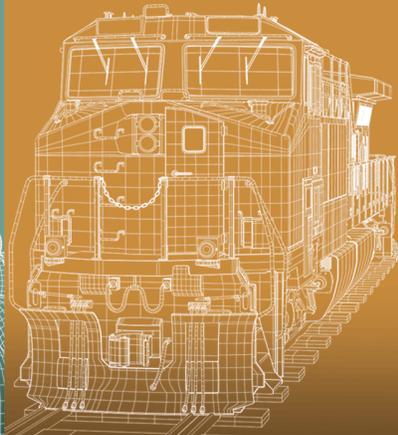
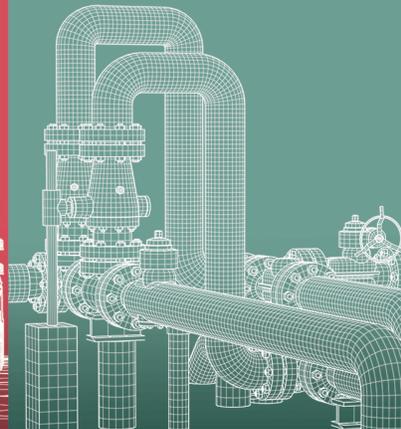




Transportation  
Safety Board  
of Canada

Bureau de la sécurité  
des transports  
du Canada



**TRANSPORTATION SAFETY BOARD OF CANADA**

**ANNUAL REPORT TO PARLIAMENT**

**2021–22**

Canada 

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*Le présent rapport est également disponible en français.*



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Place du Centre, 4th floor  
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15 June 2022

The Honourable Bill Blair, P.C., M.P.  
President of the Queen's Privy Council for Canada  
House of Commons  
Ottawa ON K1A 0A3

Dear Minister,

In accordance with subsection 13(3) of the *Canadian Transportation Accident Investigation and Safety Board Act*, the Board is pleased to submit, through you, its Annual Report to Parliament for the period 1 April 2021 to 31 March 2022.

Yours sincerely,

*Original signed by*

Kathleen Fox  
Chair



## Message from the Chair

The end of fiscal year 2021–22 marks the second year of working remotely for most of the employees of the Transportation Safety Board of Canada during the COVID-19 pandemic. Despite the substantial changes brought on by the pandemic, our employees continued to show determination and resilience in fulfilling our mandate to advance transportation safety.

This year we focused on completing some of our more detailed and complex safety investigations.

In the spring of 2021, we launched a rail safety issue investigation to understand why there is an increase in the rate of railway crossing accidents involving motor vehicles during winter months in Canada. In December, we released our safety issue investigation report that examined a series of 18 occurrences between 2013 and 2018 in Quebec and Nunavut on runways that were reduced in width during construction work. This led to a recommendation to NAV CANADA to publish graphic depictions of runway closures to accompany notices to airmen (NOTAMs).

This year also saw the completion of three highly complex and lengthy investigations. In May 2021, we released our report into the 2018 grounding of the passenger vessel *Akademik Ioffe* in the Canadian Arctic, in which we recommended that Transport Canada, in collaboration with Fisheries and Oceans Canada, develop and implement mandatory risk mitigation measures for all passenger vessels operating in Canadian Arctic coastal waters. Following the investigation, the Canadian Hydrographic Service amended its navigation chart for the area of the occurrence. In October 2021, we released our report into a fatal aircraft accident in 2017 on the territory of the Fond Du Lac Denesūliné First Nation in Saskatchewan, for which we had issued two recommendations to Transport Canada in 2018. This investigation shed light on the importance of having adequate de-icing equipment in remote northern airports in Canada. In March 2022, we released our report into the fatal loss of control and main-track train derailment near Field, British Columbia, in 2019, in which we issued three recommendations to enhance safety of train operations in cold weather through mountainous territory.

In keeping with our commitment to engage with our stakeholders, beginning in the fall of 2021 and early 2022, we met with industry for our Watchlist mid-cycle consultations to gauge progress made and discuss any emerging safety issues. The results of these sessions will inform Watchlist 2022, which will be released this fall.

Working toward our objective of becoming digital by default, we began the implementation phase of our new project tracking tool aimed at supporting the management of TSB projects. Next year, the Communications Branch will start using the tool to track projects, enabling them to manage workflow more efficiently. With restrictions around the COVID-19 pandemic easing across the country, we will be implementing a flexible, hybrid work model, incorporating a mixture of remote and in-office work. Regardless of where we work from, we will continue to conduct our critical work of advancing transportation safety from coast to coast to coast.

Kathleen Fox

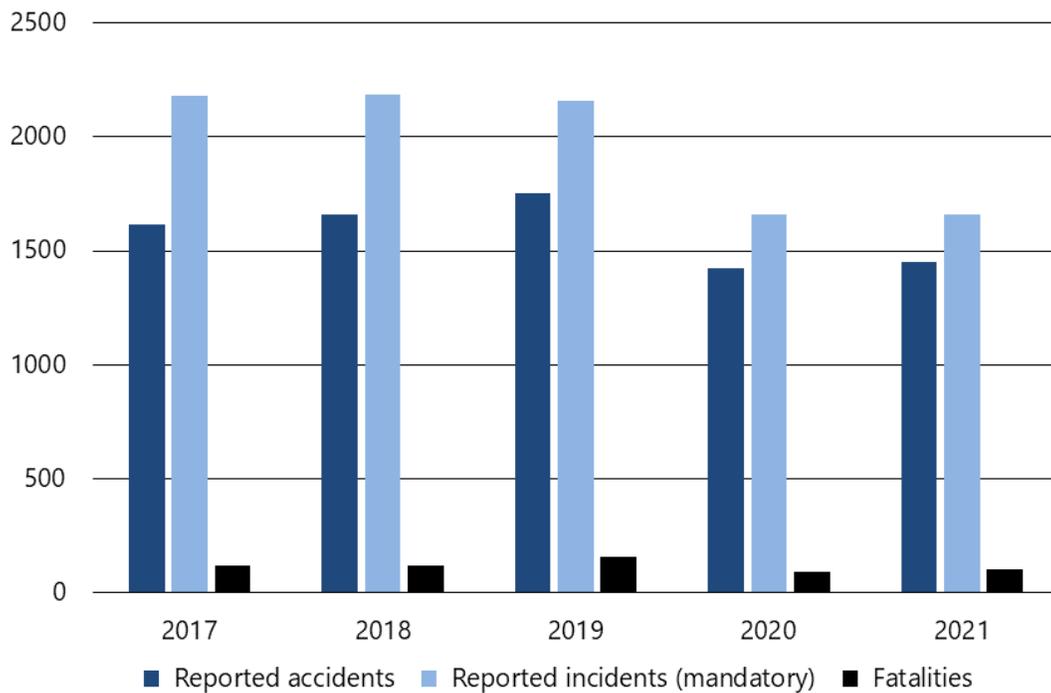


# The year in results

In 2021–22, staff from the Transportation Safety Board of Canada (TSB) assessed thousands of accidents and incidents that occurred across Canada in the air, marine, pipeline and rail transportation sectors (see the definitions in the [Policy on Occurrence Classification](#)).

TSB personnel deployed to the sites of some of these occurrences, virtually or in person, to collect data and carry out analysis in order to identify what happened and why, and highlight known and emerging safety issues—all in an effort to improve transportation safety in Canada.

Figure 1. Transportation occurrences reported to the TSB, 2017 to 2021



The total number of occurrences [reported to the TSB](#) (as required under the *Transportation Safety Board Regulations*) in the 2021 calendar year (3111) was 1% higher than the 2020 total of 3080.

In 2021, there were 1450 accidents reported, 2% above the 2020 total of 1422, but 9% below the 10-year average of 1597.

There were 10% more fatalities (103) across all transportation sectors in 2021 than there were in 2020 (94). The 2021 total represents a 23% decrease in fatalities from the 10-year average of 133.

The total of 1661 incidents reported to the TSB in 2021 is almost unchanged from the 2020 total of 1658, and a 10% decrease from the 10-year average of 1853. The latter partly results from changes made in 2014 to TSB reporting requirements.

# The TSB at work

## Deployments

TSB investigators deployed 46 times during 2021–22 (up from 29 the previous year) in response to occurrences in all sectors. These deployments took staff from the TSB regional offices and head office to locations across the country.

## Investigations

Table 1. TSB investigations, 2020–21 and 2021–22

Investigations	2020–21	2021–22
Started during year	41	54
Completed during year	66	39
In progress on 31 March of each year	59	74

In 2021–22, the TSB began 54 new investigations and completed 39 across all four transportation sectors ([air](#), [marine](#), [pipeline](#), and [rail](#)) and in [four investigative classes](#) (from in-depth and complex to limited scope).

Average completion times increased, both overall and for the various classes of investigations. Class 4 investigations accounted for 44% of the total investigations completed during the reporting year. In these limited scope investigations, the TSB gathers data, conducts a limited analysis and reports the facts regarding less complex occurrences to raise awareness of relevant safety issues.

In support of TSB investigations, engineers, technical specialists and human factors investigators began 167 projects and completed 175 technical reports in 2021–22. They also began 17 projects and completed 15 technical reports for foreign investigation agencies.

## Safety communications products

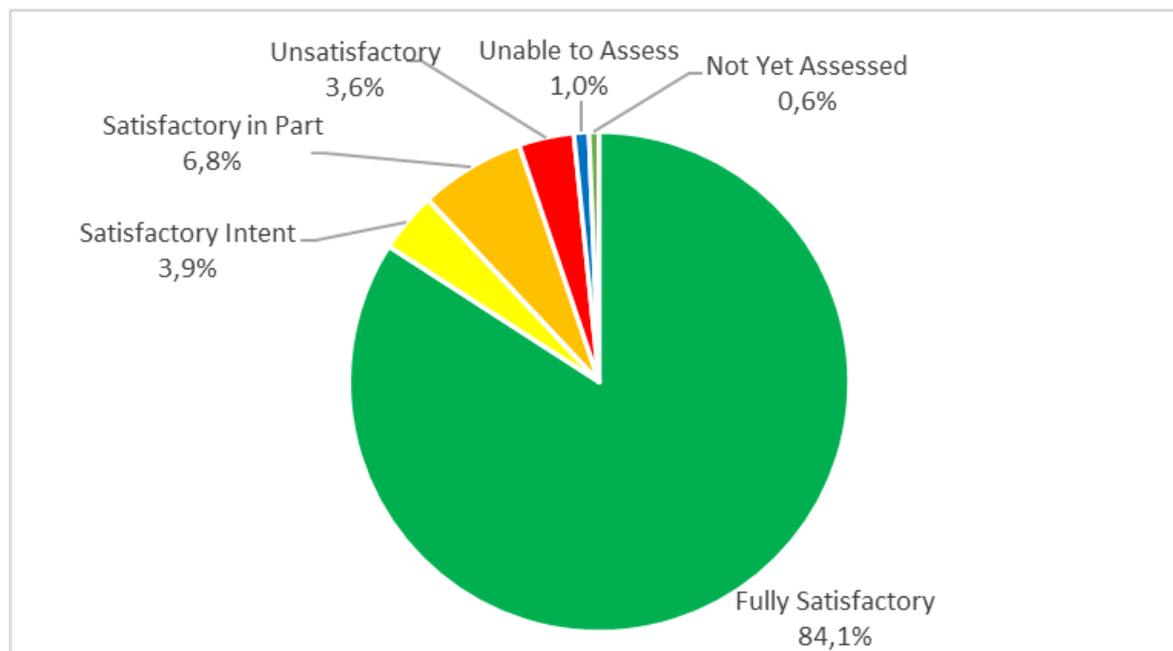
Table 2. Safety communications products issued, 2021–22

Safety advisories	Safety information letters	Safety concerns	Recommendations
6	3	1	5

Each year, the Board reassesses progress made on outstanding recommendations as part of ongoing efforts to urge stakeholders to act on the safety issues identified as a result of the TSB's investigations. In 2021–22, the Board reassessed 2 responses to outstanding recommendations as Fully Satisfactory: 1 on air transportation safety, and 1 on marine transportation safety.

Since 1990, the Board has made 617 recommendations. By the end of 2021–22, it had given 84.1% of the responses to these recommendations the highest rating of Fully Satisfactory. This means that stakeholders, including Transport Canada (TC), have acted to substantially reduce the safety deficiencies the Board identified.

Figure 2. Board assessments of responses to recommendations from 29 March 1990 to 31 March 2022



At 31 March 2022, there were 84 outstanding recommendations, slightly less than half of which date from 10 years ago or more.

Table 3. Age of outstanding recommendations at 31 March 2022

Age of recommendations	Air transportation safety	Marine transportation safety	Rail transportation safety	Total
Less than 1 year	1	1	3	5 (6%)
1 year to less than 7 years	21	9	5	35 (41.7%)
7 years to less than 10 years	1	0	4	5 (6%)
<b>Sub-total</b>	23	10	12	45 (53.6%)
10 years to less than 15 years	12	3	0	15 (17.9%)
15 years to less than 20 years	6	2	0	8 (9.5%)
20 years or more	10	3	3	16 (19%)

Age of recommendations	Air transportation safety	Marine transportation safety	Rail transportation safety	Total
<b>Sub-total</b>	28	8	3	39 (46.4%)
<b>Total</b>	51	18	15	84 (100%)

## Watchlist 2020

The TSB published the latest edition of its Watchlist in 2020. Therefore, in 2021–22, the TSB organized Watchlist mid-cycle consultations to engage with its stakeholders to gauge progress made and discuss any emerging issues. The results of these sessions will inform the next edition of the Watchlist, which will be released in the fall of 2022.

In the fall of 2021, the TSB sent questionnaires to a number of key stakeholders to solicit their input. The survey responses informed subsequent panel presentations and other discussions the TSB held with industry members at meetings of the Air Transport Association of Canada, the Helicopter Association of Canada and the Canadian Marine Advisory Council in November 2021. Consultations are planned with other stakeholders in the air and rail transportation sectors early in the new fiscal year.

## SECURITAS

Through the TSB’s SECURITAS program, transportation industry employees and the public can report, in confidence, unsafe actions and conditions they observe.

Table 4. SECURITAS reports received and closed in 2021–22

	Air transportation safety	Marine transportation safety	Pipeline transportation safety	Rail transportation safety
Reports received	93	44	0	35
Reports closed	93	44	0	35

The TSB received a total of 172 SECURITAS reports in 2021–22. This number is slightly lower than the 189 reports received the previous year.

Of the 93 SECURITAS reports of air transportation safety concerns that were submitted to the TSB, the majority (91%) were of a regulatory nature. These reports were redirected to TC. Other reports submitted were about an unreported accident and information related to an ongoing investigation.

In 2021–22, the TSB received 44 reports of marine transportation safety concerns, representing an increase of 76% from the previous year (25). This increase was likely influenced by the

easing of COVID-19 restrictions for the marine transportation industry. All regulatory matters were resolved in collaboration with TC. In total, 19 safety communications were sent out to TC or vessel owners and operators in response to SECURITAS reports.

This year the TSB received 35 SECURITAS reports of rail transportation safety concerns. Among these, the TSB received a report about crossings blocked in excess of 5 minutes, which was redirected to TC for follow-up.

By year-end, the trusted agents had closed all of the SECURITAS reports that the TSB had received.

## Communications and outreach

Regular communications and outreach are important aspects of the TSB’s efforts to advance transportation safety. Through its website, social media channels, and participation in in-person and virtual events, the TSB reaches industry and government stakeholders, as well as media and members of the public across Canada and around the world.

Table 5. TSB media and stakeholder outreach activities, 2021–22

Media requests	Interviews	News conferences	Industry outreach events
405	65	2	54

Table 6. TSB communications products, 2021–22

Deployment notices	Investigation webpages	Media advisories	News releases	Investigation reports
43	52	3	46	39

Table 7. TSB social media presence, 2021–22

Lifetime views on YouTube	Lifetime views on Flickr	Twitter followers	LinkedIn followers	Facebook followers
725 152	9 712 199	26 102	2837	1067

## Outreach activities

The TSB took part in **54 industry events and meetings** during the year, some online and others in person.

Among these was the Air Transport Association of Canada conference on 17 November 2021 in Montreal, Quebec. Chair Kathy Fox and Board Member Yoan Marier were present to gather feedback on the five Watchlist 2020 issues facing the air transportation industry. During this

90-minute session, the TSB posed a series of questions, and candidly discussed the challenges and concerns shared by the industry.

Further consultations were held with the Helicopter Association of Canada during its virtual conference on 24 November 2021. The Watchlist 2020 issues of fatigue, safety management, and regulatory surveillance made up the discussion, with a lot of feedback provided on the challenges experienced by helicopter operators in Canada.

On 7 April 2021, Board Member Ken Potter presented on the topic of the *Akademik Ioffe* investigation ([M18C0225](#)) at the Prairie and Northern Canadian Marine Advisory Council conference. Also, on 23 November 2021, Ken Potter, along with Senior Investigator – Marine Glenn Budden, led an online discussion about the four Watchlist 2020 issues facing the marine transportation industry as part of the national Canadian Marine Advisory Council fall conference.

## Behind the scenes

In the spring, we launched a **rail transportation safety issue investigation (SII)** ([R20H0082](#)) to understand why there is an increase in the rate of railway crossing accidents involving motor vehicles during winter months in Canada. An SII is broad in scope and involves looking at multiple occurrences in order to identify the underlying safety issues. Research outcomes from this SII will be communicated in a final TSB report, which will provide findings and, potentially, recommendations for improving road-rail level crossing safety, especially during winter months.

Working toward the TSB's strategic objective of becoming digital by default, we began the implementation phase of our new **project tracking tool** aimed at supporting the tracking, monitoring, searching, and reporting of TSB projects. This new tool will also provide a single, centralized location for recording project information, and a means for standardizing project information across the organization. After having onboarded our Engineering Laboratory to support the TSB's engineering and human factors projects in 2021-22, this fiscal year our Communications Branch will start using the tool to help them manage workflow more efficiently.

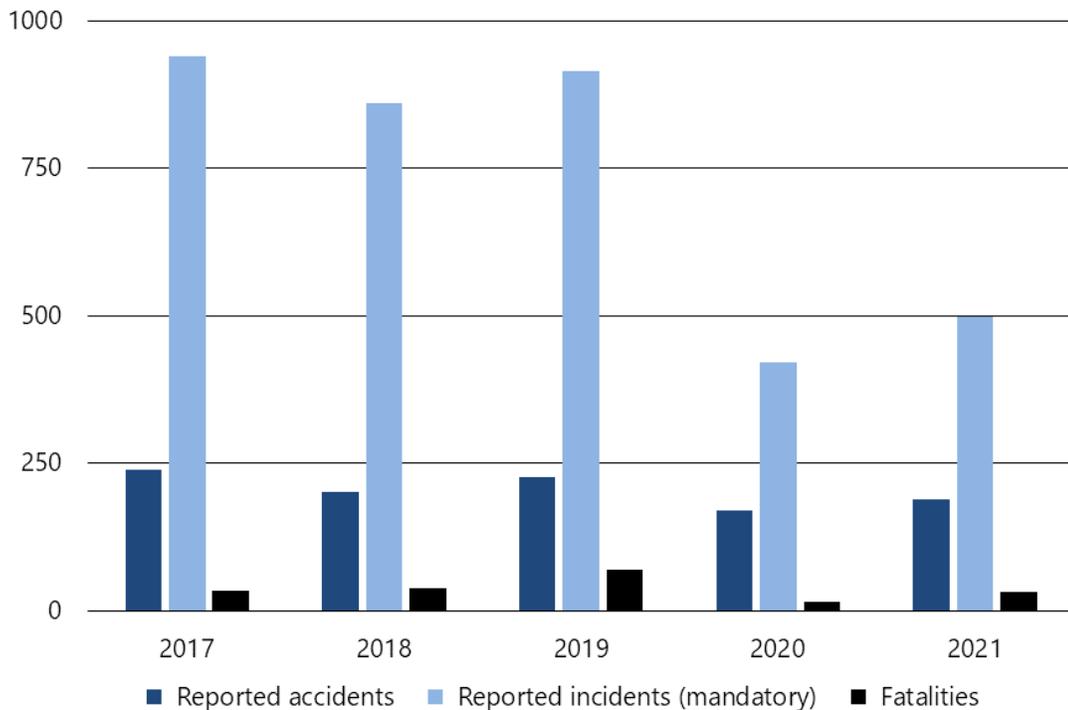
With restrictions around the COVID-19 pandemic easing across the country, this year we have been developing a flexible, **hybrid work model** for TSB employees. Adopted by many other government departments, this work model means that, on any given day, some employees will be working on-site and some off-site. Some employees will be working on-site full-time, some will be working off-site part-time and others will be working off-site full-time.

# Air transportation safety

## The year in review

The TSB received 689 reports of air occurrences in 2021 (190 accidents and 499 incidents), including 32 fatalities.

Figure 3. Air transportation accidents, incidents and fatalities, 2017 to 2021



The total number of accidents reported in 2021 (190) is 12% higher than the previous year's total of 170 accidents but 21% below the yearly average of 239 accidents reported in the previous 10 years, 2011 to 2020. Most (183) of the accidents in 2021 took place in Canada and involved Canadian-registered aircraft. In general, the number of air transportation accidents has been decreasing in the last decade.

The TSB recorded 22 fatal air transportation accidents involving 32 fatalities in 2021. This is up considerably from 12 fatal accidents involving 16 fatalities in 2020, but is still 21% below the average of 28 fatal accidents involving 47 fatalities over the ten-year period of 2011 to 2020. Eight of the 32 air transportation fatalities in 2021 involved commercial operations: 1 of them under air taxi regulations (operations subject to *Canadian Aviation Regulations* [CARs] Subpart 703), and 7 under aerial work (operations subject to CARs Subpart 702). There were no fatalities involving airliner operations (subject to CARs Subpart 705), commuter operations (subject to CARs Subpart 704), or flight training operations (subject to CARs Subpart 406) in 2021. The remaining 24 (of 32) fatalities in 2021 were linked to privately registered aircraft

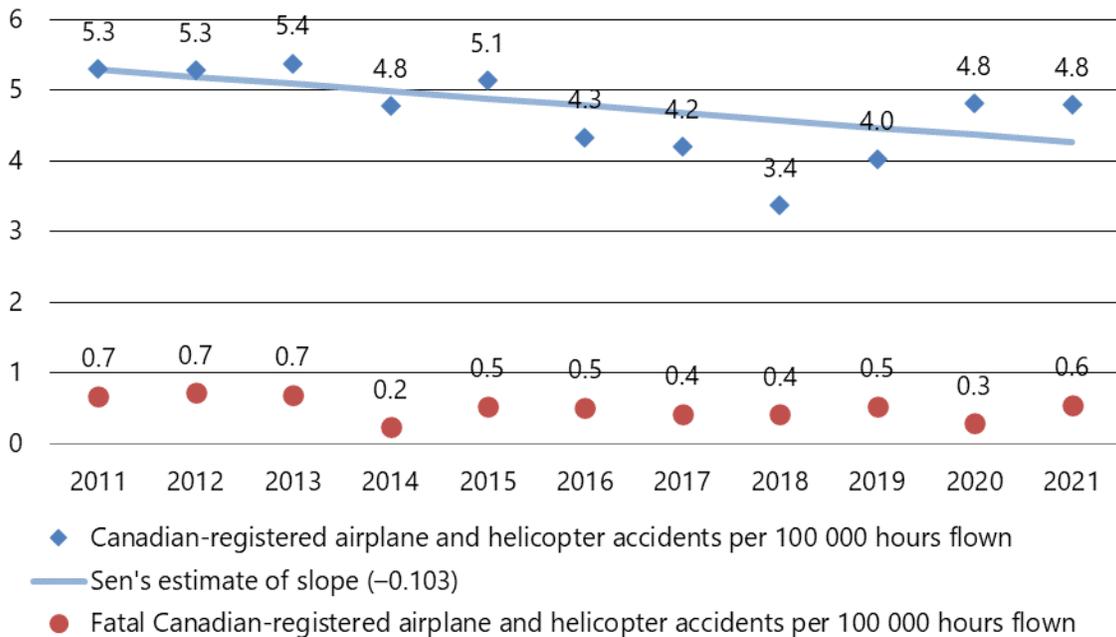
and involved recreational operators. Eight accidents in 2021 involved a release of dangerous goods. This is above the average of 4.6 per year over the previous 10 years.

In addition, 499 air transportation incidents were reported under the *Transportation Safety Board Regulations*. This represents an increase of 19% from the 421 that were reported in 2020, and is 34% below the average of 751 incidents per year between 2011 and 2020. The majority of incidents in 2021 (401 or 80%) occurred in Canada and involved Canadian-registered aircraft.

### Accident rate: A measure of air transportation safety

The overall air transportation accident rate of 4.8 accidents per 100 000 hours flown in 2021 is based on 164 accidents in Canada and abroad involving Canadian-registered airplanes and helicopters (ultralights, gyroplanes, gliders, and remotely piloted aircraft systems are excluded) and the estimated 3.422 million hours flown by Canadian-registered aircraft. This rate is equal to the 2020 rate, and slightly (4%) above the average rate of 4.6 over the previous 10 years. While the number of hours flown in 2021 increased by 10% compared to 2020, the number of reported accidents increased by a similar amount – around 10%. Taken together this means the accident rate statistic held steady.

Figure 4. Accident rate for Canadian-registered airplanes and helicopters, 2011 to 2021



### Investigations

TSB staff deployed to 27 air transportation occurrences in 2021–22 (up from 15 in 2020–21), began 37 investigations and completed 21.

**Table 8. TSB air transportation safety investigation activities, 2020–21 and 2021–22**

Activities	2020–21	2021–22
Deployments	15	27
Investigations started	16	37
Investigations completed	31	21
Investigations in progress on 31 March of each year	21	37

**Table 9. Air transportation safety investigations completed, 2020–21 and 2021–22**

Class (investigation type)	Completed investigations		Completion target (days)	Average duration (days)	
	2020–21	2021–22		2020–21	2021–22
1 (safety issue)	0	1*	730	n/a	1219
2 (complex)	2	3**	600	704	1007
3 (detailed)	17	7	450	488	491
4 (limited scope)	12	10	220	198	203

\* This was a comprehensive, five-year study of safety issues involving runways undergoing construction in Quebec and Nunavut.

\*\* One of the class 2 investigations completed in 2021–22 was into the fatal airplane crash in Fond-du-Lac, Saskatchewan, on 13 December 2017.

## Deficiencies in regulatory surveillance related to the safety of flight operations during airport construction

This safety issue investigation conducted by the TSB examined a series of 18 occurrences between 2013 and 2018 that took place at certain airports undergoing construction in Quebec and Nunavut ([A18Q0140](#)). A summary review of these occurrences revealed a particularity in the method used to carry out the construction: the width of the runway was reduced rather than the length. In all but two cases, aircraft had manoeuvred on the closed portion of the runway during takeoff or landing.

The investigation found that information pertaining to airport construction, which is temporary and may be complex, can be difficult to communicate clearly and effectively in a NOTAM. As a result of this safety issue investigation, the Board recommended that NAV CANADA make available, in a timely manner, graphic depictions of closures and other significant changes related to aerodrome or runway operations to accompany the associated NOTAMs so that the information communicated on these hazards is more easily understood (A21-01).

In addition, although the occurrences under review took place primarily in Quebec and Nunavut, the investigation determined that these deficiencies all resulted from systemic underlying causes or contributing factors that a national safety program should have identified. Inevitably, it begs the question as to whether the situation is the same in other regions. In light of this, the Board is concerned that if Transport Canada Civil Aviation does not provide adequate surveillance of airports in Canada, the risk of an accident related to flight operations at airports increases, particularly when the airports are undergoing construction.

The results of this investigation reflect the TSB's ongoing concerns about safety management and regulatory surveillance, both issues on the TSB's Watchlist 2020.

**Safety management** is an issue on the [TSB's Watchlist](#), and is a concern in the air, marine and rail transportation modes.

A lack of timely and effective **regulatory surveillance** to ensure operators in all modes are compliant is an issue on the [TSB's Watchlist](#).

### **Better de-icing equipment and practices in remote and northern airports are needed**

In its investigation report, the TSB determined that the lack of adequate de-icing equipment and the practice of taking off without de-icing led to the fatal December 2017 accident involving a West Wind Aviation<sup>1</sup> ATR-42 aircraft on the territory of the Fond Du Lac Denesūliné First Nation in Saskatchewan ([A17C0146](#)).

Shortly after takeoff, the aircraft collided with terrain. The aircraft was destroyed and all 22 passengers and three crew members were injured, ten of them seriously. One passenger died 12 days following the accident.

Early in the investigation, it was determined that the aircraft took off from the Fond-du-Lac Airport with contamination on the aircraft's critical surfaces. In 2018, the Board issued two recommendations. The first one was aimed at making sure adequate de-icing and anti-icing equipment is available for those operators who need it ([A18-02](#)). The second urged Transport Canada (TC) to take action to improve compliance with the regulations to reduce the likelihood that crews take off with snow or ice contamination ([A18-03](#)).

This highly complex and lengthy investigation also revealed a number of instances in which TC's surveillance policies and procedures were inconsistently applied to the oversight of the operator despite several concerns identified between 2010 and 2013 with its safety management system.

**Safety management** is an issue on the [TSB's Watchlist](#), and is a concern in the air, marine and rail transportation modes.

A lack of timely and effective **regulatory surveillance** to ensure operators in all modes are compliant is an issue on the [TSB's Watchlist](#).

<sup>1</sup> West Wind Aviation L.P. now operates as Rise Air.

The results of this investigation reflect the TSB's ongoing concerns about safety management and regulatory surveillance, both issues on the TSB's Watchlist 2020.

Following the occurrence, TC reached out to stakeholders, and provided educational and awareness material regarding the hazards of aircraft taking off with contaminated critical surfaces. The operator implemented new risk assessment requirements, provided its scheduled service and regular charter destinations with equipment capable of inspecting and de-icing all of its aircraft types, and amended its training programs, among other things.

### **Fatigue management among factors leading to two runway overruns in Halifax**

During its investigation into a runway overrun of a Sky Lease Cargo Boeing 747-412F at the Halifax/Stanfield International Airport in Nova Scotia, the TSB identified multiple contributing factors that led to the occurrence ([A18A0085](#)). In this occurrence, the 3 crew members received minor injuries and the sole passenger was uninjured.

During the overrun, the aircraft crossed a significant drop of 2.8 m approximately 166 m past the end of the runway and was damaged beyond repair. While this uneven terrain was beyond the 150 m (492 feet) runway end safety area proposed by TC, it was within the recommended International Civil Aviation Organization (ICAO) runway end safety area of 300 m (984 feet). The Board has previously recommended to increase Code 4 runway end safety areas to meet the ICAO recommendation (Recommendation [A07-06](#)).

The investigation also identified the presence of two fatigue risk factors that would have degraded the crew's performance during the approach and landing: the timing of the flight and insufficient restorative sleep in the 24-hour period leading up to the occurrence.

This year the TSB released another investigation report on a runway overrun at the Halifax/Stanfield International Airport ([A20A0001](#)). In this occurrence, a WestJet Airlines Boeing 737-8CT touched down with a tailwind component on the wet, snow-covered runway. Following touchdown, the aircraft could not be stopped and it overran the end of Runway 14. The aircraft came to rest in snow approximately 300 feet (91 m) beyond the runway end. There were no injuries or damage to the aircraft.

The results of these investigations reflect the TSB's ongoing concerns about runway overruns and fatigue management, both issues on the TSB's Watchlist 2020.

**Runway overruns** pose a risk to people, property and the environment. They have been an issue on the [TSB's Watchlist](#) for a decade, with no significant change in the number of these occurrences since 2005.

**Fatigue management** is an issue on the [TSB's Watchlist](#), and is a concern in the air, marine and rail transportation modes.

### **Helicopter enhanced ground proximity warning systems still not required by regulation**

In its investigation report, the TSB found that, while conducting a visual approach to an offshore helideck platform in instrument meteorological conditions near Sable Island, Nova Scotia, a Sikorsky S-92A helicopter inadvertently entered a descent before the pilots regained control of

the aircraft within approximately 13 feet of the water ([A19A0055](#)). In this occurrence, there were no injuries to the 2 crew members or 11 passengers.

The investigation determined that the helicopter entered a low-energy state: it was flying at low airspeed with a high rate of descent, a nose-up pitch attitude, and at a low power setting. The helicopter's low-energy state went undetected by the flight crew, who were focused on the helideck, which was sitting above the fog and in an area without a discernible horizon. The degraded visual environment made it difficult for the pilots to recognize the unstable approach.

Despite the helicopter's very high rate of descent into the fog bank at low airspeed with the landing gear extended, its enhanced ground proximity warning system (EGPWS) did not alert the crew to the situation. This is the result of a gap, previously identified by the TSB (investigation [A13H0001](#)), in the coverage provided by the S-92 EGPWS. If an inadvertent descent occurs with the gear down at airspeeds below 50 knots indicated airspeed, the EGPWS will provide no warning against controlled flight into terrain.

In 2016, the Board issued Recommendation [A16-10](#) calling for terrain awareness and warning systems for commercial helicopters that operate at night or in instrument meteorological conditions. At the present time, these systems are still not required by regulation. As a result, helicopter manufacturers and operators are free to disable EGPWS modes. Until EGPWS or helicopter terrain awareness and warning systems become mandatory for Canadian commercial helicopters that operate at night or in instrument meteorological conditions, flight crew and passengers aboard these flights are at increased risk of controlled flight into terrain.

### **Flap malfunction and handling of procedure led to landing accident**

In its investigation report, the TSB determined that a flap malfunction of a Bombardier Challenger 605 combined with the flight crew's handling of the flaps fail landing procedure led to a loss of pitch control and subsequent contact of the rear fuselage with the runway while landing in Calgary, Alberta ([A20W0016](#)).

A Bombardier Challenger 605 operated by the Canadian Pacific Railway Company (CP) departed Palm Beach International Airport, Florida, United States, for Calgary International Airport, Alberta, with three crew members and 10 passengers on board. During the descent, the flight crew attempted to deploy the flaps and immediately received a "FLAPS FAIL" caution message. The flight crew proceeded to complete the flaps fail landing procedure from the Quick Reference Handbook (QRH).

The investigation found that the flap failure occurred when one of the flap flexible drive shafts failed. Moisture entered the flap flexible drive shaft casing, likely through the undetected puncture holes and the drive shaft casing to flap actuator interface, which led to the subsequent corrosion and failure of the inner drive shaft. As the aircraft's actual annual utilization was approximately half of that expected by the manufacturer, the calendar time interval between maintenance inspections increased. As a result, the corrosion that developed was not detected because the shaft had not yet reached the flight-hour maintenance interval at which it would have been inspected next.

The investigation also found that the pilot monitoring did not read the cautions included on the flaps fail checklist out loud to the pilot flying during the completion of the QRH procedure. As a result, information critical to the safe operation of the aircraft was not brought to the pilot flying's attention.

During its investigation, the TSB issued Air Safety Information Letter [A20W0016-D1-L1](#) to Bombardier Aviation about the inspection interval of the Challenger 605 series flap system and cross-fleet product improvement to the Challenger CL60 series, calling for follow-up action.

Following the occurrence, CP amended its procedures to address the differences between the caution and warning notes published in the aircraft flight manual and QRH. Bombardier issued a temporary revision to the QRH flaps fail landing procedure.

## **Safety advisories and safety information letters**

The TSB issued air transportation safety advisories and information letters as part of its investigations in 2021–22.

### **Absence of standards, recommended practices and guidelines pertaining to the safety of operations at airports under construction**

As part of safety issue investigation [A18Q0140](#), the TSB issued Aviation Safety Advisory [A18Q0140-D1-A1](#) to TC in August 2021 about the absence of standards, recommended practices and guidelines pertaining to the safety of operations at airports under construction, and calling for the implementation of corrective measures as soon as possible.

### **Failure of a blade actuating pin**

As part of Air Transportation Safety Investigation [A20C0103](#) into a rejected takeoff, the TSB issued Air Safety Information Letter [A20C0103-D1-L1](#) to TC in April 2021 about a McCauley Propeller Systems blade actuating pin that failed due to a fatigue fracture, calling for follow-up action.

### **Visual approach slope indicator systems angle not harmonized with glide path angle of approach procedures with vertical guidance**

As part of Air Transportation Safety Investigation [A21O0066](#) into a runway overrun, a class 5 investigation,<sup>2</sup> the TSB issued Air Transportation Safety Information Letter [A21O0066-D1-L1](#) to TC in March 2022 about approach procedures with vertical guidance to aerodromes with shorter runways that may not be harmonized with the visual approach slope indicator systems, calling for follow-up action.

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<sup>2</sup> According to the TSB's Policy on Occurrence Classification, a class 5 investigation is limited to data gathering for statistical reporting and future analysis.

## Progress on outstanding recommendations

Of the 26 responses to air transportation safety recommendations the Board assessed or reassessed in 2021–22, 2 were closed, one after receiving a rating of Fully Satisfactory, and the other after receiving a rating of Unsatisfactory, with no further action from the United States Federal Aviation Administration expected. The remaining 24 recommendations the Board assessed or reassessed in 2021–22 obtained the following ratings: Satisfactory Intent (10), Satisfactory in Part (10), Unable to Assess (1), and Unsatisfactory (3).

TC's amendments to the *Canadian Aviation Regulations* (CARs) published this year in the *Canada Gazette*, Part II, will eliminate the ambiguity associated with the use of safety belts on board aircraft. The response to Recommendation [A19-01](#) was therefore reassessed by the Board as Fully Satisfactory. Two recommendations issued to TC in 2018 during an investigation into a loss of control and collision with terrain ([A17C0146](#)) were assessed by the Board this year as showing Satisfactory Intent ([A18-02](#) and [A18-03](#)), meaning that progress is being made to ensure that proper de-icing and anti-icing equipment is available in airports across Canada and that the likelihood of aircraft taking off with contaminated critical surfaces is being reduced.

Responses to two recent recommendations made as a result of an investigation into a runway overrun on landing ([A18Q0030](#)) show that progress is being made toward simplifying operating minima for approaches and landings at Canadian aerodromes and introducing a mechanism to stop approaches and landings that are actually banned ([A20-01](#) and [A20-02](#)). The responses were reassessed by the Board as showing Satisfactory Intent.

While amendments to the CARs published this year in the *Canada Gazette*, Part II, will reduce the risks associated with runway overruns, there is however residual risk represented by a gap between TC's regulations and an ICAO standard. Therefore, TC's response to Recommendation [A07-06](#), which was issued as a result of an investigation on a runway overrun ([A05H0002](#)), was reassessed by the Board as being Satisfactory in Part.

The response to a recommendation on runway incursions ([A18-05](#)) was also reassessed by the Board as being Satisfactory in Part, meaning that, while there is still work to be done on this issue, the Board acknowledges the steps taken to address the risk of runway incursions at Toronto/Lester B. Pearson International Airport, in Ontario.

Two responses to recommendations pertaining to Watchlist 2020 issues, safety management and regulatory surveillance, have been assessed by the Board as Satisfactory in Part ([A16-13](#) and [A16-04](#)). TC has made good progress on improving its surveillance methodology and on enhancing its oversight policies and training.

Unfortunately, other responses show that insufficient action has been planned or taken. The actions taken in response to Recommendation [A16-10](#), in which the Board recommended to TC to require terrain awareness and warning systems for commercial helicopters that operate at night or in instrument meteorological conditions, also relevant to a more recent TSB investigation on an inadvertent descent of a helicopter during an approach ([A19A0055](#)), were

considered insufficient. Also, because the risks associated with the timing of post-landing procedures, identified in Recommendation [A18-06](#), were not addressed, the United States Federal Aviation Administration's response was considered by the Board to be Unsatisfactory.

In addition, the response to Recommendation [A16-12](#), in which the Board recommended that TC require all commercial aviation operators in Canada to implement a formal safety management system, could not be assessed by the Board, because there is no clear indication as to whether TC will initiate regulatory changes to address this deficiency.

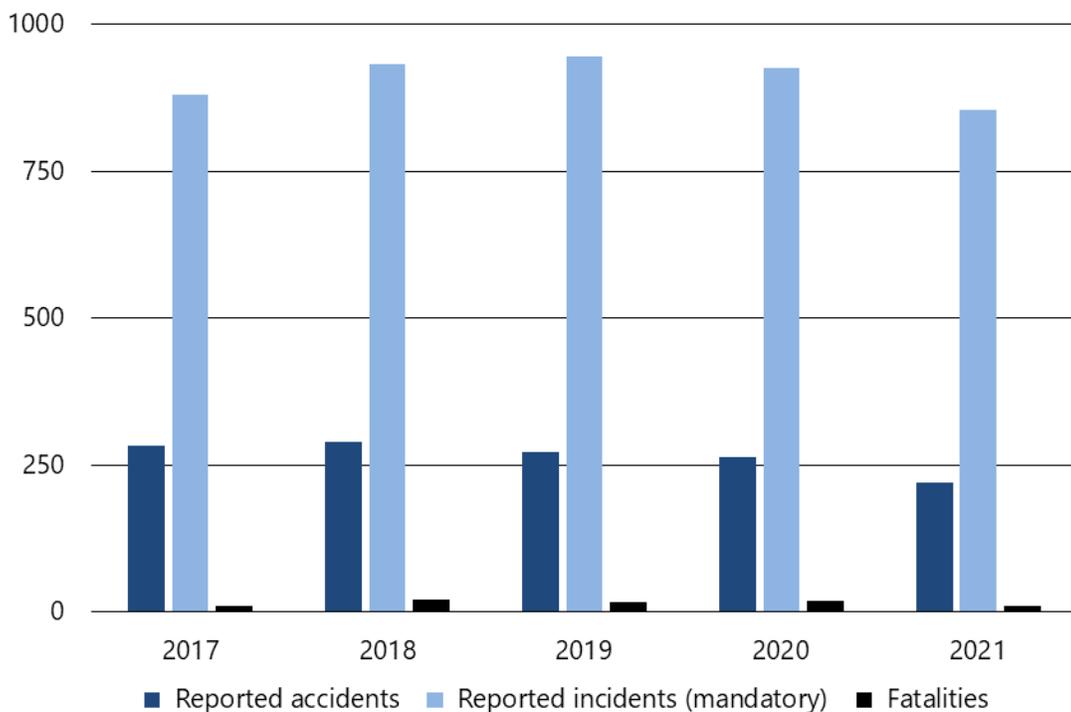
For all active recommendations, the TSB will continue to monitor the progress of planned actions and call for action to reduce or eliminate these deficiencies.

# Marine transportation safety

## The year in review

The TSB received 1075 reports of marine transportation occurrences in 2021 (220 accidents and 855 incidents), including 11 fatalities.

Figure 5. Marine transportation accidents, incidents and fatalities, 2017 to 2021



The total of 220 marine transportation accidents represents a decrease from the 264 accidents in 2020 and is lower than the 10-year average of 284. In 2021, 80% of accidents were shipping accidents (when a ship sinks, founders or capsizes, for example), compared to 82% on average over the previous 10 years. The remaining 20% of accidents in 2021 were accidents aboard ship (when a person is killed or seriously injured when boarding a ship or by falling overboard, for example), compared to the 10-year annual average of 18%.

The 11 marine transportation fatalities are fewer than the 2020 total of 18 and the 10-year average of 15.6. Of the 11 fatalities, 9 involved shipping accidents. Over the previous 10 years, fatalities have been fairly evenly divided between shipping accidents and accidents aboard ship.

As in previous years, the majority of the fatalities (8 of the 11) were related to commercial fishing (Canadian-flag vessels in Canadian waters). Due to this continuing trend, [commercial fishing safety](#) remains a key safety issue on the TSB's Watchlist.

There were 200 vessels involved in the 177 shipping accidents that took place in 2021. In 2020, 257 vessels were involved in 221 shipping accidents. The decrease was observed in all regions.

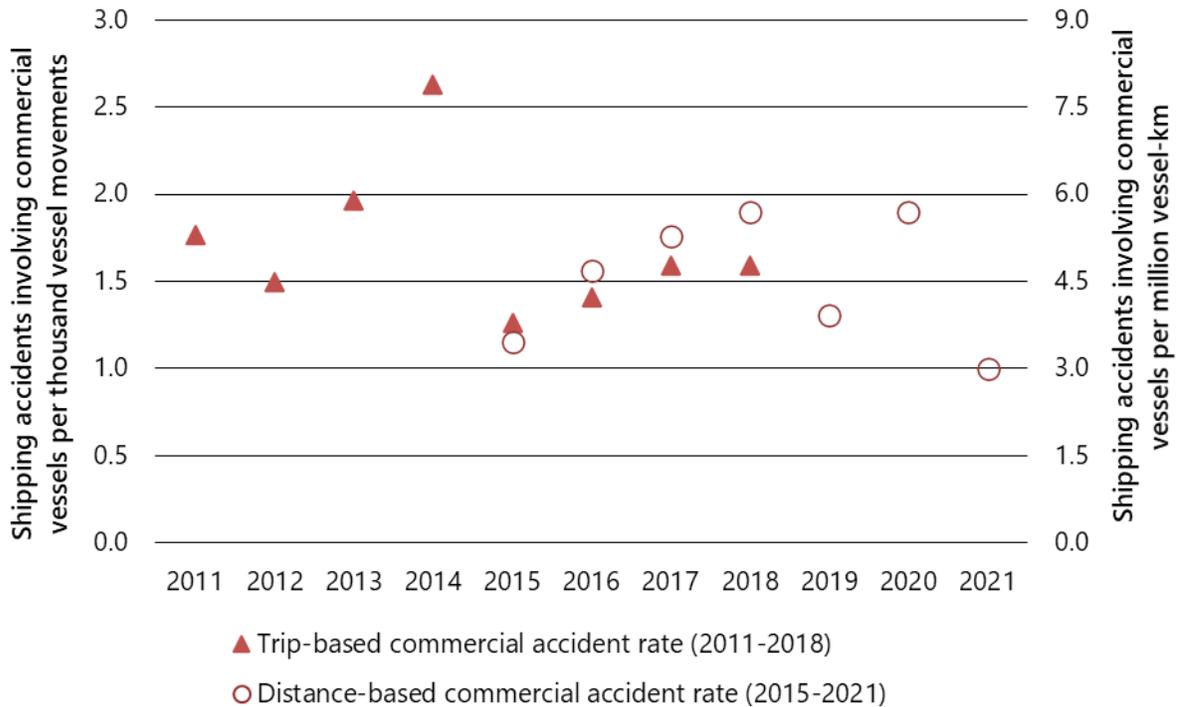


The 855 marine transportation incidents reported to the TSB in 2021 represents an 8% decrease from 2020 but a 20% increase from the 10-year average of 712. As in previous years, most reportable incidents (85%) were related to the total failure of machinery or technical systems. The increase in incidents of this type is due largely to changes made in 2014 to TSB reporting requirements.

### Accident rate: A measure of marine transportation safety

According to Transport Canada (TC), 2021 marine activity (commercial vessel-kilometres) for Canadian commercial non-fishing vessels with a gross tonnage of over 15 (excluding passenger vessels and cruise ships) was 7% above the 2015-to-2020 average. The 2021 accident rate was 3.0 accidents per million commercial vessel-kilometres, substantially lower than the 2015-to-2020 average of 4.8. (TC now provides a comprehensive distance-based metric of commercial marine activity in Canadian waters beginning from 2015. However, a seven-year series is too short to test for meaningful trends, and vessel movements are no longer captured.)

Figure 6. Shipping accident rate, Canadian commercial non-fishing vessels, 2011 to 2021



### Investigations

TSB staff deployed to 7 marine transportation occurrences in 2021–22 (slightly less than in 2020–21), began 8 investigations and also completed 8.

Table 10. TSB marine transportation safety investigation activities, 2020–21 and 2021–22

Activities	2020–21	2021–22
Deployments	8	7
Investigations started	13	8
Investigations completed	15	8
Investigations in progress on 31 March of each year	17	17

Table 11. Marine transportation safety investigations completed, 2020–21 and 2021–22

Class (investigation type)	Completed investigations		Completion target (days)	Average duration (days)	
	2020–21	2021–22		2020–21	2021–22
1 (safety issue)	0	0	730	n/a	n/a
2 (complex)	2	1	600	953	1001
3 (detailed)	4	6	450	708	771
4 (limited scope)	9	1	220	370	234

### Risk mitigation measures are needed for vessels transiting Canadian Arctic waters

In its investigation report on the 2018 grounding of the passenger vessel *Akademik Ioffe* ([M18C0225](#)), the TSB determined that there are unique risks associated with operating in the Canadian Arctic that require additional mitigation measures in order to ensure the safety of passenger vessels, and to protect the vulnerable Arctic environment.

The investigation found that the *Akademik Ioffe* ran aground in a remote area of the Canadian Arctic that was not surveyed to modern or adequate hydrographic standards, and where none of the vessel crew had ever been. Until the coastal waters surrounding the Canadian Arctic Archipelago are surveyed to modern or adequate hydrographic standards, and if alternate mitigation measures are not put in place, there is a persistent risk that vessels will make unforeseen contact with the sea bottom. The Board therefore recommended that TC, in collaboration with Fisheries and Oceans Canada, develops and implements mandatory risk mitigation measures for all passenger vessels operating in Canadian Arctic coastal waters ([M21-01](#)).

Following the occurrence, the Canadian Hydrographic Service amended its navigation chart for the area of the occurrence to include the rocky shoal on which the *Akademik Ioffe* ran aground. In addition, the authorized representative for the *Akademik Ioffe* indicated that all deficiencies

had been corrected, following the issuance of a letter of warning from TC. The Russian Federal Authority for Transport Oversight (Rostransnadzor) carried out a safety investigation and produced a marine casualty investigation report, and the P.P. Shirshov Institute of Oceanology of Russian Academy of Sciences corrected the *Akademik Ioffe's* bridge watch crew bridge equipment familiarization checklist.

### **Breakdowns in situational awareness and communications led to striking**

In its investigation report on the 2019 striking of the anchored bulk carrier *Pan Acacia* by the bulk carrier *Caravos Harmony* in Vancouver Harbour, British Columbia, the TSB determined that communication breakdowns impacted the team's situational awareness and resulted in different understandings of the emerging circumstances ([M19P0057](#)).

The *Caravos Harmony*, under the conduct of a pilot and with 22 people on board, struck the *Pan Acacia* while proceeding to anchorage D in Vancouver Harbour. Both vessels sustained damage, and no pollution or injuries were reported.

During the occurrence, the pilot and bridge crew did not share critical information to build a common and accurate understanding of the situation and this impeded timely and effective coordination of actions to safely manoeuvre the vessel and avoid the striking.

Following the occurrence, all parties involved took safety action to reduce the chances of a similar occurrence in the future. TC conducted port state control inspections of the *Pan Acacia* and the *Caravos Harmony*, the Vancouver Fraser Port Authority amended its rules for vessels refuelling at English Bay, and the Pacific Pilotage Authority and British Columbia Coast Pilots Ltd. issued recommendations as a result of their risk assessment on loaded bulk carriers entering Vancouver Harbour on a strong flood tide.

### **Fall overboard caused by unmitigated mooring line hazards**

The TSB found safety deficiencies associated with the use of workboats, including the unmitigated hazards associated with the uncontrolled movement of mooring lines, as a result of its investigation involving a self-unloading Great Lakes bulk carrier, the *Manitoulin* ([M20C0101](#)).

On the day of the occurrence, three of the *Manitoulin's* crew members were crossing over a submerged mooring line in the vessel's workboat while proceeding to shore near Sombra, Ontario, when tension came on the line and it struck the workboat. The impact caused all of the crew members to fall overboard. One of the crew members swam to shore and the other two re-boarded the workboat. No injuries were reported.

The investigation found that, if hazards associated with the use of a workboat are not adequately addressed through risk mitigation measures and if compliance with these measures is not monitored, occurrences involving workboats will continue to happen.

The results of these investigations reflect the TSB's ongoing concerns about safety management, an issue on the TSB's Watchlist 2020.

**Safety management** is an issue on the [TSB's Watchlist](#), and is a concern in the air, marine and rail transportation modes.

Following the occurrence, the operator issued a policy on the prevention of falls overboard and shared it with all captains, engineers, and officers through a memorandum. The manufacturer of the workboat changed the recommended safe limits for the power and weight of engines used with this model of workboat as a result of a flotation test.

## Safety advisories and safety information letters

The TSB issued marine transportation safety advisories and information letters as part of its investigations in 2021–22.

### Need for registration of commercial fishing vessels

As part of Marine Transportation Safety Investigation [M20A0160](#) into the sinking of the fishing vessel *Sarah Anne*, the TSB issued Marine Safety Advisory No. 02/21 to the Canadian Council of Professional Fish Harvesters in August 2021 to request the correction of an error in a report implying that fishing vessels of less than 15 gross tonnage do not require registration.

### Safe speed for vessels in Tofino Harbour

The TSB issued Marine Safety Information Letter No. 01/22 to TC in February 2022 to draw attention to the fact that not all local authorities are aware of their role in the process for creating vessel speed restrictions. This information letter was issued as part of the TSB's investigation, led by both the TSB's Air and Marine branches, into the collision between the water taxi *Rocky Pass* and a float-equipped De Havilland DHC-2 Beaver aircraft ([A21P0111](#)).

## Progress on outstanding recommendations

Of the 18 responses to marine transportation safety recommendations the Board assessed or reassessed in 2021–22, 1 was closed after receiving a rating of Fully Satisfactory.

This year the *Large Fishing Vessel Inspection Regulations* were amended to require that large fishing vessels be fitted with water level detectors in all watertight compartments below the waterline that are not intended to carry liquids. Because the changes contained in these new regulations are expected to mitigate the risk associated with the safety deficiency identified during marine investigation [M90L3034](#), TC's response to Recommendation [M94-06](#) was considered by the Board to be Fully Satisfactory.

Meaningful progress has been made this year by TC to address the safety deficiency identified in Recommendation [M11-01](#). With a regulatory proposal to be pre-published in the *Canada Gazette*, Part I, in late 2022 that will eliminate sailing vessel endorsements in the *Marine*

*Personnel Regulations*, the Board reassessed the response to the recommendation as showing Satisfactory Intent.

This year the Board also reassessed the Province of Ontario's response to Recommendation [M99-02](#), in which the Board recommended that the provinces review their workplace legislation with a view to presenting it in a manner that will be readily understood by those to whom it applies, to help ensure that the enforcement mechanism and the regulatory regime complement each other. New safety initiatives taken by the province prompted the Board to reassess its response as showing Satisfactory Intent.

Unfortunately, other responses show that insufficient action has been planned or taken on the identified safety deficiencies. The actions taken in response to Recommendation [M16-03](#) calling for stability assessments and adequate stability information for all small fishing vessels were considered insufficient by the Board. Therefore, the overall response to this recommendation was considered to be Unsatisfactory.

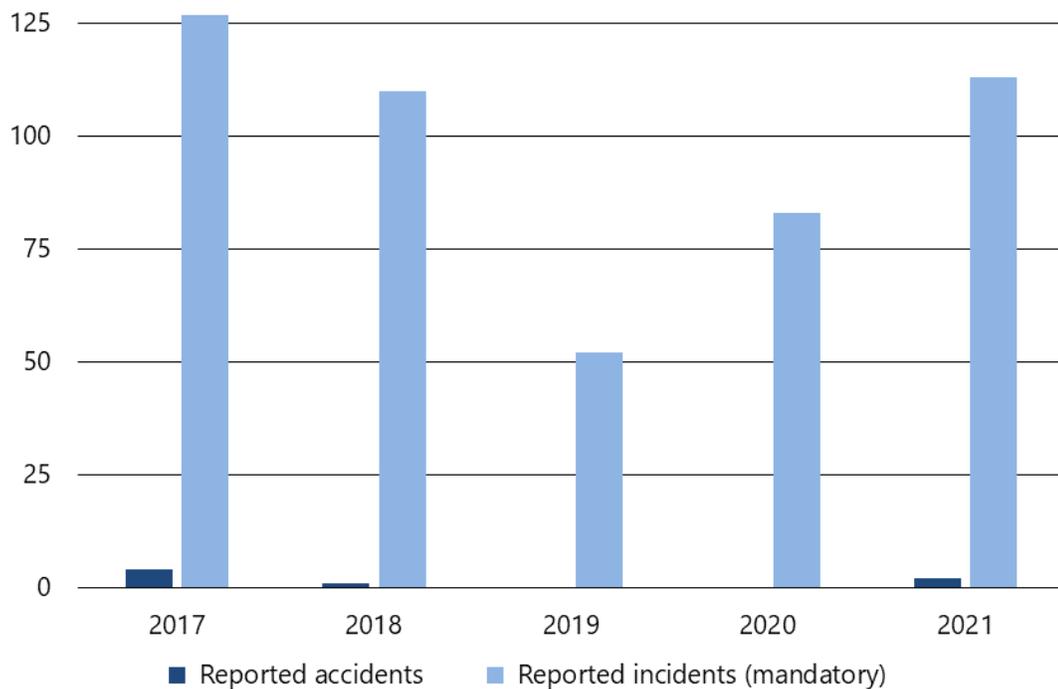
For all active recommendations, the TSB will continue to monitor the progress of planned actions and call for action to reduce or eliminate these deficiencies.

# Pipeline transportation safety

## The year in review

The TSB received 115 reports of pipeline transportation occurrences in 2021, of which 113 were incidents and 2 were accidents. There were no fatalities arising directly from the operation of any federally regulated pipeline, as has been the case since the TSB's inception in 1990.

Figure 7. Pipeline transportation accidents and incidents, 2017 to 2021



The number of occurrences for 2021 is 39% higher than in 2020 and approximates the average of 117 for the previous 10 years. The two accidents in 2021 were up from zero in 2020 but below the average of three accidents per year over the previous decade. Changes that were introduced in 2014 to the occurrence reporting criteria continue to distinguish more recent years from the years prior to 2014.

Of the 115 occurrences in 2021, 23 involved a release of product:

- This represents 20% of the occurrences in 2021, far below the 10-year average (65%).
- The majority of these occurrences involved a release of hydrocarbon gas (57%), as has been the case each year since 2015.
- Seven occurrences involved the release of product other than of hydrocarbons, namely papermaking process water.

The TSB's [Statistical Summary: Pipeline Transportation Occurrences in 2021](#) contains more information on product releases during the year.

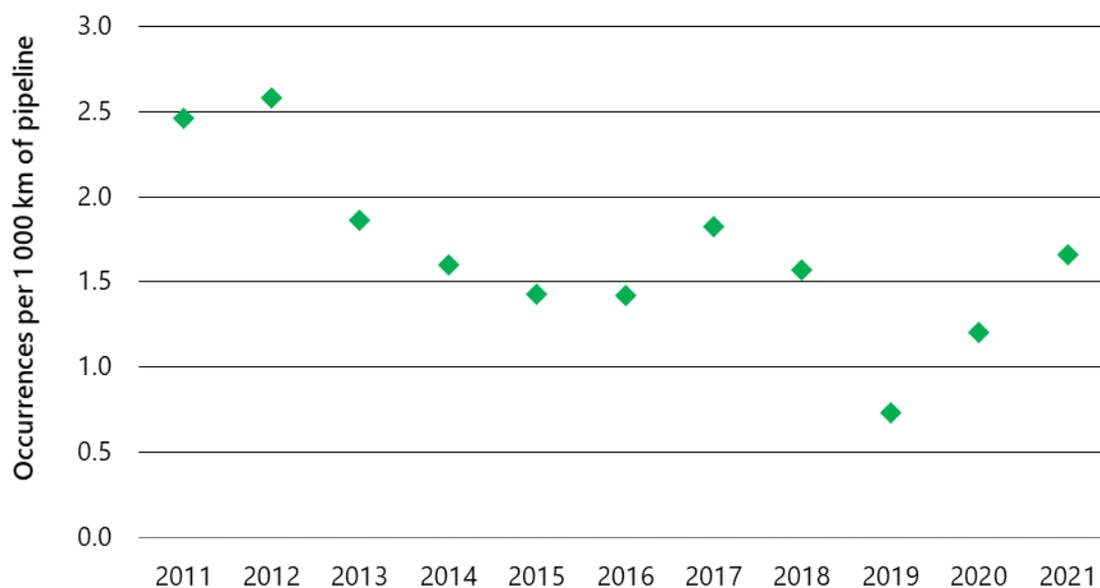
In 2021, 55 occurrences involved geotechnical, hydrotechnical or environmental activity—slope movements or river erosion, for example—representing more than twice the number reported in 2020, and well above the average of 11 such events per year over the previous 10 years. The higher level of reported occurrences since 2017 may be related to varied weather patterns and hydrotechnical activity over the last five years, as well as increased regulatory oversight, company inspections and reporting.

The most occurrences in 2021 took place in British Columbia (46 out of 115), with 28 in Alberta, 16 in Ontario and 10 in Quebec. Of the remaining occurrences, 8 were in New Brunswick, 4 in Saskatchewan, 2 in Manitoba and 1 in the Northwest Territories.

### Occurrence rate: A measure of pipeline transportation safety

There were 69 400 km of federally regulated pipeline operating in Canada in 2021, according to the Canada Energy Regulator. The 115 pipeline transportation occurrences reported to the TSB for the year resulted in an occurrence rate per 1000 km of operating pipeline of 1.7. This is up from the revised 2020 rate of 1.2, but is a return to the average of 1.7 occurrences per 1000 km from 2011 to 2020.

Figure 8. Pipeline transportation occurrence rate, 2011 to 2021



## Investigations

TSB staff deployed to 1 pipeline transportation occurrence in 2021–22 (same as for 2020–21), began 1 investigation and completed 1.

Table 12. TSB pipeline transportation safety investigation activities, 2020–21 and 2021–22

Activities	2020–21	2021–22
Deployments	1	1
Investigations started	2	1
Investigations completed	1	1
Investigations in progress on 31 March of each year	1	1

Table 13. Pipeline transportation safety investigations completed, 2020–21 and 2021–22

Class (investigation type)	Completed Investigations		Completion target (days)	Average duration (days)	
	2020–21	2021–22		2020–21	2021–22
1 (safety issue)	0	0	730	n/a	n/a
2 (complex)	0	0	600	n/a	n/a
3 (detailed)	0	0	450	n/a	n/a
4 (limited scope)	1	1	220	279	304

### Improper installation of tubing system led to release of crude oil

In its investigation report on the 2020 release of crude oil at Trans Mountain Pipeline ULC’s Sumas Pump Station in Abbotsford, British Columbia, the TSB determined that the tubing systems were not properly installed ([P20H0023](#)).

This investigation highlights the importance of pipeline companies having standards and procedures that incorporate inspections to ensure that tubing systems are properly installed. It also sheds light on the importance of having the station emergency shutdown and isolation systems properly configured to minimize the quantity of release and having a means of isolation on secondary containment systems, such as the oil-water separator, in order to prevent any off-site migration of released product.

Following the occurrence, the Canada Energy Regulator conducted emergency management and environmental protection field inspections and monitored the progress of site remediation activities. Trans Mountain Pipeline ULC developed procedures and an internal standard regarding its tubing systems, and upgraded the Sumas Pump Station, among other things.

## Safety advisories and safety information letters

The TSB issued a pipeline transportation safety advisory as part of an investigation in 2021–22.

### External risks to pipelines in agricultural areas

As part of Pipeline Transportation Safety Investigation [P21H0143](#) into third-party damage to a natural gas pipeline, the TSB issued Pipeline Safety Advisory Letter 01/22 to Manitoba Hydro in March 2022 to bring awareness to external risks to pipelines in agricultural areas.

## Progress on outstanding recommendations

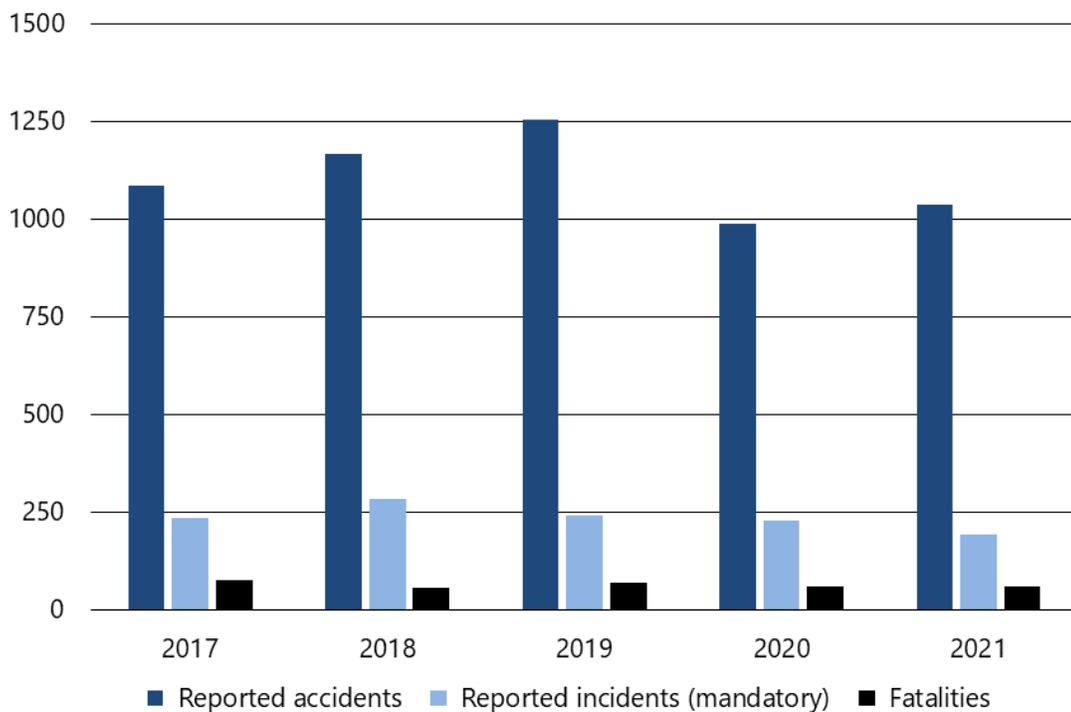
The Board did not issue any pipeline transportation safety recommendations in 2021–22 and had previously assessed all responses to pipeline transportation safety recommendations as Fully Satisfactory.

# Rail transportation safety

## The year in review

TSB received 1232 reports of rail transportation occurrences in 2021 (1038 accidents and 194 incidents), including 60 fatalities.

Figure 9. Rail transportation accidents, incidents and fatalities, 2017 to 2021



The 1038 accidents represent a 5% increase from 2020 but a 3% decrease from the 10-year average of 1071.

The 60 rail transportation-related fatalities reported in 2021 are the same as in the previous year but below the 10-year average of 71. Among the fatalities, 42 involved trespassers, compared to 40 in 2020 and the 10-year average of 40.

The number of crossing accident fatalities decreased in 2021 (16) compared to 2020 (18) and is lower than the 10-year average of 23. The TSB is conducting ongoing research to better understand crossing accidents in the winter in a safety issue investigation ([R20H0082](#)).

Among all rail transportation accidents, 86 involved dangerous goods. This is up from 82 in 2020 but is lower than the 10-year average of 125. Two accidents in 2021 resulted in dangerous goods being released.

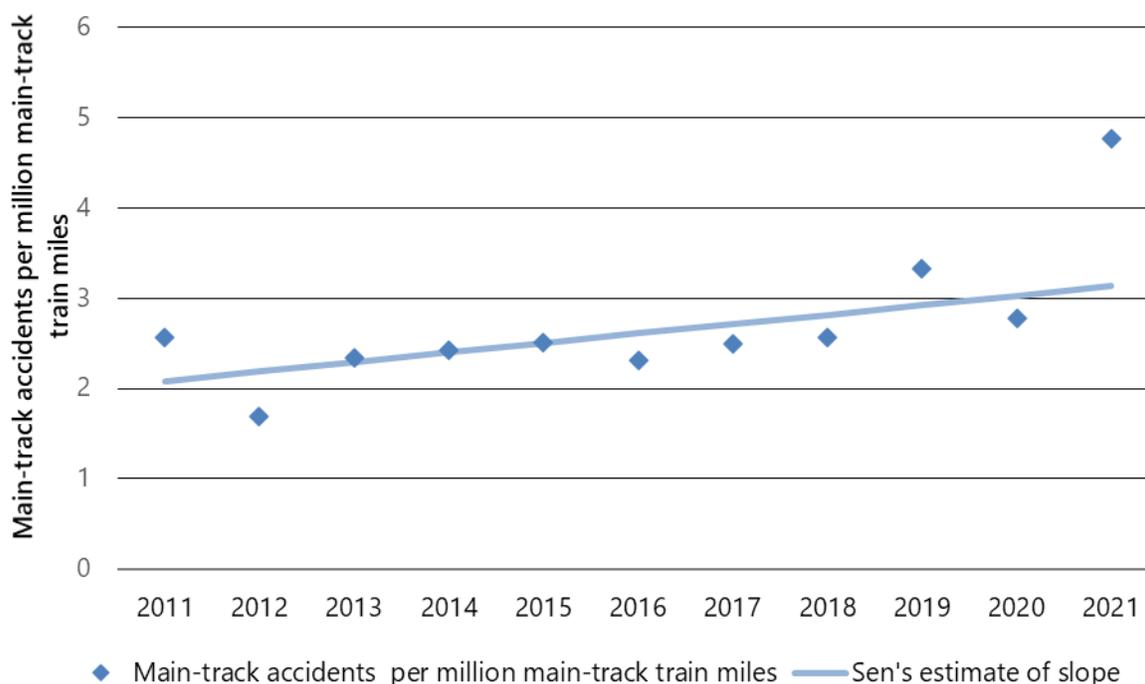
There were 194 rail transportation incidents reported to the TSB in 2021, a 15% decrease from 2020 (229), and a 30% decrease from the 10-year average (277). Incidents involving

movements that exceeded limits of authority accounted for 56% (109) of all rail transportation incidents in 2021—40 less than in 2020 and below the 10-year average of 129.

### Accident rate: A measure of rail transportation safety

According to Transport Canada (TC) data, 2021 main-track (non-yard) rail activity decreased by 1% from 2020. The main-track accident rate in 2021 was 4.8 accidents per million main-track train-miles, up from 2.8 in 2020 and above the 10-year average of 2.5. As in 2019 and 2020, a portion of main-track accidents in 2021 consists of an unusually high number of right-of-way fires reported to the TSB in 2021 (137), which primarily accounts for the increase in the main-track accident rate.

Figure 10. Main-track accident rate, 2011 to 2021



## Investigations

TSB staff deployed to 11 rail transportation occurrences in 2021–22 (an increase from 2020–21), began 8 investigations and completed 9.

Table 14. TSB rail transportation safety investigation activities, 2020–21 and 2021–22

Activities	2020–21	2021–22
Deployments	5	11
Investigations started	10	8



Activities	2020-21	2021-22
Investigations completed	19	9
Investigations in progress on 31 March of each year	20	19

Table 15. Rail transportation safety investigations completed, 2020-21 and 2021-22

Class (investigation type)	Completed investigations		Completion target (days)	Average duration (days)	
	2020-21	2021-22		2020-21	2021-22
1 (safety issue)	0	0	730	n/a	n/a
2 (complex)	5	1	600	811	1151
3 (detailed)	4	3	450	540	658
4 (limited scope)	10	5	220	374	299

## Enhancing safety of train operations in cold weather through mountainous territory

As a result of its investigation report into the 2019 derailment of 2 locomotives and 99 cars of a 112-car grain train, in which the three crew members were fatally injured near Field, British Columbia ([R19C0015](#)), the Board issued three recommendations to make train operations in cold weather safer through mountainous territory.

In its recommendations, the Board is calling for enhanced test standards and requirements for time-based maintenance of brake cylinders on freight cars operating on steep descending grades in cold ambient temperatures (R22-01); the implementation of a schedule for the installation of automatic parking brakes on freight cars, prioritizing the retrofit of cars used in bulk commodity unit trains in mountain grade territory (R22-02); and the Canadian Pacific Railway Company (CP) to demonstrate to TC that its safety management system can effectively identify hazards arising from operations using all available information, including employee hazard reports and data trends; assess the associated risks; and implement mitigation measures and validate that they are effective (R22-03).

The findings of this investigation reflect the TSB's ongoing concerns about unplanned or uncontrolled movement of rail equipment and safety management, both issues on the TSB's Watchlist 2020.

**Unplanned or uncontrolled movement of rail equipment** was added to the [TSB's Watchlist](#) in 2020. These occurrences can have and have had catastrophic consequences.

**Safety management** is an issue on the [TSB's Watchlist](#), and is a concern in the air, marine and rail transportation modes.

Following the occurrence, the TSB sent rail safety advisory letters to TC on the prevention of uncontrolled movements for trains stopped in emergency on grades of less than 1.8%, on air brake system inspection and maintenance on grain hopper cars used in CP unit train operation, and on the effectiveness of the No. 1 brake test.

TC took several initiatives after the occurrence, such as approving the railway industry's proposed new Rule 66 of the *Canadian Rail Operating Rules* (CROR) as well as the use of automated train brake effectiveness technology in lieu of No. 1 air brake test requirements on CP's unit grain trains operating between points in Western Canada and the Port of Vancouver.

Following the occurrence, CP proceeded, among other things, to remove over 5000 grain cars from service for repair.

### Failure of a rail car coupler led to rail yard collision

In its investigation report, the TSB found that the failure of a rail car coupler knuckle led to an uncontrolled movement, followed by a collision and a derailment at the CP Alyth Classification Yard in Calgary, Alberta, in 2019 ([R19C0002](#)).

A crew was switching cars eastward into the Alyth Classification Yard in Calgary when 56 cars disconnected from the yard assignment and ran uncontrolled down the lead track into the designated emergency track, contacting a cut of stationary loaded hopper cars. As a result of the collision, a total of 22 cars derailed. The investigation found that the collision and derailment occurred when a knuckle on a car being switched failed while the cut of 75 cars was in motion.

**Unplanned or uncontrolled movement of rail equipment** was added to the [TSB's Watchlist](#) in 2020. These occurrences can have and have had catastrophic consequences.

The findings of this investigation reflect the TSB's ongoing concerns about unplanned or uncontrolled movement of rail equipment, an issue on the TSB's Watchlist 2020.

Following the occurrence, the TSB issued Rail Safety Advisory Letter [01/20](#) to TC and the Association of American Railroads regarding the defects found in the broken knuckle. CP made changes to its Alyth Classification Yard operation, including a fixed designated emergency track for all switching operations, increasing the number of cars that have air brakes, and limiting tonnage while switching. CP also added retarders to help prevent cars from exiting tracks in the Alyth Classification Yard and to slow the cars down during an emergency.

### Employee fatigue contributed to collision between passenger train and track unit

The TSB's investigation report into the collision of a VIA Rail passenger train and an unoccupied CN hi-rail track unit in Les Cèdres, Quebec, highlights the importance of implementing physical defences to prevent employee fatigue from contributing to occurrences ([R20D0088](#)).

The passenger train was travelling east at the authorized speed (95 mph) on the north main track of the Canadian National Railway Company (CN) Kingston Subdivision, when the two locomotive engineers noticed a bright light in the distance. When one of them realized that the

light appeared to be coming from rolling stock on the same track as the train, a full-service air brake application was initiated and the locomotive horn and bell were sounded. A few seconds later, the train, still travelling at nearly 83 mph, struck an unoccupied pick-up truck type hi-rail track unit at Mile 30.5, in the municipality of Les Cèdres. There was no derailment and no one was injured.

An analysis was conducted to assess the fatigue of the signal maintainer in this occurrence. From this analysis, it was determined that the employee had probably accumulated a sleep debt, a condition that contributes to fatigue, given his numerous consecutive night shifts involving long hours and the fact that he was sleeping during the day, when quality of sleep is reduced.

As this occurrence demonstrates, work schedules that increase the risk of fatigue in railway employees may create high-risk situations with potentially serious consequences. Fatigue poses a risk to transportation safety because of its potential to degrade several aspects of human performance. This is why fatigue management is on the TSB's Watchlist 2020.

**Fatigue management** is an issue on the [TSB's Watchlist](#), and is a concern in the air, marine and rail transportation modes.

Following the occurrence, TC sent a notice to CN indicating that the measures implemented to prevent events such as this occurrence had been deemed insufficient. Later, CN informed TC that it had developed an employee assessment tool to check their knowledge of the regulations governing the protection of track work.

## Ensuring sufficient braking capacity to prevent uncontrolled movements

In its investigation report into a non-main-track uncontrolled movement in Prince George, British Columbia, the TSB highlighted the importance for operators and employees to ensure sufficient braking capacity to enable the control of rolling stock when switching ([R20V0230](#)).

A Canadian National Railway Company (CN) yard foreman and a helper were performing switching operations in the South Yard of CN's Prince George Terminal in Prince George using a remote control locomotive system, when an uncontrolled movement occurred. It accelerated to approximately 17 mph, ran through a crossover switch that was lined against the movement's direction of travel, damaging the switch, and subsequently came to a stop about 1250 feet before the entrance of the main track of the Fraser Subdivision. No dangerous goods were involved, and the movement did not derail. No one was injured.

The results of this investigation reflect the TSB's ongoing concerns about unplanned or uncontrolled movement of rail equipment, an issue on the TSB's Watchlist 2020.

**Unplanned or uncontrolled movement of rail equipment** was added to the [TSB's Watchlist](#) in 2020. These occurrences can have and have had catastrophic consequences.

After the occurrence, CN management carried out a safety blitz for crews operating in the Prince George Terminal, to reinforce the rules and instructions for operating in the point protection zone, and

TC revised Rule 113.3 of the *Canadian Rail Operating Rules* to require the use of air brakes to control movements during switching on grades greater than 0.4% and with more than 2000 tons.

## Safety advisories and safety information letters

The TSB issued rail transportation safety advisories as part of its investigations in 2021–22.

### Roller bearing failure resulting in derailment of Ottawa Light Rail Transit vehicle

As part of Rail Transportation Safety Investigation [R21H0099](#) into a derailment of an Ottawa Light Rail Transit train in Ottawa, Ontario, the TSB issued Rail Safety Advisory Letter No. [02/21](#) to Ottawa's City Manager in September 2021 about the failure of a roller bearing on a light rail vehicle in commuter passenger service and the use of heat detection systems to monitor temperatures of cartridge roller bearing assemblies.

### Work procedures for Ottawa Light Rail Transit vehicle maintenance

As part of Rail Transportation Safety Investigation [R21H0121](#) into a main-track derailment of an Ottawa Light Rail Transit train in Ottawa, Ontario, the TSB issued Rail Safety Advisory Letter No. [03/21](#) to Ottawa's City Manager in November 2021 about the work procedures for Ottawa Light Rail Transit vehicle maintenance, suggesting that an in-depth review of the work performed on safety-critical components be conducted.

### Conflicting authority to enter main track without obtaining a train location report

As part of Rail Transportation Safety Investigation [R21H0114](#) into a collision between two CN freight trains in Prescott, Ontario, the TSB issued Rail Safety Advisory Letter No. 01/22 to TC in January 2022 about conflicting authority to enter the main track without obtaining a train location report, suggesting that a review be performed of rail traffic controller systems software prompts of all safety-critical tasks that can be overridden when equipment is already in the block.

## Progress on outstanding recommendations

Of the nine responses to rail transportation safety recommendations the Board assessed or reassessed in 2021–22, none were closed as Fully Satisfactory. The nine responses obtained the following ratings: Satisfactory Intent (4) and Satisfactory in Part (5).

This year, TC continued its work to update the regulatory regime for railway employee qualifications and training. This means that, while the action is not yet sufficiently advanced to reduce the risks to transportation safety, progress is being made toward addressing the safety deficiency identified in Recommendation [R18-02](#) calling for training and qualification standards for railway employees in safety-critical positions. The Board therefore reassessed the response to the recommendation as showing Satisfactory Intent.

The Board also reassessed the response to Recommendation [R14-05](#) on the auditing of safety management systems, one of the recommendations issued as a result of the TSB's investigation into the 2013 runaway and main-track derailment in Lac-Mégantic, Quebec ([R13D0054](#)). TC indicated that it completed audits of all federally regulated railway companies' safety management systems and that it is in the early stages of implementing a targeted audit framework for measuring the effectiveness of the safety management system processes. The Board is encouraged by the progress and therefore considers this response to show Satisfactory Intent.

Regarding Recommendation [R13-01](#) on physical fail-safe train controls, the Board considers the responses from the Railway Association of Canada and TC to be Satisfactory in Part and strongly encourages both organizations to accelerate the pace of enhanced train control implementation. The underlying safety deficiency was identified as a result of the TSB's investigation into a rear-end train collision over 20 years ago (Railway Investigation Report [R98V0148](#); Recommendation [R00-04](#)).

For all active recommendations, the TSB will continue to monitor the progress of planned actions and call for action to reduce or eliminate these deficiencies.

# Who we are and what we do

The Transportation Safety Board of Canada (TSB) advances transportation safety in the air, marine, pipeline and rail transportation sectors in Canada:

- It conducts independent investigations into selected occurrences and makes findings about their causes and any contributing factors.
- It identifies safety deficiencies arising in transportation occurrences and makes recommendations to eliminate or reduce them.
- It reports publicly about its investigations and findings.

As part of its investigations, the TSB reviews developments in transportation safety and identifies safety risks that governments and the transportation industry must address in order to reduce the risk of injury and loss.

## Role of the Board

The Board, which comprises up to five members, including the Chair, approves all investigation reports, makes findings and issues recommendations.

### The Board

**Kathleen Fox**  
Chair

**Faye Ackermans**  
Board Member

**Paul Dittmann**  
Board Member

**Kenneth Potter**  
Board Member

**Yoan Marier**  
Board Member

The TSB website contains [biographies](#) of each Board member.

In making findings, the Board does not assign fault or determine civil or criminal liability for an occurrence. Rather, it seeks to find out what happened and why in an objective manner, independent from government, and all other departments and agencies involved in transportation, and free from any conflict of interest. It also draws impartial conclusions and makes recommendations to those best placed to act.

## About the TSB

A staff of 226, led by the Chief Operating Officer and senior management, supports the Board. The work of the organization is guided by a [five-year strategic plan](#) and five core values:

- **Respect:** We are committed to inclusiveness and to treating all individuals and organizations with consideration, courtesy, discretion, and fairness.
- **Openness:** We actively share and exchange information to advance transportation safety.
- **Safety:** We maintain and promote a positive and proactive safety culture.

- Integrity: We are guided by honesty, transparency, impartiality, propriety, and accountability for our actions and decisions.
- Excellence: We maintain a highly skilled and knowledgeable team of professionals through leadership, innovation, and commitment to continuous improvement in the delivery of our products and services.

TSB investigators are professionals with years of experience in the various transportation modes the TSB covers. They work in collaboration with engineering and technical specialists, human factors investigators and industry analysts, all of whom are supported by small teams of communications specialists, corporate services professionals and administrative officers.

The TSB's head office is in Gatineau, Quebec. The TSB also has a laboratory in Ottawa, and regional offices in Vancouver, Edmonton, Calgary, Winnipeg, Toronto, Montréal, Québec, and Dartmouth.

## The investigation process

There are three main phases of the investigation process. During the field phase, investigators collect data and assess the occurrence. This generally involves travelling to the scene of the occurrence, securing the site and documenting it, conducting interviews and selecting wreckage for further examination. Unless the investigation is limited to data collection, an investigation page is created and posted to the website, and is updated periodically as the investigation progresses.

During the examination and analysis phase, investigators review the data to determine the sequence of events leading to the occurrence and the underlying causes and contributing factors.

In the report phase, investigators draft a report on the investigation, which then goes through a review and approval process, prior to public release.

Figure 11. The TSB investigation process from occurrence to report





# Appendices

## Appendix A: Investigation reports released in 2021–22 and related safety actions

The following is a list of the investigation reports the Transportation Safety Board of Canada (TSB) released during 2021–22. Each entry includes details of any safety actions taken during the investigation and after the report was published, and a link to the main page for the investigation. The list is organized by transportation sector and in the order in which the occurrences took place.

These safety actions taken by industry stakeholders and regulators in the air, marine, pipeline, and rail transportation sectors are the tangible outcome of the TSB’s investigative work to advance transportation safety. Their efforts as a result of our findings contribute to making our transportation system even safer.

### Air transportation sector

#### INVESTIGATION REPORT [A18Q0140](#): Occurrences in Quebec and Nunavut on runways undergoing construction that are reduced in width

SAFETY ACTIONS	<p>After the TSB’s Aviation Investigation Report A17Q0059 was published on 3 July 2018, which highlighted the issue of clarity and conciseness of NOTAMs, <b>NAV CANADA</b> updated its Canadian NOTAM Procedures Manual. The new version, published on 31 January 2019, included wording to be used for NOTAMs relating to a runway width reduction: the phrase USABLE WIDTH REDUCED TO XXX FT must be included and the word WIDTH can no longer be abbreviated.</p> <p>In addition, on 10 October 2019, NAV CANADA published another version of the manual, which reflected the transition to the International Civil Aviation Organization (ICAO) NOTAM format. As explained in a frequently asked questions document about the transition to the ICAO NOTAM format,</p> <p style="padding-left: 40px;">[t]he adoption of the ICAO NOTAM format – already used by most countries – will ensure compliance with international standards and will eliminate the need for pilots who fly international routes to be familiar with more than one NOTAM format. It will also pave the way for more advanced filtering functionality, reducing NOTAM clutter by help[ing] pilots access just the NOTAMs pertinent to their flight.<sup>3</sup></p> <p>In September 2021, NAV CANADA established a unit that is responsible for expanding the proactive outreach program with airports in relation to planned airport construction activities.</p> <p>Additional corrective actions are underway by NAV CANADA to address the safety deficiencies identified in recommendation A21-01.</p>
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<sup>3</sup> NAV CANADA, NOTAM Transition FAQ [frequently asked questions] document, “Why is NAV CANADA transitioning to the ICAO NOTAM format?”, available at [navcanada.ca/en/icao%20notam%20-%20faq\\_en.pdf](http://navcanada.ca/en/icao%20notam%20-%20faq_en.pdf) (last accessed on 30 November 2021).

	<p>On 30 September 2019, <b>Transport Canada Civil Aviation</b> (TCCA) published Advisory Circular (AC) 302-030,<sup>4</sup> Adherence to Standard during periods of construction, in response to the TSB’s Aviation Safety Advisory A18Q0094-D1-A1. In this circular, TCCA reminded airport operators to comply with the applicable aerodrome standards and recommended practices and to issue detailed NOTAMs. TCCA also reminded airport operators to ensure that NOTAMs issued for construction work are very clear.</p> <p>In addition, on 5 August 2021, the TSB issued Aviation Safety Advisory A18Q0140-D1-A1,<sup>5</sup> also addressed to TCCA.</p> <p>On 16 September 2021, TCCA responded to Aviation Safety Advisory A18Q0140-D1-A1, indicating that regulations and standards in effect, as well as actions already taken in response to Aviation Safety Advisory A18Q0094-D1-A1, were sufficient.</p>
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**INVESTIGATION REPORT [A17C0146](#): Loss of control and collision with terrain, West Wind Aviation L.P.,<sup>6</sup> Avions de Transport Régional ATR 42-320, C-GWEA, Fond-du-Lac, Saskatchewan, 13 December 2017**

<p><b>SAFETY ACTIONS</b></p>	<p>The <b>TSB</b> released Recommendation A18-02 regarding access to adequate de-icing and anti-icing equipment.</p> <p>The duration of cold weather and icing conditions varies widely across Canada. Many remote northern airports have an icing season of 10 months or more. Icing conditions can be both severe and persistent.</p> <p>Thousands of flights take off every year from remote northern airports. Some airports serve as hubs, experience higher traffic volumes, and may have better equipment.</p> <p>The risks of adverse consequences likely vary from airport to airport. Identifying high-risk locations for immediate mitigation has the potential to quickly reduce the likelihood of aircraft taking off with frost, ice, or snow adhering to any critical surface at those locations.</p> <p>Transport Canada (TC), air operators, and airport authorities have the capacity to identify high-risk locations, analyze them for hazards and risks, and take mitigating action.</p> <p>Therefore, in December 2018, the Board recommended that</p> <div style="background-color: #e6f2ff; padding: 10px; margin: 10px 0;"> <p>the Department of Transport collaborate with air operators and airport authorities to identify locations where there is inadequate de-icing and anti-icing equipment and take urgent action to ensure that the proper equipment is available to reduce the likelihood of aircraft taking off with contaminated critical surfaces.</p> </div> <p>TSB Recommendation A18-02</p> <p>In its response (September 2020) and update (November 2020) to this recommendation, TC indicated that it had reached out to stakeholders, created working groups, and held discussions to address the safety issues identified in this recommendation. The COVID-19 pandemic has presented many challenges to the industry, which have delayed the development of concrete</p>
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<sup>4</sup> Transport Canada, Advisory Circular (AC) 302-030: Adherence to Standard during periods of construction, Issue 01 (30 September 2019).

<sup>5</sup> Transportation Safety Board of Canada, Aviation Safety Advisory A18Q0140-D1-A1: Absence of standards, recommended practices and guidelines pertaining to the safety of operations at airports under construction (5 August 2021), at [tsb.gc.ca/eng/securite-safety/aviation/2018/a18q0140/a18q0140-d1-a1.html](https://www.tsb.gc.ca/eng/securite-safety/aviation/2018/a18q0140/a18q0140-d1-a1.html) (last accessed on 30 November 2021).

<sup>6</sup> West Wind Aviation L.P. now operates as Rise Air.

actions to ensure proper de-icing and anti-icing equipment is available to reduce the likelihood of aircraft taking off with contaminated critical surfaces.

The TSB also released Recommendation A18-03 for TC and air operators to take action to increase compliance with *Canadian Aviation Regulations* subsection 602.11(2) and to reduce the likelihood of aircraft taking off with contaminated critical surfaces.

The absence of adequate equipment increases the likelihood that pilots will conduct a takeoff in an aircraft that has frost, ice, or snow adhering to any of its critical surfaces. Additionally, in the absence of adverse consequences, taking off with contamination on critical surfaces is a deviation that has become normalized. Therefore, providing adequate de-icing and anti-icing equipment may not be sufficient to reduce the likelihood of aircraft taking off with contaminated critical surfaces.

Some of the current defences used by the Canadian air transportation system to prevent aircraft from taking off with frost, ice, or snow adhering to any critical surface are less than adequate. Takeoffs with contaminated critical surfaces occur in substantial numbers across the spectrum of aircraft and operating categories at remote northern airports.

Non-compliance with *Canadian Aviation Regulations* (CARs) subsection 602.11(2), flight crew operating manuals, company operations manuals, and company standard operating procedures can be a single point of failure of defence framework. To mitigate this, TC and air operators must take urgent action to ensure better compliance.

Organizations can audit equipment (to inspect, de-ice, and anti-ice aircraft), policies (such as ground icing operations programs and contingencies for situations where resources are not available), training (for pilots and ground staff), and operations (procedures, compliance, deviations). Air operators could incorporate questions in before-start and before-takeoff checklists with a requirement for a clean aircraft or a mitigation response from the pilot-in-command.

Accidents related to contaminated aircraft will continue to occur until the industry and the regulator approach the issue as systemic and take action to eliminate underlying factors that can negatively affect pilot compliance.

Therefore, in December 2018, the Board recommended that

the Department of Transport and air operators take action to increase compliance with *Canadian Aviation Regulations* subsection 602.11(2) and reduce the likelihood of aircraft taking off with contaminated critical surfaces.

TSB Recommendation A18-03

In its response (September 2020) and update (November 2020) to this recommendation, TC indicated that it had reached out to stakeholders, and that educational and awareness material have been made available regarding the hazards of aircraft taking off with contaminated critical surfaces. The COVID-19 pandemic has presented challenges to TC and prevented most of its planned targeted inspections aimed at increasing compliance with CARs subsection 602.11(2). Increased compliance with the regulation would reduce the likelihood of aircraft taking off with contaminated critical surfaces.

Since the occurrence, **Rise Air** has implemented new risk assessment requirements. Risk assessments are now completed for new procedures, changes in managerial staff, and for all airports where the company normally operates and for charter destinations. All organizational changes of staff holding a regulatory role are documented through the safety management system to allow for risk assessments, including follow-up and audits to confirm information has been disseminated and procedures are followed. The risk assessments for airports include an overview of all services and facilities available, including de-icing capabilities.

	<p>The Board of Directors implemented a Safety, Operations and Customer Experience Committee that provides corporate oversight of the safety culture and safety matters.</p> <p>Rise Air has equipped each of its scheduled service and regular charter destinations with equipment capable of inspecting and de-icing all of the operator's aircraft types. Personnel at each of these locations are required to complete a daily de-icing equipment inspection to ensure the serviceability of the equipment and an annual de-icing equipment quality assurance audit is completed at the beginning of winter operations. All flight crews are also provided high-power, light-emitting diode flashlights to facilitate aircraft surface inspections.</p> <p>Written procedures have been developed requiring that flights dispatched to airports with insufficient de-icing capabilities adhere to their updated safety requirements.</p> <p>Rise Air has made significant amendments to its training programs.</p> <p>In March 2021, Rise Air launched an initiative to increase and maintain employee involvement and awareness with respect to safety.</p> <p>Rise Air continues to provide an enhanced annual ground icing operations and airborne icing training to flight crew and ground personnel in the fall to ensure personnel remain up to date with the latest regulations, policies, and procedures.</p> <p>Rise Air is conducting annual equipment audits in the fall of aircraft de-icing fluid and aircraft anti-icing fluid to ensure that the equipment is serviceable and ready to go when needed, and any additional equipment is procured in time.</p> <p>Rise Air has procured de-icing equipment and vehicles, which are now available at Saskatchewan aerodromes and mine site aerodromes from which the company operates. For their charter and medical evacuation operations, the company has procured de-icing equipment.</p> <p>Rise Air ground personnel, responsible for company de-icing services, provide daily status reports to ensure equipment is serviceable and sufficient quantities of fluid are available at each location. Mine site personnel are responsible for conducting a similar internal monitoring process at mine site aerodromes.</p>
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**INVESTIGATION REPORT [A18A0085](#): Runway overrun, Sky Lease Cargo, Boeing 747-412F, N908AR, Halifax/Stanfield International Airport, Nova Scotia, 7 November 2018**

SAFETY ACTIONS	<p>The Board is aware of some safety actions that were taken by <b>Sky Lease Cargo</b> following the occurrence; however, the TSB did not receive sufficient documentation to validate these actions.</p> <p><b>NAV CANADA</b> published a bulletin to highlight the importance of issuing landing information to pilots and to remind controllers of the procedures in the Landing Information section of the Manual of Air Traffic Services.</p>
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**INVESTIGATION REPORT [A19A0055](#): Inadvertent descent during approach, Canadian Helicopters Offshore, Sikorsky S-92A (helicopter), C-GICB, Halifax, Nova Scotia, 155 NM ESE, 24 July 2019**

SAFETY ACTIONS	<p>As a result of this occurrence, <b>Canadian Helicopters Offshore</b> took the following safety action:</p> <ul style="list-style-type: none"> <li>• voluntarily ceased all flight operations until a better understanding of the occurrence was possible;</li> <li>• conducted a review of cockpit voice recorder (CVR) and flight data recorder (FDR) preservation procedures;</li> <li>• conducted a review of the company's emergency response plan;</li> </ul>
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	<ul style="list-style-type: none"> <li>• conducted an internal safety management system (SMS) investigation to identify circumstances that contributed to the occurrence;</li> <li>• developed a degraded visual environment (DVE) approach procedure for inclusion in company standard operating procedures (SOPs);</li> <li>• developed a return to flight training package consisting of: <ul style="list-style-type: none"> <li>○ additional crew resource management (CRM) training addressing DVEs, cockpit gradient, and decision-making,</li> <li>○ simulator ground school including power management, and the new DVE approach procedure, and</li> <li>○ simulator session on the new DVE approach procedure; and</li> </ul> </li> <li>• briefed the HeliOffshore forum to raise awareness and support safe industry operations.</li> </ul> <p>As of last quarter 2019, Canadian Helicopters Offshore had voluntarily requested the Minister to suspend its air operator certificate since the company no longer had any aircraft in its possession, nor did it have any ongoing contracts.</p> <p>On 27 April 2021, following the release of the TSB’s report, <b>Sikorsky</b> released an All Operators Letter (CCS-92-AOL-21-0001) to all S-92 operators, service centres and field service representatives worldwide. The letter addressed vortex ring state avoidance, in-flight use of the enhanced ground proximity warning system, encouraged operators to develop guidelines for use of the cyclic trim release switch and highlighted the need for continued adherence to limitations stated in the Rotorcraft Flight Manual (RFM).</p> <p>Additionally, on 22 June 2021, Sikorsky sponsored a webcast with S-92 operators, service centres and field service representatives worldwide. The occurrence was discussed during the webcast, with a focus on the aircraft’s actual approach profile to the rig.</p>
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**INVESTIGATION REPORT [A20A0001](#): Runway overrun, WestJet Airlines Ltd., Boeing 737-8CT, C-FUJR, Halifax/Stanfield International Airport, Nova Scotia, 5 January 2020**

SAFETY ACTIONS	<p>Following the occurrence, <b>WestJet Airlines Ltd.</b> took the following actions:</p> <ul style="list-style-type: none"> <li>• A revised emergency response checklist was created to include the requirement to pull the cockpit voice recorder/flight data recorder circuit breakers after an incident.</li> <li>• A detailed safety review of findings and root causes upon completion of the internal investigation was completed with both flight crew members by the Chief Pilot, B737.</li> <li>• A flight data monitoring (FDM) trigger was created to monitor landings over the maximum tailwind. This item will be monitored as part of the existing FDM quarterly event review.</li> <li>• A Flight Safety Flash was sent out to the entire pilot group bringing awareness to the event and: <ul style="list-style-type: none"> <li>○ highlighting the importance of considering continually changing conditions that may impact runway surface or anticipated wind conditions;</li> <li>○ highlighting the importance of utilizing actual runway of intended landing for performance calculations and the requirement to use 1 of the 3 required methods to calculate numbers: the aircraft communications addressing and</li> </ul> </li> </ul>
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	<p>reporting system Landing Distance Calculator, the Takeoff and Landing Report, and the Quick Reference Handbook actual landing distance table; and</p> <ul style="list-style-type: none"> <li>○ clarifying the 15% safety margin.</li> </ul> <p><b>Boeing</b> is studying a potential runway awareness capability called the takeoff performance alert. This capability is comprised of an algorithm and flight crew alert for the takeoff portion of a flight, and is being evaluated for certain existing and future Boeing models.</p>
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INVESTIGATION REPORT [A20Q0013](#): Hard landing and aft fuselage strike, Air Inuit Ltd., de Havilland DHC-8-314 (C-GXAI), Schefferville Airport, Quebec, 20 January 2020

SAFETY ACTIONS	<p><b>Air Inuit Ltd.</b> took the following safety actions:</p> <ul style="list-style-type: none"> <li>• After the accident, an internal bulletin was issued to pilots regarding stabilized approaches and best practices for the pilot monitoring.</li> <li>• The video entitled “Dash 8 Q400 Pitch Awareness” was included in all initial and recurrent training.</li> <li>• The review of pitch awareness during preparation briefings for simulator training was improved.</li> <li>• An interim amendment of the standard operating procedures, regarding stabilized approaches and low energy awareness, was issued through an internal bulletin.</li> <li>• The Dash 8 standard operating procedures were revised to improve guidelines on several subjects, including visual approaches and identifying stabilized approach gates.</li> <li>• The training program was revised to ensure that all training elements are covered within the 2-year cycle for recurrent training.</li> </ul>
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INVESTIGATION REPORT [A20Q0015](#): Controlled flight into terrain, Service aérien gouvernemental of Quebec, Bell 206L-4 (helicopter), C-GSQA, Lac Saint-Jean, Quebec, 22 January 2020

SAFETY ACTIONS	<p>The <b>Quebec Ministry of Transport</b> met with the helicopter pilots of the air service to discuss the flat light phenomenon and the use of the radar altimeter during low altitude missions. These items will be included in their standard operating procedures manual.</p> <p>The ministry has also asked the Centre Québécois de formation aéronautique to address this subject in the context of crew resource management training.</p>
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INVESTIGATION REPORT [A20P0013](#): Runway excursion, WestJet Encore Ltd., De Havilland Aircraft of Canada Ltd. DHC-8-402, C-FKWE, Terrace Airport, British Columbia, 31 January 2020

SAFETY ACTIONS	<p><b>WestJet Encore Ltd.</b> issued a revision to the Quick Reference Handbook (QRH) on 14 February 2020 that included changes to contaminated runway operations:</p> <ul style="list-style-type: none"> <li>• when the reported Canadian Runway Friction Index does not align with the runway surface condition; and</li> <li>• during active precipitation.</li> </ul> <p>Current revisions of the Transport Canada <i>Aeronautical Information Manual</i> and the <i>Canada Flight Supplement</i> were added in the Electronic Flight Bag (EFB). Additionally, effective August 2021, all airports where WestJet Encore Ltd. operates have been transitioned to the Global Reporting Format (GRF) when reporting runway conditions. The GRF provides a significant</p>
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	<p>increase in the accuracy of prevalent runway conditions. As a result, WestJet Encore Ltd. incorporated GRF reporting references into the landing distance calculations available through the EFB software suite and QRH with training on the use of GRF provided to all flight crew.</p> <p>On 14 January 2021, the <b>Terrace-Kitimat Airport Society</b> issued a memo informing staff of changes to its winter maintenance plan.</p>
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**INVESTIGATION REPORT [A20W0016](#): Loss of pitch control on landing, Canadian Pacific Railway Company, Bombardier CL -600-2B16 (Challenger 605), C-GKCP, Calgary International Airport, Alberta, 23 February 2020**

SAFETY ACTIONS	<p>In response to the TSB’s Air Safety Information Letter A20W0016-D1-L1, issued on 29 July 2020, <b>Bombardier</b> issued a temporary revision to the Quick Reference Handbook (QRH) flap fail procedure, on 12 January 2021, to draw crew attention to the nose-up pitching tendency which can occur when thrust reversers are deployed, and noting that this tendency is controllable with elevator and may be minimized by ensuring that nose wheel touchdown is achieved and nose down elevator applied, before selecting reverse thrust.</p> <p>Bombardier has also undertaken the following safety actions:</p> <ul style="list-style-type: none"> <li>• added a calendar cap to the flap flexible drive shaft inspection task;</li> <li>• established a low-usage maintenance program threshold for the Challenger 600 series aircraft;</li> <li>• issued a communication to Challenger 600 Series operators reminding them that the Challenger 600 Series recommended maintenance program is based on an assumed average annual aircraft usage, and that it is each operator’s responsibility to ensure their maintenance program is tailored to their operations; and</li> <li>• reviewed the current aircraft flight manual, QRH and flight crew operating manual procedures for all non-normal landings, for all Challenger 600 series aircraft, and made modifications as required to prevent the aircraft from pitching up during landing.</li> </ul> <p>As a result of the TSB’s findings, the <b>Calgary Airport Authority</b> re-opened a conditional stand-by with their Fire and Crash Rescue Services called “Condition Orange”, whereby the aircraft rescue and fire-fighting teams are ready and in stand-by posture and deployed outside of the fire hall doors during a declaration of in-flight issues while on approach into Calgary International Airport. Condition Orange will be documented and included in training.</p> <p>Following the occurrence, <b>Canadian Pacific Railway Company</b> conducted a comparison of various Aircraft Flight Manual (AFM) and QRH procedures that involved reduced flap landings conditions. As a result of this review, some internal procedures were amended to address the differences between the caution or warning notes published in the AFM and QRH.</p>
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**INVESTIGATION REPORT [A20C0016](#): Runway excursion, Perimeter Aviation LP, Fairchild SA227-DC Metro 23, C-GJVB, Dryden Regional Airport (CYHD), Ontario, 24 February 2020**

SAFETY ACTIONS	<p>Since the occurrence, <b>Perimeter Aviation LP</b>:</p> <ul style="list-style-type: none"> <li>• released a flight operations bulletin entitled “Metro Propeller Lock Release,” which describes the procedure to ascertain the positive release of the propeller start locks;</li> <li>• amended the SA-227 standard operating procedures manual to highlight the importance of confirming the start locks are disengaged;</li> <li>• amended the SA-227 “Before Taxi” checklist. Removal of start locks is now a stand-alone checklist item and the last checklist item to complete before taxi commences;</li> </ul>
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	<ul style="list-style-type: none"> <li>implemented scheduled semi-annual simulator training at the 6-month mark for all <i>Canadian Aviation Regulations</i> (CARs) subparts 703 and 704 flight crew members who have less than 2 years' experience in the seat they are occupying. This training includes effective directional control techniques during the take-off roll and a review of company policies, procedures, and techniques related to turboprop engine (TPE) 331 propeller lock engagement and disengagement; and</li> <li>issued a bulletin on 9 February 2021 to further increase awareness and understanding of the Metro propeller start lock system.</li> </ul>
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INVESTIGATION REPORT [A20C0037](#): Runway excursion, Buffalo Airways Ltd., Beechcraft King Air A100, C-FCBZ, Kugaaruk Airport, Nunavut, 28 April 2020

SAFETY ACTIONS	<p>After the occurrence, management at <b>Buffalo Airways Ltd.</b> conducted a survey among its pilots. The survey collected data regarding knowledge and understanding of aerodrome visibility restrictions and how they apply to operations in visibilities of less than ½ statute miles (SM). It revealed that there were misunderstandings: not all pilots realized that, in the absence of a published reduced visibility operations procedure in the Canada Flight Supplement, the minimum visibility for operating at an aerodrome is ½ SM. The visibility is as reported by a weather observer, or, when no weather is reported, it is determined by the pilot-in-command on approach.</p> <p>The chief pilot reviewed Transport Canada Advisory Circular 602-002: Aerodrome Operating Visibility with each pilot individually. Advisory Circular 602-002 was also added to the Buffalo Airways Flight Simulator Training Manual and is reviewed during initial and recurrent flight training.</p> <p>Since the occurrence, the <b>Nunavut Department of Economic Development and Transportation</b> established a standing offer agreement for the servicing of airport mobile equipment and airfield lighting at Kugaaruk Airport. Qualifying contractors are available for servicing airport equipment and airfield lighting and electronics, avoiding unnecessary delays in sourcing qualified technicians. There have been numerous visits to Kugaaruk Airport for standard equipment preventative maintenance inspections, airfield lighting preventative maintenance inspections, and corresponding equipment repair work.</p> <p>A new airport winter maintenance manual was adopted in the fall of 2020; the manual offers additional guidance on the issuance of notices to airmen (NOTAMs) with more emphasis on inclement winter conditions and in particular when no airport maintenance is available as a result. The new manual also provides more guidance on the management of snow banking in and around movement areas including the posting of the necessary advisories when snowbanks exceed the allowable limits.</p> <p>Since the occurrence, a California Bearing Ratio (CBR) test was conducted at Kugaaruk Airport; the test confirmed excellent CBR values.</p>
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INVESTIGATION REPORT [A20P0105](#): Pilot fatally injured during ground operations, Wilderness Seaplanes Ltd., de Havilland DHC-2 Mk. I, C-FDSG, Port Hardy Water Aerodrome, British Columbia, 7 December 2020

SAFETY ACTIONS	<p>In response to this occurrence, <b>Wilderness Seaplanes Ltd.</b> now requires all staff at Port Hardy Water Aerodrome (CAW5) to wear a personal flotation device (PFD) while working on the dock and to complete propeller safety training. The additional safety actions were subsequently implemented by Wilderness Seaplanes Ltd.:</p> <ul style="list-style-type: none"> <li>A webcam was installed on dock at CAW5 in June 2021.</li> </ul>
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	<ul style="list-style-type: none"> <li>• Since December 2020, pilots must call the dispatcher or meet in person instead of sending a message before going on dock.</li> <li>• Since December 2020, at safety-critical times, there will be a second person at the dock.</li> <li>• Since December 2020, a later departing schedule on shorter winter days was implemented to allow for more daylight and therefore give better lighting conditions for preparing the aircraft before a flight. Check-in times for the pilot at the harbour will be no earlier than 30 minutes before sunrise, and there will be no departures before sunrise.</li> <li>• Dock surface traction was added with roofing. Water access ladders were added in 3 positions.</li> <li>• Since December 2020, staff is required to wear PFDs while on the dock.</li> <li>• As of December 2020, all staff have been trained on propeller safety, and a training program was added for new hires. Ground crew received training to recognize magnetos position.</li> <li>• As of January 2021, enhanced defects reporting and identifying procedures were implemented in the event a “LIVE” magneto<sup>7</sup> is detected. Aircraft will be tagged with a hazard tag, providing a visual cue for anyone approaching it.</li> <li>• In January 2021, changes were made to the docking procedures: if magnetos are used to shutdown the engine for docking, the aircraft will be restarted once secured to the dock and shutdown with the propeller procedure of cutting off the mixture.</li> <li>• Propeller hazard lines were introduced in February 2021, consisting of paint or decals to increase awareness to the propeller hazard areas on the aircraft.</li> </ul>
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**INVESTIGATION REPORT [A21P0001](#): Loss of control, Privately registered Mooney M20F, C-GYGN, vicinity of Upper Kananaskis Lake, Alberta, 3 January 2021**

SAFETY ACTIONS	The Board is not aware of any safety action taken following this occurrence.
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**INVESTIGATION REPORT [A21O0006](#): Loss of control and collision with terrain, Privately registered Blackshape S.P.A. Prime BS100, C-GPOT, Ottawa/Carp Airport, Ontario, 10 February 2021**

SAFETY ACTIONS	Following the release of the TSB safety investigation report, <b>Blackshape S.P.A Prime</b> revised the Airplane Flight Manual to include a warning in the Engine Failure After Take-off emergency procedures of the manual.
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**INVESTIGATION REPORT [A21Q0007](#): Loss of control and collision with terrain, Wag-A-Bond (amateur-built aircraft), C-GKGX, Barron Lake, Gore, Quebec, 3 March 2021**

SAFETY ACTIONS	The Board is not aware of any safety action taken following this occurrence.
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<sup>7</sup> A “LIVE” magneto means a magneto that is not functioning properly.



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, 2 May 2021

SAFETY ACTIONS	<p>The <b>Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry</b> put out a communication to all pilots, reviewed all their checklists and amended them as required, and amended their standard operating procedures.</p> <p>In October 2021, a meeting was held with all training pilots and management to review the outcomes of the year, including the accident.</p> <p>Following the accident, the chief pilot reinforced to pilots that they are under no time constraint to complete a circuit and that they should take the time needed to complete the appropriate checklists, and communicated to training pilots that they are supported if they delay or cancel their place on a flight. In spring 2022, the chief pilot will be holding a meeting with all of the training pilots about standards and go/no-go decisions.</p>
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INVESTIGATION REPORT [A21C0052](#): Loss of control and collision with terrain, Helicopter Transport Services (Canada) Inc., Bell 214ST, C-GDYZ, Nipigon, Ontario, 14 NM NE, 7 June 2021

SAFETY ACTIONS	<p>Immediately following the occurrence, <b>Helicopter Transport Services (Canada) Inc.</b> (HTSC) grounded the 3 remaining Bell 214STs in its fleet pending inspection of each helicopter's complete tail rotor drivetrain to verify correct installation.</p> <p>A memo was distributed to all pilots reminding them about ensuring sufficient airspeed to maintain helicopter control during an emergency involving the tail rotor or a total loss of tail rotor thrust in cruise flight.</p> <p>The Emergency Equipment and Procedures Ground Training curriculum now includes training in loss of tail rotor effectiveness and total loss of tail rotor thrust.</p> <p>The HTSC Bell 214ST daily inspection was amended to require the opening of an additional access panel to facilitate the inspection of the engine-deck-mounted tail rotor driveshaft hanger and the No. 2 coupling assembly.</p> <p>A 5-page handout was added to the HTSC Bell 214ST aircraft certification authority type training course. The handout emphasized inspection areas and reiterated the requirement for a thorough dual control check during the 500-hour/12-month servicing of the 3 coupling assemblies.</p>
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INVESTIGATION REPORT [A21Q0052](#): Collision with a lawn tractor during landing, Nanchang CJ6A, Saint-Esprit, Quebec, 5 July 2021

SAFETY ACTIONS	<p>The Board is not aware of any safety action taken following this occurrence.</p>
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INVESTIGATION REPORT [A21O0066](#): Runway overrun, Thunder Airlines, Beechcraft A100 King Air, Moosonee Airport, Ontario, 6 August 2021

SAFETY ACTIONS	<p>Following the occurrence, <b>Thunder Airlines</b> issued a "Long landings and precision approaches" memo to all flight crew on 25 August 2021 reminding them of the following points:</p> <ul style="list-style-type: none"> <li>• the importance of flying a stabilized approach to touchdown and within the associated parameters</li> <li>• the importance of conducting a go-around if the approach becomes unstable</li> </ul>
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	<ul style="list-style-type: none"> <li>• the importance of speed control and touchdown point</li> <li>• braking techniques and the risks associated with hydroplaning</li> <li>• revised approach minima of 300 feet above ground level for approaches with vertical guidance to runways less than 4200 feet in length, unless: <ul style="list-style-type: none"> <li>○ the runway is bare and dry, or</li> <li>○ there is a headwind component of 10 knots or greater.</li> <li>○ <i>Canada Air Pilot</i> minima may be used when either or both of the preceding conditions have been met.</li> </ul> </li> </ul>
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INVESTIGATION REPORT [A21W0071](#): Collision with terrain, Mooney M20C, Slave Lake Airport, Alberta, 12 NM N, 31 August 2021

SAFETY ACTIONS	The Board is not aware of any safety action taken following this occurrence.
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INVESTIGATION REPORT [A21C0088](#): Rollover upon landing, Canadian Helicopters Limited (dba Acasta HeliFlight Inc.), Bell 206L-1 (helicopter), C-GIKX, Hope Bay Aerodrome, Nunavut, 8 NM SSW, 14 September 2021

SAFETY ACTIONS	Following the accident, <b>Canadian Helicopters Limited / Acasta HeliFlight Inc.</b> published 2 articles in the company's newsletter, one on dynamic rollovers and the other on the accident, drawing attention to the facts and circumstances detailed in the TSB's report.
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## Marine transportation sector

INVESTIGATION REPORT [M18A0001](#): Bottom contact, passenger ferry Deer Island Princess II, Little Letete Passage, New Brunswick, 2 February 2018

SAFETY ACTIONS	Following the occurrence, <b>Coastal Transport Limited</b> (CTL) completed an internal investigation of the occurrence with respect to weather, timeline of events, damage, observations, root causes, recommendations, and costs by consulting with the masters working on the Deer Island ferry service. The review resulted in no changes to the safety management system for operations at low tide. Following the occurrence, CTL repaired the tide boards located at Letete and Butler Point.
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INVESTIGATION REPORT [M18C0225](#): Grounding, Passenger vessel Akademik Ioffe, Latitude 69 ° 43.043' N, Longitude 091° 20.951' W, Astronomical Society Islands, Nunavut, 24 August 2018

SAFETY ACTIONS	<p>Following the occurrence, <b>Transport Canada</b> (TC) issued a letter of warning to the authorized representative of the <i>Akademik Ioffe</i>, requiring that all deficiencies be addressed and a corrective action plan issued. It was also communicated that any future non-compliance would result in greater enforcement actions. TC then received a letter from the authorized representative of the <i>Akademik Ioffe</i>, indicating that all deficiencies had been corrected.</p> <p>Following the occurrence, the <b>Canadian Hydrographic Service</b> amended navigation chart 7502: <i>Northwest Territories – Gulf of Boothia and/et Committee Bay</i>, via a Notice to Mariners (12 October 2018) to include the rocky shoal on which the <i>Akademik Ioffe</i> ran</p>
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	<p>aground, at position 69 ° 43.00' N, 091° 21.00' W. The amended chart indicates “rep 2018”<sup>8</sup> and a depth of 5.2 m.</p> <p>Following the occurrence, the <b>Russian Federal Authority for Transport Oversight</b> (Rostransnadzor) carried out a safety investigation and produced a marine casualty investigation report. The report identified poor and unreliable charting in the area the <i>Akademik Ioffe</i> sailed as the cause of the grounding. The report recommended that mariners increase watchkeeping with more bridge watch personnel and more lookouts when sailing in confined waters, use a forward-looking sonar system, maintain minimal safety speed to keep steerage of the vessel, and use anchors as a dip line to navigate unknown waters. Finally, Rostransnadzor recommended to the P.P. Shirshov Institute of Oceanology of Russian Academy of Sciences that the <i>Akademik Ioffe’s</i> crew are made aware of the investigation’s conclusions, and that it establish procedures to prevent a recurrence.</p> <p>Following the occurrence, the <b>P.P. Shirshov Institute of Oceanology of Russian Academy of Sciences</b> corrected the <i>Akademik Ioffe’s</i> bridge watch crew bridge equipment familiarization checklist to include familiarization with the electronic chart display and information system (ECDIS).</p>
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**INVESTIGATION REPORT [M19A0025](#): Sinking and loss of life, workboat Captain Jim, approximately 4 NM southeast of Halifax Harbour, Nova Scotia, 29 January 2019**

SAFETY ACTIONS	<p>Following the occurrence, <b>RMI Marine</b> took steps to ensure that only Transport Canada–certified personnel operate its vessels and that its vessels are inspected and function-tested by company personnel on a quarterly basis. RMI Marine also implemented a new mobile app so that completed forms and records are automatically transmitted to the office. Finally, RMI Marine implemented regular training on the procedure to configure the engine-driven pump for use as a bilge pump.</p>
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**INVESTIGATION REPORT [M19P0057](#): Striking of the anchored vessel Pan Acacia, bulk carrier Caravos Harmony, Vancouver Harbour, British Columbia, 17 March 2019**

SAFETY ACTIONS	<p>Following the occurrence, <b>Transport Canada</b> (TC) boarded the <i>Caravos Harmony</i> to conduct a port state control inspection and identified several contraventions of SOLAS, the <i>Collision Regulations</i>, and the <i>Maritime Labour Convention</i> (2006), including the following:</p> <ul style="list-style-type: none"> <li>• One of the port windlass safety pins was missing.</li> <li>• The rudder angle indicators on bridge had +1-degree errors.</li> <li>• The under-keel clearance information was missing on the planned route.</li> <li>• There was an error in the magnetic compass.</li> </ul> <p>TC also identified items indicating a systematic failure to apply the International Safety Management Code (ISM Code) on maintenance and emergency preparedness. TC also requested that an ISM Code audit be carried out by the classification society Registro Italiano Navale (RINA).</p> <p>TC also conducted a port state control inspection of the <i>Pan Acacia</i>.</p> <p>Following the occurrence, the <b>Vancouver Fraser Port Authority</b> amended its rules for vessels refuelling at English Bay. As of July 2020, refuelling of all vessels can occur in English Bay, thereby reducing the number of inbound laden bulk carriers transiting through the First Narrows Traffic Control Zone (TCZ-1).</p>
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<sup>8</sup> “Rep 2018” indicates that the shoal was included in the chart on the basis of a report made in 2018.



Following the occurrence, the **Pacific Pilotage Authority (PPA)** and **British Columbia Coast Pilots Ltd.** conducted a risk assessment on loaded bulk carriers entering Vancouver Harbour on a strong flood tide. Based on the result of the risk assessment, the PPA issued an interim notice to industry on 4 April 2019 that stated that while the TSB was completing its investigation of the occurrence involving the *Caravos Harmony*, the PPA recommended the following interim measures when the flood current exceeded 1.5 knots:

- An escort tug with a minimum bollard pull of 65 tonnes is to be ordered for any inbound loaded bulk carrier with a length overall of between 200 m and 250 m and a draft in excess of 12 m transiting to an anchorage between Vancouver Wharves and Centerm.
- The escort tug is to be made fast 2 cables west of the Lions Gate bridge on First Narrows.
- For vessels over 250 m in length, users should refer to the information about First Narrows TCZ-1 in the Port Information Guide.

A note in the interim notice also indicated that it would be amended and clarified once the TSB report was published.

On 18 March 2019, a **RINA** surveyor carried out an ISM Code audit on the *Caravos Harmony* and issued the following 3 major non-conformities with a request for a follow-up audit in 2 months:

- Not all non-conformities are reported to the company's designated person ashore.
- The measures to ensure response to all emergency situations are not always effective.
- The procedures for the completion of passage plans are not always fully addressed.

On 12 April 2019, a RINA surveyor attended the vessel to conduct a follow-up audit and confirmed that the non-conformities had been rectified. Between 24 and 30 April 2019, the vessel underwent repairs to its bow area. An additional ISM Code audit was carried out, which resulted in no further findings or actions required.

After the occurrence, **Iason Hellenic Shipping Co. Ltd (IHS)** reviewed the performance of the crew and the crewing agents and replaced the crewing agents at the time of the occurrence with a new fully certified agency. The new agency will recruit crew under the strict supervision of the IHS departments in order to ensure that crew selection and performance is rigorous and in full compliance with safety management system (SMS) procedures and policies.

IHS also asked the new crewing agents to provide additional training to masters and the senior bridge team before embarkation. The training covered the master-pilot relationship as well as passage planning, master-pilot exchanges, and bridge resource management and communications.

The company will review fleet-wide crew awareness and adherence to SMS procedures (mainly those related to navigation standards, maintenance and repair reporting, and safety practices) during more frequent visits on board until satisfied with the conduct of the new crew.

The annual office-to-ship exercises were amended to include a collision scenario in order to assess crew knowledge and reactions to this type of emergency, and lessons learned to be shared across the fleet.

Masters and chief officers of the fleet were instructed to ensure adherence to SMS procedures during anchoring operations. The master and the company will provide additional training on anchoring practices and maintenance after auditing, reviewing, and assessing new crew performance. A circular was sent to all of the fleet regarding the need for passage planning with the electronic chart display and information system.

	<p>After the occurrence, <b>Pan Ocean Company Ltd.</b>, the owner of <i>Pan Acacia</i>, took the following safety actions:</p> <ul style="list-style-type: none"> <li>• The vessel's crew was given a shipboard education session on emergency responses to various accidents, including collisions/allisions.</li> <li>• The company's orientation guide for masters was amended to include a specific reference to the allision involving the <i>Pan Acacia</i> and to provide guidance on anti-collision measures to be taken while vessels are at anchor.</li> <li>• Vessels in the fleet were instructed to post the company's safe working rules for anchor watches and to remind crew to have thorough knowledge of the rules.</li> </ul>
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**INVESTIGATION REPORT [M20C0101](#): Crew fall overboard after workboat struck by mooring line, unregistered workboat belonging to the bulk carrier Manitoulin, St. Clair River, near Sombra, Ontario, 12 May 2020**

SAFETY ACTIONS	<p>Following the occurrence, a due diligence report was completed by the master and crew at <b>Lower Lakes Towing Ltd.</b> While completing the report, the master and crew discussed the incident, and the workboat operators on the <i>Manitoulin</i> were told to never cross slack mooring lines.</p> <p>On 18 January 2021, Lower Lakes Towing Ltd. issued a policy on the prevention of falls overboard. The policy includes best practices and lessons learned to prevent falls overboard. It also includes descriptions of activities and hazards that may lead to falls overboard, critical activities for various crew members in the prevention of falls overboard, and a job hazards analysis. A memorandum was issued to all captains, engineers, and officers to inform them about the policy.</p> <p>Following the occurrence, <b>Smoker Craft Inc.</b>, the manufacturer of the workboat, performed a flotation test on a workboat of the same model. The test resulted in a change to the recommended safe limits for the power and weight of engines used with this model of workboat. The revised maximum power limit is 22 kW (30 hp), and the revised weight limit is 159 kg. Smoker Craft Inc. is in the process of notifying all relevant parties about these changes.</p>
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**INVESTIGATION REPORT [M20C0145](#): Striking of berth, bulk carrier CSL Tadoussac, Port of Québec, Québec, Quebec, 10 June 2020**

SAFETY ACTIONS	<p>The <b>Laurentian Pilotage Authority</b> (LPA) conducted a case study of this occurrence and sent letters to the pilot and the master informing them of the study's conclusions.</p> <p>Before this occurrence, the LPA had prepared a detailed policy on the exchange of information between masters and pilots, entitled Policy on Master-Pilot Exchange (MPX), which came into effect on 23 June 2020. Following this occurrence, this policy was sent to the pilot and the master at the same time as the study's conclusions.</p>
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**INVESTIGATION REPORT [M20P0320](#): Grounding, barge Lafarge Eagle, towed by tug Mauna Loa with tug Sea Imp XI assisting, Fraser River, British Columbia, 1 November 2020**

SAFETY ACTIONS	<p><b>Salmon Bay Barge Line</b> conducted an internal investigation to determine causes and contributing factors as well as compiled lessons learned as a result of the occurrence. The company identified shortcomings with respect to use of assist tugs, training for vessel arrivals/departures and notification procedures in their safety management system.</p>
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## Pipeline transportation sector

INVESTIGATION REPORT [P20H0023](#): Release of crude oil incident, Trans Mountain Pipeline ULC, Sumas Pump Station, Abbotsford, British Columbia, 12 June 2020

SAFETY ACTIONS	<p>Following the occurrence, the <b>Canada Energy Regulator</b> conducted emergency management and environmental protection field inspections and monitored the progress of site remediation activities.</p> <p><b>Trans Mountain Pipeline ULC</b> (Trans Mountain) developed a procedure to verify the integrity of the existing tubing systems and developed an internal standard outlining the requirements for the construction and quality assurance of new tubing systems, as well as a procedure for the installation of tubing systems by Trans Mountain personnel. Trans Mountain also added an automated isolation valve on the inlet of the equation-of-state<sup>9</sup> tubing system and a check valve on the outlet, and reconfigured the emergency shutdown logic to allow select automated valves to be actuated remotely after an emergency shutdown. Furthermore, in 2021, Trans Mountain upgraded the Sumas Pump Station, including the installation of containment and drainage features, a new oil-water separator, and a lined containment area around the station's above-ground piping.</p>
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## Rail transportation sector

INVESTIGATION REPORT [R19C0002](#): Non-main-track collision and derailment, Canadian Pacific Railway, Yard Assignment CW11-06, Alyth Classification Yard, Calgary, Alberta, 6 January 2019

SAFETY ACTIONS	<p>On 18 January 2019, pursuant to section 31 of the <i>Railway Safety Act</i>, <b>Transport Canada</b> (TC) issued a Notice and Order to CP for an immediate threat to safe railway operations due to the lack of sufficient safeguards during switching practices at the east end of the Alyth classification yard. The Notice and Order indicated that there was a risk of cars rolling uncontrolled that could cause harm to employees, the public or the environment. TC received a response from CP that described the measures CP had taken following the Notice and Order. TC determined that the measures taken by CP addressed the immediate threat to safe railway operations, and the Notice and Order was revoked on 28 January 2019.</p> <p>On 6 January 2020, the <b>TSB</b> issued Rail Safety Advisory Letter 01/20 to TC and the Association of American Railroads (AAR). The advisory suggested to TC and the AAR to follow up with the appropriate equipment manufacturers to ensure that vulnerabilities (such as porosity and inclusions) are not introduced into the knuckle castings during the manufacturing process.</p> <p>On 9 November 2020, TC responded that it had contacted the AAR and was informed that the AAR reviewed the advisory and concluded that the forces encountered from kicking cars was likely the most significant contributing factor to failure of the knuckle rather than the porosity of the material found in it. TC also stated that, since the AAR established the requirements for knuckles in use in North American freight interchange service, including specifications on the design, mechanical and chemical properties of the cast component as well as the required testing, it has requested that the AAR contact the knuckle manufacturer to seek its input and determine if additional measures are needed.</p>
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<sup>9</sup> The equation-of-state system is a collection of instrumentation for measuring the parameters (such as density, viscosity, pressure, temperature, and colour) of the product passing through the Sumas Pump Station. These data are used for process control, batch tracking, and leak detection purposes.

	<p><b>Canadian Pacific Railway</b> (CP) subsequently made physical changes to Alyth C-Yard by extending the pad<sup>10</sup> from 300 feet to 425 feet and raising the King Switch 10 inches to add a slight ascending grade to facilitate pin pulling. Furthermore, CP installed 7 pincher retarders on the pull-back track; these retarders were placed west of the pad operator's work location. Pincher retarders were also applied to all tracks on the east end of the classification yard. Also, emergency retarder activation buttons were placed at each end of the pad.</p> <p>After the occurrence, CP made immediate changes by adding a locomotive engineer to all working assignments in the C-Yard until all changes were made. Locomotive engineers were also instructed to limit tractive effort to a maximum of 600 A. Furthermore, CP reduced the speed for kicking empty cars to 4 mph and for kicking loaded cars to 1 mph, and eliminated the practice of kicking cars with brakes applied. Also, CP set the maximum tonnage on the switching lead to 7000 tons. A total of 10% of cars are to have air brakes coupled and charged for use while switching. Further, the designation of emergency tracks is no longer discretionary; track CT-01 became the designated emergency track for both sides of Alyth C-Yard.</p>
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**INVESTIGATION REPORT [R19C0015](#): Uncontrolled movement of rolling stock and main-track train derailment, Canadian Pacific Railway Company, Freight train 301-349, Mile 130.6, Laggan Subdivision, Yoho, British Columbia, 4 February 2019**

<p>SAFETY ACTIONS</p>	<p>The <b>TSB</b> sent the following rail safety advisory letters to Transport Canada (TC):</p> <ul style="list-style-type: none"> <li>• 04/19: "Prevention of uncontrolled train movements for trains stopped in emergency on grades of less than 1.8%"</li> <li>• 05/19: "Air brake system inspection and maintenance on grain hopper cars used in CP [Canadian Pacific] unit train operation"</li> <li>• 04/20: "Effectiveness of No. 1 brake test"</li> </ul> <p>Following the occurrence, <b>TC</b> took the following safety action:</p> <ul style="list-style-type: none"> <li>• 8 February 2019: Issued Ministerial Order (MO) 19-03 concerning the application of a sufficient number of hand brakes when a train is stopped on a grade of 1.8% or greater in order to recharge the air brake system.</li> <li>• 27 December 2019: Provided a response to TSB rail safety advisory letters 04/19 and 05/19 indicating in part that it had commissioned SHARMA (a research and engineering consulting firm) to conduct an analysis to evaluate current practices and alternatives for train operations on mountain grade.</li> <li>• 24 April 2020: Approved the railway industry's proposed new <i>Canadian Rail Operating Rules</i> (CROR) Rule 66, Securing Equipment after an Emergency Brake Application on Grade, which outlines hand brake requirements for securing trains on heavy grades and mountain grades (i.e., any grade greater than 1.0%).</li> <li>• 27 April 2020: Issued MO 20-08, requiring all federally regulated companies to report all occurrences of emergency brake applications when a train is stopped on heavy or mountain grade to TC.</li> <li>• 27 April 2020: Ordered that federally regulated railway companies, including CP, file with TC by 25 May 2020 a copy of all company instructions related to CROR Rule 66.</li> </ul>
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<sup>10</sup> The pad is a hard-packed gravel surface on the south side of the pull-back track where the foreman can walk alongside the moving cars to disconnect the couplings.

- December 2020: Approved the use of automated train brake effectiveness technology in lieu of No. 1 air brake test requirements on CP's unit grain trains operating between points in Western Canada and the Port of Vancouver.
- 13 April 2021: MO 19-03 was repealed as it was superseded by CROR Rule 66.
- 29 July 2021: Issued MO 21-04, which reimplemented the requirements of MO 20-08, requiring railway companies to report all occurrences of emergency brake applications when a train is stopped on heavy or mountain grade.

**CP** took the following safety action as a result of this occurrence:

- 6 February 2019: Issued System Bulletin CPSB-005-019, which revised the train handling procedures for the Laggan Subdivision with respect to recovering from an emergency brake application on mountain grades. The revised procedures indicated that, for the first 25 cars, hand brakes must be applied and retainers set to the high pressure (HP) position; the instructions also indicated that retainers must be set to the HP position on all remaining cars.
- 8 February 2019: Issued Operating Bulletin OPER-AB-015-19, which revised the train-handling procedures for the Laggan Subdivision. This bulletin stated, in part, that, when the hot box detector at Mile 111.0 reports a temperature of  $-20^{\circ}\text{C}$  or below, all movements with a weight per operative brake above 100 tons must not exceed 10 mph between Signal 1267 and Field. It also indicated that all movements experiencing an undesired release of the air brakes between Mile 125.7 and Field must stop, set retainers to the HP position on all loaded cars and report the undesired release immediately to the rail traffic controller. Furthermore, concerning emergency brake application recovery, the bulletin stated that the conductor must immediately secure the movement with the sufficient number of hand brakes.
- 12 February 2019: Began testing wheels on all westbound grain trains passing by cold wheel sites installed on the Laggan Subdivision (Mile 130.2) and on the Mountain Subdivision (Mile 30.2, Mile 95.1, and Mile 111.7). As a result, over 5000 grain cars were found to have bad brakes and were bad ordered.
- 12 February 2019: Began collecting and monitoring automated train brake effectiveness (ATBE) data for its grain car fleet to establish the effectiveness and accuracy of the process. Based on the results, the ATBE initial algorithms were adjusted for application to the grain car fleet.
- 25 February 2019: Issued System Bulletin CPSB-009-19 regarding a revision to the General Operating Instructions (GOI) stating that, during certain weather conditions, in advance of a location that will require the use of the air brakes, the locomotive engineer (LE) must make an effective minimum brake application to determine that the brakes are working properly.
- 4 March 2019: Made it mandatory, under its cold wheel repair program, to replace the four reservoir gaskets before conducting the single car test, and to use a calibrated soap and an applicator brush.
- 7 March 2019: Issued System Bulletin CPSB-011-19, which raised CP's No. 1 brake test operative brake standard to 100% on all trains operating on the Canadian network, which is an increase from the regulatory standard of 95%.

Also in 2019, CP updated the wiring in its SD70 type locomotive to support a software modification. The change includes dynamic brake enhancements for distributed power trains to retain dynamic braking on all remote locomotives after an emergency brake application. Additional software changes, developed in collaboration with the manufacturer of CP's General

Electric locomotive fleet, were implemented in 2021. By December 2021, approximately 95% of the 782 locomotives had the software update installed.

CP also developed an advanced locomotive engineer training program to supplement LE skill sets and provide additional preparation for addressing adverse conditions in the field. The 8-hour training, which expands on principles that were always present in the LE training programs, consists of a two-hour refresher course on air brakes and five advanced simulation runs.

### **Safety action required**

#### **Reducing the risk of uncontrolled movements through the implementation of periodic maintenance requirements for brake cylinders**

In this occurrence, the brake cylinders on the freight cars were leaking compressed air, a situation exacerbated by their age and condition and the extreme cold temperature (the ambient temperature was in the range of  $-25^{\circ}\text{C}$  to  $-28^{\circ}\text{C}$ ), reducing the braking capacity of the train's automatic air brake system. From post-occurrence testing, it was found that about 50% of the cars on the occurrence train had reduced air brake effectiveness during the initial descent of Field Hill and, as a result, an emergency brake application was necessary. Given the extreme cold temperature and the length of time the train's cars were stationary with the brakes applied at Partridge, the rate of brake cylinder pressure loss on some cars was likely excessive. Consequently, about three hours later, the brakes could no longer hold the train, which began to roll on its own.

If TC and the railway industry do not take measures to prevent excessive brake cylinder leakage on freight cars, the risk of a loss of control due to insufficient braking capacity will persist, a risk that increases on steep descending grades, especially in cold ambient temperatures. Therefore, the Board recommended that

the Department of Transport establish enhanced test standards and time-based maintenance requirements for brake cylinders on freight cars operating on steep descending grades in cold ambient temperatures.

TSB Recommendation R22-01

#### **Reducing the risk of uncontrolled movements through the implementation of automatic parking brake technology**

There are several factors that can reduce the effectiveness of hand brakes, most notably low input torque (the amount of force applied by the operator at the hand brake wheel), service wear, and reduced coefficient of friction of the brake shoes from rail conditions such as the presence of ice or snow. When some of the hand brakes on a train are not fully effective, more hand brakes are needed to achieve the brake force necessary to hold it stationary.

Applying a large number of hand brakes requires a sustained effort over several hours. As fatigue sets in, the force that operators are able to exert at each hand brake wheel may diminish over time; with lower input torque, the effectiveness of the hand brakes is reduced, requiring more hand brakes to be applied.

There is technology available approved by the Association of American Railroads for securing trains, which takes most of these variables out of the equation: automatic parking brakes for rail vehicles (APBs), such as Wabtec's Automatic Park Brake and New York Air Brake's ParkLoc. APB technology has been tested and approved for use on North American railways, but it has not been widely adopted.

Because APBs lock the brake cylinder piston into position on the cars, their effectiveness is independent of input torque, and it is not affected by brake cylinder leakage. APBs, therefore, can hold a train on a steep grade indefinitely.

Better and more numerous administrative defences have not been successful in establishing safety redundancy against uncontrolled movements. To date, the Canadian railway industry and

the regulator have yet to look beyond strengthening an administrative defense such as the use of hand brakes.

Until physical defences such as automatic parking brakes are implemented across the Canadian railway network, the risk of uncontrolled movements due to inadequate train securement will persist, especially on steep grades where the effectiveness of hand brakes cannot be tested. Therefore, the Board recommended that

the Department of Transport require Canadian freight railways to develop and implement a schedule for the installation of automatic parking brakes on freight cars, prioritizing the retrofit of cars used in bulk commodity unit trains in mountain grade territory.

TSB Recommendation R22-02

### **Risk management through hazard identification, data trend analysis, and risk assessments**

Before this occurrence, safety hazard reports involving poorly braking unit grain trains descending Field Hill in cold winter weather had been submitted by train crews for a number of years in January and February. Although CP's procedure for safety hazard reporting was actively followed at the Calgary terminal, the follow-up process was not effective at analyzing trends. CP did not consider that the trend in safety hazard reports represented a "safety concern," as per the *Railway Safety Management System Regulations, 2015* (SMS Regulations), or by CP's own procedure.

Risk assessments must be conducted before implementing operational changes that have the potential to introduce new hazards or increase the level of severity of existing hazards. CP had made several modifications to the operating procedures for Field Hill, such as changes to the speed threshold at which trains are permitted to descend Field Hill, and changes to the requirements for retainers and hand brakes after an emergency brake application. However, CP did not conduct a risk analysis to assess how these changes would have an impact on safety. Further, the SMS Regulations require that railway companies ensure that employees performing duties essential to safe railway operations have the skills and qualifications required to perform their duties safely. However, when CP changed its training program for conductors on the Laggan Subdivision, it did not conduct a risk assessment of this change.

The effectiveness of safety management systems (SMS) remains a concern and is included in the TSB Watchlist 2020. Federally regulated railways have been required to have an SMS since 2001, and regulatory requirements were significantly enhanced in 2015. However, since then, companies' SMS have not produced the expected safety improvements associated with mature safety management and safety culture, as the rate of main-track train accidents has not improved. The TSB believes that railway companies' SMS are not yet effectively identifying hazards and mitigating risks.

When hazards are not identified, either through reporting, data trend analysis, or by evaluating the impact of operational changes, and when the risks are not rigorously assessed, gaps in the safety defences can remain unmitigated, increasing the risk of accidents. Ultimately, the railway companies themselves must ensure that they have the culture, structures, and processes in place to allow for proactive identification of hazards, assessment of risks, and implementation of mitigation strategies. However, TC also has a responsibility to ensure that railway companies not only comply with the SMS Regulations, but are also managing the risks in their operations effectively.

	<p>Until CP's overall corporate safety culture and SMS framework incorporate a means to comprehensively identify hazards, including the review of safety reports and data trend analysis, and assess risks before making operational changes, the effectiveness of CP's SMS will not be fully realized. Therefore, the Board recommended that</p> <p style="padding-left: 40px;">the Department of Transport require Canadian Pacific Railway Company to demonstrate that its safety management system can effectively identify hazards arising from operations using all available information, such as employee hazard reports and data trends; assess the associated risks; and implement mitigation measures and validate that they are effective.</p> <p style="padding-left: 40px;">TSB Recommendation R22-03</p>
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**INVESTIGATION REPORT [R19E0147](#): Main-track train derailment, Canadian Pacific Railway, Train 201-27, Mile 7.52, Leduc Subdivision, Blackfalds, Alberta, 27 September 2019**

SAFETY ACTIONS	<p><b>Canadian Pacific Railway</b> updated the track between the Labuma north switch and the Canadian National Railway Company (CN) connection track switch, including the turnouts, to 136-pound rail. The turnout frogs were also upgraded to lift-type frogs.</p> <p>On 6 November 2020, <b>Transport Canada</b> issued Ministerial Order 20-10, which provided additional requirements to operate a "higher risk key train" at prescribed speed limits. Among those additional requirements, railways may implement speed restrictions based on temperature rather than time of year. To do so, they must implement a winter operation risk mitigation plan that prescribes, for a subdivision or portions of a subdivision, a rail grinding frequency that ensures that rail surface conditions do not hinder the detection of internal rail defects during rail flaw inspections.</p>
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**INVESTIGATION REPORT [R20V0230](#): Non-main-track uncontrolled movement, Canadian National Railway Company, Remote control locomotive system, Yard assignment 1500 North end, Mile 462.4, Chetwynd Subdivision, Prince George Terminal, South Yard, Prince George, British Columbia, 13 November 2020**

SAFETY ACTIONS	<p>After the occurrence, <b>Canadian National Railway Company</b> management carried out a safety blitz for crews operating in the Prince George Terminal, to reinforce the rules and instructions for operating in the point protection zone (PPZ).<sup>11</sup></p> <p><b>Transport Canada</b> revised Rule 113.3 of the <i>Canadian Rail Operating Rules</i>. The revisions came into force on 28 October 2021, requiring the use of air brakes to control movements during switching on grades greater than 0.4% and with more than 2000 tons.</p>
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**INVESTIGATION REPORT [R20D0088](#): Collision between a train and a track unit, VIA Rail Canada Inc. passenger train VIA 68 and STL 099285 hi-rail vehicle, Mile 30.5, Canadian National Railway Company, Kingston Subdivision, Les Cèdres, Quebec, 6 December 2020**

SAFETY ACTIONS	<p>On 15 December 2020, <b>Transport Canada</b> (TC) sent a notice to Canadian National Railway Company (CN) indicating that the measures implemented to prevent events such as this occurrence had been deemed insufficient.</p>
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<sup>11</sup> In order to facilitate the safety and productivity of remote control locomotive system operations, many yards have implemented track control zones known as point protection zones (PPZ). A PPZ is an area of track, with clearly defined limits, that is under the control of a single crew. A PPZ allows the operation of yard movements without having an employee riding the lead end of each movement.

	On 6 January 2021, <b>CN</b> informed TC that it had developed an employee assessment tool to check their knowledge of the regulations governing the protection of track work.
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**INVESTIGATION REPORT [R21D0001](#): Employee fatality, Canadian National Railway Company, Yard assignment YPC011-06, Mile 1.9, Montreal Subdivision, Montréal, Quebec, 6 January 2021**

SAFETY ACTIONS	<p>Following the occurrence, <b>Canadian National Railway Company</b> (CN) issued a circular to warn its employees about sudden stretch on the couplers resulting from slack action following excessive use of the independent brake. The circular reiterated the safety rules for riding equipment, the rules for communication between peers, and the importance of remaining vigilant to protect oneself against sudden movements and shocks caused by slack action. CN also issued an operating bulletin requiring movements on the Port of Montreal spur to be led by a locomotive or, when shoving equipment, by caboose<sup>12</sup> CN 79834.</p> <p>On 09 July 2021, <b>Transport Canada</b> sent CN a letter of non-compliance related to rules on employees riding equipment. The letter also raised concerns about non-conformities with CN special instructions, in particular General Operating Instruction 8.12.4 and General Rule A(xii) of the <i>Canadian Rail Operating Rules</i>.</p>
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**INVESTIGATION REPORT [R21M0002](#): Main-track train derailment, Canadian National Railway Company, Freight train M30631-25, Mile 8.04, Pelletier Subdivision, Albertine Station, New Brunswick, 26 January 2021**

SAFETY ACTIONS	<p>Following the occurrence, <b>Canadian National Railway Company</b> (CN) initiated a proactive cross key<sup>13</sup> inspection program for cars having the same manufacturer, draft gear design and manufacturing timeframe as the occurrence car. Of the 604 cars inspected, 408 were found to have a defective cross key.</p> <p>The <b>component manufacturer</b> revised the cross key geometry by increasing the radius in the area in which cracking had occurred in order to lower stresses and improve performance.</p>
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**INVESTIGATION REPORT [R21T0007](#): Uncontrolled movement resulting in a non-main-track train derailment, Goderich Exeter Railway, Train 581-01, Parrish & Heimbecker Limited elevator facility at the Port of Goderich, Mile 45.9, Goderich Subdivision, Goderich, Ontario, 1 February 2021**

SAFETY ACTIONS	<p>On 5 February 2021, <b>Goderich Exeter Railway</b> (GEXR) issued Bulletin No 002-2021, which stated in part that “[e]ffective immediately, Locomotive Engineers operating in Goderich Yard are prohibited from exiting the cab of locomotives to perform other than functions that are directly related to Locomotive Engineers.” That same day, Transport Canada (TC) issued a notice to GEXR to acknowledge the action taken.</p> <p>On 12 February 2021, <b>TC</b> issued a letter of non-compliance to GEXR for equipment that was not left properly secured as per Rule 112 of the <i>Canadian Rail Operating Rules</i>.</p> <p>On 10 March 2021, TC issued two ministerial orders (MOs) pursuant to the <i>Railway Safety Act</i> (RSA).</p> <p>Ministerial Order MO 21-01, issued under section 32.01 of the RSA, required all railway companies and local railway companies listed in the MO to implement safety measures “to</p>
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<sup>12</sup> Caboose are equipped with platforms at both ends, providing a safe position for employees when riding equipment.

<sup>13</sup> Freight cars on a train are connected to one another using a coupler, a component of the draft assembly (either a mechanical draft gear or, as in this occurrence, a hydraulic end-of-car cushioning device. In the draft assembly, the cross key secures the coupler to the yoke.

	<p>ensure that an accident caused by an unintentional release of the air brakes does not reoccur.”<sup>14</sup></p> <p>Ministerial Order MO 21-02 was issued under section 19 of the RSA. This MO required railway companies and local railway companies listed in the Schedule of the MO to</p> <p style="padding-left: 40px;">revise the <i>Railway Locomotive Inspection and Safety Rules</i> to incorporate design and performance parameters for locomotives with roll-away protection, and to revise the <i>Canadian Rail Operating Rules</i> to develop a precise definition of attended versus unattended equipment as well as incorporate requirements on the use of roll-away protection to reduce the risks of an uncontrolled movement.<sup>15</sup></p>
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**INVESTIGATION REPORT [R21V0118](#): Main-track train derailment, Canadian National Railway Company, Freight train A47251-02, Mile 547.7, Chetwynd Subdivision, Hodda Station, British Columbia, 3 June 2021**

SAFETY ACTIONS	The TSB is unaware of any safety action having been taken as a result of this occurrence.
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<sup>14</sup> Transport Canada, Minister of Transport Order Pursuant to Section 32.01 of the *Railway Safety Act*, Chapter R-4.2, [R.S., 1985, C. 32 (4th Supp.)] (MO 21-01) (10 March 2021).

<sup>15</sup> Transport Canada, Minister of Transport Order pursuant to Section 19 of the *Railway Safety Act*, Chapter R-4.2, [R.S., 1985, C. 32 (4th supp.)] (MO 21-02) (10 March 2021).