Transportation Safety Board of Canada
Bureau de la sécurité des transports du Canada

AIR TRANSPORTATION SAFETY INVESTIGATION REPORT A21O0127

RUNWAY OVERRUN

I.M.P. Group Limited
Embraer EMB-505 (Phenom 300E), C-GRIA
Kingston/Norman Rogers Airport, Ontario
30 November 2021

Canada

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Summary

On 30 November 2021, at 1754 Eastern Standard Time, the Embraer EMB-505 (Phenom 300E) (registration C-GRIA, serial number 50500566) aircraft, operated by I.M.P. Group Limited, departed Montréal/Pierre Elliott Trudeau International Airport (CYUL), Quebec, for an instrument flight rules flight to Kingston/Norman Rogers Airport (CYGK), Ontario, with 2 pilots on board.

At 1829, the aircraft landed on Runway 19 following an instrument landing system approach. The second-in-command, who was the pilot flying, applied full braking within seconds of touchdown but did not feel the expected aircraft deceleration. The pilot-in-command also attempted to stop the aircraft once it was apparent that the expected braking was not taking place; this had no added effect on the deceleration of the aircraft. The aircraft departed the runway's end at a speed of 61 knots, entering a grassy area. It continued for approximately 440 feet before coming to a stop.

Neither pilot was injured, the aircraft was undamaged, and there was no damage to airport fixtures.

1.0 FACTUAL INFORMATION

1.1 History of the flight

At approximately 1700[1] on 30 November 2021, the 2 pilots scheduled on the occurrence flight met at a fixed-base operator[2] at Montréal/Pierre Elliott Trudeau International

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1 All times are Eastern Standard Time (Coordinated Universal Time minus 5 hours).

2 A fixed-base operator provides services including but not limited to: fuel, parking, flight planning facilities for pilots, and a departure lounge for passengers.

Airport (CYUL), Quebec, for a pre-flight briefing. The flight was to be a night[3] instrument flight rules (IFR) flight between CYUL and Kingston/Norman Rogers Airport (CYGK), Ontario, that would last approximately 35 minutes and cover a distance of 144 nautical miles (NM). The flight crew were familiar with the route, having landed on Runway 19 at CYGK before on more than one occasion. The aircraft was an Embraer EMB-505 (Phenom 300E), which was operated by I.M.P. Group Limited (I.M.P. Group) under *Canadian Aviation Regulations* (CARs) Subpart 604—*Private Operators*.

The pilot-in-command, seated in the right seat, was the pilot monitoring, while the second-in-command, seated in the left seat, was the pilot flying (PF). The flight proceeded uneventfully until the aircraft touched down on Runway 19 at CYGK following the instrument landing system approach.

At 1829, the main landing gear (MLG) of the aircraft touched down within the touchdown zone at an indicated airspeed of 113 knots approximately 1200 feet beyond the displaced threshold of Runway 19. The PF began braking within 2 seconds of touchdown, with maximum braking occurring after approximately 8 seconds. The aircraft did not decelerate appreciably during these 8 seconds, and the crew did not feel pulsing or shuddering through the braking system, which is typically felt when the anti-skid engages. After a brief verbal exchange between the pilots about the insufficient deceleration, the pilot monitoring also applied his brakes, with no added effect. Following 24 seconds of full brake application, during which braking performance did not improve, and with approximately 200 feet of runway remaining, the PF pulled the emergency parking brake in an effort to increase the braking effectiveness. The emergency parking brake application did not alter or improve the deceleration of the aircraft.

The aircraft overran the runway while skidding slightly to the left, with the nose to the right of the aircraft track. The overrun began approximately 45 feet left of the centreline at a speed of 61 knots. The aircraft continued to slide onto the soft grassy area beyond the runway's end for approximately 400 feet before coming to a stop 30 feet left of the runway extended centreline and 48 feet short of the approach lighting structure for Runway 01 (Figure 1), remaining within the runway-end safety area (RESA) throughout the overrun.

[3] On the evening of the occurrence, sunset at CYUL took place at 1613, while sunset at CYGK was at 1629.

Figure 1. The occurrence aircraft taken the morning after the overrun (Source: TSB)

1.2 Injuries to persons

There were no injuries.

1.3 Damage to aircraft

There was no damage to the aircraft resulting from the runway overrun.

1.4 Other damage

Not applicable.

1.5 Personnel information

At the time of the occurrence, both pilots held the appropriate licence and met the recency requirements for the flight in accordance with existing regulations. Records indicate that the pilot-in-command had attended recurrent simulator training in April 2021, and the second-in-command had attended recurrent simulator training in August 2021. The simulator training included emergency procedures related to the braking system. The occurrence flight was the first flight of the day for both pilots.

Table 1. Personnel information

	Pilot-in-command	Second-in-command
Pilot licence	Airline transport pilot licence (ATPL)	Airline transport pilot licence (ATPL)
Medical expiry date	01 June 2022	01 January 2022
Total flying hours	32 200	2500
Flight hours on type	1132	326.3
Flight hours in the 7 days before the occurrence	0.8	0
Flight hours in the 30 days before the occurrence	16.2	13.5
Flight hours in the 90 days before the occurrence	101.2	60
Flight hours on type in the 90 days before the occurrence	69.4	54

1.6 Aircraft information

Table 2. Aircraft information

Manufacturer	Embraer
Type, model, and registration	EMB-505, Phenom 300E, C-GRIA
Year of manufacture	2020
Serial number	50500566
Certificate of airworthiness issue date	04 September 2020
Total airframe time	216.3 hours
Engine type (number of engines)	Pratt and Whitney PW535E1 (2)
Maximum allowable take-off weight	8340 kg
Recommended fuel types	Jet A, Jet A-1, Jet B
Fuel type used	Jet A

1.6.1 General

Records indicate that the aircraft was operated within its weight and centre-of-gravity limits at the time of the occurrence.

Deceleration of the Phenom 300E aircraft on the runway incorporates the combined effects of main wheel braking, using a brake-by-wire[4] system, and a ground spoiler system, which uses a weight-on-wheels input that activates automatically if certain parameters are met. The Phenom 300E is not equipped with thrust reversers.

In this occurrence, these systems functioned as designed, and there was no indication that a system malfunction had contributed to the runway overrun. There were no recorded outstanding defects at the time of the occurrence. The aircraft's tires were found to be

[4] A brake-by-wire system uses transducers to sense the pilot's brake pedal inputs as well as the aircraft's main wheel speed. Using a brake control unit, the system determines the ideal braking forces for the real-time conditions and sends the appropriate signal to hydraulic actuators, which physically operate the brakes.

inflated to the correct pressure and to have acceptable tire tread depth; they were not damaged. The main wheel brakes were determined to be within serviceable limits.

1.6.2 Anti-skid protection

Anti-skid protection controls the amount of hydraulic pressure applied by the pilots on the brakes in order to prevent a wheel from skidding.[5] Anti-skid provides the maximum braking effort for the runway surface in use, minimizing tire wear and optimizing stopping distance. Anti-skid protection is provided when the normal braking system is used and is not available when the emergency braking system is in use. The following caution statement appears in the aircraft flight manual (AFM):

> ANTISKID PROTECTION IS NOT AVAILABLE FOR
> EMERGENCY/PARKING BRAKE. SKIDDING THE TIRES
> DOES NOT DECREASE STOPPING DISTANCE AND
> MAY CAUSE TIRE BLOWOUT.[6]

When the anti-skid system senses an impending skid condition, it modulates the brake pressure to each wheel to prevent wheel lockup and optimize braking effectiveness. The flight crew typically feel a pulsing or shuddering, similar to anti-lock brake activation in automobiles, as the system applies and releases brake pressure.

The cockpit voice and data recorder (CVDR) data for the occurrence flight indicated that the anti-skid system was operating as designed during the occurrence. The maximum brake pressure values achieved during the anti-skid modulation are indicative of braking on a slippery surface.

An examination of the runway surface the following morning did not reveal any wheel skid marks on the runway surface that could be attributed to this occurrence.

1.6.3 Performance calculation

Performance information for the Phenom 300, including take-off and landing distances, take-off and landing speeds, and other operational information, is normally computed by the flight management system during flight, based on data entered by the flight crew. The information presented by the flight management system is derived from data published in the AFM, some of which can also be found in the quick reference handbook (QRH). These data are arranged in a number of tables, which provide landing distances applicable to a range of aircraft weights and configurations, as well as environmental parameters such as height above sea level (ASL), temperature, and runway contaminants.

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5 Skidding is detected when the actual speed of a wheel drops below an optimal reference speed.

6 Embraer S.A., *Phenom 300 FAA Airplane Flight Manual,* Rev. 22 (23 September 2021), Emergency & Abnormal Procedures, Emergency Braking Technique, Block 4-01, p. 14.

Regarding landing technique, the Phenom 300 pilot operating handbook states that in order to achieve the landing performance as stated in the AFM, the following conditions must be met:

- Steady three degree angle approach at V_{REF} in landing configuration;
- V_{REF} airspeed maintained at runway threshold;
- Idle thrust established at runway threshold;
- Attitude maintained until MLG touchdown;
- Maximum brake applied immediately after MLG touchdown;
- Antiskid system operative.[7]

Another block in the Phenom 300 pilot operating handbook titled *Cold Weather Operation* states that pilots should "conduct a positive landing to ensure initial wheel spin-up and initiate firm ground contact upon touchdown […]."[8]

During pre-flight planning for the occurrence flight, the pilots used the QRH to calculate the landing distance; based on the reported conditions, they used the wet runway numbers in the appropriate table. For aircraft with a weight of 16 000 pounds on landing, the QRH indicates a no-wind unfactored landing distance[9] of 3806 feet at sea level, and 3918 feet at an elevation of 1000 feet ASL. The aircraft's actual weight was 15 840 pounds, CYGK is at an elevation of 303 feet ASL, and there was approximately 4 knots of tailwind at the estimated time of arrival. Using the 10-knot tailwind chart, the unfactored numbers for 16 000 pounds are 4668 feet at sea level, and 4798 feet at an elevation of 1000 feet ASL.

The investigation extrapolated the above numbers to account for the elevation at CYGK and the forecast tailwind, which resulted in a landing distance of approximately 4187 feet. Because the approach to Runway 01 was reported by NOTAM to be unusable, the longest landing distance available (LDA) at CYGK at the time of the occurrence was 5000 feet, using Runway 19.

Commercial operators operating similar aircraft (turbojets) under CARs Subpart 704 are required to be able to land their aircraft within 60% of the landing distance available.[10] However, because this aircraft was operated under CARs Subpart 604, this additional landing distance was not required by regulation.

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7 Embraer S.A., *Phenom 300 Pilot's Operating Handbook Performance Data*, Volume 2, Rev. 19 (04 October 2021), Landing Technique, Block 3-45-20, p. 1.

8 Embraer S.A., *Phenom 300 Pilot's Operating Handbook*, Volume 1, Rev. 19 (04 October 2021), Landing on Wet or Slippery Runways, Block 2-15, p. 18.

9 Unfactored landing distance is the actual landing distance data, without any additional safety margins.

10 Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, paragraph 704.49(1)(a).

1.7 Meteorological information

Aerodrome forecasts (TAFs) provide a description of the most likely weather conditions for aviation operations within a 5-NM radius of an aerodrome. The amended TAF for CYGK, issued on 30 November at 1610 and valid from 1600 to 2300, was available to the occurrence flight crew before their departure from CYUL. It included the following:

- winds from 050° true (T) at 5 knots
- visibility 3 statute miles (SM)
- light snow
- scattered cloud at 500 feet above ground level (AGL)
- overcast ceiling at 1500 feet AGL

According to the TAF, between 1700 and 1900, there would be light rain and snow, mist, and an overcast ceiling at 700 feet AGL.

The aerodrome routine meteorological reports (METARs) at CYGK are summarized in Table 3.

Table 3. Aerodrome routine meteorological reports for Kingston/Norman Rogers Airport in the hours shortly before the aircraft departed Montréal/Pierre Elliott Trudeau International Airport, up to 30 minutes after the occurrence

Time	Wind (direction/speed)	Visibility (SM)/ Precipitation	Ceiling (AGL)	Temp (°C)	Dew point (°C)	Altimeter (inches of mercury)
1500	090°T / 3 kt	1 ¼ / light snow	Overcast 1400 ft	0	−1	29.82
1600	050°T / 4 kt	1 / light snow	Overcast 1300 ft	−0	−1	29.82
1700	060°T / 5 kt	2 / light snow	Overcast 1300 ft	−0	−1	29.81
1800	050°T / 6 kt	1 / light snow	Overcast 600 ft	−0	−1	29.80
1900	Variable / 2 kt	1 ½ / light snow	Overcast 1200 ft	−0	−1	29.80

The information from the observation taken at 1800 as well as the contents of the runway surface condition report (see 1.7.1 *Runway surface condition NOTAM*) were received by the pilots through the automatic terminal information service broadcast as they prepared for the approach.

The reported temperature at CYGK had been above freezing since 1100 on the day of the occurrence and was first recorded to be below freezing at 1600, when the temperature was recorded as −0.2°C.

Temperatures reported in a METAR are rounded up to the next warmest degree Celsius. Thus, a reported temperature of −0°C (M00) means that the actual measured temperature was between −0.1°C and −0.9°C. In fact, the temperatures measured at 1500, 1600, 1700, 1800, and 1900 were 0°C, −0.2°C, −0.3°C, −0.3°C, and −0.2°C, respectively.

According to the wind reported in the METAR issued at 1800, a tailwind component of approximately 3.5 knots would have been present when the aircraft was landing on Runway 19. The CVDR data indicated that there were 4 knots of tailwind acting on the aircraft during the moments before touchdown.

The flight crew, along with the airport maintenance worker, were able to inspect the runway approximately 30 minutes after the occurrence; they observed that it was slippery and that there was up to ¾ inch of slush present. It was reported that the snowfall had begun to intensify around the time of the occurrence and that it continued during the hour following the occurrence. During the visual portion of the final approach, the flight crew observed the runway surface to be black in appearance.

1.7.1 Runway surface condition NOTAM

A runway surface condition NOTAM (RSC NOTAM) includes a runway condition code (RWYCC), which describes conditions for 3 equal portions of the entire paved surface of the runway (not at the runway threshold). At 1726, the following RSC NOTAM was reported for Runway 19 at CYGK, indicating good braking action consistent with operations on a wet runway:

- RWYCC RWY 19: 5/5/5
  - First portion – 100% wet
  - Second portion – 30% wet snow 1/8 inch depth
  - Third portion – 40% wet snow 1/8 inch depth

There had been no arrivals, departures, or maintenance activity on Runway 19 between the issue of the runway condition report at 1726 and the arrival of the occurrence aircraft at 1829. No requests had been made for an updated runway condition report between the issue of this RSC NOTAM and the runway overrun.

A Canadian Runway Friction Index (CRFI) measurement for Runway 19 was not conducted at the time of this runway condition report, given that it would not have been valid due to the nature of the observed contamination on the runway (see 1.17.2.3 *Canadian Runway Friction Index* for more details).

1.8 Aids to navigation

Published instrument approaches exist for all runways at CYGK. Due to the reported wet conditions, the crew determined that there was insufficient LDA on Runway 07/25. Additionally, a NOTAM issued on 28 October 2021 indicated that the RNAV approach to Runway 01 was unusable. Therefore, the only instrument approaches available to the occurrence crew were the instrument landing system and RNAV approaches for Runway 19.

1.9 Communications

Not applicable.

1.10 Aerodrome information

CYGK is a certified airport located on the outskirts of Kingston, Ontario. The airport owner, operator, and certificate holder is the City of Kingston.

The airport has a NAV CANADA flight service station (FSS) that provides advisory service between the hours of 1115Z and 0400Z in a Class E control zone that extends 5 NM around and from the surface up to 3300 feet ASL over CYGK. The airport has 2 runway surfaces: Runway 01/19, which is 6001 feet long and 100 feet wide, and Runway 07/25, which is 3909 feet long and 100 feet wide; both runway surfaces are asphalt.

The published LDA for Runway 19 is 5000 feet since the threshold is displaced by 1001 feet, while the published LDA for Runway 01 is 5622 feet since the threshold is displaced by 379 feet.

Beyond the end of the paved surface of Runway 19, there is a RESA measuring 150 m in length and 60 m in width. This RESA meets the Transport Canada (TC) requirements as stated in section 302.602 of the CARs.

A NOTAM issued on 28 October 2021 indicated a temporary threshold displacement on Runway 01 of 663 additional feet, reducing the LDA to 4959 feet, which is why the RNAV approach was unusable. This NOTAM indicated that the displacement was due to a tree on a neighbouring property penetrating the obstacle limitation surface[11] for the approach to Runway 01. Management at CYGK had planned to resolve this issue with its neighbour in the spring of 2022.

1.11 Flight recorders

The airplane was equipped with an L3/Fairchild FA2100-3083 combination CVDR (serial number 002033297), which provided both flight data recorder and cockpit voice recorder functions. The CVDR was sent to the TSB Engineering Laboratory in Ottawa, Ontario, and was downloaded successfully.

Data for the entire occurrence flight were captured and downloaded from the CVDR.

1.12 Wreckage and impact information

Not applicable.

1.13 Medical and pathological information

According to information gathered during the investigation, there was no indication that the flight crew's performance was affected by medical or physiological factors.

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[11] An obstacle limitation surface is "a surface that establishes the limit to which objects may project into the airspace associated with an aerodrome consisting of the following; a takeoff surface, an approach surface, a transitional surface and an outer surface." (Source: Transport Canada, TP 1247E, *Aviation - Land Use in the Vicinity of Aerodromes*, 9th edition (2013/2014), Definition, p. 6.)

1.14 Fire

There was no indication of fire either before or after the occurrence.

1.15 Survival aspects

Not applicable.

1.16 Tests and research

1.16.1 TSB laboratory reports

The TSB completed the following laboratory reports in support of this investigation:

- LP025/2022 – CVDR Download
- LP184/2021 – FDR Analysis

1.17 Organizational and management information

1.17.1 Transport Canada

The regulations and standards governing the operation of certified airports are set out in Subpart 302 of the CARs and in TC's *Aerodromes Standards and Recommended Practices* (TP 312).

1.17.1.1 Reporting runway conditions

The airport operator is required to make available Aircraft Movement Surface Condition Reports (AMSCR), which detail the surface condition of all movement areas at an airport, including runways, taxiways, and aprons. Guidance for the content and issuance of these reports is found in TC's Advisory Circular (AC) 300-019.[12]

These reports are required from the first snowfall of the season until the conditions are bare and dry. The maximum interval between reports is 8 hours. Additional reports are required when there is a significant change in the runway surface conditions. Significant changes include:

> (a) Any change in the RWYCC;
>
> (b) Any change in CRFI of 0.05 or more;
>
> (c) Any change in the contaminant type;
>
> (d) Any change of 20% or more in the reportable contaminant coverage;
>
> (e) Any change in contaminant depth […]; and
>
> (f) Any other information, which according to assessment techniques, is considered to be significant. For example, following the application or removal of sand or

[12] Transport Canada, Advisory Circular (AC) 300-019: Global Reporting Format (GRF) for Runway Surface Conditions (Issue 02: 21 February 2021), at tc.canada.ca/en/aviation/reference-centre/advisory-circulars/advisory-circular-ac-no-300-019#toc5_3 (last accessed on 10 February 2023).

> chemicals; following snow removal or sweeping; changes in conditions caused by rapid increases or decreases in temperature.[13]

1.17.1.2 Canadian Runway Friction Index

According to the regulations,[14] CRFI is required to be reported only when any the following condition is present:

> (i) ice,
>
> (ii) wet ice consisting of a thin film of water on ice,
>
> (iii) compacted snow,
>
> (iv) slush on ice,
>
> (v) dry snow not exceeding 2.5cm (1 inch) in depth,
>
> (vi) de-icing chemical solution or sand on ice, or
>
> (vii) frost.[15]

1.17.1.3 Global reporting format

On 01 June 2021, TC introduced Canada's version of the International Civil Aviation Organization (ICAO) Global Reporting Format (GRF) for runway surface condition reporting, through the issue of an AC.[16] The GRF was developed to mitigate the hazards associated with flight operations on wet or contaminated runways, including the risks of runway overruns or lateral excursions. The implementation date for the GRF in Canada was 12 August 2021.

1.17.1.3.1 Runway surface condition NOTAM

Information about the runway condition is disseminated to pilots via an RSC NOTAM. Runway conditions can be described in 2 ways: a report of the condition of the entire runway length, or a report of the condition of each third of the runway. The decision to report in thirds versus the entire runway length is made by the airport authority, in consultation with the primary users of the airport.[17]

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13 Ibid., section 13: Requirements to issue an ASMCR, at tc.canada.ca/en/aviation/reference-centre/advisory-circulars/advisory-circular-ac-no-300-019#toc5_3 (last accessed on 10 February 2023).

14 Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, section 302.416.

15 Ibid., Standard 322: Airports, Division IV: Airport Winter Maintenance, paragraph 322.416(2)(b).

16 Transport Canada, Advisory Circular AC 700-057: Global Reporting Format (GRF) for Runway Surface Conditions: Guidance for Flight Operations (Issue 01: 01 June 2021), at https://tc.canada.ca/en/aviation/reference-centre/advisory-circulars/advisory-circular-ac-no-700-057 (last accessed on 10 February 2023).

17 Transport Canada, Advisory Circular AC 300-019-02: Global Reporting Format (GRF) for Runway Surface Conditions, (Issue 02: 21 February 2021), section 5.3 Reporting by runway thirds, at tc.canada.ca/en/aviation/reference-centre/advisory-circulars/advisory-circular-ac-no-300-019#toc5_3 (last accessed on 10 February 2023).

When reported in thirds, the report includes an RWYCC between 0 and 6 for each third of the runway, separated by a diagonal slash, with 0 signifying zero braking action, and 6 representing ideal braking (dry runway). For example, a 6000-foot runway reported as 5/4/5 would indicate that the first and last 2000-foot sections of the runway would allow for good braking (wet runway), while the middle 2000 feet would allow good-medium braking.

The RWYCC is established using a runway condition assessment matrix (RCAM),[18] which correlates observations made by airport staff to determine the RWYCC. The observer has the authority to downgrade (or, in some cases, upgrade) the RWYCC generated by the RCAM, if their physical observations or pilot reports indicate that the number generated by the RCAM does not match the observed conditions. If such a change has been made, it will be reflected in the remarks section of the RSC NOTAM.[19]

1.17.2 City of Kingston

The City of Kingston is the owner and operator of CYGK. As such, it is responsible for maintaining and operating the airport according to the regulations. Operating hours extend from 0500 until 2330 during the week and 0900 until 2100 on weekends. There is normally a minimum of 2 staff members present during operating hours, although it is permissible, according to airport procedures, to operate with a single staff member, as was the case on the evening of the occurrence.

1.17.2.1 Runway inspections and winter maintenance

During operating hours, CYGK staff are required to inspect all movement areas on the airport at intervals not to exceed 4 hours, monitoring for changes to runway conditions as well as for wildlife activity. During winter, a continuous watch is kept on the runway surfaces. Maintenance such as plowing, sweeping, and chemical treatment of the runways is planned to accommodate regularly scheduled arrivals and departures and other known traffic.

At the time of the occurrence, the *Canada Flight Supplement* entry for CYGK indicated that winter maintenance was available within limited hours during weekdays and that maintenance outside of these hours was available with 3 hours of prior notice.

1.17.2.2 Aircraft Movement Surface Condition Reports

Staff at CYGK are responsible for producing AMSCRs, which are issued as RSC NOTAMs during the winter maintenance season.

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18 Ibid., section 6.4 Runway condition code, Table 3, at tc.canada.ca/en/aviation/reference-centre/advisory-circulars/advisory-circular-ac-no-300-019#toc6_4 (last accessed on 10 February 2023).

19 Ibid., section 6.6: RWYCC downgrade assessment criteria, at tc.canada.ca/en/aviation/reference-centre/advisory-circulars/advisory-circular-ac-no-300-019#toc6_6 (last accessed on10 February 2023).

The RSC NOTAM is prepared by the airport maintenance staff who have been trained to make the observations that are the basis for the reports. For Runway 01/19, which CYGK has chosen to report in thirds, the staff observe the type and percent coverage of contaminant on each third of the runway and enter their estimate of the depth and type of contaminant, as well as the relative coverage area of that contaminant in percent (e.g. 1/4 inch wet snow, covering 20% of the runway width), into a tablet-based software application. The software is programmed to correlate these observations using the RCAM; it then generates the RSC NOTAM, which is automatically published. A notification is sent automatically to the CYGK FSS specialist, stating that a new report is available.

The *Snow Removal and Ice Control Plan at Kingston Airport* outlines the following conditions that require an additional AMSCR to be generated:

- when there is a significant change to runway surface conditions.
- when the runway is swept following anti-icing, de-icing or sanding.
- when the runway is cleared of snow.
- following any aircraft incident or accident on a runway.
- whenever the cleared runway width falls below full width. In this case, the report contains the location and description of the uncleared areas of the runway such as depth of snow, windrows, snowbanks, etc.; and
- in response to a reasonable request by a carrier, pilot or Kingston FSS.[20]

Although there was continuous snowfall after the issuance of the 1726 RSC NOTAM and some snow accumulation was evident on the apron area of the airport, the runways continued to appear bare and wet, and the conditions were not deemed to have significantly changed.

Approximately 30 minutes after the occurrence, the runway was inspected by the flight crew and the airport maintenance worker, who observed that it was slippery. While the *Snow Removal and Ice Control Plan at Kingston Airport*, based on guidance from AC 300-019, states that an AMSCR should be generated following an incident or accident, this was not completed. Instead, the airport maintenance worker, in an effort to prepare the runway for an upcoming scheduled departure, plowed Runway 19 before preparing the next AMSCR. This RSC NOTAM, published at 2002, indicated a RWYCC of 3/3/3, reporting 1.5 inches of wet snow covering 100% of the runway surface.

1.17.2.3 Canadian Runway Friction Index

Under appropriate conditions, the CRFI can be measured using a decelerometer attached to 1 of 2 staff vehicles. The decelerometer is activated while driving on the runway and generates a CRFI value automatically.

An excerpt from CYGK's snow removal and ice control plan reads as follows:

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[20] YGK Airport, *Snow Removal and Ice Control Plan at Kingston Airport*, Amendment #13 (December 2021), Part VI, section 1.0: Aircraft Movement Surface Runway Condition Reports (AMSCR), p. 7.

> Because of the mechanical and operational limitations under certain conditions, runway friction readings produced by decelerometer devices may provide inaccurate results. For this reason, CRFI readings will not be taken when the following runway surface conditions exist:
>
> - wet runway surface (water on runway surface).
> - slush on runway surface; or
> - loose snow exceeding 2.5 cm on the runway surface.[21]

Based on this guidance, there were no CRFI measurements taken at CYGK during the afternoon of the occurrence.

1.17.2.4 Known traffic

On the day of the occurrence, there were 3 daily scheduled flights (6 total aircraft movements) at CYGK. The final aircraft movement of the day was scheduled to depart at 2000 on the evening of the occurrence; this was the only aircraft movement that the airport staff member on duty was aware of until he witnessed the occurrence flight, beginning when the aircraft was on short final. During this time, he was preparing snow-clearing equipment at the base of the FSS tower in preparation for snow clearing on Runway 01/19 in advance of the scheduled 2000 departure. Plowing and sweeping the full width of Runway 01/19 takes a single staff member approximately 1 hour.

1.17.2.4.1 Traffic awareness

Airport staff monitor a publicly available aircraft tracking website to maintain awareness of incoming and unscheduled IFR traffic. Flight data for the occurrence aircraft had been blocked by the operator, and thus, the airport employee was unaware that the occurrence aircraft would be arriving at approximately 1830. It is not uncommon for a private or business aircraft operator to block its flight activity on such websites in the interest of privacy.

NAV CANADA is not required to provide information to the airport operator regarding incoming unscheduled flights. There is no sharing of information about incoming unscheduled flights between the airport maintenance staff and the FSS specialist on site, or the aircraft service providers at the airport.

1.17.3 NAV CANADA

1.17.3.1 Kingston flight service station

NAV CANADA operates an FSS at CYGK. An FSS is "an ATS [air traffic service] unit that provides services pertinent to the arrival and departure phases of flight at uncontrolled aerodromes and for transit through a MF [mandatory frequency] area."[22]

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21 Ibid., section 2.0: Runway Surface Friction Assessment, p. 7.

22 NAV CANADA, *Manual of Air Traffic Services—Advisory Services—Flight Service Station* (effective 28 October 2021), Glossary.

At the time of the occurrence, there was 1 flight service specialist on duty, which was in accordance with unit procedures.

The FSS specialist on duty is notified, through the computer system, of incoming flights shortly after they depart from their point of origin. There were no formal procedures in place at CYGK to share this information with airport staff.

1.17.4 I.M.P. Group Limited

I.M.P. Group is a privately-held investment corporation, which includes a diverse portfolio of business units, including some in the aviation sector. The occurrence aircraft was one of approximately 28 aircraft registered to the I.M.P. Group, many of which are privately owned by individuals or corporations. The I.M.P. Group provides aircraft management services through its business unit known as Execaire.

In order to operate an aircraft under its air operator certificate, a company providing aircraft management services will assume ownership of the aircraft and will appear as the owner of the aircraft on the certificate of registration. The occurrence aircraft was being operated under the authority of a private operator registration document, which limits the use of the aircraft to an individual flying for recreation or pleasure, or for a business to transport its own employees or clients. Operations under a private operator registration document are subject to CARs Subpart 604.

1.18 Additional information

1.18.1 TSB Watchlist

The TSB Watchlist identifies the key safety issues that need to be addressed to make Canada's transportation system even safer.

Runway overruns are a **Watchlist 2022 issue.** As this occurrence demonstrates, when a runway overrun occurs during landing, it is important that the aircraft have an adequate safety area beyond the end of the runway to reduce adverse consequences.

Despite the millions of successful movements on Canadian runways each year, runway overrun accidents sometimes occur during landings or rejected takeoffs. From 01 January 2005 to 30 June 2022, there were on average 9.3 runway overrun occurrences per year at Canadian aerodromes, of which 6.7 occurred during landing. The TSB investigated 24 of these occurrences in this period, issuing 6 recommendations to Canadian authorities. Five recommendations are still active[23] and one is closed.[24]

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23 TSB recommendations A20-02, A20-01, A07-06, A07-05, and A07-01.

24 TSB Recommendation A07-03.

Runway overruns: ACTIONS REQUIRED

Despite the actions taken to date, the number of runway overruns in Canada has remained constant since 2005 and demands a concerted effort to be reduced.

The issue of runway overruns will remain on the TSB Watchlist until

- TC demonstrates that the residual risk at airports with runways that are not required to comply with the ICAO's 150 m standard is as low as reasonably practicable; and
- TC requires operators of airports with runways longer than 1800 m that have a runway-end safety area (RESA) shorter than ICAO's recommended length of 300 m to conduct formal runway-specific risk assessments and to take action to mitigate the risks of overruns to the public, property, and the environment.

2.0 ANALYSIS

In this occurrence, there was no indication that a mechanical or system fault contributed to the runway overrun, nor was there evidence that operational deviations or pilot actions during the approach or landing roll affected the outcome.

The analysis will therefore focus on the information available to the flight crew regarding the runway condition, the information available to the airport maintenance staff regarding the incoming flight, and the actual runway surface condition at the time of the overrun.

2.1 Pre-flight planning

The NOTAMS were reviewed by the pilots before their flight, including the NOTAM indicating that the area navigation (RNAV) approach for Runway 01 was unusable, and the runway surface condition (RSC) NOTAM indicating a runway condition code for Runway 19 of 5/5/5, which corresponds with good braking action.

Using the manufacturer's performance information found in the quick reference handbook, the pilots calculated that there was sufficient landing distance available in the reported wet conditions to safely use Runway 19 at Kingston/Norman Rogers Airport (CYGK), Ontario.

Finding as to causes and contributing factors

The most recent runway surface condition NOTAM reviewed by the crew, which was issued 63 minutes before the landing, reported good braking conditions. As a result, they determined that a safe landing was possible.

2.2 Airport staff

At the time of the overrun, the airport maintenance worker had been preparing to clear snow from Runway 19 in advance of the evening's only scheduled aircraft movement, which was a departure at 2000.

The primary means for airport staff at CYGK to maintain awareness of incoming unscheduled traffic is through the use of a public flight-tracking website. In this case, the flight information had been blocked by the aircraft operator. There were no procedures in place at CYGK for the flight service station specialist on duty, who would have been notified in advance of the incoming flight, to alert airport staff of these flights.

Finding as to risk

If airport operator employees, who are responsible for maintenance of the runway surfaces, are not notified in advance of non-scheduled arrivals and departures, they will be unable to plan airport maintenance tasks, such as snow clearing, to prepare for these movements, increasing the risk of an occurrence, such as a runway lateral excursion or overrun.

2.3 Actual runway surface conditions

The aerodrome routine meteorological reports (METARs) issued during the hours leading up to the occurrence indicated both that snow had been falling steadily and that the

temperature had dropped below freezing. While a change from 0°C to -0°C, or from 00 to M00 as indicated in a METAR, may not appear to be significant, this indicates a shift in temperature from above freezing to below freezing.

In this occurrence, this reduction in air temperature to below freezing occurred just before sunset, when the runway surface was no longer being warmed by the sun.

Data from the cockpit voice and data recorder were analyzed along with engineering data to determine the actual runway surface friction during the overrun. It was determined that the surface friction on Runway 19 at the time of the occurrence was consistent with that of an ice-covered runway.

The airport employee, who drove down the runway while preparing the 1726 runway surface condition NOTAM, assessed the runway surface as being wet. Nearly an hour later, during the visual portion of their final approach, the flight crew observed the runway surface to be black in appearance, confirming their expectation of a wet runway, which was consistent with the conditions reported in the RSC NOTAM.

Findings as to causes and contributing factors

During the time between the issuance of the RSC NOTAM and the occurrence landing, some of the moisture on the runway surface had frozen, resulting in an icy surface with limited friction available for braking.

While the aircraft touched down at the planned speed within the touchdown zone and the brakes were applied immediately, the decreased braking effectiveness resulted in the runway overrun.

3.0 FINDINGS

3.1 Findings as to causes and contributing factors

These are conditions, acts or safety deficiencies that were found to have caused or contributed to this occurrence.

1. The most recent runway surface condition NOTAM reviewed by the crew, which was issued 63 minutes before the landing, reported good braking conditions. As a result, they determined that a safe landing was possible.

2. During the time between the issuance of the runway surface condition NOTAM and the occurrence landing, some of the moisture on the runway surface had frozen, resulting in an icy surface with limited friction available for braking.

3. While the aircraft touched down at the planned speed within the touchdown zone and the brakes were applied immediately, the decreased braking effectiveness resulted in the runway overrun.

3.2 Findings as to risk

These are conditions, unsafe acts or safety deficiencies that were found not to be a factor in this occurrence but could have adverse consequences in future occurrences.

1. If airport operator employees, who are responsible for maintenance of the runway surfaces, are not notified in advance of non-scheduled arrivals and departures, they will be unable to plan airport maintenance tasks, such as snow clearing, to prepare for these movements, increasing the risk of an occurrence, such as a runway lateral excursion or overrun.

4.0 SAFETY ACTION

4.1 Safety action taken

The aircraft operator, I.M.P. Group Limited, has updated procedures to include the task of notifying the airport operator of planned arrivals when environmental conditions may be affecting the runway condition, and to require pilots to request updated runway condition reports if conditions warrant.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 11 January 2023. It was officially released on 28 February 2023.