction during critical phases of flight, a practice that can interrupt the flow of normal crew communication and coordination.
- The flights may consist of manoeuvres and scenarios that do not occur as part of daily operations and are not detailed in the SOPs.
- When the pilot-in-command is directing the flight path (for example, "Let's extend the downwind" or "Turn your base now"), the trainee is physically flying the aircraft, but there is potential for confusion regarding who is actually in control of the flight path and who is responsible for initiating checklists.

¹⁷ Ibid., Section 5.2: Standard Calls, p. 5-1.

¹⁸ Ibid., Section 5.9: Landing Checks, p. 5-6.

¹⁹ In this occurrence, the instructor pilot was designated as the pilot-in-command.

In this occurrence, the flapless landing was being conducted as a handling exercise, rather than being treated as simulated malfunction.²⁰ Neither the AFM nor the SOPs provide procedures or checklists specific to a flapless approach and landing. This absence of guidance means that any flapless approach and landing is effectively an abnormal procedure.

Safety messages

Air operators who use 2-crew aircraft should ensure that their company SOPs clearly define how checklists are intended to be actioned and that items affecting aircraft configuration are confirmed and verified.

Flight crews are reminded to exercise additional vigilance during airborne training flights, given the significant potential for distraction from normal cockpit duties while instruction is taking place.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 20 October 2021. It was officially released on 04 November 2021.

Visit the Transportation Safety Board of Canada's website (www.tsb.gc.ca) for information about the TSB and its products and services. You will also find the Watchlist, which identifies the key safety issues that need to be addressed to make Canada's transportation system even safer. In each case, the TSB has found that actions taken to date are inadequate, and that industry and regulators need to take additional concrete measures to eliminate the risks.

²⁰ A simulated malfunction would require the pilots to simulate an abnormal procedure, including use of the quick reference handbook procedures, and leave the circuit to allow time for troubleshooting (if necessary) before returning to land.

ABOUT THIS INVESTIGATION REPORT

This report is the result of an investigation into a class 4 occurrence. For more information, see the Policy on Occurrence Classification at www.tsb.gc.ca.

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