Federal Aviation Administration

Initial En Route Qualification Training

Instructor
Lesson 39
Weather Hazards and Controller Responsibilities

Course 50148001

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LESSON PLAN DATA SHEET

COURSE NAME:	INITIAL EN ROUTE QUALIFICATION TRAINING
COURSE NUMBER:	50148001
LESSON TITLE:	WEATHER HAZARDS AND CONTROLLER RESPONSIBILITIES
DURATION:	6+00 HOURS
DATE REVISED:	2022-02
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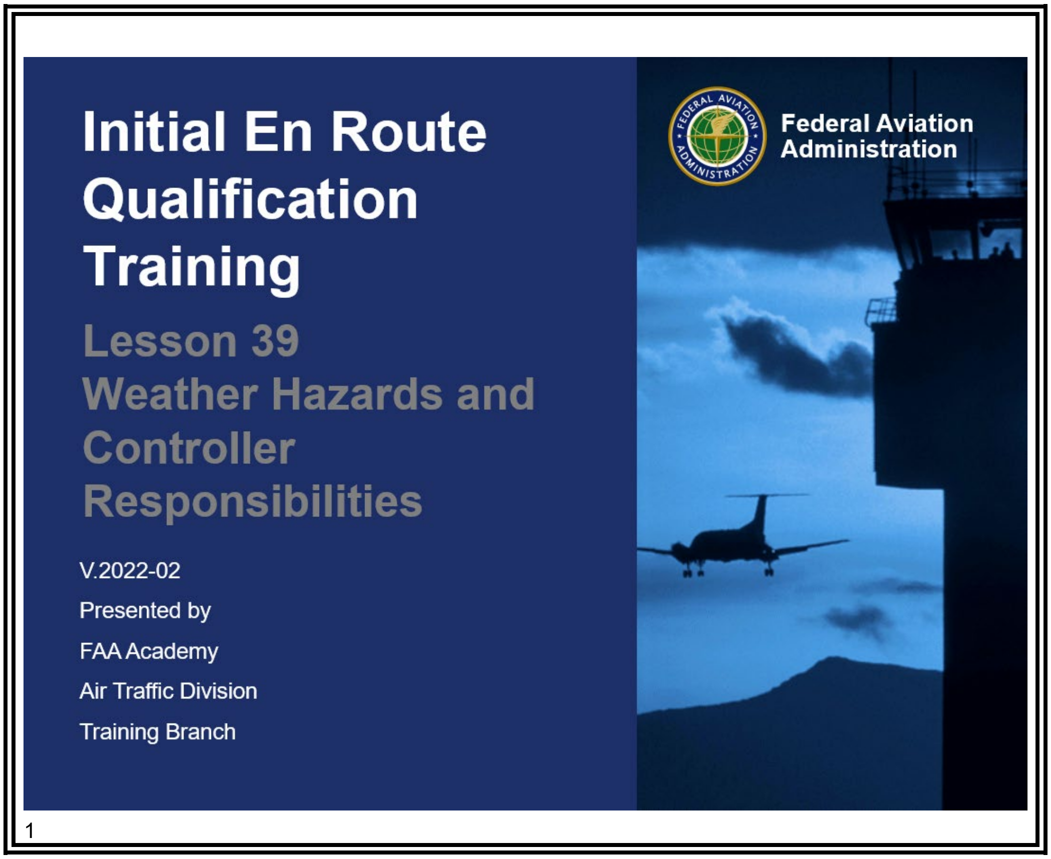
REFERENCE(S):	UCAR/COMET: FORECASTING AVIATION ICING, ICING TYPE AND SEVERITY; NWS JETSTREAM - ONLINE SCHOOL WEATHER; FAA-H-8083-15A - INSTRUMENT FLYING HANDBOOK; AC-0045G - AVIATION WEATHER SERVICES; AC 00-6A - AVIATION WEATHER; NASA IN-FLIGHT ICING TRAINING FOR PILOTS; AMS GLOSSARY OF METEOROLOGY; AOPA SAFETY ADVISOR: AIRCRAFT ICING; AC-91-74A - PILOT GUIDE: FLIGHT IN ICING CONDITIONS; AERONAUTICAL INFORMATION MANUAL (AIM); FAA ORDER JO 7110.65 - AIR TRAFFIC CONTROL; FAA ORDER JO 7210.3 - FACILITY OPERATION AND ADMINISTRATION; FAA ORDER JO 7110.311 - PROCEDURAL GUIDANCE FOR FAA, FAA ORDER JO 7110.65 FOLLOWING EN ROUTE AUTOMATION MODERNIZATION (ERAM) IMPLEMENTATION,
HANDOUT(S):	SAMPLE PIREP
EXERCISE(S)/ ACTIVITY(S):	PIREP EXERCISE
END-OF-LESSON TEST:	YES *(REFER TO ELT39.PDF)*
PERFORMANCE TEST:	NONE
MATERIALS:	NONE
OTHER PERTINENT INFORMATION:	THIS LESSON USES THREE AOPA TRAINING MATERIALS—ICING ENCOUNTER AND WEATHER WISE FOR ATC: THUNDERSTORMS & ATC, AND VFR INTO IMC

☞ ***NOTE:*** *As you prepare for this lesson, recall and be prepared to talk about examples and personal experiences that illustrate or explain the teaching points in the lesson.*

INTRODUCTION

Gain Attention



In previous lessons you have learned about aircraft characteristics as well as the technical aspects of your job as an Air Traffic Controller.

In this lesson, you will learn about your responsibilities as they relate to hazardous weather, and how differences in aircraft and crew ability may affect your control decisions.

INTRODUCTION *(Continued)*

Opening Scenario

ACCIDENT N6579X

Aviation within itself is not inherently dangerous. But to an even greater degree than the sea, it is terribly unforgiving of carelessness, incapacity and neglect. – Anonymous

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- Accident: N6579X, C210A, April 19, 2006, Ludville, Georgia
- Pilot: Former test pilot, first human to fly faster than twice the speed of sound in 1953, over 9000 hours of flight time, instrument rating.
- Flight: IFR flight, in contact with ATC (EN ROUTE), precipitation depicted on the controller's scope was **not** provided to the pilot as required.
- The NTSB report indicates that the plot of the aircraft radar track data showed that the airplane entered extreme precipitation in a thunderstorm before the loss of radar contact."

Purpose

This lesson explores the three main types of aviation weather hazards—icing, turbulence, and thunderstorms—and the weather products associated with these hazards. In addition, it covers common misconceptions about aircraft capabilities and needs with regard to weather.

INTRODUCTION *(Continued)*

Lesson Objectives

LESSON OBJECTIVES

On an End-of-Lesson Test and in accordance with FAA Orders JO 7110.65 and 7210.3, you will identify conditions and controller responsibilities for three main aviation weather hazards:

- Icing
- Turbulence
- Thunderstorms

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☞ ***NOTE:*** *Teach from graphic.*

AIRCRAFT AND CREW CHARACTERISTICS

Terminology

📖 **Visual Meteorological Conditions (VMC)** is when the pilot is able to navigate using visual references outside the cockpit. Pilots flying under VFR flight rules **must** operate in VMC. IFR pilots can be operating in VMC.

📖 **Instrument Meteorological Conditions (IMC)** is when the pilot is **only** able to navigate using instrument references inside the cockpit. To legally operate in IMC, a pilot **must** be instrument rated and on an IFR flight plan

Aircraft and Crew Characteristics

⊙ In general, air carriers/Part 121 aircraft are able to handle encounters with adverse weather much better than GA aircraft.

- Air carriers have a schedule to maintain, and are expected (and designed) to handle a certain amount of in-flight weather phenomena
- GA aircraft are generally expected to avoid hazardous weather by planning their flight around it or delaying their flight
  - In the event that GA aircraft inadvertently encounter hazardous weather, they are expected to exit the conditions as soon as possible

⊙ Air carrier crew

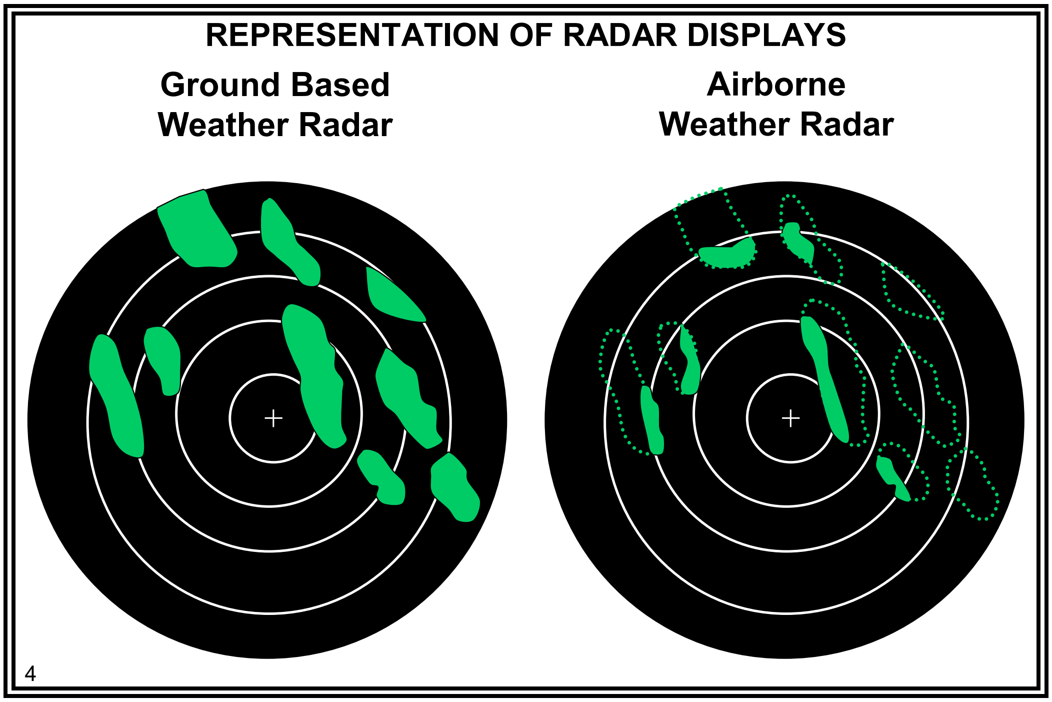
- The great majority of air carrier crews have the following advantages with regard to weather encounters:
  - Cockpit workload – more evenly distributed because there are at least two pilots
  - Experience with weather/IMC – professional pilots fly when scheduled and encounter weather routinely, gaining valuable experience handling adverse weather and operating in IMC

Continued on next page

Aircraft and Crew Character-istics (Cont'd)

⊙ Air carrier aircraft

- Air carrier aircraft are required to meet higher equipage and engineering standards
- Airborne weather radar - air carriers have airborne weather radar with better equipment on the larger jets as compared to the regional jets
- Airborne weather radar does not display the full extent of precipitation areas as compared to ground based weather radar



CLASS NOTE: The graphic above is a representation of what different radars could display on their display screens

☞ ***NOTE:*** *Airborne weather radar only sees part of the precipitation. Non shaded areas are invisible to airborne weather radar. WARP/NEXRAD displays ground based weather radar precipitation*

- De-ice and anti-ice – air carrier aircraft requiring certification for flight into known icing conditions (larger jets are generally better equipped than regional jets)
  - → Often when a GA pilot encounters hazardous weather, it is an inadvertent encounter that catches them by surprise

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AIRCRAFT AND CREW CHARACTERISTICS *(Continued)*

Aircraft and Crew Character-istics (Cont'd)

- GA crew
  - GA pilots vary in their ability to handle adverse weather
    - Cockpit workload – often a single pilot operation, especially for single engine props and many multi engine props
      - → Cockpit workload level can be extremely high for a single pilot during a hazardous weather encounter
    - Experience with weather/IMC – most GA pilots try to fly in good weather and do **not** have a great deal of experience/skill in handling adverse weather
- GA aircraft
  - There is a wide variation in equipage on GA aircraft
    - Airborne weather radar – **most** GA aircraft, especially props, do **not** have airborne weather radar (if they do, it is **not** as advanced as the equipment on board an air carrier)
    - De-ice and anti-ice – **most** GA aircraft, especially props, are **not** certificated for flight into known icing and generally need to exit icing conditions as soon as they are encountered
    - Engineering – **most** GA aircraft are **not** engineered to as rigorous a standard as air carrier aircraft, and are **not** as structurally capable of handling significant turbulence or ice

DUTY PRIORITY

Priority
JO 7110.65,
par. 2-1-1, 2-1-2

PRIORITY

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- Give first priority to:
  - Separating aircraft
  - Issuing safety alerts

- Use good judgment to prioritize all other provisions of JO 7110.65 based on requirements of the situation at hand.
  - Perform action **most** critical from safety standpoint first

DUTY PRIORITY *(Continued)*

Provision of Additional Services
JO 7110.65, par. 2-1-2

⦿ Provide additional services to the extent possible, contingent **only** upon:

- Higher priority duties
- Other factors, including:
  - Limitations of radar
  - Volume of traffic
  - Frequency congestion
  - Controller workload

☞ ***NOTE:*** *Workload limitations will be different for each controller, and each controller should exercise good judgment when determining his/her limits.*

⦿ Additional services are **not** optional, but required when workload permits.

- Additional services include weather dissemination

ATC RESPONSIBILITIES

ATC Responsibilities
JO 7110.65, par. 2-1-1;
JO 7210.3, par. 6-3-1, 10-3-1

ATC RESPONSIBILITIES

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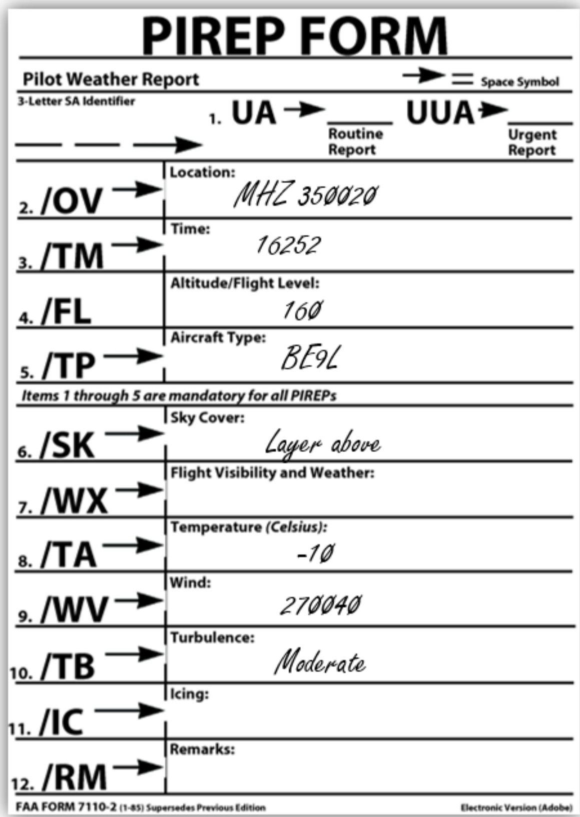
- Be familiar with current weather conditions in your sector and sectors around you when coming on duty.
- Stay aware of current weather information needed to perform ATC duties.
- Controllers **shall** advise pilots of hazardous weather that may impact operations within 150NM of their sector or area of jurisdiction.
- Solicit and disseminate PIREPs.
- Relay PIREP information in a timely manner.
- Relay all operationally significant PIREPs to the facility weather coordinator.

ATC RESPONSIBILITIES *(Continued)*

Solicitation
JO 7110.65,
par. 2-6-3;
JO 7210.3,
par. 6-3-1, 10-3-1

SOLICITATION



PIREP FORM

Pilot Weather Report — ➔ = Space Symbol

3-Letter SA Identifier — 1. UA ➔ (Routine Report) — UUA ➔ (Urgent Report)

2. /OV ➔	Location:	MHZ 350020
3. /TM ➔	Time:	16252
4. /FL	Altitude/Flight Level:	160
5. /TP ➔	Aircraft Type:	BE9L
Items 1 through 5 are mandatory for all PIREPs		
6. /SK ➔	Sky Cover:	Layer above
7. /WX ➔	Flight Visibility and Weather:	
8. /TA ➔	Temperature *(Celsius)*:	-10
9. /WV ➔	Wind:	270040
10. /TB ➔	Turbulence:	Moderate
11. /IC ➔	Icing:	
12. /RM ➔	Remarks:	

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NOTE: *Hand out sample PIREP to students.*

⊙ Solicit PIREPs when requested or when one of the following conditions exist or is forecasted for your area of jurisdiction:

- Ceilings at or below 5,000 feet (include cloud base/tops report)
- Visibility (surface and aloft) at or less than five miles
- Thunderstorms and other related phenomena
- Turbulence (moderate or greater)
- Icing (light or greater)
- Wind shear
- Volcanic ash clouds

NOTE: *When providing approach control services, obtain at least one descent/climbout PIREP each hour.*

Continued on next page

Solicitation (Cont'd)
JO 7110.65, par. 2-6-3;
JO 7210.3, par. 6-3-1, 10-3-1

⊙ Disseminate reports of the following conditions as URGENT PIREPs:

- Tornadoes, funnel clouds, or waterspouts
- Severe or extreme turbulence (including clear air turbulence)
- Severe Icing
- Hail
- Low level wind shear (defined as wind shear within 2,000 feet of the surface.)
- Volcanic eruptions and volcanic ash clouds
  - Detection of Sulphur Dioxide (SQ2) and Hydrogen Sulfide (H2S) in the cabin.
    - → SQ2 and H2S are associated with volcanic activity. SQ2 smells like a freshly struck match and H2S smells like rotten eggs.
- Any other weather phenomena reported which are considered by you, the specialist, to be hazardous or potentially hazardous to flight operations

⊙ As a Radar-Associate, you are responsible to record, classify and disseminate PIREPs whenever a pilot reports any of the conditions listed above, whether or **not** the PIREP was solicited.

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ATC RESPONSIBILITIES *(Continued)*

Solicitation (Cont'd)
JO 7110.65,
par. 2-6-3;
JO 7210.3,
par. 6-3-1, 10-3-1

SOLICITATION (CONT'D)

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- Record with PIREPs:
  - Time
  - Aircraft position
  - Aircraft type
  - Altitude
  - Icing type/intensity and air temperature in which icing is occurring
    - When PIREP involves icing
- Obtain PIREPs directly from pilot.
- Relay PIREPs in a timely manner to:
  - **All** concerned aircraft
  - Weather coordinator
- Urgent PIREPs **must** be immediately broadcast over the frequency and distributed via local and national directives.
- As a Radar-Associate, you are responsible to immediately ensure that Urgent PIREPs are forwarded to the Facility Weather Coordinator by passing the Urgent PIREP to your supervisor (evaluating instructor at the Academy) and then verbally coordinating with other sectors/facilities that **may** be affected by the hazardous condition.

Urgent PIREP is weather phenomena reported by a pilot which represents a hazard or a potential hazard to flight operations.

PIREP EXERCISE

Exercise

PIREP EXERCISE

Purpose: to practice coordinating PIREPs as required

Directions: determine if PIREP is required and, if so, complete the PIREP

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Directions

☞ ***NOTE:*** *Read each pilot transmission aloud to the class. Either the student or yourself may act as the receiving controller.*

Review the pertinent aircraft information provided for each question and listen carefully as the instructor reads the pilot transmission. Then determine if a PIREP form is required and, if appropriate, classify the PIREP, filling out the form with all required and otherwise pertinent information.

☞ ***NOTE:*** *Instructors are encouraged to add examples to this exercise, based on their own experience.*

Question 1

Pertinent Information	
Time	2230
Aircraft Call Sign	N2378F
Aircraft Type	BE9L/I
Altitude	40↑80
Position	3nm W of SQS
Pilot Transmission	
"Aero Center, November two-three-seven-eight foxtrot with you three miles west of Sidon out of four-thousand for eight-thousand. We've been picking up some light rime ice since about thirty-five hundred; do you have any other reports?"	

Continued on next page

PIREP EXERCISE *(Continued)*

Question 1 (Cont'd)

☞ ***NOTE:*** *Click to show the answer slide.*

ANSWER*: A PIREP **is** required for icing of light or greater intensity. Light rime ice is classified as a Routine PIREP (UA). Icing PIREPs should include outside air temperature.*

PIREP FORM

Pilot Weather Report ➔ = Space Symbol

3-Letter SA Identifier: ZAE ➔	1. UA ➔ X (Routine Report)	UUA ➔ ___ (Urgent Report)
2. /OV ➔	Location:	SQS270003
3. /TM ➔	Time:	2230
4. /FL	Altitude/Flight Level:	035-040
5. /TP ➔	Aircraft Type:	BE9L/I
Items 1 through 5 are mandatory for all PIREPs		
6. /SK ➔	Sky Cover:	
7. /WX ➔	Flight Visibility and Weather:	
8. /TA ➔	Temperature *(Celsius)*:	-3
9. /WV ➔	Wind:	
10. /TB ➔	Turbulence:	
11. /IC ➔	Icing:	LGT RIME
12. /RM ➔	Remarks:	

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PIRP EXERCISE *(Continued)*

Question 2

Pertinent Information	
Time	1519
Aircraft Call Sign	N4523P
Aircraft Type	C310/A
Altitude	100
Position	10nm W of HEDUD
Pilot Transmission	
“Center, this is Cessna two-three papa: We’ve been in constant light chop since we left Jackson. Do you know how long this is going to last?”	

☞ ***NOTE:*** *Click to show the answer slide.*

ANSWER*: A PIREP form is* ***not*** *required for turbulence reports of less than moderate intensity. Controller should solicit other PIREPS to ascertain the conditions along N23P’s route.*

Continued on next page

Question 2 (Cont'd)

PIREP FORM

Pilot Weather Report → = Space Symbol

3-Letter SA Identifier

___ ___ ___ →

1. UA → ____ Routine Report UUA → ____ Urgent Report

2. /OV →	Location:
3. /TM →	Time: NO
4. /FL	Altitude/Flight Level: PIREP
5. /TP →	Aircraft Type: REQUIRED

Items 1 through 5 are mandatory for all PIREPs

6. /SK →	Sky Cover:
7. /WX →	Flight Visibility and Weather:
8. /TA →	Temperature *(Celsius):*
9. /WV →	Wind:
10. /TB →	Turbulence:
11. /IC →	Icing:
12. /RM →	Remarks:

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PIRIP EXERCISE *(Continued)*

Question 3

Pertinent Information	
Time	2123
Aircraft Call Sign	AAL269
Aircraft Type	MD90/Q
Altitude	FL180
Position	25nm E of MHZ
Pilot Transmission	
“Center, American two-sixty-nine has a line of thunderstorms building to the south from about our one o’clock and about thirty miles. The tops look to be above twenty. We’d like to deviate north and climb to FL220.”	

☞ ***NOTE:*** *Click to show the answer slide.*

ANSWER: *A PIREP form **is** required when there are reports of strong frontal activity, squall lines, or thunderstorms. The classification of the PIREP (UA or UUA) will be determined at the controller’s discretion after considering the extent of the potential hazard.*

☞ ***NOTE:*** *Explain to students that thunderstorms may be a UUA at controller discretion.*

Continued on next page

PIREP EXERCISE *(Continued)*

Question 3 (Cont'd)

PIREP FORM

Pilot Weather Report → = Space Symbol

3-Letter SA Identifier: ZAE →

1. UA → X (Routine Report) UUA → ____ (Urgent Report)

2. /OV →	Location:	MHZ090025
3. /TM →	Time:	2123
4. /FL	Altitude/Flight Level:	180
5. /TP →	Aircraft Type:	MD90

Items 1 through 5 are mandatory for all PIREPs

6. /SK →	Sky Cover:	
7. /WX →	Flight Visibility and Weather:	
8. /TA →	Temperature *(Celsius)*:	
9. /WV →	Wind:	
10. /TB →	Turbulence:	
11. /IC →	Icing:	
12. /RM →	Remarks:	LINE TS S FR 5NW MHZ TOPS 200+

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PIREP EXERCISE *(Continued)*

Question 4

Pertinent Information	
Time	0138
Aircraft Call Sign	UAL430
Aircraft Type	H/MD11/Q
Altitude	FL230
Position	MLU105045
Pilot Transmission	
"Center, United four-thirty's in moderate to severe turbulence. Can we get higher?"	

☞ ***NOTE:*** *Click to show the answer slide.*

ANSWER: *An URGENT PIREP (UUA)* ***is*** *required for reports of severe or extreme turbulence (including clear air turbulence.)*

☞ ***NOTE:*** *Explain to students that moderate turbulence alone would require a routine (UA) PIREP.*

Continued on next page

PIREP EXERCISE *(Continued)*

Question 4 (Cont'd)

PIREP FORM

Pilot Weather Report → = Space Symbol

3-Letter SA Identifier

ZAE →

1. **UA** → ____ Routine Report **UUA** → X Urgent Report

2. **/OV** →	**Location:** MLU105045
3. **/TM** →	**Time:** 0138
4. **/FL**	**Altitude/Flight Level:** 230
5. **/TP** →	**Aircraft Type:** H/MD11
Items 1 through 5 are mandatory for all PIREPs	
6. **/SK** →	**Sky Cover:**
7. **/WX** →	**Flight Visibility and Weather:**
8. **/TA** →	**Temperature *(Celsius)*:**
9. **/WV** →	**Wind:**
10. **/TB** →	**Turbulence:** MOD-SEV
11. **/IC** →	**Icing:**
12. **/RM** →	**Remarks:**

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PIREP EXERCISE *(Continued)*

Question 5

Pertinent Information	
Time	0018
Aircraft Call Sign	N2868D
Aircraft Type	C650/I
Altitude	25↑110
Position	4nm NE VKS
Pilot Transmission	
"Aero center, Citation six eight delta departed Vicksburg zero-zero-one-five, climbing out of two-thousand-five-hundred for one-one-thousand. We're fighting a 30 knot head wind; do you know what the winds are at eleven?"	

☞ ***NOTE:*** *Click to show the answer slide.*

ANSWER*: Wind reports, independent of other hazards (wind shear, turbulence, etc.), do* ***not*** *require a PIREP, unless the specialist considers it to be potentially hazardous to flight operations.*

Continued on next page

Question 5 (Cont'd)

PIREP FORM

Pilot Weather Report → = Space Symbol

3-Letter SA Identifier

__ __ __ →

1. **UA** → ____ Routine Report **UUA** → ____ Urgent Report

2. **/OV** → Location:

3. **/TM** → Time: NO

4. **/FL** Altitude/Flight Level: PIREP

5. **/TP** → Aircraft Type: REQUIRED

Items 1 through 5 are mandatory for all PIREPs

6. **/SK** → Sky Cover:

7. **/WX** → Flight Visibility and Weather:

8. **/TA** → Temperature *(Celsius)*:

9. **/WV** → Wind:

10. **/TB** → Turbulence:

11. **/IC** → Icing:

12. **/RM** → Remarks:

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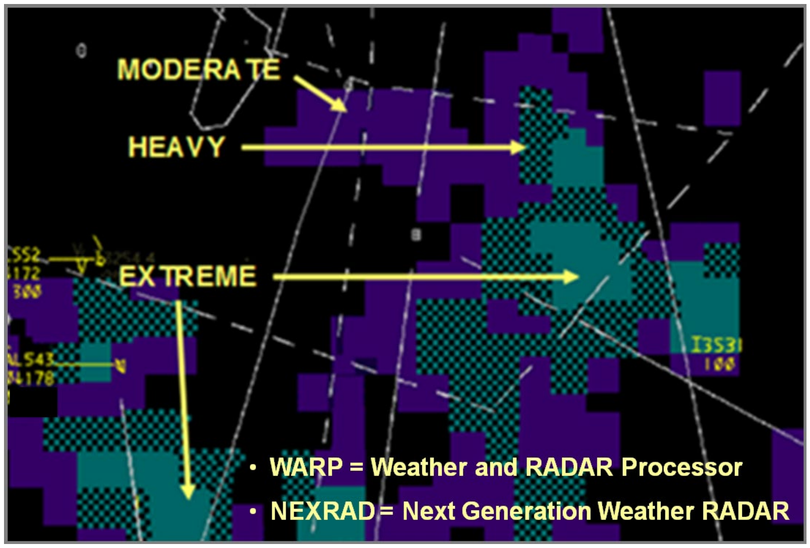
ATC RESPONSIBILITIES *(Continued)*

WARP/ NEXRAD
JO 7110.65, pars. 2-6-1, 2-6-2, 2-6-3, 2-6-4; JO 7210.3, par. 6-3-1, 10-3-1

WARP/NEXRAD



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- Issue pertinent information on observed/reported weather or chaff areas.
- Issue echo intensity (i.e. moderate, heavy or extreme) when that information is available.
- Provide radar navigational guidance and/or approve deviations around weather or chaff areas when requested by the pilot.
- Issue weather and chaff information by defining the area of coverage in terms of azimuth and distance from the aircraft.
- When a deviation **cannot** be approved as requested and the situation permits, suggest an alternative course of action.
- In areas of significant weather, plan ahead and be prepared to suggest, on pilot's request, alternative routes/altitudes.
    - Weather significant to the safety of aircraft includes such conditions as tornadoes, lines of thunderstorms, embedded thunderstorms, large hail, wind shear, microbursts, moderate to extreme turbulence, and light to severe icing

ATC RESPONSIBILITIES *(Continued)*

Knowledge Check

KNOWLEDGE CHECK

QUESTION: Providing additional services, such as relaying weather information is an optional part of the controller's role.

A. True

B. False

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☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *B*

KNOWLEDGE CHECK

QUESTION: Who should receive PIREPs?

A. All pilots, controllers, and facilities

B. All affected pilots, controllers, and facilities

C. All affected pilots

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☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *B*

Continued on next page

ATC RESPONSIBILITIES *(Continued)*

Knowledge Check (Cont'd)

QUESTION: What actions are required by the controller?

A. Advise pilots of hazardous weather that may impact operations within 150 NM of their sector or area of jurisdiction

B. Become familiar with, and stay aware of, current weather conditions in your sector and surrounding sectors, when coming on duty, and throughout your shift

C. Issue pertinent weather information, including echo intensity when that information is available, to the pilot on observed/reported weather or chaff areas

D. All of the above

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☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *D*

QUESTION: If requested by the pilot, provide radar navigational guidance and/or approve deviations around weather or chaff areas.

A. True

B. False

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☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *A*

OVERVIEW OF WEATHER ADVISORY FORECASTS

Airmen's Meteoro-logical Information (AIRMET)
AC-0045G
Change 1

- ⊙ Forecasts of hazardous aviation weather are differentiated by the target audience.

- 🕮 An **AIRMET** is a concise description of the occurrence or expected occurrence of specified en route weather phenomena which may affect the safety of aircraft operations, but at intensities lower than those which require the issuance of a SIGMET.

- ⊙ AIRMETs are intended for dissemination to **all** pilots in flight to enhance safety and are of particular concern to operators and pilots of aircraft sensitive to the phenomena described and to pilots **without** instrument ratings.

Significant Meteorologic-al Information (SIGMET)
AC-0045G
Change 1

- 🕮 A **SIGMET** is a concise description of the occurrence or expected occurrence of specified en route weather phenomena which may affect the safety of aircraft operations.

- ⊙ A **SIGMET** provides aircraft operators and aircrews notice of potentially hazardous en route phenomena such as thunderstorms and hail, turbulence, icing, sand and dust storms, tropical cyclones, and volcanic ash.

- ⊙ SIGMETs are intended for dissemination to **all** pilots in flight to enhance safety.

- ⊙ Convective SIGMETs are issued for thunderstorms in the lower 48 States. For all other locations (Oceanic, Alaskan and Hawaiian Flight Information Regions) a regular SIGMET will be issued for thunderstorms.

Center Weather Advisories (CWAs)
AC-0045G
Change 1
AIM

- 🕮 A CWA is an aviation weather warning for conditions meeting or approaching national in-flight advisory (AIRMET, SIGMET or Convective SIGMET) criteria.

- ⊙ A **CWA** is an unscheduled inflight, flow control, air traffic, and air crew advisory. By nature of its short lead time, the CWA is **not** a flight planning product. It is generally a short term forecast for conditions beginning within the next two hours.

- ⊙ Center Weather Advisories are issued by National Weather Service forecasters at Center Weather Service Units (CWSU).

- 🕮 A **CWSU** is a joint FAA/NWS weather support team located in all EN ROUTE CENTERS.
  - The team consists of NWS meteorologist and FAA traffic management personnel

OVERVIEW OF WEATHER ADVISORY FORECASTS

(Continued)

Controller Responsibilities for Issuing AIRMETs, SIGMETs, and CWAs
JO 7110.65, par. 2-6-2 ; JO 7110.311, par. 2-6-2

⦿ Controllers **must** advise pilots of hazardous weather that may impact operations within 150 NM of their sector or area of jurisdiction. Hazardous weather information contained in the advisories includes Airmen's Meteorological Information (AIRMET), Significant Meteorological Information (SIGMET), Convective SIGMET (WST), Urgent Pilot Weather Reports (UUA), and Center Weather Advisories (CWA).

- The broadcast is **not** required if aircraft on your frequency will **not** be affected

⦿ Controllers **must** broadcast a hazardous inflight weather advisory on all frequencies, except emergency frequency, upon receipt of hazardous weather information. (This broadcast satisfies the requirements of the preceding paragraph).

⦿ Pilots requesting additional information must be directed to contact the nearest Flight Service.

⦿ As a Radar-Associate, you will receive SIGMETs, CWAs, AIRMETs, etc., and you **must** ensure that the radar controller is made aware of them in a timely manner.

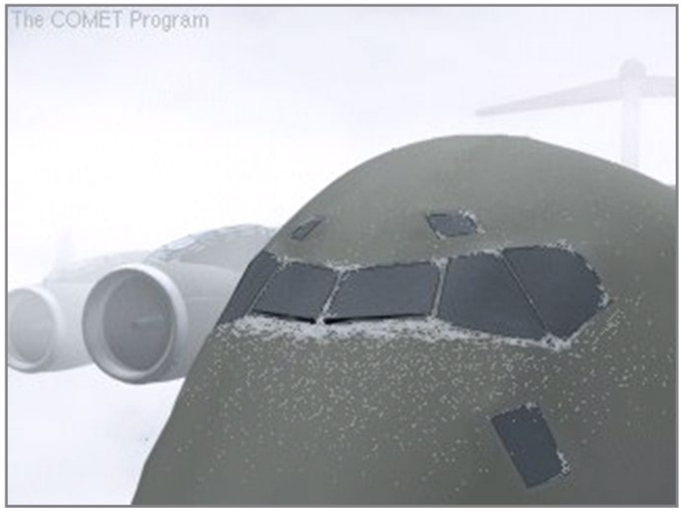
⦿ Controllers **must** electronically acknowledge hazardous weather information messages, which may be received via either the SIGMET or GI views, after appropriate action has been taken.

NOTE: *While hazardous weather information is commonly distributed via the SIGMET View, it is possible to receive the information via the GI View.*

ICING

Overview
AC 91-74A

ICING OVERVIEW



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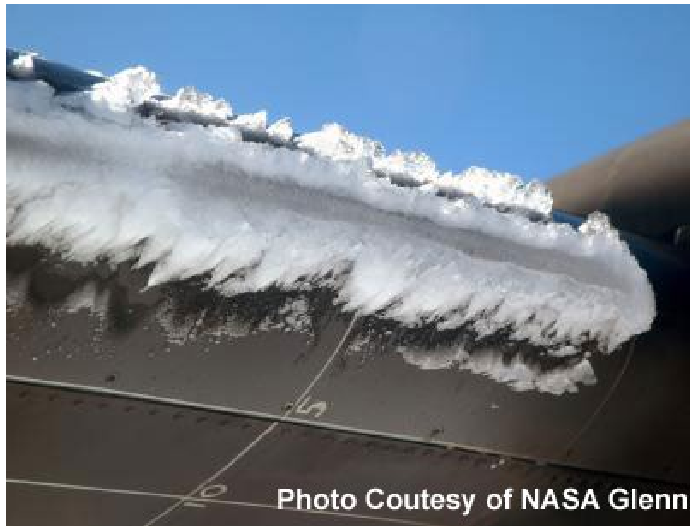
- Icing is a major aviation hazard to all aircraft types.
    - Even a short encounter in icing conditions can cause fatal accidents
- The **most** hazardous icing conditions are encounters with freezing rain (FZRA) and freezing drizzle (FZDZ).
    - Even aircraft that are certified for flight into known icing conditions are **not** evaluated for their ability to handle these conditions
- Currently, ground based weather radar and airborne weather radar systems are **unable** to provide precise, real-time information on areas of ice.
- Icing forecast products are heavily dependent on the solicitation and dissemination of pilot reports (PIREPs).
- Myth: Do **not** assume that aircraft capable of IFR flight are also certified for flight into known icing; these are two totally separate things.
    - It is important to note that aircraft that are approved for instrument flight rules (IFR) operations, but **not** certified for known icing conditions, are **not** tested during the certification process for inadvertent icing encounters

NOTE: For more information, refer to Appendix A for the link to the AC-91-74A – Pilot Guide: Flight in Icing Conditions.

STRUCTURAL ICING

Structural Icing

STRUCTURAL ICING



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AC 91-74A.

NASA In-Flight Icing Training for Pilots

AC 00-6A

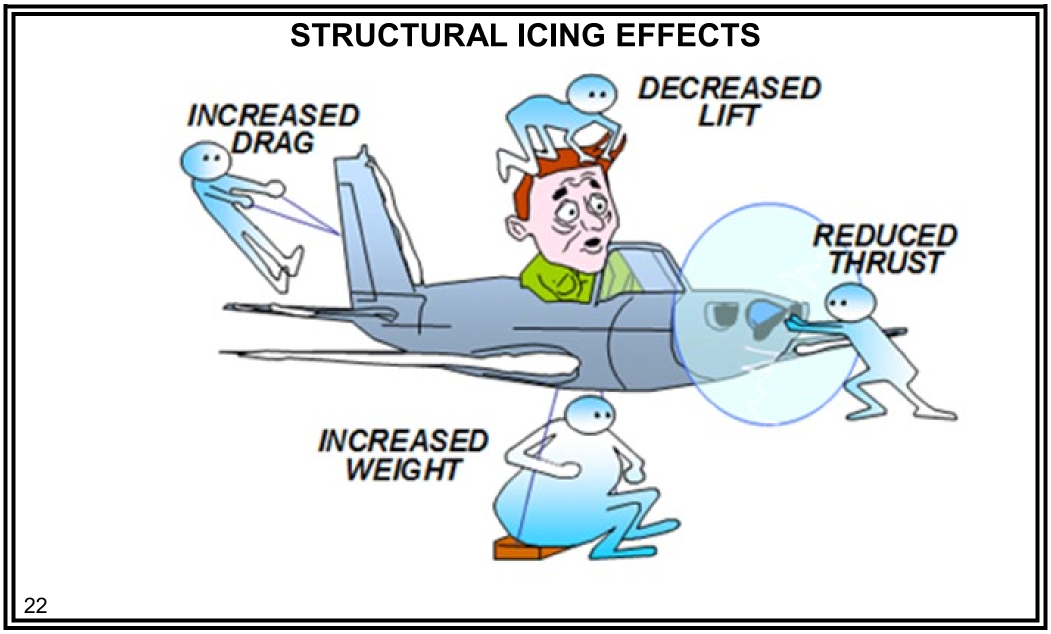
- Structural icing is ice that forms on aircraft surfaces.
  - Normally occurs between +2 degrees and -20 degrees C
- Two conditions are necessary for structural ice to occur:
  - The aircraft **must** be flying in visible moisture such as drizzle, rain, or cloud drops
  - The temperature at the point where the precipitation hits the aircraft must be 0 degrees C or colder
- Aircraft can experience icing 365 days a year. Generally, as the altitude increases, the temperature decreases.

NOTE: The two other types of aircraft ice, induction ice and instrument ice, will be covered in greater depth at your facility.

Continued on next page

STRUCTURAL ICING *(Continued)*

Structural Icing Effects
AC 00-6A



- Structural icing reduces aircraft efficiency by either slowing the aircraft down or forcing it downward.

Continued on next page

Structural Icing Effects (Cont'd)

STRUCTURAL ICING EFFECTS (CONT'D)

Primary Force	Icing Effect on Force	Resulting Effect on Aircraft
Lift	Decreased	Excessive loss of lift will cause aircraft to lose altitude
Weight	Increased	Excessive weight will cause aircraft to lose altitude
Thrust	Decreased	Excessive loss of thrust will cause aircraft to lose airspeed and lift
Drag	Increased	Excessive drag will cause aircraft to lose airspeed and lift

23

AC 00-6A

- Since icing is a cumulative hazard, if an aircraft is left in icing conditions for an extended period, the effects on the aircraft may be such that climbing to exit the icing conditions is **no** longer an option.

AIM

NOTE: A half inch of ice can reduce the lift of some aircraft by 50 percent.

Continued on next page

STRUCTURAL ICING *(Continued)*

Knowledge Check

KNOWLEDGE CHECK

QUESTION: Controllers must advise pilots of hazardous weather within ____ miles of their sector or area of jurisdiction.

A. 150

B. 100

C. 50

24

NOTE: *Click once to show answer.*

ANSWER: *150 miles*

KNOWLEDGE CHECK

QUESTION: Why could there be icing in July?

25

NOTE: *Click once to show answer.*

ANSWER: *Aircraft flying through visible precipitation can experience icing 365 days a year due to the decrease in temperature experienced at high altitudes.*

TYPES OF AIRCRAFT ICING

Types of Structural Ice

- There are three types of structural ice; each has unique characteristics:
  - Clear Ice
  - Rime Ice
  - Mixed Ice

Clear Ice

UCAR COMET Forecasting Aviation Icing: Icing Type and Severity

AOPA Safety Advisor: Aircraft Icing

- The **most** dangerous form of icing.
- Appears translucent or clear and generally smooth.
- Temperatures close to freezing point (0 to -10 degrees C), large amounts of liquid water, and large droplets.
- Can accumulate very rapidly and is difficult to remove.

TYPES OF AIRCRAFT ICING *(Continued)*

Rime Ice

RIME ICE

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AC 91-74A

- Appears rough, milky, and opaque.

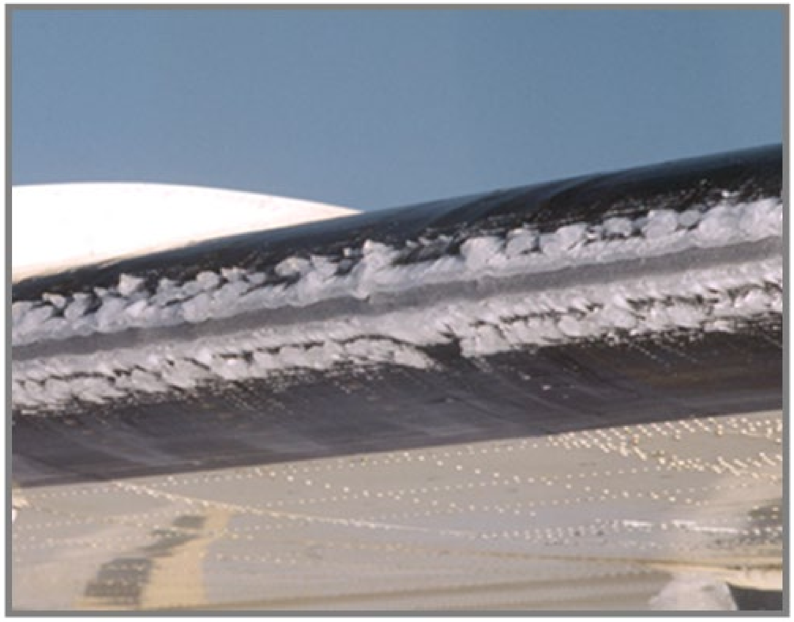
UCAR/COMET: Forecasting Aviation Icing: Icing Type and Severity

- Temperatures (-15 to -20 degrees C), lesser amounts of liquid water than with clear ice, and small droplets.
- Formed by the instantaneous freezing of supercooled droplets as they strike the aircraft.

TYPES OF AIRCRAFT ICING *(Continued)*

Mixed Ice

MIXED ICE



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UCAR/COMET: Forecasting Aviation Icing: Icing Type and Severity

- Mixture of both clear and rime ice.
- Forms in temperatures from -10 to -15 degrees C
- Appears as layers of relatively clear and opaque ice
- Occurs when drops vary in size from small to large.
- Mixed ice is similar to clear ice in that it can spread over more of the airframe's surface
    - Therefore more difficult to remove than rime ice.

INTENSITIES OF STRUCTURAL ICE

Icing Intensities Effects
AIM

ICING INTENSITY EFFECTS

Icing Intensity	Airframe Ice Accumulation
Trace	Ice becomes perceptible. Deicing/anti-icing equipment is **not** used unless icing is encountered for an extended period of time (over 1 hour).
Light	The rate of accumulation may create a problem if flight is prolonged in this environment (over 1 hour). Occasional use of de-icing/anti-icing equipment removes/prevents accumulation.
Moderate	Rate of accumulation is such that even short encounters become potentially hazardous and use of de-icing/anti-icing equipment or flight diversion is necessary.
Severe	De-icing/anti-icing equipment fails to reduce or control the hazard. Immediate flight diversion is necessary.

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⊙ There are four intensities of structural icing:

- Trace
- Light
- Moderate
- Severe

☞ ***NOTE:*** *Have the students read through appendices B and C for further examples of the effects of icing.*

NOTE: Refer to Appendix B for the Structural Icing Pilot story and Appendix C for the Icing Effects NTSB Example.

INTENSITIES OF STRUCTURAL ICE *(Continued)*

Knowledge Check

KNOWLEDGE CHECK

QUESTION: What icing intensity is potentially hazardous with short encounters and use of anti-ice/de-ice equipment is necessary?

A. Light

B. Moderate

C. Severe

30

NOTE: *Click once to show answer.*

ANSWER: *B*

KNOWLEDGE CHECK

QUESTION: Structural Icing affects aircraft by___________.

A. Increasing weight and decreasing drag

B. Decreasing weight and increasing thrust

C. Increasing weight and decreasing thrust

31

NOTE: *Click once to show answer.*

ANSWER: *C*

Continued on next page

INTENSITIES OF STRUCTURAL ICE *(Continued)*

Knowledge Check (Cont'd)

KNOWLEDGE CHECK

QUESTION: When VFR conditions are present, where can a VFR flight encounter icing?

A. In clouds

B. In freezing rain and freezing drizzle

C. In fog

32

☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *B*

SOURCES OF ICING INFORMATION

PIREPs

PIREPs

33

- One of the **most** important sources of icing information is the PIREP—it is the **only** real-time source for reporting the presence of icing.
    - Currently, ground-based weather radar and airborne weather radar systems are unable to provide real-time information on icing
        - At this time, icing forecast products are heavily dependent on the solicitation and dissemination of pilot reports (PIREPs)
- Icing intensity is subjective, and icing conditions are extremely variable in space and time, so PIREPs depend on the ice type and ice protection of the reporting aircraft.
    - The difference between an aircraft that encounters icing and one that does not may be a few hundred feet or a few minutes in time
    - If a pilot's aircraft is smaller, has less power, or has less ice protection than the reporting aircraft, it may experience more serious icing than the reporting aircraft in the same exact meteorological conditions
        - → For example, a Boeing 747 could report light icing when flying through conditions causing a Mooney to report severe icing

Continued on next page

SOURCES OF ICING INFORMATION *(Continued)*

PIREPs (Cont'd)

⦿ Soliciting and relaying PIREPs on icing provides critical safety information:

- Allows aircrews to make better informed decisions about whether to avoid or penetrate areas where icing has been reported
- Allows forecasters to issue SIGMETs or CWAs in a more timely fashion

⦿ When soliciting/receiving icing PIREPs, it is essential to obtain the aircraft type, altitudes ice was encountered, and the temperature, in addition to the type and intensity of ice.

- Since FZDZ and FZRA are indicative of particularly hazardous icing conditions for **all** aircraft, it is good technique to ask the pilot if they are present

⦿ When soliciting PIREPs on icing, at a minimum, record the following information:

JO 7110.65

- Time
- Aircraft position
- Aircraft type
- Altitude
- Icing type and intensity
- Outside air temperature

⦿ It is also helpful to record whether the aircraft was in a climb or a descent.

- Since more surfaces are subject to accretion while the aircraft is in a climbing or descending attitude, this information is helpful to other pilots when relaying PIREPs to them

Continued on next page

PIREPs (Cont'd)
JO 7210.3

- ⦿ Reports of severe icing are considered Urgent PIREPs and need to be delivered to the Center Weather Coordinator immediately as directed by local and national directives.
    - Urgent PIREPs also need to be broadcast over the frequency.
- ⦿ It is also important to know when aircraft are **not** receiving icing.
    - This information can be equally important to both the controller and the pilot.
    - This information is also valuable for NWS forecasters as it can be used to improve icing forecasts. This will ultimately benefit Air Traffic Controllers.

NOTE: PIREP information is **always** given in MSL since altitudes are reported from the pilot perspective, **not** a ground based weather reporting station.

- ⦿ As a Radar-Associate, you are responsible for accurately writing down the PIREP information and giving it to the supervisor (evaluating instructor at the Academy) for forwarding to the Center Weather Coordinator

Continued on next page

SOURCES OF ICING INFORMATION *(Continued)*

PIREPs (Cont'd)

SAMPLES OF PIREPs

MPV UA /OV MPV/TM 1606/FL100/TP C310/TA M01/IC LGT RIME

WMC UA /OV INA 090005/TM 1450/FL130/TP GLAS/TA M01/IC LGT CLR 130-120/RM ZLC

WG UA /OV CYWG 090025 /TM 1515 /FLUNKN /TP BE9L /IC LGT-MOD CLR 110-130/RM DURD

GPI UA /OV FCA/TM 1214/FL080/TP DH8D/TA M07/IC LGT-MOD MX 080-150/RM ZLC

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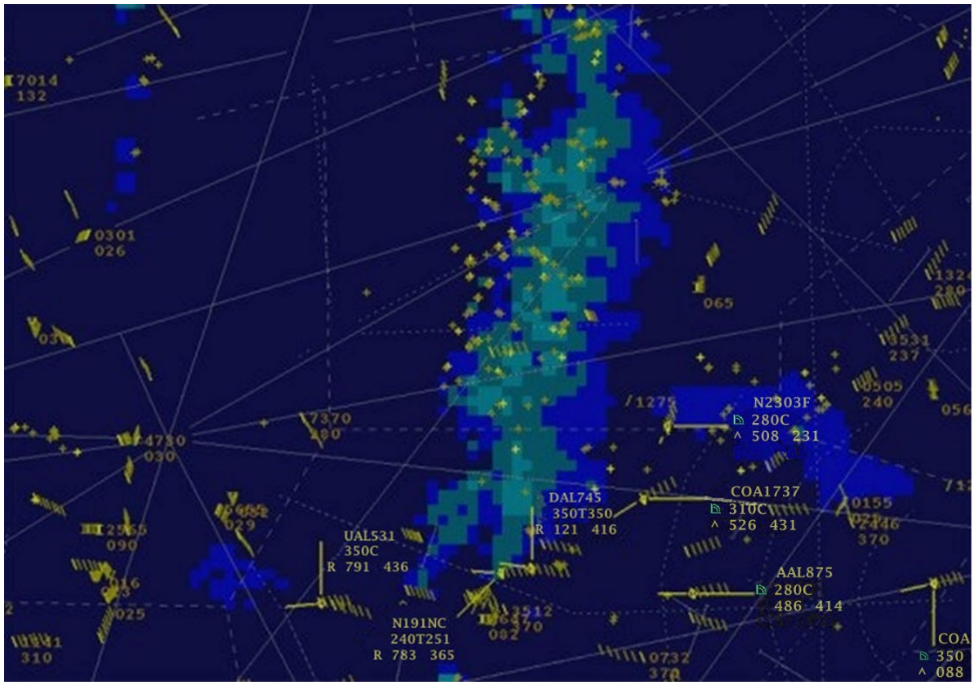
- These are examples of actual PIREPs that were received by En Route controllers.
- Most PIREPs that are received by En Route controllers during thunderstorm activity are turbulence reports, tops/estimated tops reports, icing, and hail.
- Tops reports can be very valuable in indicating how quickly a storm is building.
  - The height of the tops is an indication of the storm’s intensity (the higher the tops, the more intense the storm)

SOURCES OF ICING INFORMATION *(Continued)*

Radar Weather Displays

RADAR WEATHER DISPLAYS



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- Radar weather displays a picture of where precipitation is located.
    - Icing **may** be associated with precipitation. Therefore, from radar, controllers **may** have a good idea where icing conditions exist.
- WARP/NEXRAD does **not** display light precipitation, so En Route controllers do **not** see light precipitation on the ERAM display.
    - Neither pilots nor controllers can see drizzle or freezing drizzle on their radar display

SIGMETs, AIRMETs, CWAs

- Remember, SIGMETs, AIRMETs, and CWAs also contain information about icing.

SOURCES OF ICING INFORMATION *(Continued)*

Knowledge Check

KNOWLEDGE CHECK

QUESTION: What is the only source of information on existing icing?

A. AWOS and ASOS METAR weather reports

B. PIREPs

C. Radar derived weather displays

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NOTE: *Click once to show answer.*

ANSWER: *B*

DISCUSSION QUESTION: What is the significance of freezing drizzle?

ANSWER: *Freezing drizzle indicates hazardous icing conditions for all aircraft. It is a light form of precipitation that controllers **cannot** see on the ERAM display.*

CONTROLLER RESPONSIBILITY

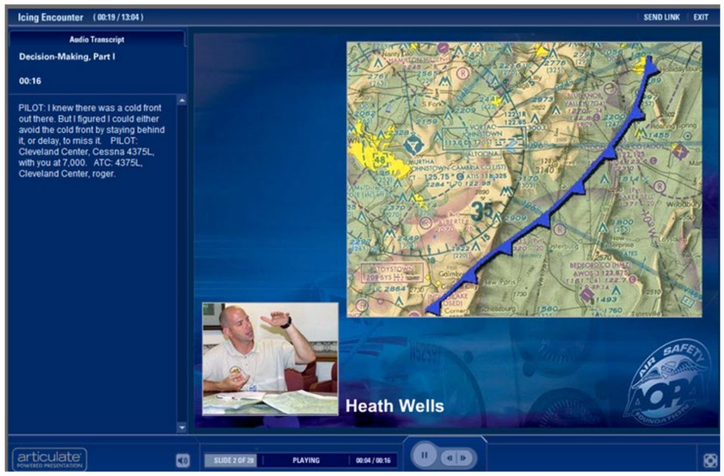
Controller Best Practices
JO 7110.65, par. 2-6-1

- The best thing a controller can do for a pilot is to keep them out of the icing altogether.
- Become familiar with current weather when coming on duty, and stay aware of current weather conditions.
- Know your bases and tops.
- Be aware of the freezing levels in your sector via EDST and other sources.
- As a Radar-Associate, you are responsible to maintain the Status Information Area with pertinent weather product updates and include them in your position relief briefing.

PILOT/CREW RESPONSIBILITY

Pilot/Crew Responsibil-ity
AC 91-74A

PILOT/CREW RESPONSIBILITY



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⊙ The crew has a great deal of responsibility with regard to flight into known or forecast icing conditions.

- Aircraft is either certified for flight into known icing conditions or **not**
- The ability to handle known icing varies significantly between aircraft, even among those certified for flight into known icing
  - The crew **must** be extremely familiar with aircraft limitations as outlined in the aircraft operating manual
- Certification for flight into known icing does **not** currently include testing of the aircraft in freezing rain, freezing drizzle or supercooled large droplets (SLD) conditions
  - These conditions are hazardous for **all** aircraft
- Final authority and responsibility for the safety of a flight rests with the pilot in command

☞ ***NOTE:*** *Follow the directions in the Lead Binders to play the “Icing Encounter” video.*

PILOT/CREW RESPONSIBILITY *(Continued)*

Knowledge Check

KNOWLEDGE CHECK

◈ **QUESTION:** What are controller requirements when there are known icing conditions?

A. Solicit a PIREP

B. Include icing conditions in Position Relief Briefing

C. Always keep aircraft advised of known icing conditions

D. All of the above

38

☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *D*

KNOWLEDGE CHECK

◈ **QUESTION:** When must a controller solicit PIREPs?

A. When icing exists or is forecast to exist at a light degree or greater

B. When icing exists or is forecast to exist at a moderate degree or greater

C. When icing exists or is forecast to exist at an extreme degree or greater

39

☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *A*

TURBULENCE

Turbulence
AMS Glossary of Meteorology

📖 **Turbulence** is any irregular motion of an aircraft in flight, especially when characterized by rapid up-and-down motion, caused by a rapid variation in wind speed or direction.

- Turbulence can be caused by convection, wind shear or obstruction to wind flow (also called mechanical turbulence).
- Turbulence is described in terms of intensity and altitude in weather forecasts and PIREPs.

NTSB Example DEN08LA055

☞ ***NOTE:*** *Have students read the NTSB report.*

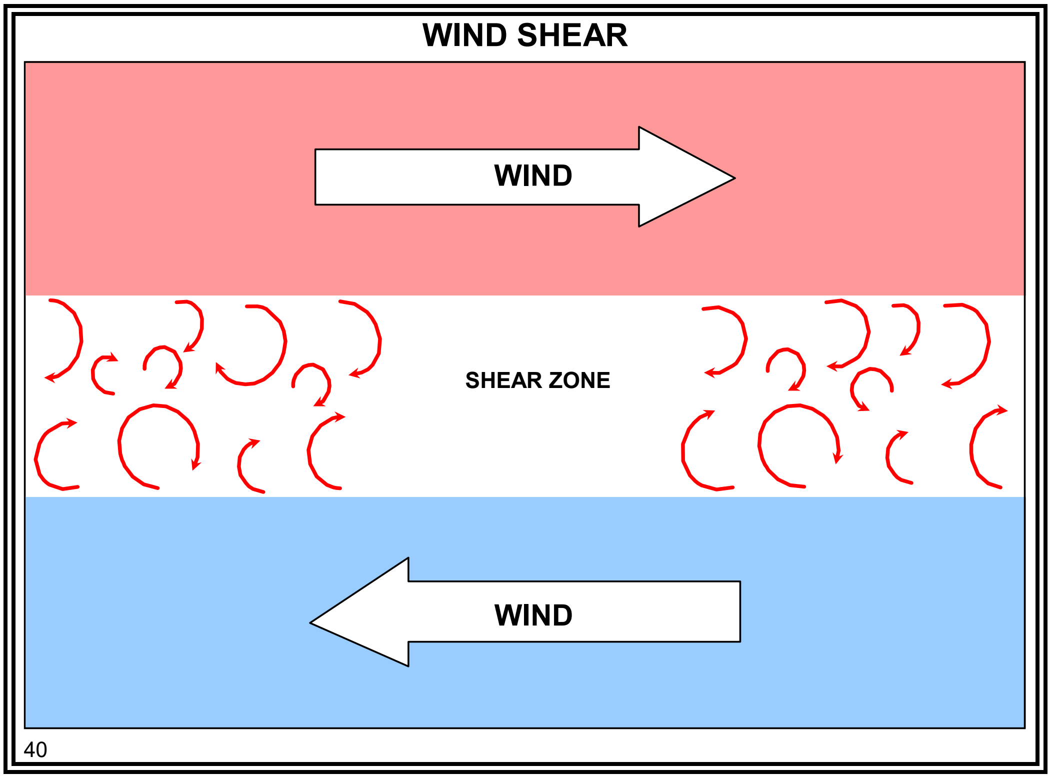
On February 3, 2008, at 0659 mountain standard time, a de Havilland DHC-8-202, N444YV, operated by Mesa Airlines as flight 7106 and piloted by an airline transport certificated pilot, was not damaged when it encountered severe turbulence approximately 35 miles northwest of Denver, Colorado. Visual meteorological conditions prevailed at the time of the accident. The scheduled domestic passenger flight was being conducted under the provisions of Title 14 CFR Part 121, and an instrument flight rules flight plan had been filed. The flight attendant was seriously injured and the captain sustained minor injuries. There were **no** injuries to the first officer and 19 passengers aboard the flight. The flight originated at Casper, Wyoming, approximately 0545, and was en route to DEN.

According to Mesa Airlines, the flight was descending on the RAMMS 5 STAR (Standard Terminal Arrival Route) and was encountering "light chop." The FASTEN SEATBELTS sign was illuminated. Approximately 5 miles inside RAMMS intersection, as the flight was descending from 14,000 feet to 13,000 feet, it encountered severe turbulence. The captain called the flight attendant on the intercom, but she did **not** answer. An emergency medical technician (EMT), who was a passenger on the flight, answered and reported the flight attendant was lying on the floor unconscious. The EMT and an off-duty United flight attendant tended to the injured flight attendant. The captain declared an emergency and the airplane landed at Denver. The flight attendant was transported to a hospital where she underwent surgery for several fractured vertebrae. It was later determined that the captain had suffered a slight concussion.

☞ ***NOTE:*** *Stress to students how turbulence can happen at any time—you may or may **not** have an AIRMET or SIGMET. They **only** way a controller can know about some situations is through PIREPs; therefore, if this situation occurs, it should be captured in your Status Information Area.*

TURBULENCE *(Continued)*

Wind Shear



TURBULENCE *(Continued)*

AMS Glossary of Meteorology
AC 00-6

📖 **Wind shear** is a change in wind speed and/or direction within a short distance.

- The change in speed and/or direction can be over a horizontal distance or a vertical distance
  - An example of a horizontal change in wind speed and/or direction would be a wind change from Jackson Airport to Hawkins Field.
  - An example of vertical change in wind speed and/or direction would be a change from 10,000 feet to 15,000 feet.
- Turbulence **can** exist with wind shear
  - Wind shear can occur at low-levels of the atmosphere or high-levels of the atmosphere.
    - The jet stream is a source for high-level turbulence in the form of clear air turbulence.
    - Fronts and temperature inversions are a source for non thunderstorm low-level turbulence.
    - Thunderstorms are a source of low-level wind shear turbulence
  - Wind shear turbulence can reach extreme intensities.
  - The wind shear can cause an unwanted loss or gain of airspeed
  - Turbulence can be very damaging to **all** aircraft types

TYPES OF TURBULENCE

Low-Level Wind Shear (LLWS)

LOW-LEVEL WIND SHEAR (LLWS)

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AIM

- ⊙ Low-level wind shear (LLWS) is a particularly dangerous form of wind shear and is hazardous to **all** aircraft.
  - **Most** prominent meteorological phenomena that cause significant LLWS are thunderstorms
  - LLWS is **always** present if there is a downburst.
  - The microburst is the most severe form of the downburst
  - Wind shear associated with a microburst is most dangerous to aircraft near the ground as in the approach, landing, and take-off phases of flight.
  - Can produce extreme turbulence
  - Pilots and affected facilities **must** be advised immediately of low-level wind shear reports
- ⊙ LLWS Effects
  - Causes dramatic changes in head and tail winds during critical take-off and landing phases of flight

TYPES OF TURBULENCE *(Continued)*

Clear Air Turbulence (CAT)

CLEAR AIR TURBULENCE

42

AMS Glossary of Meteorology

- Clear air turbulence (CAT) is often encountered in the vicinity of the jet stream typically where no clouds are present.
  - Often caused by, and found near, the jet stream which consists of relatively strong winds concentrated within a narrow stream of the atmosphere
  - Most common between approximately 20,000 and 50,000 feet
  - Sometimes found in the vicinity of mountain ranges
- Effects
  - **No** visible indication that turbulence is present to either the controller or pilot
  - Pilots rely on PIREPs for reports of exact locations of Clear Air Turbulence
    - AIRMETs and SIGMETs may also contain information about CAT

AC-0045G Change 1

TURBULENCE INTENSITIES

Terms
JO 7210.3
par. 6-9-8;
AIM

TERMS

43

- Turbulence Intensities.

Light Turbulence is turbulence that momentarily causes slight, erratic changes in altitude and/or attitude.

Moderate Turbulence is turbulence that is similar to light turbulence but of greater intensity. Changes in altitude and/or attitude occur but the aircraft remains in positive control at all times.

- Moderate turbulence usually causes variations in indicated airspeed, but air speed variations are usually small.

    - Occupants feel strains against seat belts or shoulder straps
    - Unsecured objects are dislodged
    - Food service and walking are difficult

Continued on next page

TURBULENCE INTENSITIES *(Continued)*

Terms (Cont'd)
JO 7210.3, par. 6-9-8

📖 **Severe Turbulence** is turbulence that causes large, abrupt changes in altitude and/or attitude. It usually causes large variations in indicated airspeed. Aircraft may be momentarily out of control.

⊙ In severe turbulence:

- Occupants are forced violently against seat belts or shoulder straps
- Unsecured objects are tossed about
- Food service and walking are impossible

📖 **Extreme Turbulence** is turbulence in which the aircraft is violently tossed about and is practically impossible to control.

⊙ In extreme turbulence structural damage is possible.

AIM

NOTE: Although FAA Order JO 7110.65 makes **no** mention of "chop" with regard to PIREPs, it is a term that pilots use repeatedly when relaying PIREPs. Understanding the difference is important. Chop is **only** used for light or moderate intensity turbulence that is exhibits rhythmic bumpiness. Chop will often be described in terms of occasional, intermittent, or continuous.

Knowledge Check

KNOWLEDGE CHECK

QUESTION: What turbulence intensity is described when occupants feel strain against their seat belts, there is difficulty in walking, and loose objects move about?

A. Light turbulence

B. Moderate turbulence

C. Severe turbulence

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☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *B*

KNOWLEDGE CHECK

QUESTION: What form of turbulence can result in large and abrupt altitude changes?

A. Moderate turbulence

B. Severe turbulence

C. Severe and extreme turbulence

45

☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *C*

SOURCES OF INFORMATION ON TURBULENCE

PIREP Information Relating to Turbulence
JO 7110.65, par. 2-6-3;
JO 7210.3, par. 6-3-1, 10-3-1

PIREPs

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- PIREPs are the sole form of real time information on the intensity of turbulence and where turbulence is located, both horizontally and vertically.
- In accordance with JO 7110.65, PIREPs **must** be solicited when turbulence of a moderate degree or greater, or LLWS exists or is forecast for your area of jurisdiction.
- Clear communication between controller and pilot is essential when receiving and disseminating PIREPs.
- PIREPs on turbulence are subjective, and relaying the information accurately is important. If a pilot is describing turbulence in other than standard terms, clarify the communication.

Turbulence Reporting Parameters
AIM

- When reporting turbulence, a pilot may attach one of the following qualifiers to the report:
  - Light
  - Moderate
  - Severe
  - Extreme
  - Occasional—less than 1/3 of the time
  - Intermittent—1/3 to 2/3
  - Continuous—more than 2/3

CLASS NOTE: Remember, SIGMETs, AIRMETs, and CWAs also contain information about turbulence.

IMPACT ON ATC

Impact On ATC

IMPACT ON ATC

47

- Turbulence impacts ATC by reducing usable airspace.
  - Aircraft may request **not** to fly at the altitudes in which turbulence has been reported
  - Aircraft may reduce their airspeed to minimize the effects of turbulence
  - Special Use Airspace utilization may be minimized if turbulence prohibits civilian aircraft from flying over the top
- Frequency congestion may become a big issue as pilots give PIREPs and request information on ride reports
  - Transmissions spent on relaying weather information may increase
- Capacity to utilize routine control techniques may be reduced
  - Speed control
  - Vectoring for in trail spacing
- Increased workload due to issuing weather re-routes
  - Aircraft experiencing turbulence can be anticipated to request a clearance for mitigation in the form of vectors, altitude change, or to fly an offset
- As a Radar-Associate, you **must** be aware of these possible impacts and be prepared to act accordingly; coordinating with other sectors/facilities and Special Use Airspace users as necessary (utilizing point-outs, APREQs, etc.), to provide a safe means for the aircraft under your control to avoid the turbulence.

Knowledge Check

KNOWLEDGE CHECK

QUESTION: Soliciting PIREPs when turbulence of a moderate degree or greater exists or is forecast to exist is a requirement.

A. True

B. False

48

☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *A*

KNOWLEDGE CHECK

QUESTION: How does turbulence impact ATC?

A. Aircraft may reduce airspeeds to minimize the impact of the turbulence

B. May increase frequency congestion

C. May reduce the amount of usable airspace

D. All of the above

49

☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *D*

Continued on next page

IMPACT ON ATC *(Continued)*

Knowledge Check (Cont'd)

KNOWLEDGE CHECK

◈ **QUESTION:** Which of the following is **not** a controller requirement?

A. Advise pilots of hazardous weather that may impact their operations

B. Issue pertinent information on observed and reported weather

C. Stop aircraft below altitudes with reported turbulence

50

☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *C*

THUNDERSTORMS

Thunder-storms

THUNDERSTORMS

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Thunderstorm & ATC Video

AOPA VIDEO

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☞ ***NOTE:*** *Follow the directions in the Lead Binders to play the "Thunderstorm Hazards" video.*

Continued on next page

THUNDERSTORMS *(Continued)*

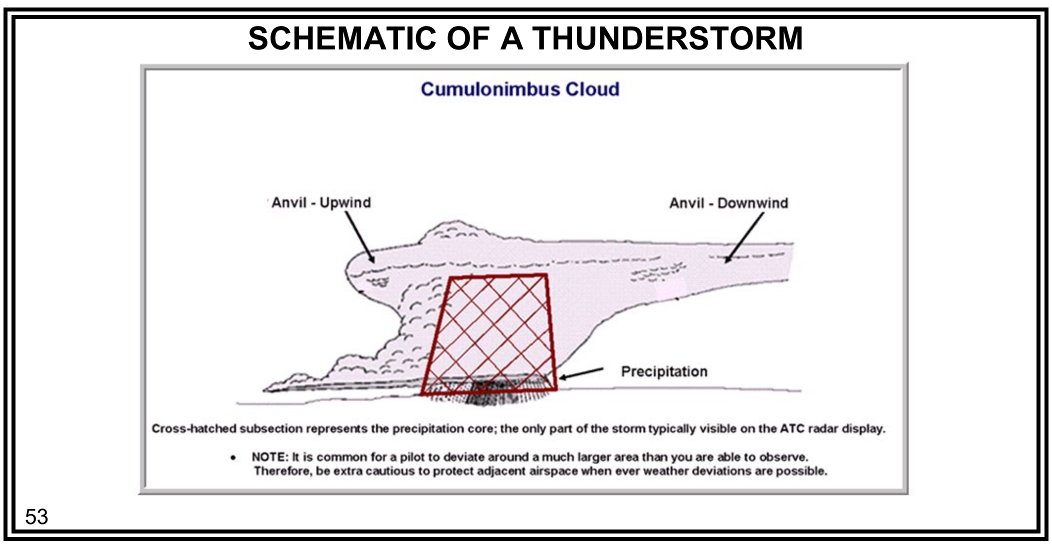
Thunderstorm & ATC Video (Cont'd)

AC 00-6

FAA-H-8083-15A

- **All** thunderstorms are potentially hazardous to aviation.
- Thunderstorms can develop very rapidly.
- Although they can occur anytime throughout the year, thunderstorms normally occur in warm weather when the air is unstable.
- Air masses tend to be warm in the spring and summer and due to higher temperatures, contain large amounts of water vapor.
- Higher surface temperatures can create temperature instability leading to strong convective updrafts and cumulus clouds.

Schematic



- A thunderstorm is made visible by a cumulonimbus cloud.
- An En Route controller will **only** see the weather radar precipitation returns associated with a thunderstorm.
    - A thunderstorm is generally much bigger than the radar indicates

THUNDERSTORMS *(Continued)*

Embedded Thunder-storms

- Thunderstorms can be embedded in clouds, smoke or haze (usually clouds).
- Embedded cells can be especially hazardous because:
  - They are **not** visible to pilots
  - Unless the aircraft has onboard weather radar, the pilot may **never** see the thunderstorm along their route
  - The thunderstorms closest to the aircraft can mask the presence of embedded storms farther from the aircraft with some types of onboard weather radar
  - Since embedded cells are often part of a line of thunderstorms, they are difficult to deviate around
- Myth: All IFR aircraft have airborne weather radar.
  - GA aircraft, especially props, **rarely** have weather radar on board

Knowledge Check

KNOWLEDGE CHECK

QUESTION: Why are embedded thunderstorms particularly hazardous?

A. They are often in a line of thunderstorms, so they are difficult to deviate around

B. The thunderstorms closest to the aircraft can mask the presence of embedded storms further from the aircraft with some types of onboard weather radar

C. The pilot can not see them to avoid them

D. All of the above

54

NOTE: *Click once to show answer.*

ANSWER: *D*

THUNDERSTORM HAZARDS

Thunderstorm Hazards
AC 00-6;
FAA-H-8083-15A

THUNDERSTORM HAZARDS

55

- Thunderstorms **may** contain any or all weather phenomena known to be hazardous to aircraft, including:
  - Severe to Extreme turbulence
  - Severe Icing
  - Hail
  - Lightning
  - Downbursts
  - Low level wind shear
  - Tornadoes
  - Low ceilings and reduced visibility
- Typically hazards associated with thunderstorms can extend to 20 miles from the thunderstorm.
  - Pilots should avoid very strong or severe thunderstorms by at least 20 miles.
  - Therefore to fly through a very strong or severe line of thunderstorms, they should be separated by at least 40 miles.
  - The **only** way to avoid the hazards of a thunderstorm is to avoid the thunderstorm altogether.
- As a Radar-Associate, you **must** be aware of these hazards; be prepared for pilot requests to deviate around the storm; and be ready to protect your airspace as well as the airspace of adjacent sectors/facilities and Special Use Airspace, utilizing point-outs, re-routes, hand-offs, etc., as appropriate.

Continued on next page

THUNDERSTORM HAZARDS *(Continued)*

Thunderstorm Hazards (Cont'd)

☞ ***NOTE:*** *Follow the instructions below for running the AOPA Weather Wise Thunderstorm course.*

1. *Double-click on the **thunderstorms.exe** file. The course will automatically launch.*

2. *Click **Begin Course** to start.*

☞ ***NOTE:*** *Have students read the thunderstorm story found in Appendix D.*

NOTE: Refer to Appendix D, Aircraft Accident N53589, to read about a thunderstorm example.

THUNDERSTORM HAZARDS *(Continued)*

Hail

HAIL

56

- Hail can occur from the top of the thunderstorm to the surface of the earth.
- Hail can also be found several miles away from the cumulonimbus cloud producing the thunderstorm,

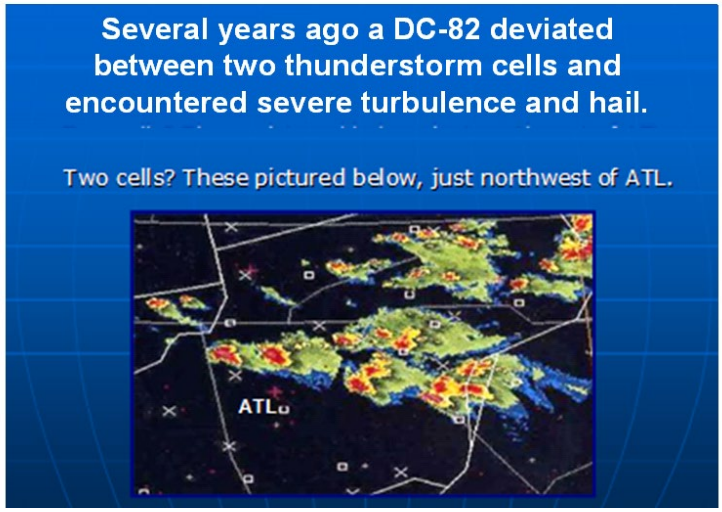
Effects of Hail on Aircraft

- Hail can damage the windshield.
- Hail can damage aircraft and make them difficult to control.
  - Hail has broken the nose cone protection on board radar systems rendering them useless
  - Hail damage disrupts the airflow over the airfoils, reducing lift

THUNDERSTORM HAZARDS *(Continued)*

Accident – Hail Damage

ACCIDENT – HAIL DAMAGE



57

- The hazards of hail are demonstrated in the following incident that occurred near Atlanta, Georgia.

- Knowing they had damage to the aircraft, the pilot asked to divert to Nashville; the Atlanta Center controller suggested they land at the nearest airport which was Chattanooga, and the pilot agreed.

- That suggestion enabled the pilot to land his aircraft and passengers, safely. Atlanta Center controllers and the Chattanooga controllers were instrumental in that safe landing.

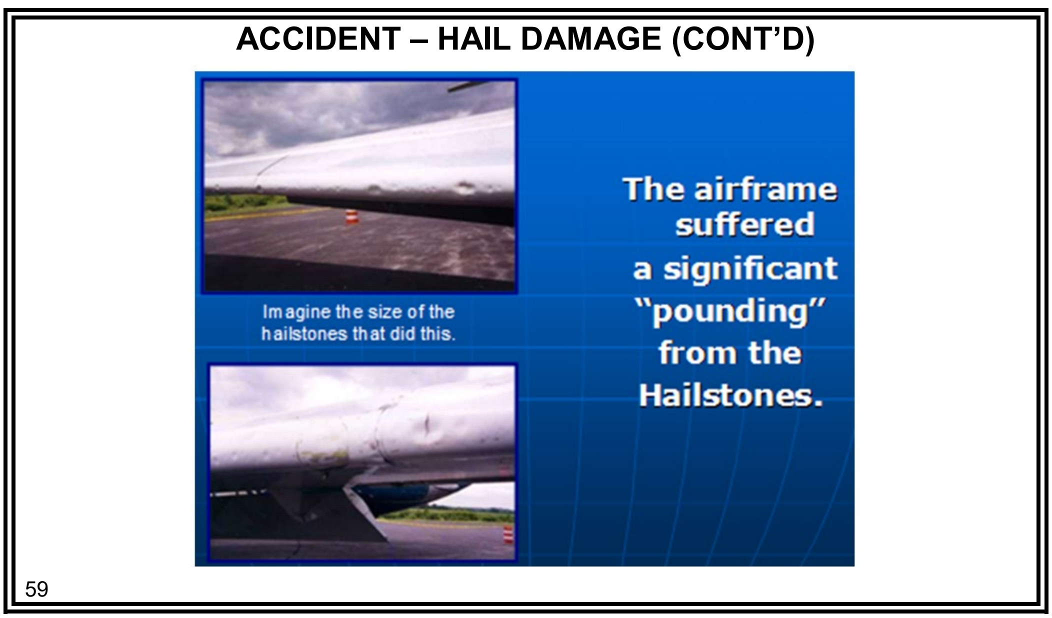
- The DC-82 sustained substantial damage.

Continued on next page

THUNDERSTORM HAZARDS *(Continued)*

Accident – Hail Damage (Cont'd)

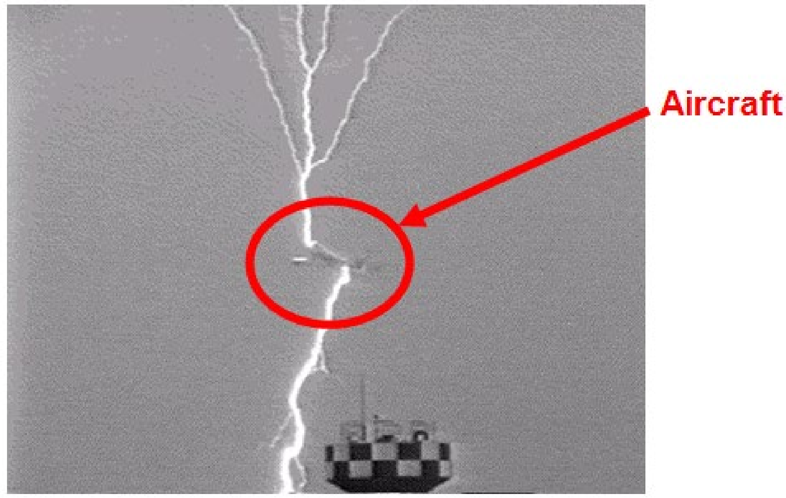
☞ ***NOTE:*** *Teach from graphic.*



☞ ***NOTE:*** *Teach from graphic.*

Lightning

LIGHTNING



60

☞ ***NOTE:*** *Click once to point out aircraft.*

⊙ Lightning occurs within and several miles away from the main thunderstorm.

- It can occur within the anvil or out of the sides of the cumulonimbus cloud
- Lightning can extend cloud to cloud, cloud to air or cloud to ground

⊙ Lightning can damage or disable the aircraft by:

- Disabling electrical systems
  - If electrical systems fail, the aircraft beacon will **not** show up on radar; however, a primary target may still be visible
  - Radio equipment can be extensively damaged
- Igniting fuel vapors
- Temporarily blinding pilots

THUNDERSTORM HAZARDS *(Continued)*

Tornadoes
NWS Jetstream: Online School for Weather

TORNADOES

61

- Most tornadoes occur with supercell thunderstorms.
- Most tornadoes are usually brief, lasting only a few minutes although they can sometimes last for more than an hour.
- Tornadoes can take on quite different appearances as they develop, mature, and dissipate.

THUNDERSTORM HAZARDS *(Continued)*

IMC/IFR Conditions

LOW CEILING AND REDUCED VISIBILITY

62

- IMC/IFR ceilings are common with thunderstorms.
  - IMC can be caused by reduced visibility which can occur anywhere within the thunderstorm/cumulonimbus cloud
  - Reduced visibility may occur underneath the thunderstorm due to heavy precipitation
  - IFR ceilings can occur directly underneath the thunderstorm

THUNDERSTORM HAZARDS *(Continued)*

Knowledge Check

KNOWLEDGE CHECK

QUESTION: How does hail affect the aircraft?

A. Can break the nosecone, damaging onboard weather radar

B. Can break the windshield

C. Can damage the skin of the aircraft, affecting lift

D. All of the above

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☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *D*

KNOWLEDGE CHECK

QUESTION: Lightning can affect flight in the following ways?

A. Damage electrical systems

B. Damage radio equipment

C. Temporarily blind the pilot

D. All of the above

64

☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *D*

Continued on next page

THUNDERSTORM HAZARDS *(Continued)*

Knowledge Check (Cont'd)

KNOWLEDGE CHECK

- **QUESTION:** How quickly can thunderstorm hazards affect flight?

  A. Immediately

  B. Within five minutes of action is **not** taken

  C. As soon as the flight is affected by two or more of the hazards simultaneously

65

☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *A*

SOURCES OF THUNDERSTORM INFORMATION

Thunderstorm Weather Products

THUNDERSTORM WEATHER PRODUCTS

- WARP/NEXRAD
- METAR Reports
- Convective SIGMETS
- CWAs
- PIREPs

66

⊙ There are several sources of information available to a controller that indicate the presence or forecast of thunderstorms:

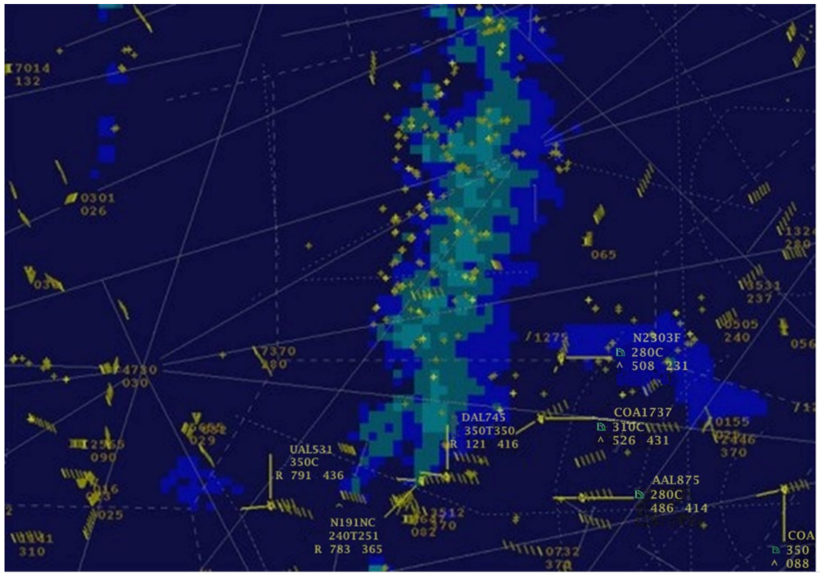
- WARP/NEXRAD
- METAR reports
- Convective SIGMETs
- CWAs
- PIREPs

⊙ Whenever thunderstorms are present or forecast, the hazards associated with them could be present as well.

SOURCES OF THUNDERSTORM INFORMATION
(Continued)

WARP/ NEXRAD

WARP/NEXRAD



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- The precipitation information that is immediately available to the controller is the WARP/NEXRAD display.

- WARP is the computer at the ARTCC that takes data from numerous NEXRAD sites, compiles it, and then processes it for display on the ERAM screen.

- Each sector's weather display is derived from direct and indirect connections to NEXRAD. In other words, WARP can receive data from NEXRAD sites within and outside of the center boundaries.

  - Does **not** show light precipitation on the en route display

- WARP/NEXRAD radar **only** displays precipitation.

  - Only moderate, heavy and extreme precipitation intensities are displayed on the system

    - It does not display light precipitation
    - The precipitation displayed is often smaller in diameter than the precipitation and cumulonimbus cloud associated with the actual thunderstorms

  - WARP/NEXRAD does **not** depict icing, turbulence, cloud boundaries, etc.

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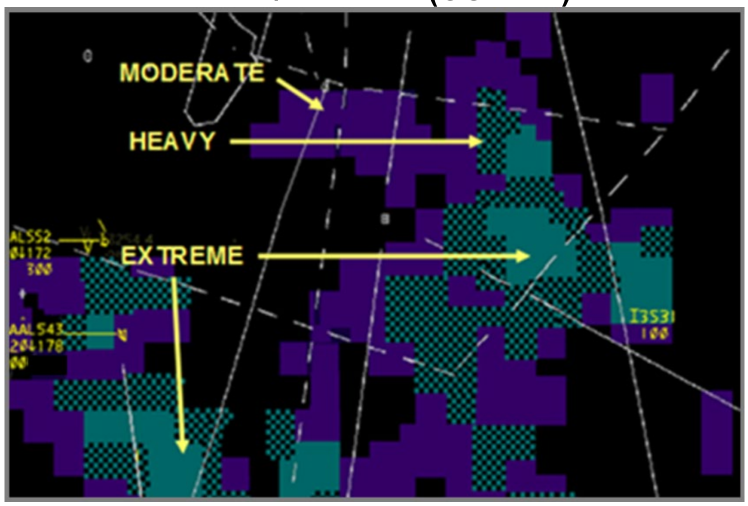
SOURCES OF THUNDERSTORM INFORMATION
(Continued)

WARP/ NEXRAD (Cont'd)

WARP/NEXRAD (CONT'D)



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- ⦿ When describing WARP/NEXRAD weather to pilots, refer to it as "precipitation" and use the terms "moderate," "heavy," and "extreme."

- ⦿ Examples when describing WARP/NEXRAD weather on the radar scope:

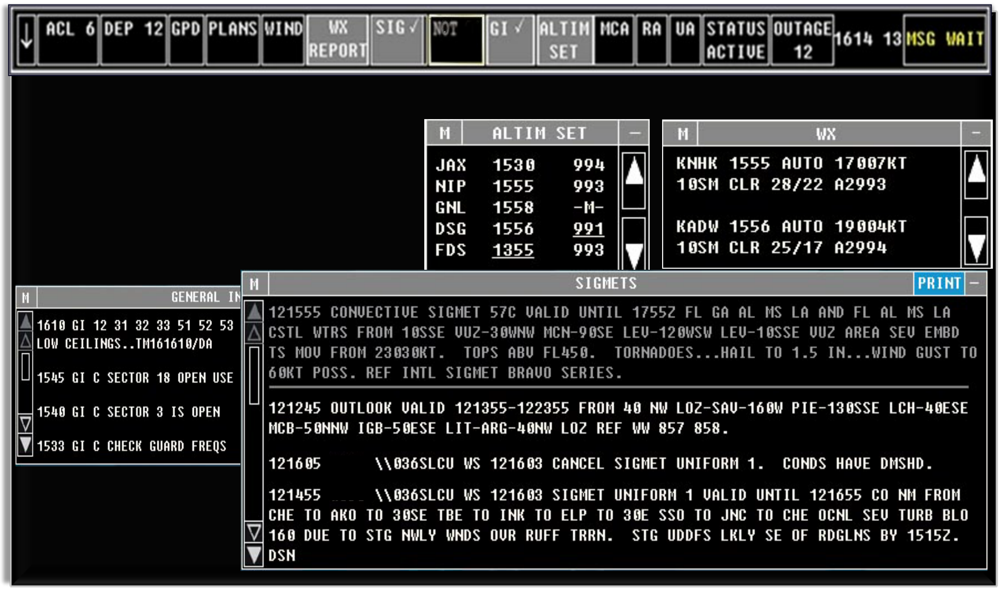
✈ **Phraseology Examples**

  - "MODERATE PRECIPITATION BETWEEN NINE O'CLOCK AND TWO O'CLOCK, THREE ZERO MILES. PRECIPITATION AREA IS FOUR ZERO MILES IN DIAMETER."
  - "HEAVY PRECIPITATION BETWEEN TEN O'CLOCK AND TWO O'CLOCK, ONE FIVE MILES. PRECIPITATION AREA IS TWO FIVE MILES IN DIAMETER."
  - "EXTREME PRECIPITATION BETWEEN TEN O'CLOCK AND THREE O'CLOCK, FOUR ZERO MILES. PRECIPITATION AREA IS FIVE ZERO MILES IN DIAMETER."

SOURCES OF THUNDERSTORM INFORMATION
(Continued)

Convective SIGMET
AC-0045G

CONVECTIVE SIGMET



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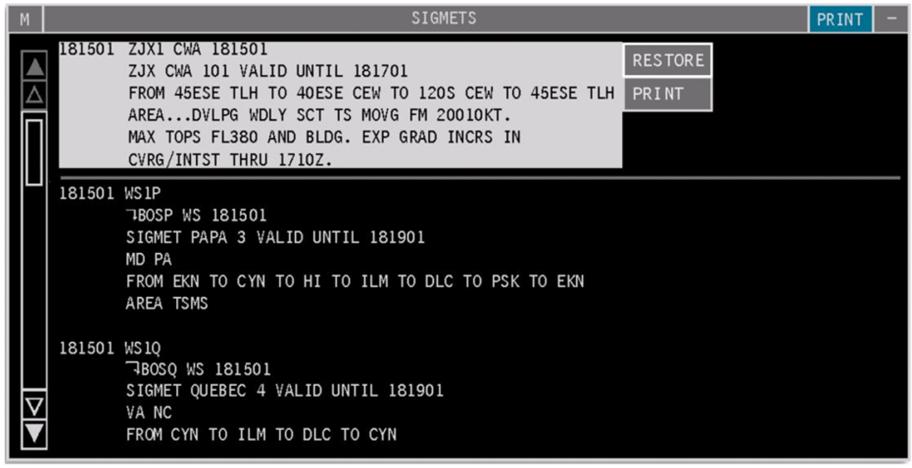
- Convective SIGMETs are issued for the conterminous U.S. (CONUS) instead of SIGMETs for thunderstorms.
- Convective SIGMETs may be distributed to the areas of specialization as General Information (GI) messages.
- **Any** Convective SIGMET implies severe or greater turbulence, severe icing, and low level wind shear.
    - These conditions are hazardous to **all** categories of aircraft

SOURCES OF THUNDERSTORM INFORMATION

(Continued)

Center Weather Advisory (CWA)
AC-0045G

CENTER WEATHER ADVISORY (CWA)



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- CWA is issued as an unscheduled aviation weather warning for conditions meeting Convective SIGMET criteria.

  - CWA may precede or refine a Convective SIGMET.
  - It may also highlight significant thunderstorms **not** meeting Convective SIGMET criteria.
  - A CWA is used to alert pilots of existing or anticipated adverse weather conditions that are expected to occur within 2 hours from the time that it is issued.

SOURCES OF THUNDERSTORM INFORMATION
(Continued)

Knowledge Check

KNOWLEDGE CHECK

- **QUESTION:** WARP/NEXRAD weather display depicts__________.

  A. precipitation

  B. cloud boundaries

  C. turbulence

71

☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *A*

KNOWLEDGE CHECK

- **QUESTION:** En route WARP/NEXRAD displays depict the following intensities:

  A. Light, moderate, and extreme

  B. Moderate, heavy, and extreme

  C. Light, moderate, heavy, and extreme

72

☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *B*

Continued on next page

SOURCES OF THUNDERSTORM INFORMATION
(Continued)

Knowledge Check (Cont'd)

KNOWLEDGE CHECK

QUESTION: Issuance of a Convective SIGMET __________.

A. implies conditions that are hazardous to only light aircraft

B. implies severe or greater turbulence, severe icing and low level wind shear

C. occurs for all 50 States (CONUS and non-CONUS)

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☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *B*

KNOWLEDGE CHECK

QUESTION: Which of the selections below hold true for PIREPs?

A. Must be solicited when requested

B. Must be solicited when thunderstorms and related phenomena exist or are forecast to exist

C. Both statements are true

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☞ ***NOTE:*** *Click once to show answer.*

ANSWER: *C*

PILOT RESPONSE

Pilot
AIM

PILOT RESPONSE

75

- How much an aircraft will deviate around a thunderstorm is based on pilot experience, flight visibility, aircraft cockpit resources, and company policy.

- Pilots may deviate around areas that are **not** depicting precipitation on the radar scope.

- Pilots' official safety guidance is to deviate at least 20 miles from the edge of the thunderstorm.

- Pilots may deviate even when the previous aircraft did **not** deviate, due to rapidly building or rapidly moving storms.

- **Caution:** Aircraft in IMC will generally be **unable** to see and avoid embedded thunderstorms.

DISCUSSION QUESTION: How do thunderstorms affect ATC?

ANSWER: *Useable airspace decreases and congestion increases due to pilot requests, PIREPs, frequency of relaying radar derived weather information and hazardous weather information.*

ACCIDENT N6579X CASE STUDY

Accident - N6579X

ACCIDENT – N6579X

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☞ ***NOTE:*** *Walk the students through the details of this accident.*

On April 19, 2006, about 1110 (all times are Eastern Daylight Time) a C210A, N6579X, owned and operated by a commercial pilot, crashed into a remote mountainous terrain near Ludville, Georgia, after entering a thunderstorm. The pilot, the sole occupant, was fatally injured.

The pilot**,** age 84, held a commercial certificate with airplane single-engine land, multi-engine land and instrument airplane ratings. His total flight experience exceeded 9,000 hours. He had flown 95.5 hours in the previous 12 months, 23.1 of which had been within the previous 30 days. The pilot formerly was an aeronautical research pilot with the National Advisory Committee for Aeronautics (NACA) High Speed Flight Station at Edwards Air Force Base in California. During his 5 years with the NACA, he flew the X-1, XF-92, X-4, X-5, Douglas D-558-I Skystreak, and the Douglas D-558-II Skyrocket. He became the first human to fly faster than twice the speed of sound. From 1955-1960, he was employed by North American Aviation as the chief engineering test pilot during the development and testing of the X-15 rocketplane.

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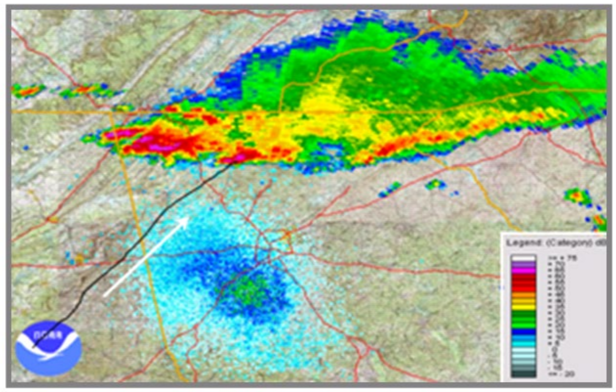
ACCIDENT N6579X CASE STUDY *(Continued)*

Accident N6579X (Cont'd)

ACCIDENT – N6579X (CONT'D)

Weather at the time of accident



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Flight Details:

- **Approx 0656** – The pilot receives a Direct User Access Terminal (DUAT) weather briefing. He obtained weather briefing material that included Area Forecasts, Convective Outlooks, Severe Weather Watches, Convective SIGMETs, AIRMETs, METAR reports, radar reports, Terminal Aerodrome Forecasts, and Winds and Temperatures aloft data. Based on the information in the briefing, thunderstorms were forecast along the planned route of flight. Before departure the pilot discussed the weather with an acquaintance and mentioned that he *"might need to work his way around some weather, but it did not look serious."*
- **Approx 1005** - The flight departed Prattville, Alabama en route to Manassas, Virginia. The flight progressed without incident through several sectors and leveled at 110.
- **Approx 1046** – Pilot checked in to Atlanta EN ROUTE CENTER sector 5, level at 110, and subsequently received 2 local altimeter settings.

Continued on next page

Accident N6579X (Cont'd)

ACCIDENT – N6579X (CONT'D)

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- **Approx 1055** – Convective SIGMET15E is issued and warned of an area of severe embedded thunderstorms over portions of Alabama, Georgia, Tennessee and North Carolina. The thunderstorms were moving southward at 35 kts with tops to FL450. The thunderstorms had the potential for 2 inch hail, both surface and aloft, wind gusts to 60 kts, severe to extreme turbulence, severe icing, localized IFR conditions, and microburst potential.
- **Approx 1100** – N65679X was told to contact Atlanta EN ROUTE CENTER, Sector 38.
- **Approx 1101** – N6579X checked in level at 110, received **no** response, called again, and was then provided the local altimeter setting.
- **Approx 1109** – N6579X transmitted, "*Atlanta, this is seven niner x-ray. I'd like to deviate south of weather*." The controller replied, *"Six five seven niner x-ray roger. We'll show you deviating south for weather and your Mode C indicates one one thousand five hundred."* N6579X did **not** respond.

Continued on next page

ACCIDENT N6579X CASE STUDY *(Continued)*

Accident N6579X (Cont'd)

ACCIDENT – N6579X (CONT'D)

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The weather radar images surrounding N6579X's flightpath indicated a large cluster of intense to extreme echoes moving southward across northern Georgia. These echoes intersected the airplane's flightpath and were consistent with those of a heavy precipitation supercell thunderstorm.

- **Approx 1110** – radar contact was lost with N6579X at 5,500 ft.

The plot of the radar track data indicated that the airplane entered a thunderstorm with extreme precipitation before the loss of radar contact. According to the aircraft radar track data, N6579X's last radar return was located under the anvil of a cumulonimbus cloud.

A review of the ATC communications confirmed that the pilot was **not** provided any severe weather advisories. Convective SIGMET15E was active, but **never** issued. In fact, the hard copy of Convective SIGMET15E was found ripped up in the trash can.

Continued on next page

Accident N6579X (Cont'd)

N6579X was **never** advised of the radar-depicted weather on the Sector 38 controller's scope. When interviewed, the sector 38 controller acknowledged that adverse weather was present "all over" his sector, including in the accident aircraft's flightpath. The controller said he did **not** issue the information to the pilot because he felt the weather conditions displayed on the radar scope were unreliable. He stated that pilots have a better idea of where adverse weather is and that he expects them to inform him on what actions they need to take to avoid it.

At the time of the accident, the Atlanta EN ROUTE sector 38 controller's workload consisted of the accident airplane and one other airplane. Review of sector 38 communications and radar data failed to identify any limitations of radar, excessive traffic, frequency congestion, or workload issues that would have prevented the controller from issuing pertinent weather information to N6579X.

Discussion

QUESTION: Providing weather information is considered an additional duty. Does that imply that it is optional?

QUESTION: FAAO 7110.65, Paragraph 2-1-2 that discusses duty priority states that first priority is given to separating aircraft and issuing safety alerts. Good judgment **shall** be utilized in prioritizing all other provisions. It goes on to say that the action that is **most** critical from a safety standpoint is performed first. What action do you feel was the **most** critical from a safety standpoint? Why?

QUESTION: The controller stated that they did **not** issue the radar depicted weather because they felt it was unreliable. Do you feel this is a defendable response? Why or why not?

QUESTION: Do you think that complacency may have played a part in this accident? If so, on whose part(s)?

☞ ***NOTE:*** *Follow the directions in the Lead Binders to play the "VMC into IMC" video.*

IN CONCLUSION

Lesson Review

LESSON REVIEW

The following topics were covered in this lesson:

- Icing
- Turbulence
- Thunderstorms

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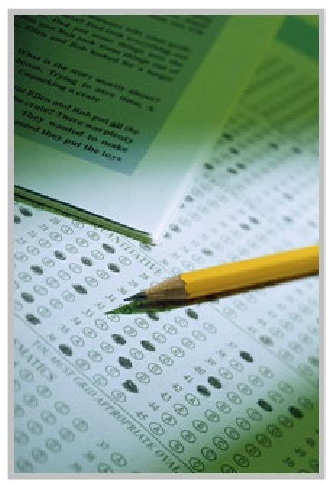
☞ ***NOTE:*** *Teach from graphic. Review and elaborate briefly on the topics covered in this lesson.*

End-of-Lesson Test

END-OF-LESSON TEST

Weather Hazards



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APPENDIX A: ADVISORY CIRCULAR AC-91-74B

For more information on icing conditions, please refer to AC-91-74B found at

http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1028388

APPENDIX B: STRUCTURAL ICING PILOT STORY

Structural Icing Pilot Story

NOTE: All of these photos were taken immediately after the icing encounter described below:

In January of 2007 a pilot flying from northern Wisconsin to the Chicago area took off about 0500 local time. He was flying a C182 with deicing boots and a heated propeller. Weather was IFR with low ceilings for the entire Midwest, but temperatures aloft and all the way to the ground were -10 C

Around Rockford, Illinois, the aircraft encountered Severe Clear Icing. The amount of ice you see in the photos above was accumulated in approximately 1 minute. The pilot was unable to climb out of the conditions and all the airports in the vicinity were at or below minimums making it impossible for him to exit the conditions.

Being alone in the aircraft he did not want to take his hands off the yoke long enough to try to look up an unfamiliar approach. Also, the aircraft was barely flying at this point and with the increased stall speed, he did not want to change the attitude of the aircraft or put it into a turn. Any changes of configuration could have put the aircraft into a stall from which he would likely not recover.

Continued on next page

APPENDIX B: STRUCTURAL ICING PILOT STORY

(Continued)

Structural Icing Pilot Story (Cont'd)

He opted to continue on to Aurora, IL where he was familiar with the approach and airport. He also knew that in the vicinity of the airport were mostly open fields in the event that he was unable to successfully make it to the airport.

By the time he commenced the approach into Aurora, he was only flying at 80-85 knots at full power. The entire windshield had ¾ “ of ice on it so he had to push open the side window and look out of it to try to see the airport. Breaking out shortly before touchdown, he was able to safely land the aircraft.

The accumulation of ice was so dramatic, that after he landed, he had to break icicles off the underside of the wing to open the pilot side door.

This example ended favorably, but so easily could have resulted in a fatality. This story demonstrates how quickly and unexpectedly icing can accumulate.

APPENDIX C: ICING EFFECTS NTSB EXAMPLE

NTSB Example

This aircraft accident occurred on November 29, 2008 in Rock River, Wyoming. There were 2 people on board and they were able to walk away from the aircraft.

The pilot reported that during a cross country flight conducted under instrument flight rules, he encountered clouds that contained clear ice. Ice built up rapidly on the airplane, which was in cruise flight at 16,000 ft. In an effort to get out of the icing conditions, he requested and received clearance to progressively lower altitudes down to 10,000 ft. The airplane continued to accumulate ice. He requested a turn, and this was denied by the controller as there were two other planes on the vicinity with similar icing problems. He then requested and received clearance to 9,000 feet, where he could see portions of the ground. At this point, “both the windshields were completely covered with clear ice as were the unprotected portions of the aircraft” and both engines were operating at full power.

Continued on next page

APPENDIX C: ICING EFFECTS NTSB EXAMPLE

(Continued)

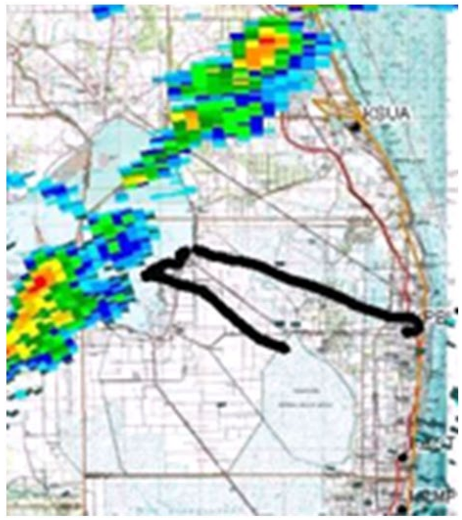
NTSB Example (Cont'd)

The pilot informed the controller that he needed to descend further. At an altitude of 7,500 feet, he circled several times, attempting to see if he could reach an airport for landing. No ice had melted or come off the airplane, and the weather was deteriorating. The pilot decided to land on the highway. On final approach to land, the airplane collided with a power line, which severed the upper half of the rudder and vertical stabilizer. The pilot turned the airplane slightly left, and landed the airplane with the landing gear down in a terraced field next to the highway. During the landing roll, the landing gear was sheared off when the plane encountered a ditch. The pilot stated that he had “no forward visibility due to the clear ice that completely covered the windshields.”

NOTE: This aircraft had ice protection equipment and was a relatively fast twin. Fortunately the pilot did an excellent job of ditching the aircraft with no injuries or loss of life.

APPENDIX D: AIRCRAFT ACCIDENT – N53589

Aircraft Accident – N53589



- Student and flight instructor departed on an IFR flight plan at 8:45 local.
- Pilot encountered an area of clouds.
- TRACON advised the pilot that the Center had been vectoring traffic through a “break” in the clouds.
- Center requests TRACON assign N53589 290 heading.
- N53589 is transferred to Center frequency.
- A few moments later the pilot encountered IFR conditions, moderate rain, and light turbulence.

Continued on next page

APPENDIX D: AIRCRAFT ACCIDENT – N53589

(Continued)

Aircraft accident – N53589 (Cont'd)

- Shortly thereafter the pilot encountered severe turbulence and elected to make a 180-degree turn.
- About halfway through the turn with the aircraft in a 30-degree bank, the aircraft encountered stronger turbulence, updrafts and downdrafts which caused the aircraft to go into a 90-degree bank.
- The passenger window blew out and the door hinges no longer held the door shut.

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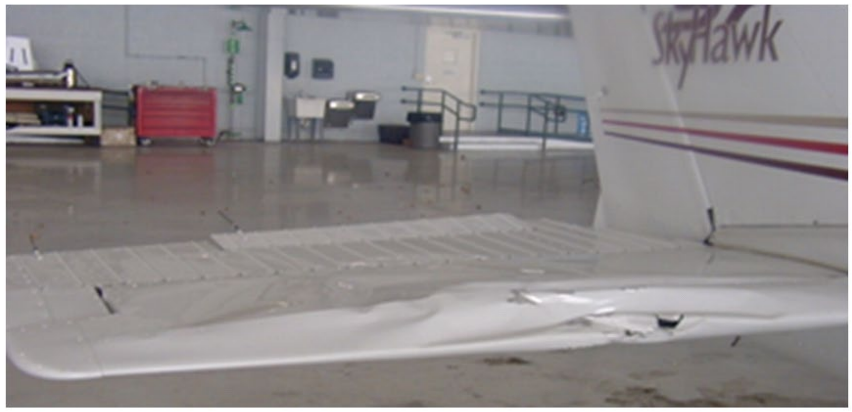
APPENDIX D: AIRCRAFT ACCIDENT – N53589

(Continued)

Aircraft accident – N53589 (Cont'd)



- A few moments later they hit another thunderstorm cell with more up and down drafts. The aircraft hit the cell at 6,000 ft. The pilot regained control of the aircraft at 2,000 ft. Here again, what appeared to be a hole, was **not** free of the dangers that accompany thunderstorms. They change quickly! Be VERY cautious. This pilot and flight instructor were fortunate enough to get this aircraft back on the ground safely.

- The NTSB Probable Cause was the flight crew's inadvertent encounter with clouds while being vectored by ATC while operating in instrument meteorological conditions.

- A factor in the accident was the ATC personnel's (EN ROUTE) inadequate weather avoidance assistance.

APPENDIX E: NTSB CASE STUDY—SAE08LA072

NTSB Case Study: SEA08LA072

⦿ History Of Flight

On February 8, 2008, at 1018 Pacific standard time (PST), an experimental Lancair ES, N329BW, collided with terrain approximately 4 miles northeast of Albany Municipal Airport, Albany, Oregon. The pilot and 2 passengers were killed. The airplane sustained substantial damage. The airplane was being operated under the provisions of Title 14 Code of Federal Regulations Part 91, and an instrument flight rules (IFR) flight plan was filed. A combination of visual meteorological conditions and instrument meteorological conditions prevailed. The flight departed from McNary Field, Salem, Oregon, at 1010, and was destined for Klamath Falls Airport, Klamath Falls, Oregon.

A witness was working outside, about 2 miles west of the accident site. He heard an engine revving up and down repeatedly. He looked in the sky for an airplane while he continued to hear this sound, and then he saw the airplane come out of a cloud layer about 2,000 feet above ground level. As the airplane came out of the cloud layer, the right wing pitched down and the airplane was in a clockwise corkscrew pattern, at a descent angle of approximately 45 degrees. It continued this corkscrew pattern until going out of view of the witness. During the descent, the witness recalled hearing the engine running. The witness then heard the airplane impact the ground.

Continued on next page

NTSB Case Study: SEA08LA072 (Cont'd)

According to information provided by the Seattle En Route center, the pilot seated in the right seat filed an IFR flight plan. Following departure, a pilot from the accident airplane contacted the Seattle EN ROUTE at 1006:58 and was cleared to climb to 13,000 feet MSL. At 1012:40 the controller advised the airplane that there were earlier reports of moderate icing between 10,000 and 12,000 feet MSL A voice responded with the airplane call sign. At 1013:20, the controller advised that the icing reports were moderate-mixed icing. No response was received from the airplane and the controller queried him at 1013:40. The airplane responded at 1013:46 with the call sign. At 1017:43 an occupant of the airplane contacted the controller stating the airplane's call sign. At 1017:56 a transmission from the airplane stated, "…ah niner bravo whiskey we have (unintelligible) niner bravo whiskey." The controller advised the airplane that the transmission was not intelligible and at 1018:05 a transmission for the airplane reported, "…nine bravo whiskey we're an emergency situation niner bravo whiskey emergency (unintelligible)." There were no further transmissions from the accident airplane.

The airplane was assigned a discrete transponder code, and radar data obtained from the Seattle EN ROUTE showed that a target identified as the accident airplane was climbing through 10,400 feet MSL at 1017. Radar contact and communication were lost with the airplane at 1018.

- Meteorological Information

The closest official aviation routine weather report (METAR) was McNary Field. The following conditions were reported at 1003: wind from 180 degrees at 14 knots, gusting to 19 knots, 10 statute miles visibility, light rain, clouds were scattered at 2,900 feet, broken at 3,500 feet, and overcast at 6,000 feet, temperature was 42 degrees Fahrenheit, dew point was 39 degrees Fahrenheit, and the altimeter was 30.29 inches of Mercury.

- Wreckage and Impact Information

The airplane impacted a flat farm field, and the wreckage was confined to the impact area. All control surfaces remained attached to the airplane structure. There was minimal leading edge damage to the wings and horizontal stabilizer, and the engine was buried in approximately 3 feet of soft muddy terrain.