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# **Investigation of Events Involving Aerodynamic Degradation of the Vertical Stabilizer/Rudder During Ground Icing Conditions**

June 2026

Final report



U.S. Department of Transportation  
**Federal Aviation Administration**

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## Acronyms

<b>Acronym</b>	<b>Definition</b>
ECR	European Central Repository
AIDS	Accident Incident Database
NTSB	National Safety Transportation Board
FAA	Federal Aviation Administration
NASA ASRS	National Aeronautics and Space Administration Aviation Safety Reporting System
TSBC	Transportation Safety Board of Canada
CADORS	Civil Aviation Daily Occurrence Reporting System
EASA	European Aviation Safety Agency

## **Executive summary**

Current Federal Aviation Administration (FAA) rules and regulations require that critical surfaces be free of frozen contamination prior to takeoff. The vertical stabilizer is defined as a critical surface by the FAA. However, there is currently a lack of standardization in the treatment of aircraft vertical surfaces contaminated with ice and snow. Some operators in the United States exclude the de/anti-icing fluid treatment of vertical surfaces, including the tail, while others only consider treatment in ongoing freezing precipitation. Some reports have also indicated that treatment of the tail may worsen takeoff performance, as the de-icing fluid on the tail may lead to increased accumulation of contamination in active precipitation conditions.

The FAA initiated a research project to conduct a study of aircraft takeoff incidents during winter weather conditions to determine if any can be attributed to the vertical stabilizer. This study will help lead to policy development and guidance by FAA Flight Standards.

# 1 Introduction

A question has been raised as to whether the vertical stabilizer on transport category aircraft needs to be deiced during ground icing conditions. This study will document the investigation of incidents or accidents in which a failure to adequately deice the vertical stabilizer and/or rudder contributed to causing the failure.

Two separate databases were queried: the Icemaster database, which incorporates icing data from three United States government and two Canadian government databases. This source was documented previously by Green (2015).

The second source database was the European Central Repository (European Union Aviation Safety Agency (EASA)).

## 2 Database descriptions and initial queries

### 2.1 Icemaster database

Since the publication of *The Icemaster Database and an Analysis of Aircraft Aerodynamic Icing Accidents and Incidents* (Green, 2015), the Icemaster database has been updated with events through December of 2020, and also with data from the Transportation Safety Board of Canada (TSBC) as well as the Canadian Civil Aviation Daily Occurrence Reporting System (CADORS). It now contains 23,834 events related to icing, drawn from the National Safety Transportation Board (NTSB), FAA Accident Incident Database (AIDS), National Aeronautics and Space Administration Aviation Safety Reporting System (NASA ASRS), TSBC, and CADORS databases.

Note that the web-accessible databases do not always contain all reported events; hence, searches conducted through online interfaces may be incomplete. For instance, to perform a complete search of the database provided by TSBC, all five data tables must be downloaded from *Data and statistics on air transportation occurrences* (Transportation Safety Board of Canada (TSBC), 2021).

### 2.2 European Central Repository

The ECR database contains reports of occurrences from member states of the European Union (EU) as well as reports from the European Aviation Safety Agency (EASA). Access to and use of the ECR are governed by EU law, and the information contained in this database is available only upon request (European Union Aviation Safety Agency (EASA), 2014). The ECR-obtained

data extending back as far as October 1998, but it is not particularly robust until January 2000. This data has not been incorporated into Icemaster and was queried separately. The initial query to the ECR database was constructed in the same way as previous queries of the five databases referenced above when building Icemaster, using the following keywords to search the “narrative” and “headline” fields of the ECR database:

- ice
- icing
- deice
- de-icing
- deicing
- deicer
- de-icer
- frost
- freezing
- rime
- snow
- de-ice

This yielded 265,920 events. In accordance with European Union Regulation 376/2014 on the reporting, analysis, and follow-up of occurrences in civil aviation, this set of data was refined by constraining the data using the following criteria in the “events” and “precipitation and other weather phenomena” fields:

**Events:**

- Equipment/Aerodrome and ATM Equipment/Aerodrome surfaces
- Equipment/Aerodrome and ATM Equipment/Aerodrome Ground Support Equipment – Other/De-icing Equipment Failure
- Equipment/Ice/Rain Protection System/Aerofoil Anti-Ice/De-Ice System

- Equipment/Ice/Rain Protection System/Air Intake Anti-Ice/De-Ice System
- Equipment/Ice/Rain Protection System/Pitot/Static Anti-Ice System
- Equipment/Ice/Rain Protection System/Other Anti-Ice/De-Ice System
- Equipment/Engine Bleed Air System/Engine Anti Icing System
- Operational/Aerodrome Operations/Aerodrome Services Management/Aerodrome Snow/Ice Removal Insufficient
- Operational/Aerodrome Operations/Aerodrome Services Management/Aerodrome Snow/Ice Removal Not Available
- Operational/Aerodrome Operations/Aircraft De-icing
- Operational/Aircraft Flight Operations/Flight Crew Operation/Interpretation of Equipment/Anti-Icing/De-Icing Hold-over time (HOT) Management
- Operational/Aircraft Flight Operations/Material Falling from Aircraft/Falling Ice from External Surfaces of Aircraft
- Operational/Aircraft Flight Operations/Material Falling from Aircraft/Falling Ice from Toilet Water
- Operational/Aircraft Flight Operations/Material Falling from Aircraft/Falling Ice from Galley Drains
- Operational/Aircraft Flight Operations/Material Falling from Aircraft/Falling Ice from Potable water
- Operational/Aircraft Flight Operations/Material Falling from Aircraft/Falling Ice from Undetermined Sources
- Operational/Aircraft Flight Operations/Object Ingestion by Engine/Ice Ingestion
- Operational/Aircraft Flight Operations/Weather and Environmental Encounters

**Precipitation and Other Weather Phenomena:**

- Characteristics/Freezing
- Phenomenon type/Precipitations/Snow
- Phenomenon type/Precipitations/Drizzle

- Phenomenon type/Precipitations/Snow grains
- Phenomenon type/Precipitations/Ice pellets
- Phenomenon type/Precipitations/Hail
- Phenomenon type/Precipitations/Small hail/snow pellets
- Phenomenon type/Precipitations/Ice crystals

The results of this process narrowed the dataset to 13,495 events.

### 3 Refinement by aircraft type

The study was limited to transport category aircraft. A list of each unique aircraft type designation existing within Icemaster was generated. A total of 3,502 unique aircraft type designations were extracted; many of these were the same type written in numerous different ways. Table 1 shows an example list of different type designations used in various public reports, all of which would fall under the ATR-42 type family. Within the set of 3,502 unique type designations, 1,229 were considered eligible for analysis.

Table 1. Example list of distinct type designations

<b>Make</b>	<b>Model</b>
ATR	42
ATR	ATR 42-300
ATR	ATR 42-500
ATR	ATR-42
AEROSPATIALE	ATR 42
AEROSPATIALE	ATR 42 300
AEROSPATIALE	ATR 42-300
AEROSPATIALE	ATR 42-320
AEROSPATIALE	ATR-42

Table 2 shows the type families that the eligible type designations belonged to. All of the designations in Table 1 would belong to the ATR-42 family in Table 2.

Table 2. Icemaster transport aircraft type list

<b>Make</b>	<b>Model</b>
AEROSPATIALE	ATR 42
AEROSPATIALE	ATR 72
AEROSPATIALE	CONCORDE
AIRBUS	A300
AIRBUS	A310
AIRBUS	A319
AIRBUS	A320
AIRBUS	A321
AIRBUS	A330
AIRBUS	A340
AIRBUS	A400M
British Aerospace	146
British Aerospace	125
British Aerospace	748
British Aerospace	ATP
BEECH	400
BOEING	707
BOEING	717
BOEING	720
BOEING	727
Boeing	737
BOEING	747
BOEING	757
BOEING	767
Boeing	777
BOEING	KC-135R
BOMBARDIER	CL-600-2B19
Cessna	500
CESSNA	525
Cessna	550
CESSNA	560
CESSNA	650
CONVAIR	340

<b>Make</b>	<b>Model</b>
CONVAIR	580
DASSAULT	FALCON 20
DASSAULT	FALCON 2000
DASSAULT	FALCON 50
DASSAULT	FALCON 900
DASSAULT	FALCON 10
DEHAVILLAND	DHC-8
DEHAVILLAND	DHC-7
DORNIER	328
MCDONNELL-DOUGLAS	DC-9
MCDONNELL-DOUGLAS	DC-10
MCDONNELL-DOUGLAS	MD-11
MCDONNELL-DOUGLAS	MD-80
EMBRAER	EMB-120
EMBRAER	EMB-145
EMBRAER	ERJ 170
EMBRAER	ERJ 190
FAIRCHILD	F-28 MK 1000
FOKKER	100
FOKKER	F-27
FOKKER	F-28
GULFSTREAM	G-IV
HAWKER BEECHCRAFT CORP.	4000
HAWKER BEECHCRAFT CORP.	900XP
ILYUSHIN	IL-62
ISRAEL AIRCRAFT (IAI)	1124
ISRAEL AIRCRAFT (IAI)	1125
LEAR	24
LEAR	24B
LEAR	24D
LEAR	25
LEAR	25B

<b>Make</b>	<b>Model</b>
LEAR	25C
LEAR	25D
LEAR	35A
LEAR	35
LEAR	36A
LEAR	60
LEAR	45
LKHEED	382
LOCKHEED	188
LOCKHEED	1011
NIHON	YS-11A
Not Reported	Heavy Transport
Not Reported	Heavy Transport, Low Wing, 4 Turbojet Eng
Not Reported	Large Transport
Not Reported	Large Transport, Low Wing, 2 Turbojet Eng
Not Reported	Large Transport, Low Wing, 3 Turbojet Eng
Not Reported	Light Transport, High Wing, 2 Turboprop Eng
Not Reported	Light Transport, Low Wing, 2 Turbojet Eng
Not Reported	Light Transport, Low Wing, 2 Turboprop Eng
Not Reported	Medium Large Transport
Not Reported	Medium Large Transport, Low Wing, 2 Turbojet Eng
Not Reported	Medium Transport
Not Reported	Medium Transport, High Wing, 2 Turboprop Eng
Not Reported	Medium Transport, Low Wing, 2 Turbojet Eng
Not Reported	Medium Transport, Low Wing, 2 Turboprop Eng
ROCKWELL	NA-265-25

<b>Make</b>	<b>Model</b>
SAAB	340
SHORT BROTHERS	SD3-30
SHORT BROTHERS	SD3-60

Out of the 23,834 total events in the Icemaster database, 10,818 involved eligible types.

Likewise, the ECR data was refined to only include transport category types. Table 3 shows the type designations from the ECR that were considered eligible for inclusion.

Table 3. ECR transport aircraft type list

<b>Make</b>	<b>Model</b>
AIRBUS	A300
AIRBUS	A310
AIRBUS	A318
AIRBUS	A319
AIRBUS	A320
AIRBUS	A321
AIRBUS	A330
AIRBUS	A340
AIRBUS	A350
AIRBUS	A380
ALENIA	C27
ANTONOV	AN26
ATR	42
ATR	72
BRITISH AEROSPACE	ATP
BRITISH AEROSPACE	146
BRITISH AEROSPACE	125
BRITISH AEROSPACE	146
BRITISH AEROSPACE	4100
BEECH	400
BOEING	717
BOEING	737
BOEING	747

<b>Make</b>	<b>Model</b>
BOEING	757
BOEING	767
BOEING	777
BOEING	787
BOEING	C17
BOMBARDIER	BD100
BOMBARDIER	BD500
BOMBARDIER	BD500
BOMBARDIER	BD700
BOMBARDIER	BD700
BOMBARDIER	CL600
CESSNA	525
CESSNA	550
CESSNA	551
CESSNA	560
CESSNA	650
CESSNA	680
CESSNA	750
DASSAULT	FALCON 10
DASSAULT	FALCON 2000
DASSAULT	FALCON 50
DASSAULT	FALCON 7X
DASSAULT	FALCON 900
DASSAULT	FALCON 900EX
DASSAULT	MYSTERE FALCON 20
DASSAULT	MYSTERE FALCON200
DE HAVILLAND	DH115
DE HAVILLAND	DHC-7
DE HAVILLAND	DHC-8
DOUGLAS	DC-9
EMBRAER	EMB120
EMBRAER	EMB135
EMBRAER	EMB145
EMBRAER	ERJ170

<b>Make</b>	<b>Model</b>
EMBRAER	ERJ175
EMBRAER	ERJ190
EMBRAER	ERJ195
FOKKER	F-27
FOKKER	F-28
GRUMMAN	G-159
GULFSTREAM	G-IV
GULFSTREAM	GULFSTREAM 100
GULFSTREAM	GULFSTREAM 200
GULFSTREAM	GULFSTREAM 280
GULFSTREAM	G-V
GULFSTREAM	G-VI
HAWKER	400
HAWKER	4000
LEARJET	35
LEARJET	36
LEARJET	40
LEARJET	45
LEARJET	55
LEARJET	60
LOCKHEED	188
LOCKHEED	C-130
MCDONNELL DOUGLAS	MD-11
MCDONNELL DOUGLAS	MD-88
MCDONNELL DOUGLAS	MD-90
SAAB	2000
SAAB	340
SHORT	SC-7
SHORT	SD3-60

Of the 13,495 events in the tailored ECR dataset, 10,045 were considered eligible types.

## 4 Vertical stabilizer queries

### 4.1 Icemaster

The next step in the investigation was to construct a query that targeted the issue of vertical stabilizer icing. This was done using the following four keywords:

- rudder
- vertical
- stabilizer
- yaw

If none of these keywords appeared in any part of the event narrative, there would be no way to discern a problem with ice adhering to the vertical stabilizer.

When this query was conducted within the narrative fields of the Icemaster database, it yielded 735 events. This set was further narrowed in three steps:

- Excluding events in which the keyword “vertical” appeared in the narrative but the keywords “stabilizer,” “rudder,” and “yaw” do not;
- Excluding events in which the keyword “stabilizer” appeared in the narrative but the keywords “vertical,” “rudder,” and “yaw” do not;
- Excluding events in which the phase of flight was identified as either “cruise,” “initial approach,” “final approach,” or “landing.”

This further reduction left 238 events eligible for analysis.

### 4.2 ECR

Reports in the ECR are predominantly written in English, but there are numerous reports written on other languages. Of these, French and German appear to be the most frequent. The basic keyword query was therefore expanded when applied to the ECR data to contain equivalent words in both French and German.

- rudder
- ruder
- gouvernail

- gouverne
- vertical
- vertikal
- stabilizer
- stabilisator
- stabilisateur
- yaw
- embardee
- gieren

This yielded 460 events. These events were further narrowed by querying the fields “Event Type Level 3,” “Event Type Level 4,” and “Headline” for the following criteria:

- Crosswind Encounter
- Headwind Encounter
- Tailwind Encounter
- Lightning Strike
- High Wind Encounter
- Turbulence Encounter
- Wind Shear/Microburst Encounter
- Poor Visibility Encounter

Events that met the above criteria were removed from consideration. This resulted in 213 events.

## 5 Results

Out of the total of 451 events evaluated, only one was found that directly implicated a problem with failing to de-ice the vertical stabilizer. This was an event involving a Cessna Citation 680,

departing Platov in the Rostov-on-Don region of Russia on December 21, 2018. The narrative read:

When we got to the airplane in the morning, we found it to be covered in a layer of clear ice. We asked for a 2-step de-icing, which was done remotely with engines running. There was no precipitation at time of de-ice until departure. During the climb out we received a ReTrim Nose Left CAS message. We disconnected the auto pilot and found the aircraft to be out of trim. But we needed more than half scale rudder trim to keep the aircraft flying straight which is unusual. No other indications in the form of abnormal engine indications, vibrations or handling capabilities. After troubleshooting and a call with Fleet management, we decided to continue to destination and inspect the tail section. Suspected ice to be the cause. During descent into warmer air the requirement for left rudder trim became less and less and before approach it was back to neutral. During inspection of the tail section I found pieces of clear ice on the rudder surface, but it was still hard to see! We de-iced again and had no problems on the next flight. (European Union Aviation Safety Agency (EASA))

There did not appear to be any technical investigation that could have validated this claim. The statement made by the crew that no precipitation was observed until the time of departure leaves open a question of whether the ice subsequently discovered on the rudder surface was accreted before or after departure.

On December 12, 1985, a DC-8 departing Dayton, Ohio, generated a similar report: “Rudder control problem during climb required six-degree trim to fly straight. Deiced before departure” (Federal Aviation Administration, 2021).

In this case, there is almost no information, and it cannot be discerned whether the remark “deiced before departure” refers to remaining ice as a cause, as in the Rostov event, or if it indicates that, since they had deiced, the rudder problem could not have been due to ice.

There were two significant reports of control vibrations that may have involved the rudder. On November 7, 2016, a BAe 146 departed Gothenburg, Sweden and experienced heavy flight control vibrations (European Union Aviation Safety Agency (EASA)). This was subsequently attributed to “extensive ice coverage on multiple flight control surfaces” remaining after an inadequate deicing process. The “SHK has concluded that the vibrations were due to the unbalance of the elevator system that arose due to the ice contamination.” No mention was made of any rudder involvement.

On December 7, 2017, C-GIAB, an Air Inuit Bombardier DHC-8-314 (report number A17Q0187):

Was on an instrument flight rules flight AIE803 from Salluit, QC (CYZG) to Montreal/Pierre Elliott Trudeau, QC (CYUL) with 3 crew members and 14 passengers on board. While the aircraft reached an altitude of 8 000 ft following departure from CYZG, the crew felt the yoke shake hard back and forth and decided to divert the flight to Puvirnituk, QC (CYPX) where it landed with no other incidents. While inspecting the aircraft, ground workers noticed ice on the rudder and elevator. (Transportation Safety Board of Canada (TSBC), 2021; Transportation Safety Board of Canada (TSBC), 2021)

There is no mention of whether the aircraft was deiced prior to takeoff, or whether there was even a need for deicing. No discussion of whether the ice noticed on the rudder and elevator actually caused the control yoke displacements was found.

There were three reports of ice jamming rudder movement; curiously, all three involve the Fokker F27.

On October 28, 2007, the flight crew of a Fokker F27, operating in Iceland, “found the rudder to be stuck during the before take-off flight control check. The aircraft had been poorly de-iced and a piece of ice was found in between the rudder horn balance and vertical stabilizer.” (European Union Aviation Safety Agency (EASA))

On March 16, 2009, another Fokker F27, operating in Sweden, “returned to the parking spot after it was found that the rudder movement had been restricted by frozen ice. The aircraft had to be de-iced for the second time” (European Union Aviation Safety Agency (EASA)).

On January 13, 2017, another Swedish Fokker F27 reported a “stuck rudder after deicing” (European Union Aviation Safety Agency (EASA)).

## 6 Conclusions

There is no documented history of ice accreted on the vertical stabilizer prior to takeoff compromising yaw authority, with the possible exceptions of the Citation 680 and the DC-8 cited above.

The incident involving the BAe 146 departing Gothenburg suggests that an investigation of the effects of unremoved ground icing on control balancing may be warranted for those aircraft that use any type of aerodynamic balancing.

The several reports of a jammed rudder, though peculiar to the Fokker F27, suggest that certain types of vertical stabilizer/rudder design and construction may expose the rudder to similar problems.

Finally, it must be emphasized that in the United States, there is no program for mandatory occurrence reporting. Therefore, it is possible that there have been other cases of jammed rudders and aerodynamic vibrations that resulted in no damage or reportable events, and they simply did not get reported under voluntary programs.

## 7 References

- European Union Aviation Safety Agency (EASA). (2014, April 3). Regulation (EU) No 376/2014 On the Reporting, Analysis, and Follow-up of Occurrences in Civil Aviation. European Parliament, Council of the European Union. Retrieved from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014R0376>
- European Union Aviation Safety Agency (EASA). (n.d.). European central repository (ECR). Retrieved April 11, 2021, from [https://transport.ec.europa.eu/transport-modes/air/aviation-safety/occurrence-reporting\\_en](https://transport.ec.europa.eu/transport-modes/air/aviation-safety/occurrence-reporting_en)
- Federal Aviation Administration. (2021, April). *FAA Accident and Incident Data System (AIDS) Brief Report(s)*. Retrieved from FAA Aviation Safety Information Analysis and Sharing (ASIAS): [https://www.asias.faa.gov/apex/f?p=100:18:::NO::AP\\_BRIEF\\_RPT\\_VAR:19851212069729I](https://www.asias.faa.gov/apex/f?p=100:18:::NO::AP_BRIEF_RPT_VAR:19851212069729I)
- Green, S. D. (2015). *The Icemaster Database and an Analysis of Aircraft Aerodynamic Icing Accidents and Incidents*. William J. Hughes Technical Center. Atlantic City, NJ: Federal Aviation Administration.
- Transportation Safety Board of Canada (TSBC). (2021, April). *Air transportation safety investigations and reports*. Retrieved from <https://www.tsb.gc.ca/eng/rapports-reports/aviation/index.html>
- Transportation Safety Board of Canada (TSBC). (2021, April). *Data and statistics on air transportation occurrences*. Retrieved from <https://www.tsb.gc.ca/eng/stats/aviation/index.html>