RESTRICTIONS TO VISIBILITY

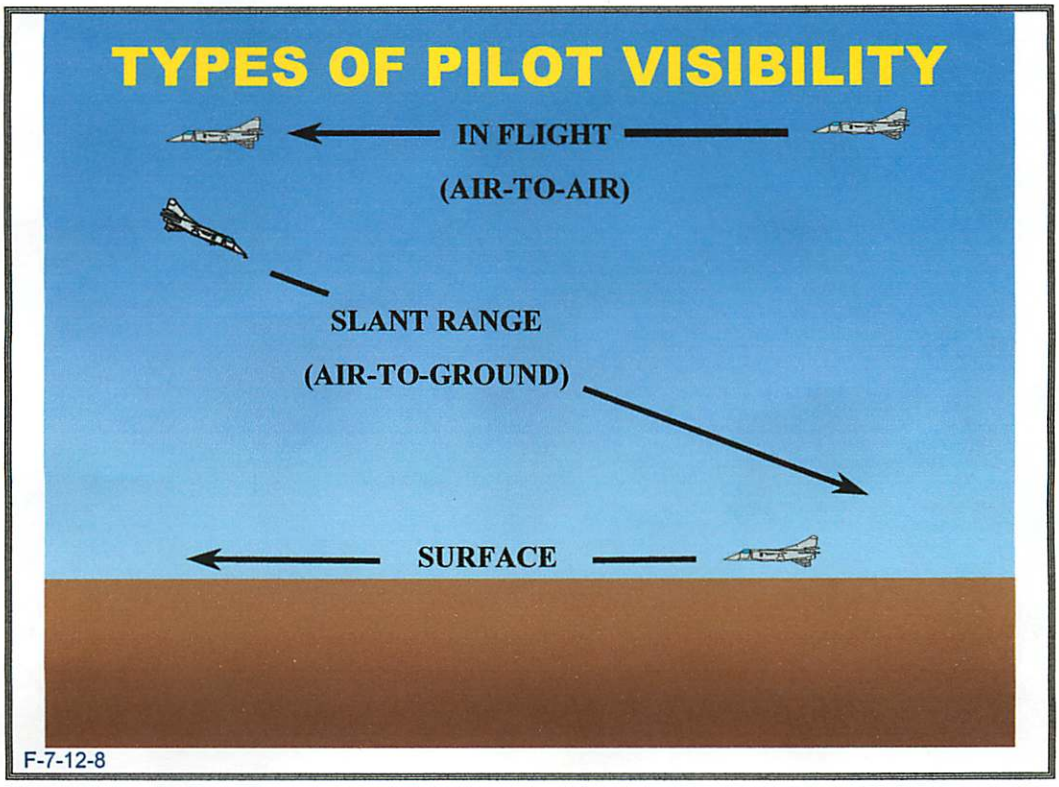
Visibility Definition

Visibility is the greatest distance at which selected objects can be seen and identified.

Restricted Visibility Definition

Restricted visibility is defined as a visibility of 6 miles or less.

Types of Pilot Visibility



- Three types of visibility are experienced by pilots,
  - Inflight (air-to-air)
  - Slant range (air-to-ground)
  - Surface

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RESTRICTIONS TO VISIBILITY *(Continued)*

Pilot Visibility Requirements

- Pilot requirements for good visibility depend on type of flight.
- **VFR flights** require good visibility for all phases of flight.
  - VFR pilots primarily use visual references to maintain the proper attitude of the aircraft.

CLASS NOTE: VFR only pilots who inadvertently enter IFR conditions will typically loose control of the aircraft in about 3 minutes. The result is usually a fatal accident from a stall/spin.

  - Visual references on the ground confirm aircraft position.
  - VFR pilot must maintain traffic separation visually.
- **IFR flights** generally require good visibility during takeoff and landing.
  - Except where airport, aircraft and pilot capabilities allow operations down to zero visibility/zero ceiling.
  - Traffic separation is accomplished by ATC in areas of reduced visibilities.

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Review

Series-4

RESPONSE ITEM

VFR pilots must have good visibilities _____.

A. only during takeoff and landing

B. only while en route

C. during all phases of flight

F-7-12-9

RESPONSE ITEM

IFR pilots generally require good visibility _____.

A. during takeoff and landing

B. only while enroute

C. during all phases of flight

F-7-12-10

RESPONSE ITEM

Which ceiling ranges are Marginal VFR?

A. less than 1,000 feet

B. 1,000 to 3,000 feet

C. 3,000 to 5,000 feet

F-7-12-11

RESPONSE ITEM

Which visibilities are Marginal VFR?

A. less than 1 mile

B. 1 to 3 miles

C. 3 to 5 miles

F-7-12-12

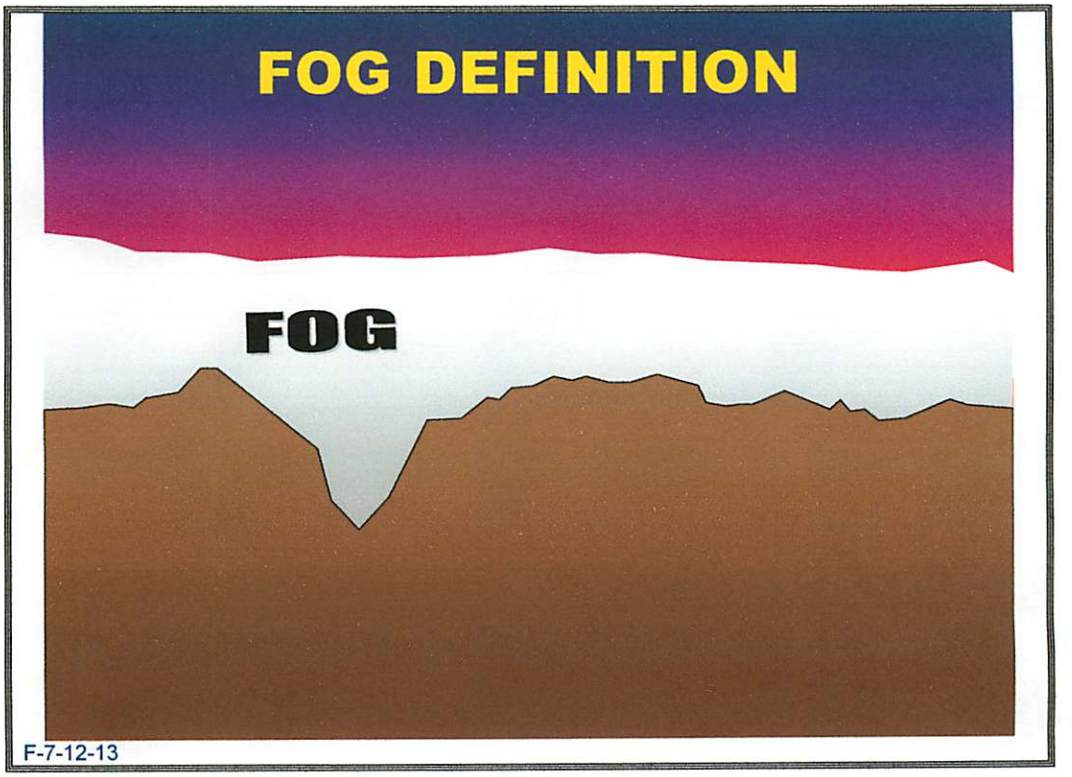
RESTRICTIONS TO VISIBILITY

Restricting Phenomena

The following phenomena restrict visibility encountered by pilots.

- Fog
- Haze and Smoke
- Dust and Blowing Dust
- Volcanic Ash
- Blowing Sand
- Blowing Snow
- Precipitation

Fog



Fog Definition

Fog is a cloud in contact with the ground.

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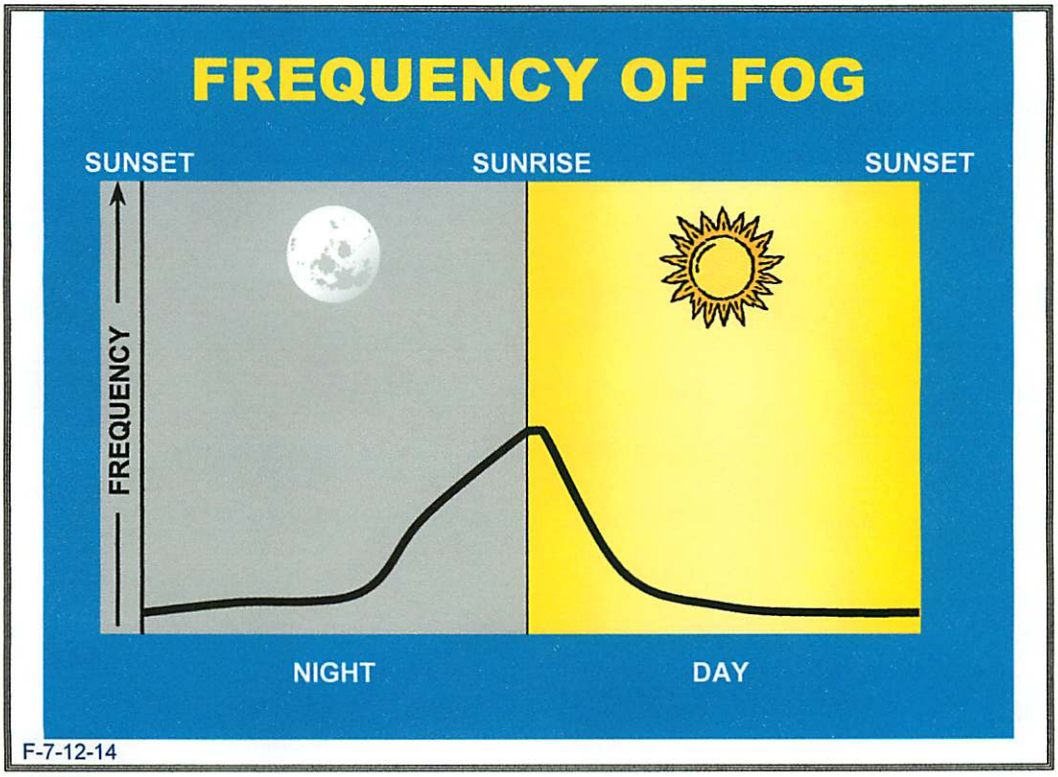
RESTRICTIONS TO VISIBILITY *(Continued)*

Frequency of Fog



⊙ The frequency of fog peaks shortly after sunrise.

Fog Development

⊙ Fog can develop through the following processes:

- Surface temperature decreases to dew point.
  - warm moist air in contact with colder surface
  - upslope flow (adiabatic cooling)
  - evaporational cooling (latent heat)
- Surface dew point increases to temperature (via evaporation).
  - Air flows over a moist surface
    - → ocean, lake, rain-soaked ground
  - Warm rain falling through colder air
- Combination of both of the above.

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RESTRICTIONS TO VISIBILITY *(Continued)*

Types of Fog

⊙ There are five different types of fog:

1. Radiation fog
2. Advection fog
3. Upslope fog
4. Rain-induced fog
5. Steam fog

CLASS NOTE: The name identifies the development process.
CLASS NOTE: Each type of fog has unique characteristics.

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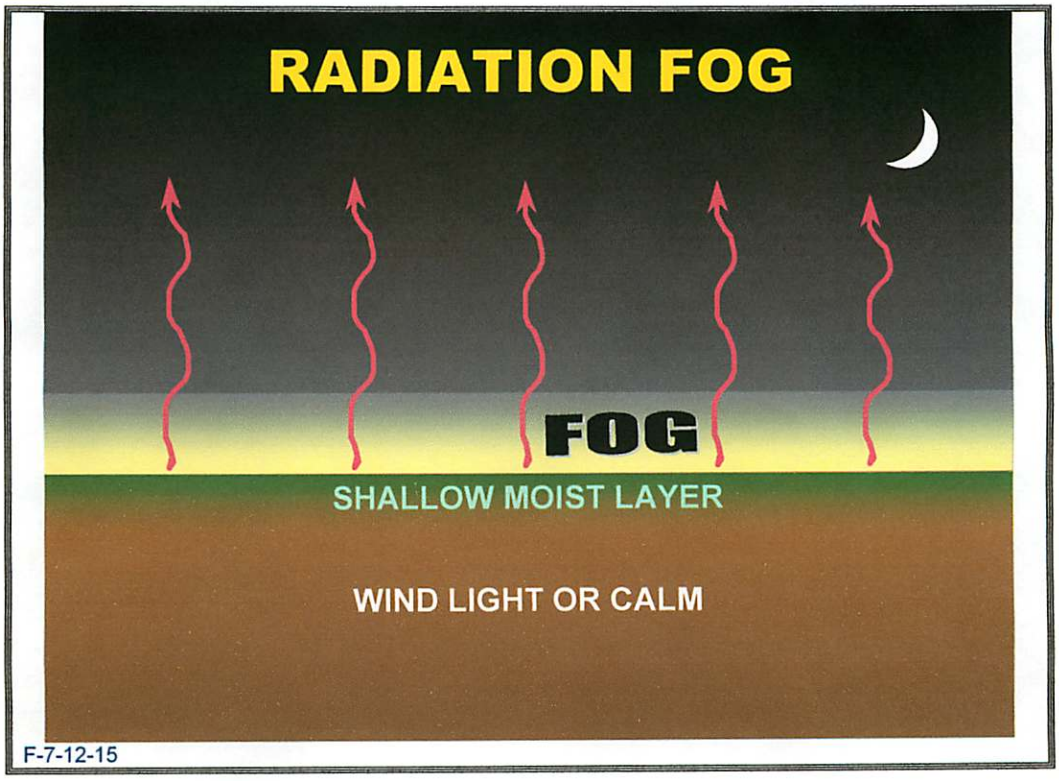
RESTRICTIONS TO VISIBILITY *(Continued)*

Radiation Fog



Radiation Fog:

Causes

- ⊙ Ground cools at night due to radiational cooling.
  - Favorable conditions:
    - – Clear sky
    - – Light surface wind
      - → Usually due to surface high or ridge
- ⊙ Moist surface air cools to saturation by conduction.
  - Favorable conditions:
    - – Shallow moist layer
    - – Abundant condensation nuclei
      - → Dust, pollen, etc.

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RESTRICTIONS TO VISIBILITY *(Continued)*

Radiation Fog:

Character-istics

- Often patchy, shallow, and in low areas
- Lowest visibility around sunrise
- Usually dissipates around mid-morning

CLASS NOTE: Radiation fog does not spread by advection.

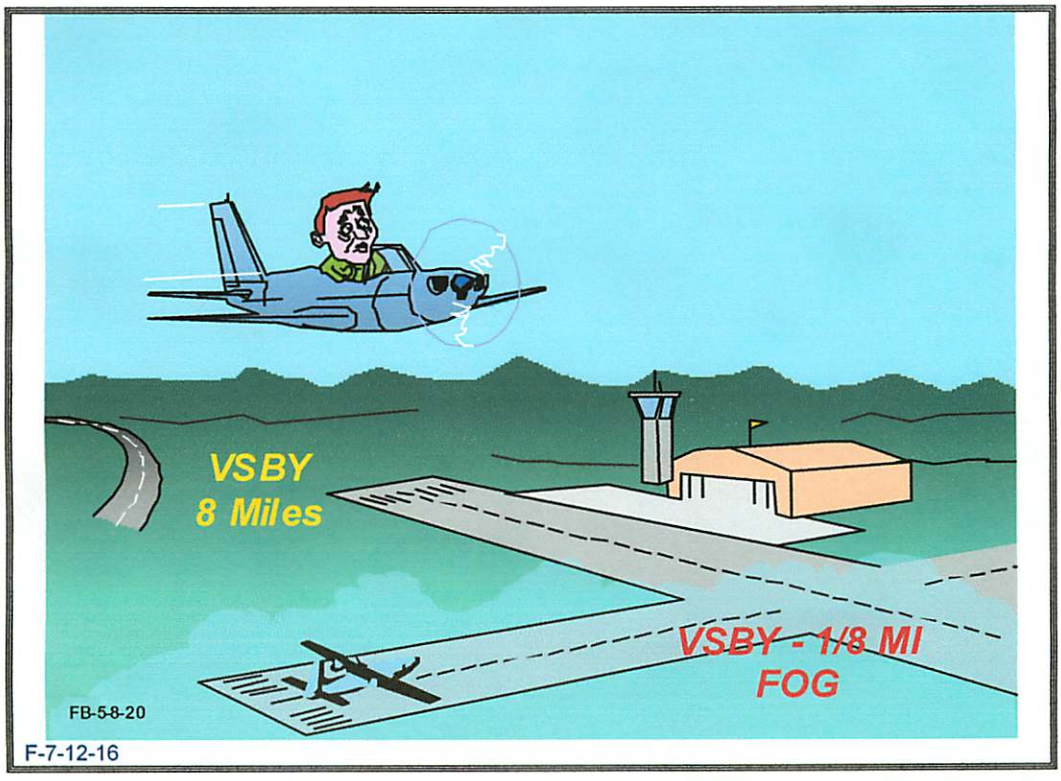
Radiation Fog:

Dissipation

- Dissipates due to daytime heating.
  - Surface air warms by conduction and becomes unsaturated.
  - Usually dissipates by mid-morning.

Radiation Fog:

Illustration



F-7-12-16

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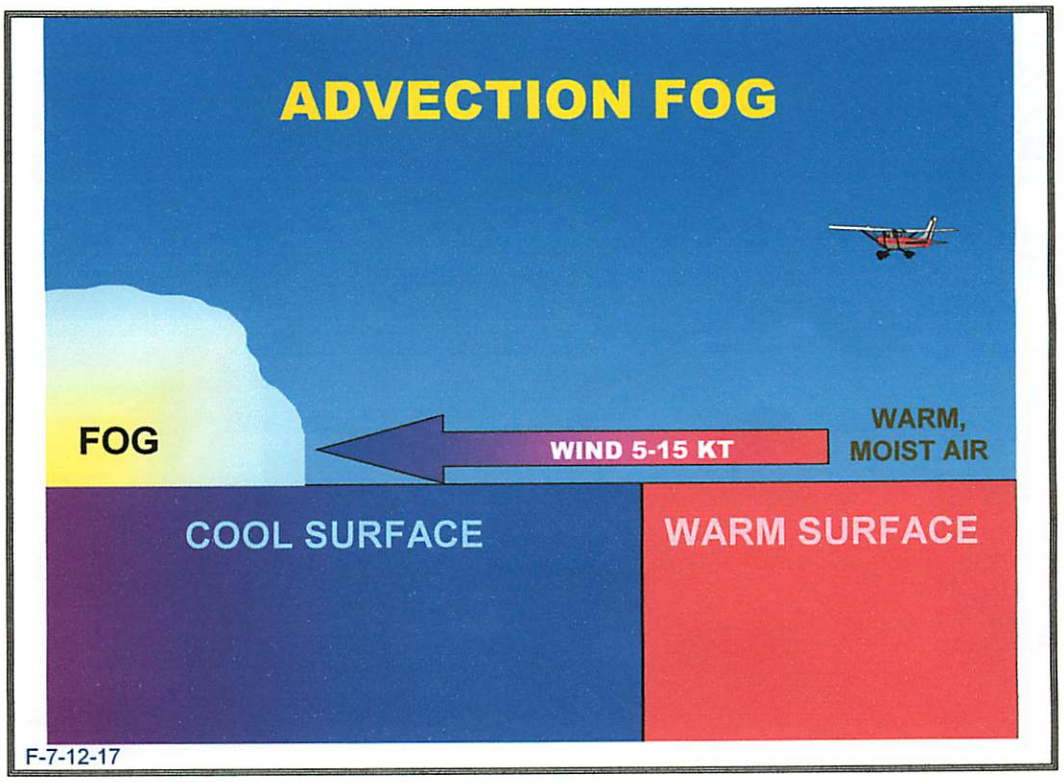
RESTRICTIONS TO VISIBILITY *(Continued)*

Advection Fog



F-7-12-17

Advection Fog:

Causes

- ⊙ Moist surface air is advected over a colder surface.
  - Surface wind speed of 5 to 15 knots is most favorable.
  - Colder surface is often:
    - a snow field
    - colder ground
    - colder water
- ⊙ Air cools to saturation by conduction
  - Mixing increase the depth of the cooling

Advection Fog:

Character-istics

- ⊙ Persistent
  - Sometimes for days.
- ⊙ Covers a wide area
- ⊙ Can form under a cloudy sky

CLASS NOTE: Advection winds can spread fog well downstream.

Continued on next page

RESTRICTIONS TO VISIBILITY *(Continued)*

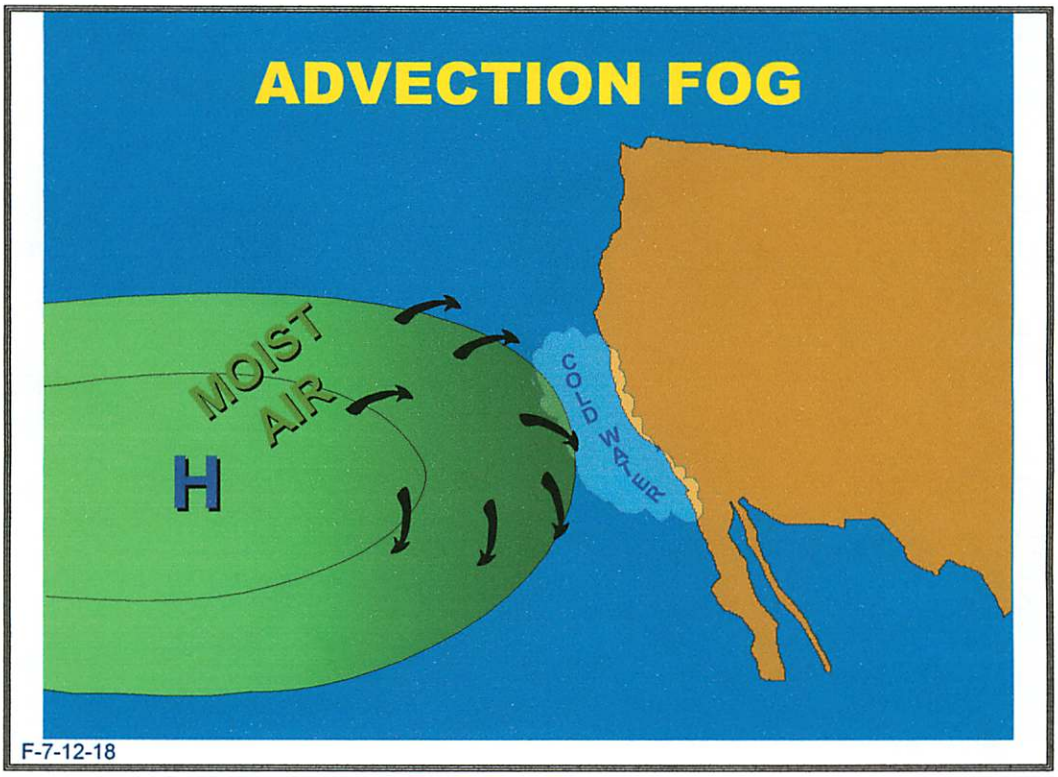
Advection Fog:

Dissipation

- Surface winds cease or change direction.
  - Fog often continues, it just stops moving.
- Colder surface warms.
- Turbulent mixing produces low ceilings instead of fog.
  - Occurs when surface winds exceed 15 knots.

Advection Fog:

Illustration of Advection Fog Over Cold Water



- Colder surface water along the West Coast.
- Moist surface air is advected over colder water.

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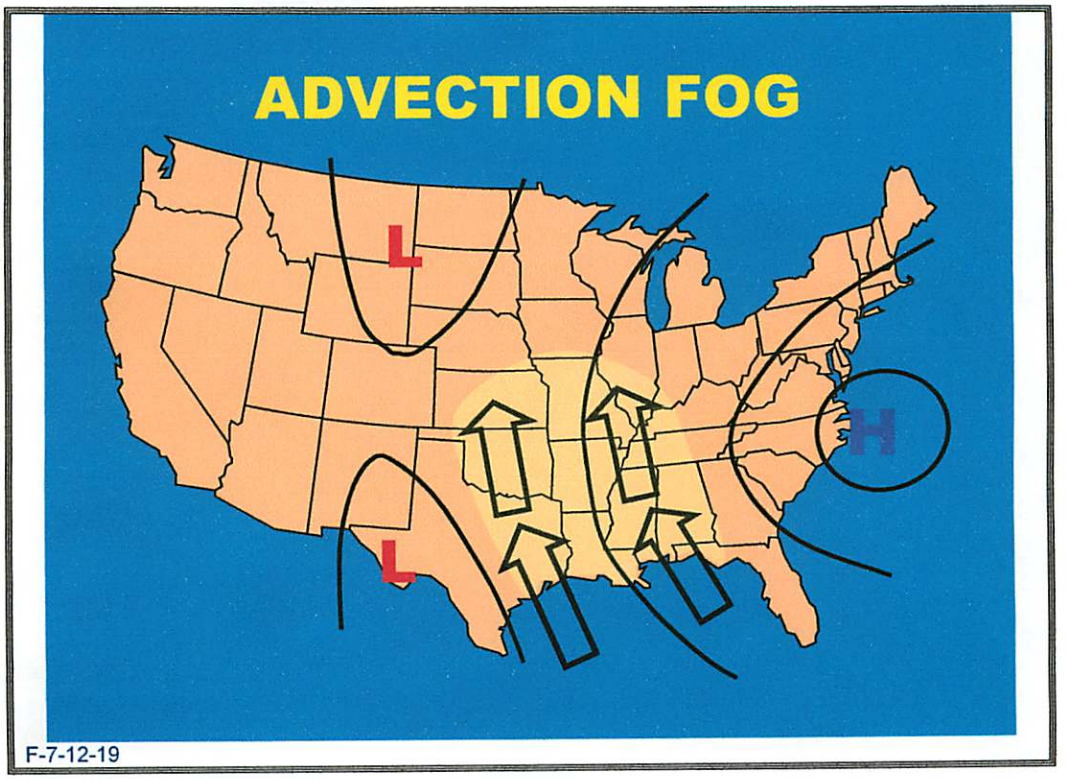
RESTRICTIONS TO VISIBILITY *(Continued)*

Advection Fog:

Illustration of Advection Fog Over Cold Land



- Cold land over Central Plains.
- Moist surface air is advected over colder land.

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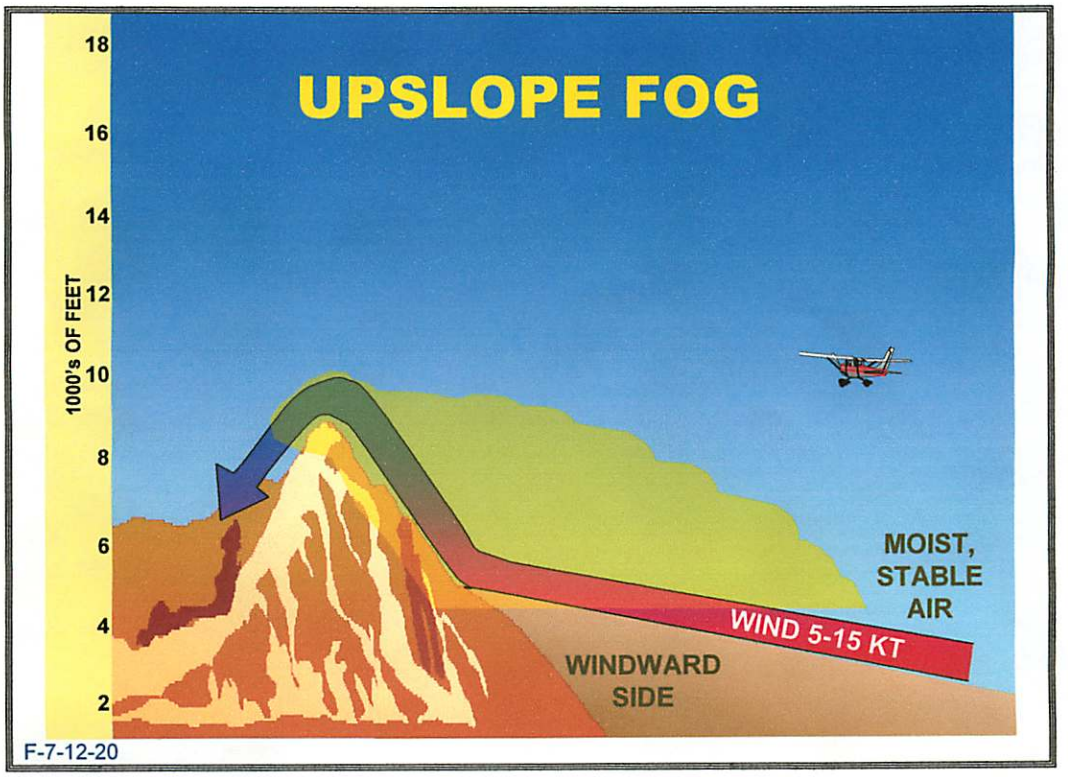
RESTRICTIONS TO VISIBILITY *(Continued)*

Upslope Fog



Upslope Fog:

- ⊙ Moist, stable, surface air moves up sloping terrain.

Causes

  - Surface wind speed of 5 to 15 knots is most favorable.

- ⊙ Air cools to saturation by expansion to form fog.

  - Mixing increases the depth of the cooling, creating a deeper fog layer.

CLASS NOTE: Terrain temperatures will modify cooling rate.

Upslope Fog:

- ⊙ Persistent

Character-istics

- ⊙ Covers a wide area
- ⊙ Can form under cloudy skies
- ⊙ Obscures hills and mountains

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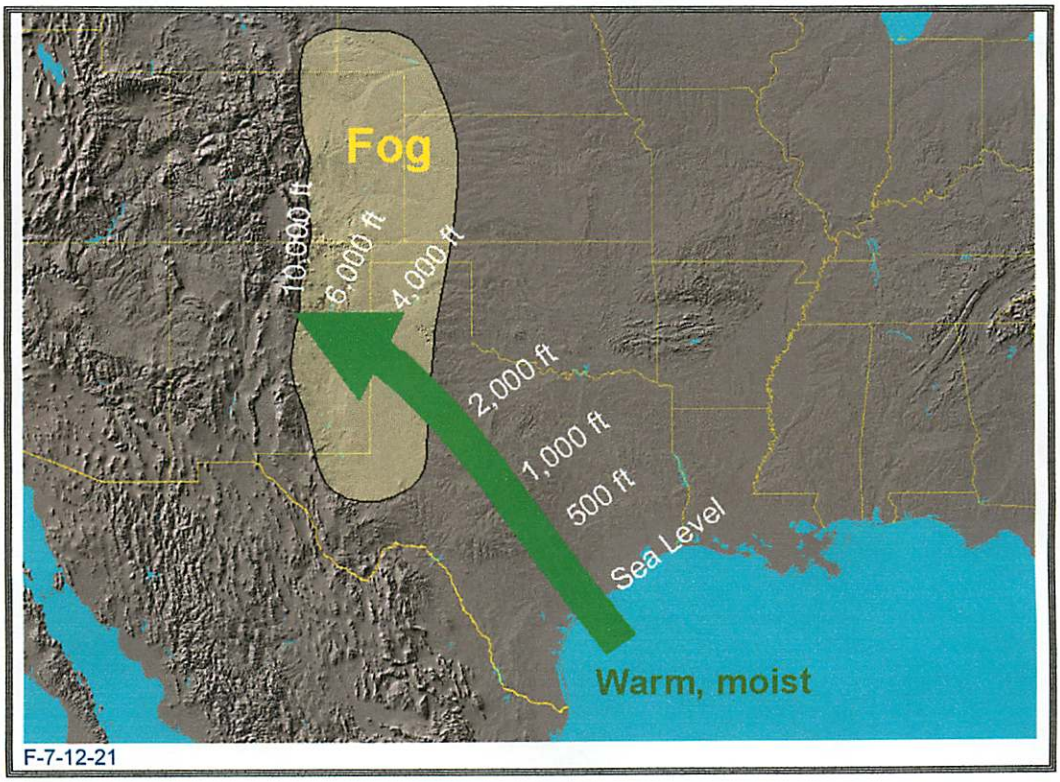
RESTRICTIONS TO VISIBILITY *(Continued)*

Upslope Fog: ⊙ Fog formation will end when surface winds cease or change direction.

Dissipation ⊙ Fog will dissipate when downslope winds develop.

Upslope Fog:

Illustration of Upslope Fog over the high plains



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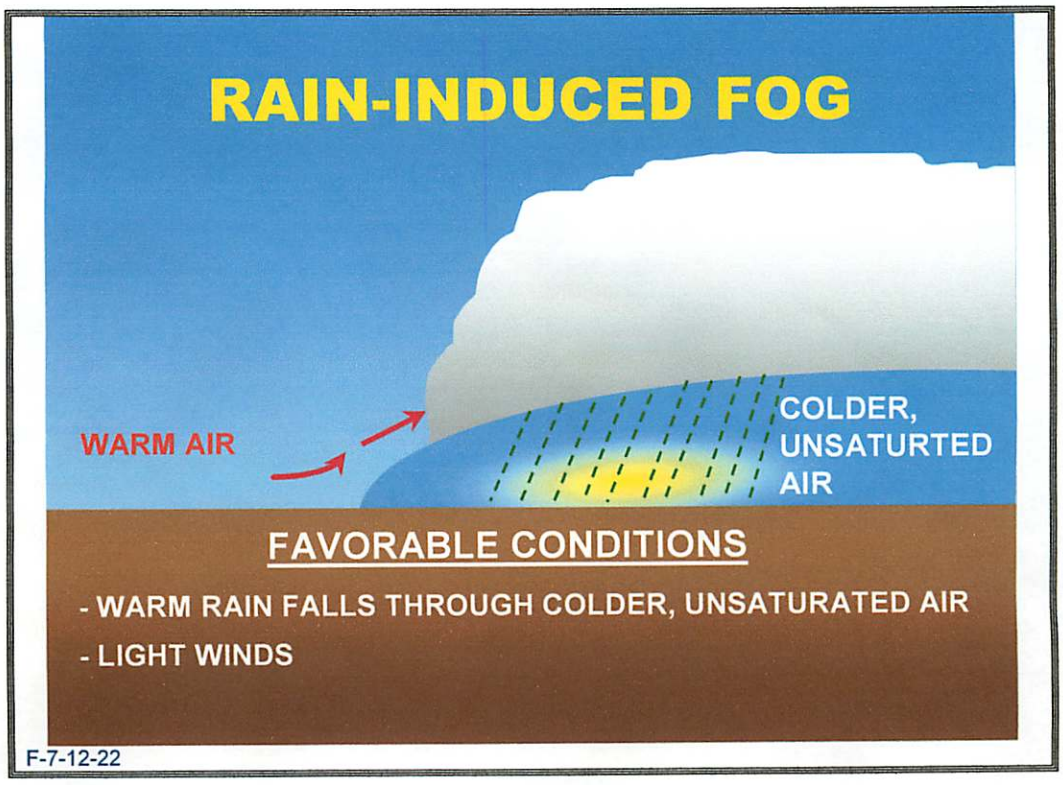
RESTRICTIONS TO VISIBILITY *(Continued)*

Rain-induced Fog



Rain-induced Fog:

Causes

- ⊙ Warm rain falls through colder, unsaturated air
  - Water vapor content increases due to evaporation of rain drops.
  - Air is cooled to saturation by latent heat of evaporation.
- ⊙ This process can produce either low clouds or fog.
  - Fog is produced when wind speeds are 15 knots or less.
  - Low clouds are produced when wind speeds are greater than 15 knots due to turbulent mixing.

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RESTRICTIONS TO VISIBILITY *(Continued)*

Rain-induced Fog:

Character-istics

- Persistent
- Covers wide area
- Mostly occurs with warm fronts or stationary fronts
  - Fog forms on cold-air side of front.

Rain-induced Fog:

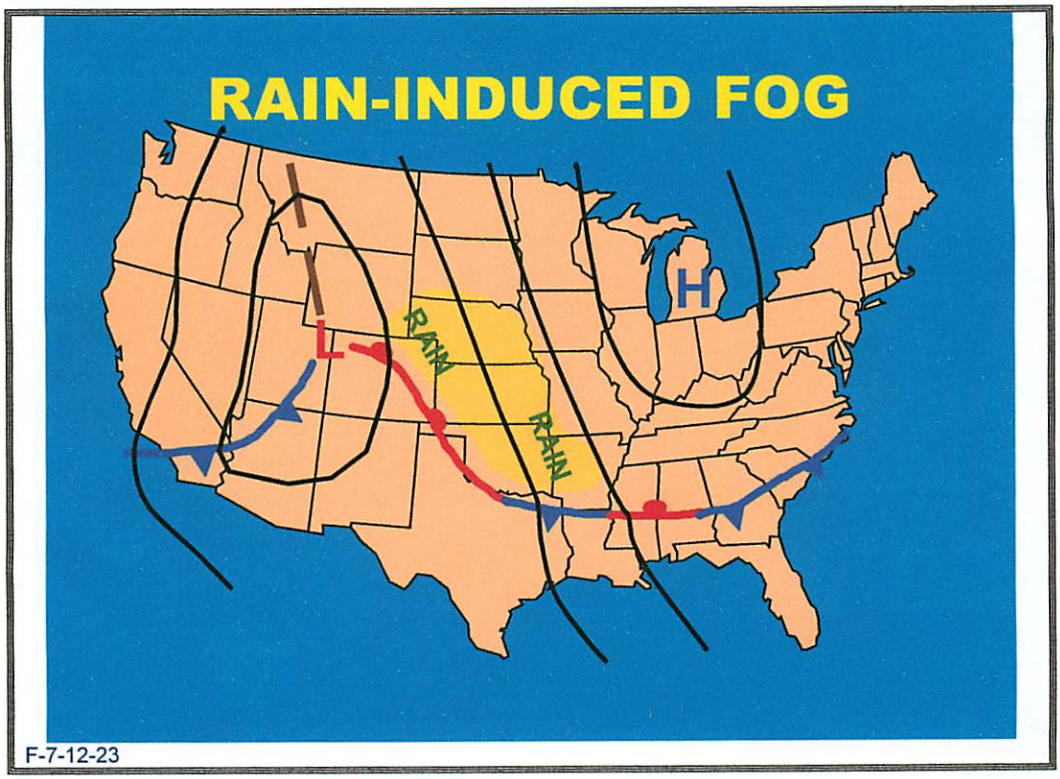
Dissipation

- Formation ends when precipitation stops.

CLASS NOTE: However, fog and/or low ceilings often continue.

Rain-induced Fog:

Illustration



- Warm front and stationary front with overrunning.
- Warm rain falls through colder air.

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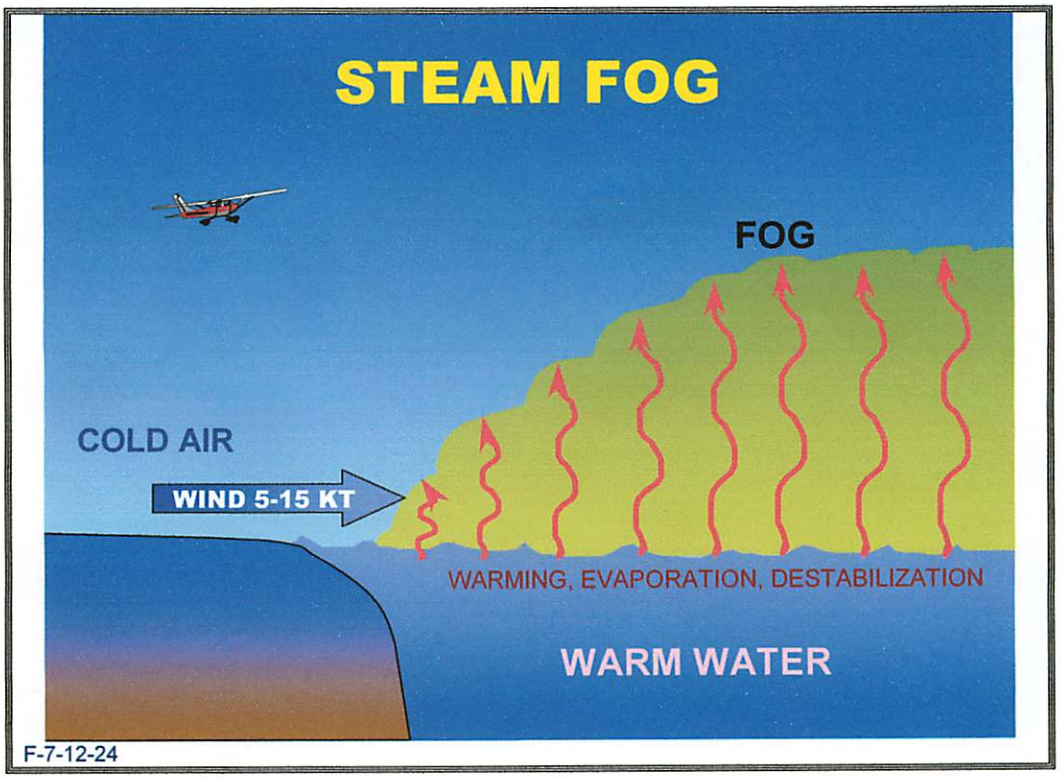
RESTRICTIONS TO VISIBILITY *(Continued)*

Steam Fog



Steam Fog: ⊙ Cold air moving over warm water.

Causes

- Evaporation increases dew point temperature
- Shallow convection results from conduction heating
  - Shallow layer of absolute instability.
  - This is the only fog type due to unstable air.
- Air cools to saturation by expansion

CLASS NOTE: Stronger convection causes low ceilings.

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RESTRICTIONS TO VISIBILITY *(Continued)*

Steam Fog:

Character-istics

- Persistent
- Can be widespread
- Low-level convection present
  - Convection is usually weak

CLASS NOTE: The larger the water body, the more persistent and widespread the fog.

Steam Fog:

Dissipation

- Formation processes end when:
  - surface winds cease or change direction.
  - colder ground warms on windward side of water.

Steam Fog:

Example

F-7-12-25 Courtesy Dr. Joe Moran

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Review

Series-8

RESPONSE ITEM

Fog occurs most frequently _____.

A. Around noon

B. Shortly after sunset

C. Shortly after sunrise

F-7-12-26

RESPONSE ITEM

A condition that could lead to the formation of fog is _____.

A. temperature increasing more rapidly than dew point

B. temperature decreasing and dew point increasing

C. dew point decreasing more rapidly than temperature

F-7-12-27

RESPONSE ITEM

_____ fog forms as a result of nighttime cooling of the ground.

A. Steam

B. Upslope

C. Radiation

F-7-12-28

RESPONSE ITEM

Advection fog can form when moist air _____.

A. flows over a cooler surface

B. flow over a warmer surface

C. is colder than the surface

F-7-12-29

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Review (Cont'd)

RESPONSE ITEM

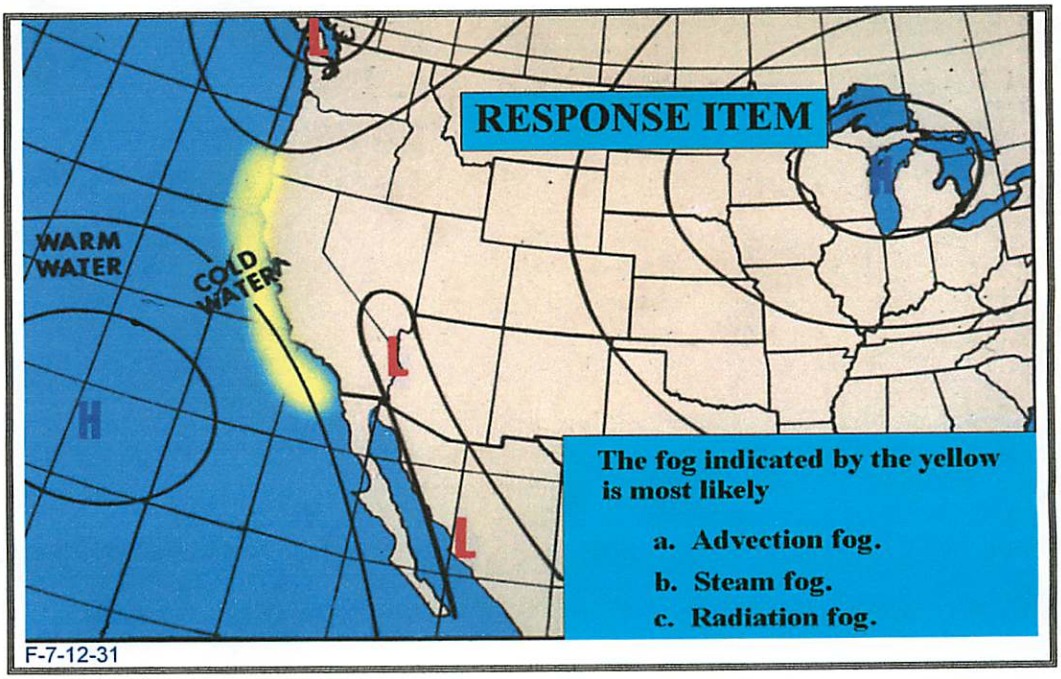
_____ fog forms as a result of cold air moving over warm water.

A. Advection

B. Steam

C. Radiation

F-7-12-30



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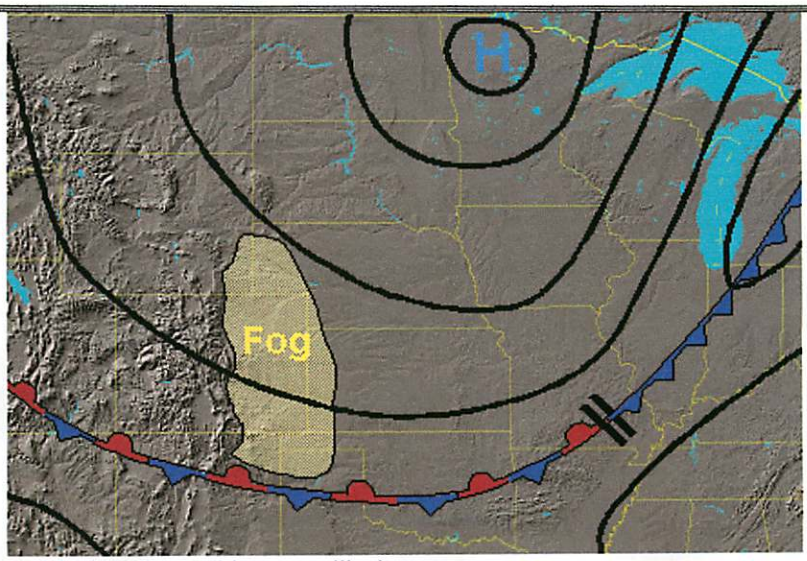
Review (Cont'd)



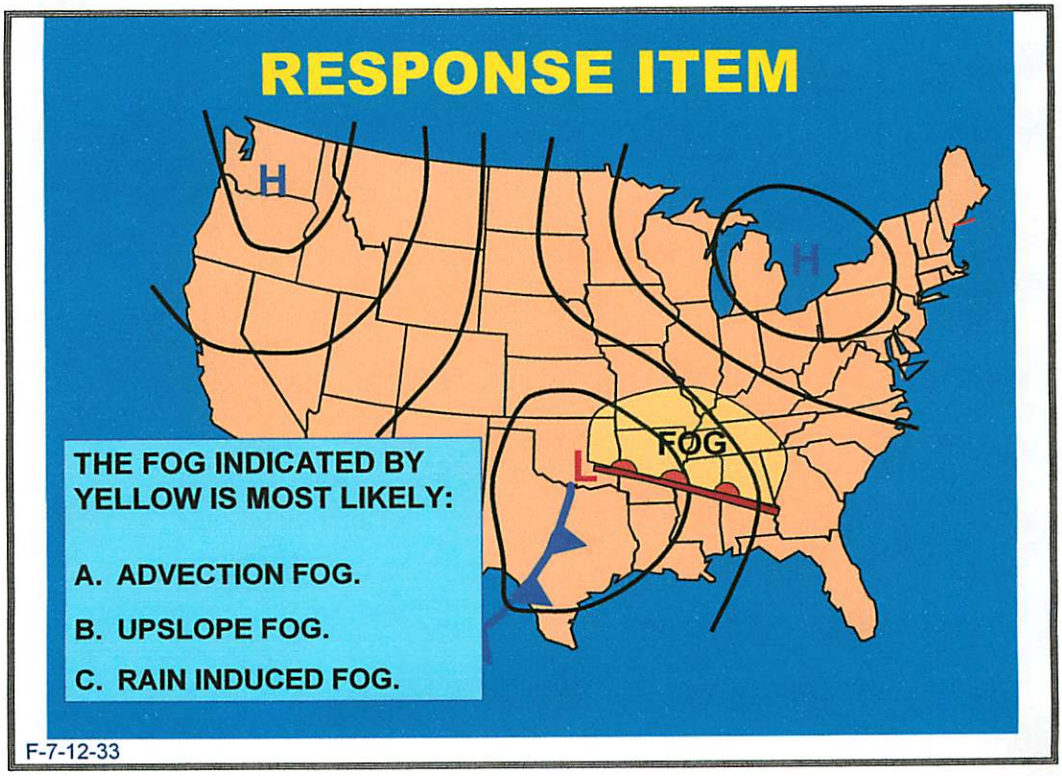
The type of fog indicated is most likely_____.

A. advection

B. upslope

C. steam

F-7-12-32



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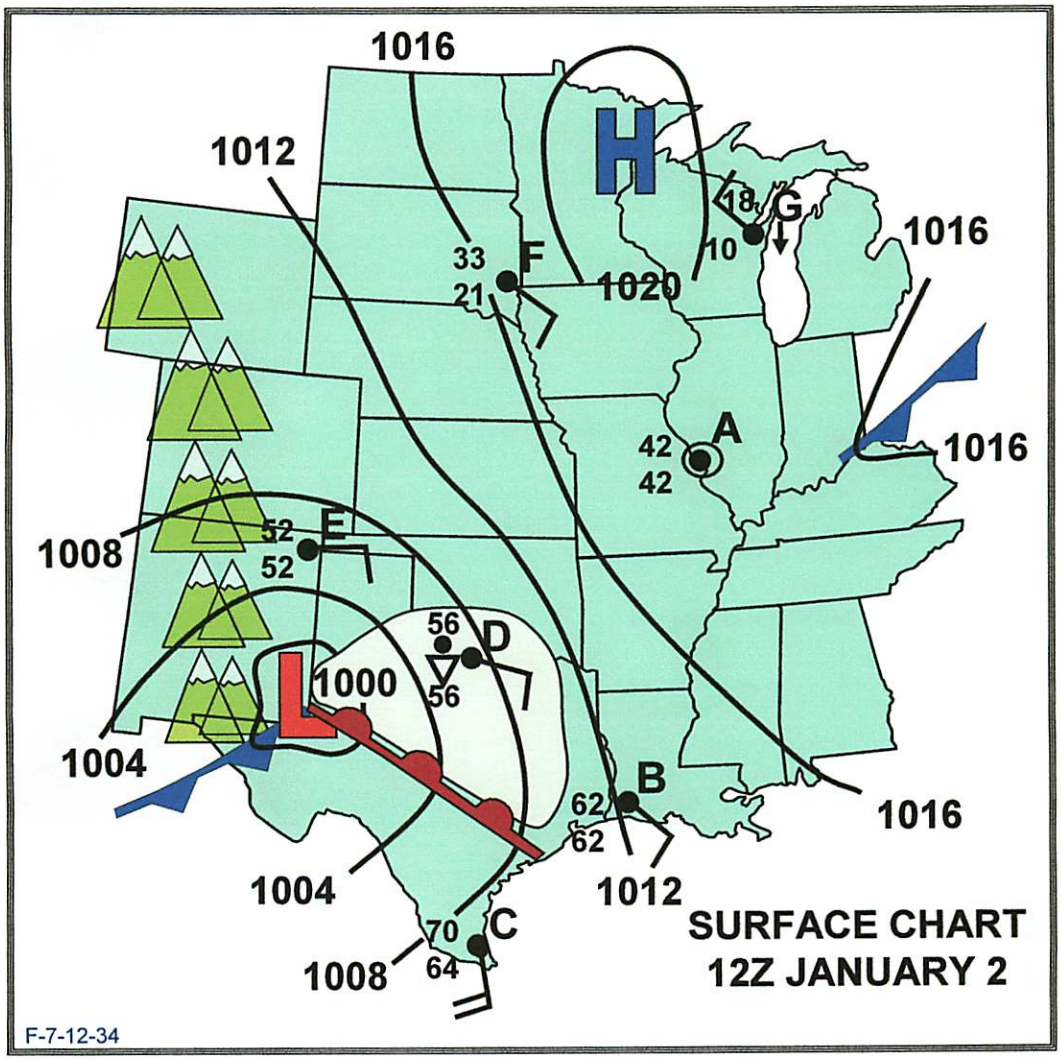
FOG PRACTICE EXERCISE

Directions **Use the 12Z surface chart below to answer questions 1 through 3.**

Surface Chart



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FOG PRACTICE EXERCISE *(Continued)*

Questions:

1. What kind of fog (if any) would you expect at the following points? (Note: Lake Michigan water temperature is 50^0F.)

   Point A _____

   Point B _____

   Point D _____

   Point E _____

   Point F _____

   Point G _____

2. How long will the fog probably last at the following points?

   Point A _____

   Point D _____

   Point G _____

3. Station C is more likely to have low ceilings than fog.

   Why? _____

End of practice exercise

RESTRICTIONS TO VISIBILITY *(Continued)*

Smoke and Haze

F-7-12-35

Smoke and Haze:

Definition

Smoke is particulate matter in the atmosphere resulting from combustion processes.

Haze is fine dust or salt particles dispersed through a portion of the atmosphere. The particles are so small that they cannot be felt or individually seen, but they diminish horizontal visibility and give the atmosphere an opalescent appearance that subdues all colors.

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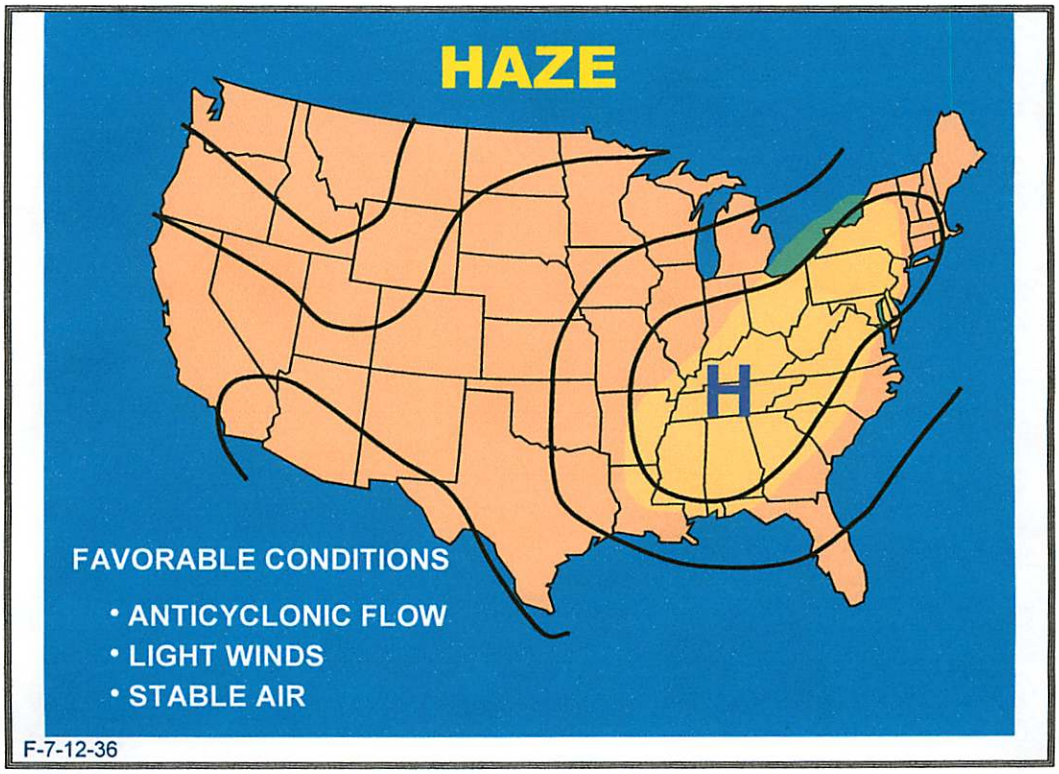
RESTRICTIONS TO VISIBILITY *(Continued)*

Haze:

Causes



⊙ A particle source region must be present

- Factories
- Certain type of foliage

⊙ A large stationary high

- Generally a subtropical high
- Allows particle concentration to increase, especially near the surface.
- Provides:
  - Anticyclonic flow
    → divergence
    → downward motion
  - Light wind
  - Stable air

CLASS NOTE: Smoke from forest fires or other local sources may produce reduced visibilities under a much wider range of conditions than listed here.

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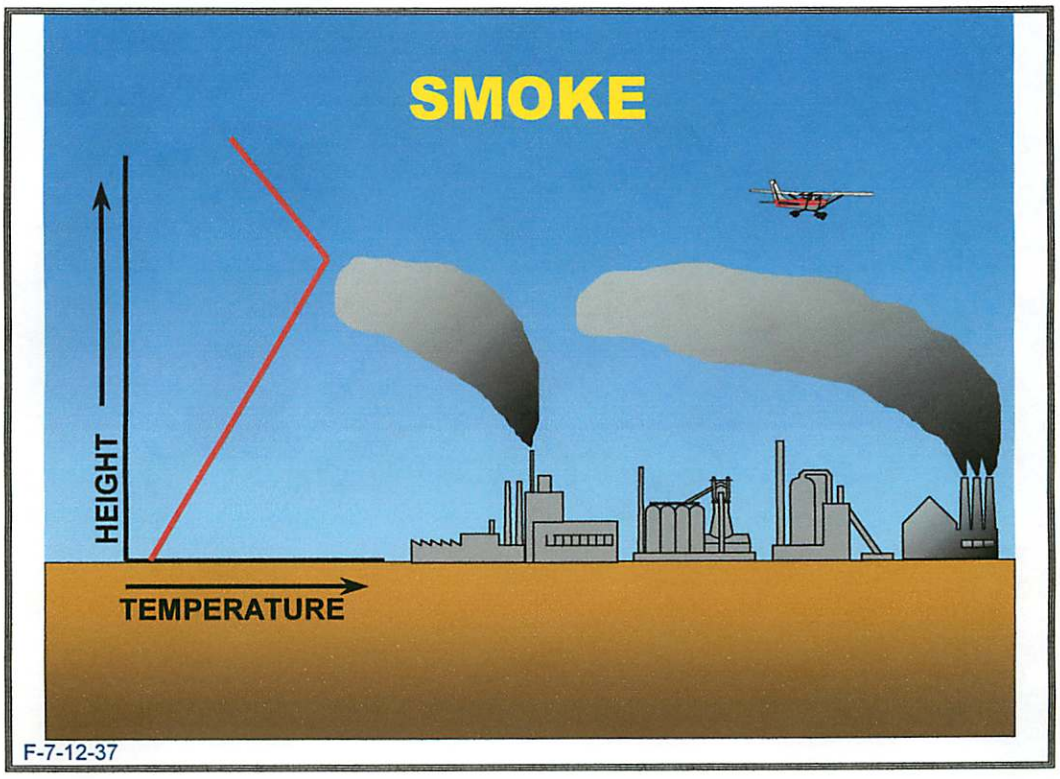
RESTRICTIONS TO VISIBILITY *(Continued)*

Smoke:

Favorable Conditions



- A surface-based temperature inversion
  - Resists vertical dispersion
- A light wind

Smoke and Haze:

Character-istics

- Does not dissipate due to daytime heating
- Promotes fog formation
  - Condensation nuclei.
- Often widespread
- Remains suspended for extended periods
- Visibility usually lower when looking toward the sun
- Usually, only few thousand feet thick, but may extend to 15,000 to 20,000 feet

CLASS NOTE: Smoke and haze do not directly cause damage to aircraft.

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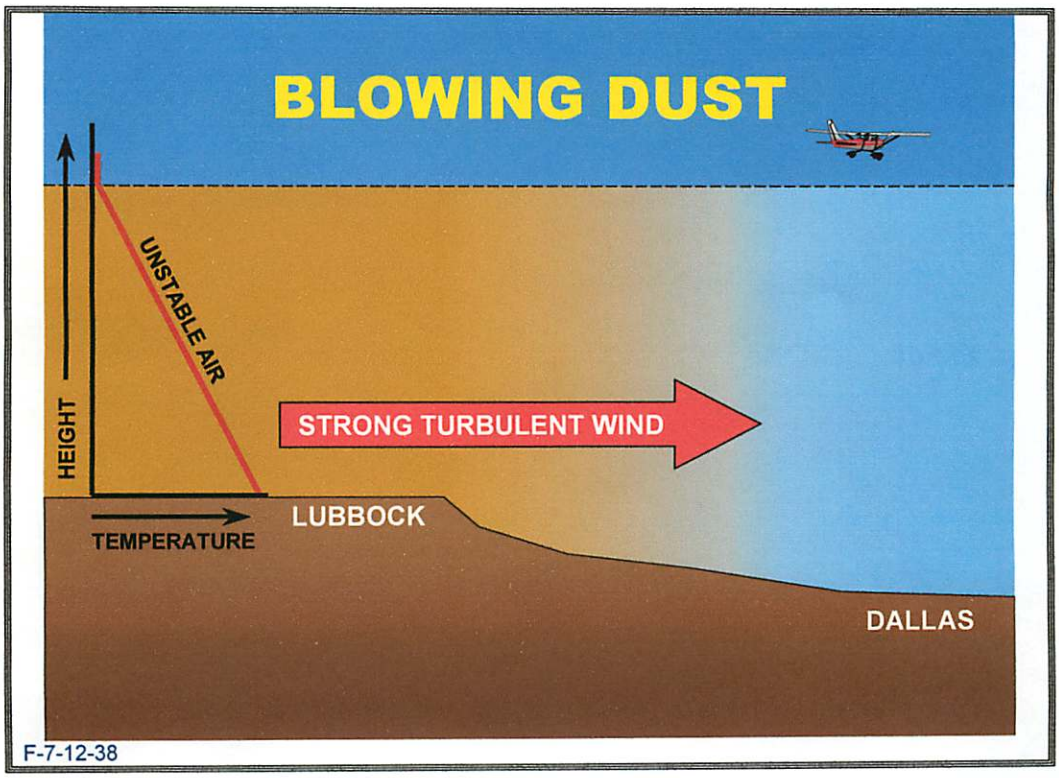
RESTRICTIONS TO VISIBILITY *(Continued)*

Dust and Blowing Dust



Dust and Blowing Dust: Definitions

Dust is solid material suspended in the atmosphere in the form of small irregular particles, many of which are microscopic in size. It imparts a tannish or grayish hue to distant objects.

Blowing dust is dust picked up locally from the surface of the Earth and blown about in clouds or sheets.

Dust and Blowing Dust: Causes

- Strong, turbulent wind
- Unstable air
- Barren terrain
  - Small, loose dirt particles present

Dust and Blowing Dust: Characteristics

- Can damage aircraft
- Remains suspended for extended periods
- May extend to 15,000 feet
- Advecting winds can spread conditions well downstream

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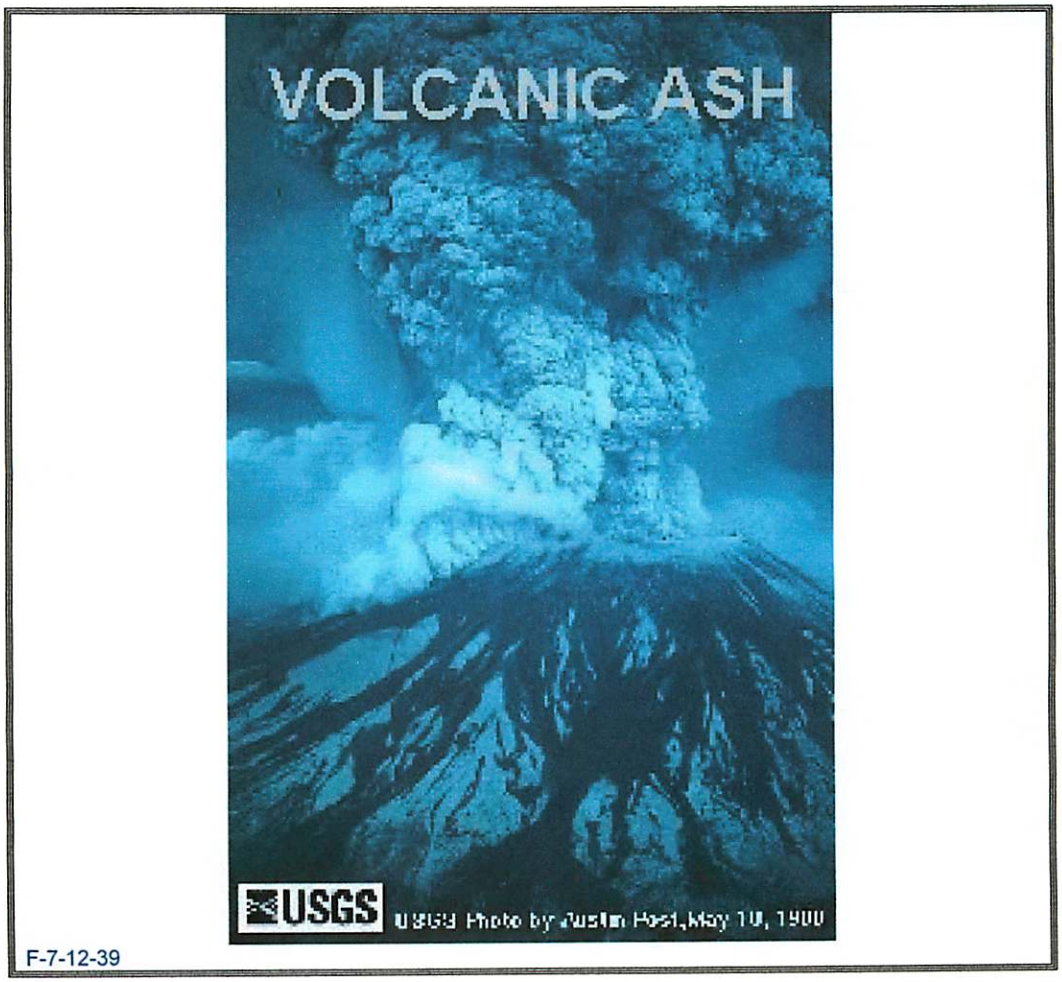
RESTRICTIONS TO VISIBILITY *(Continued)*

Volcanic Ash



F-7-12-39

Volcanic Ash: Definition

A white or grayish powder produced by a volcanic eruption.

Volcanic Ash: Characteristics

- Can severely damage aircraft
  - stop/destroy engines
  - glaze over windshield
  - acidic damage to airframe
- Remains suspended for extended periods
- Extends to great height
- Advecting winds can spread conditions well downstream

CLASS NOTE: Volcanic ash particles expelled into the atmosphere can vary in concentration depending on distance and time from eruption.

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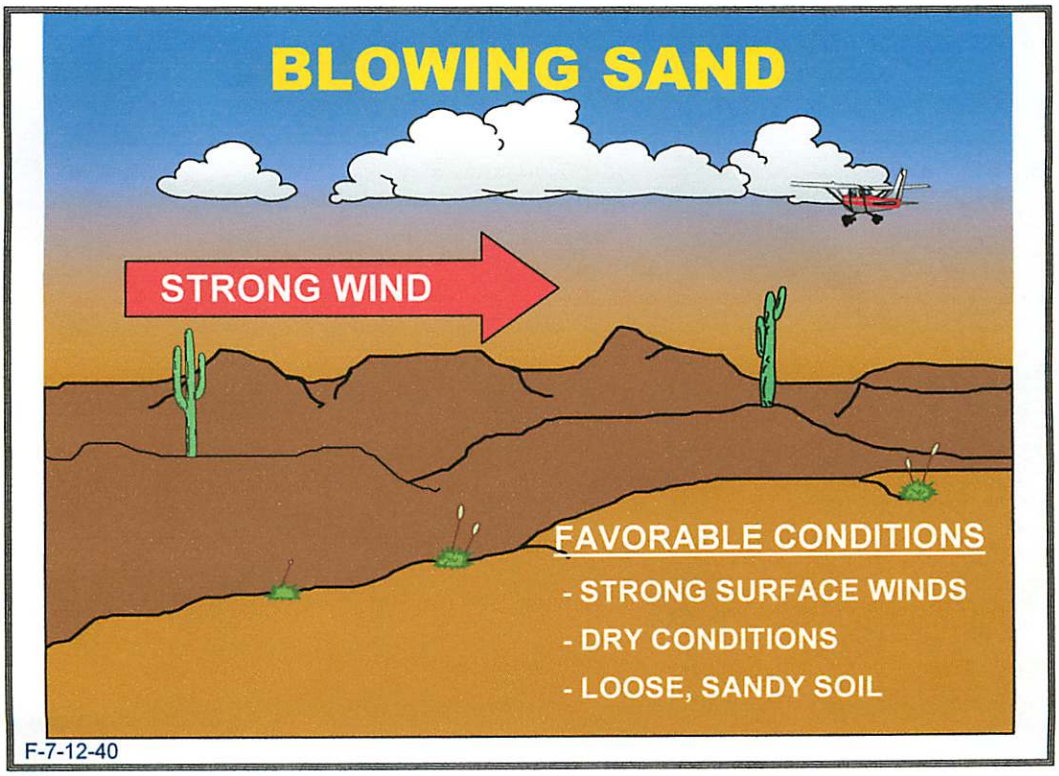
RESTRICTIONS TO VISIBILITY *(Continued)*

Blowing Sand



Blowing Sand:

Definition

Blowing sand is sand picked up from the surface of the Earth by the wind and blown about in clouds or sheets.

CLASS NOTE: Most common across desert regions.

Blowing Sand:

Causes

- Strong surface winds
- Dry conditions
- Loose, sandy soil

Blowing Sand:

Character-istics

- Can damage aircraft
- Confined to low levels
  - Generally below 2,000 feet AGL
- Visibility improves rapidly with subsiding winds

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RESTRICTIONS TO VISIBILITY *(Continued)*

Blowing Snow

F-7-12-41

Blowing Snow:

Definition

Blowing snow is snow lifted from the surface of the Earth by the wind to a height of six feet or more above the surface and blown about in such quantities that horizontal visibility is restricted at and above that height.

Blowing Snow:

Causes

- Dry snow
- Strong surface wind

CLASS NOTE: Also causes snow drifts on the runway

Blowing Snow:

Character-istics

- Confined to low levels
- Visibility improves rapidly with subsiding winds

CLASS NOTE: Gravity pulls snowflakes back to the ground.

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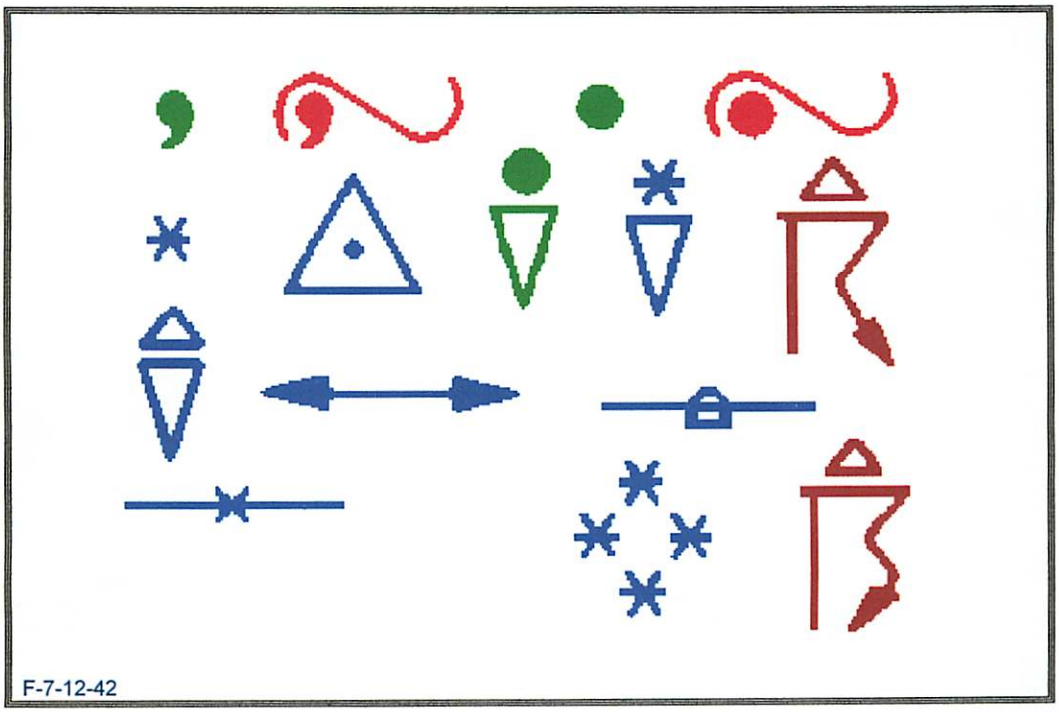
RESTRICTIONS TO VISIBILITY *(Continued)*

Precipitation



F-7-12-42

Precipitation:

Definition

Precipitation is any of the forms of water particles, whether solid or liquid, that falls from the atmosphere and reaches the ground. Precipitation includes drizzle, rain, snow, snow pellets, snow grains, ice crystals, ice pellets, and hail.

Precipitation:

Causes

- Adequate moisture
- Upward vertical motion mechanism

Precipitation:

Character-istics

- Snow is most effective in reducing visibility
- Drizzle frequently occurs with fog
- Rain rarely reduces visibility below one mile

CLASS NOTE: Rain can collect on the windshield and reduce cockpit visibility. This is significant for taxiing and landing an aircraft. High airspeed and/or high RPM prop-wash of single engine aircraft generally cleans the windshield.

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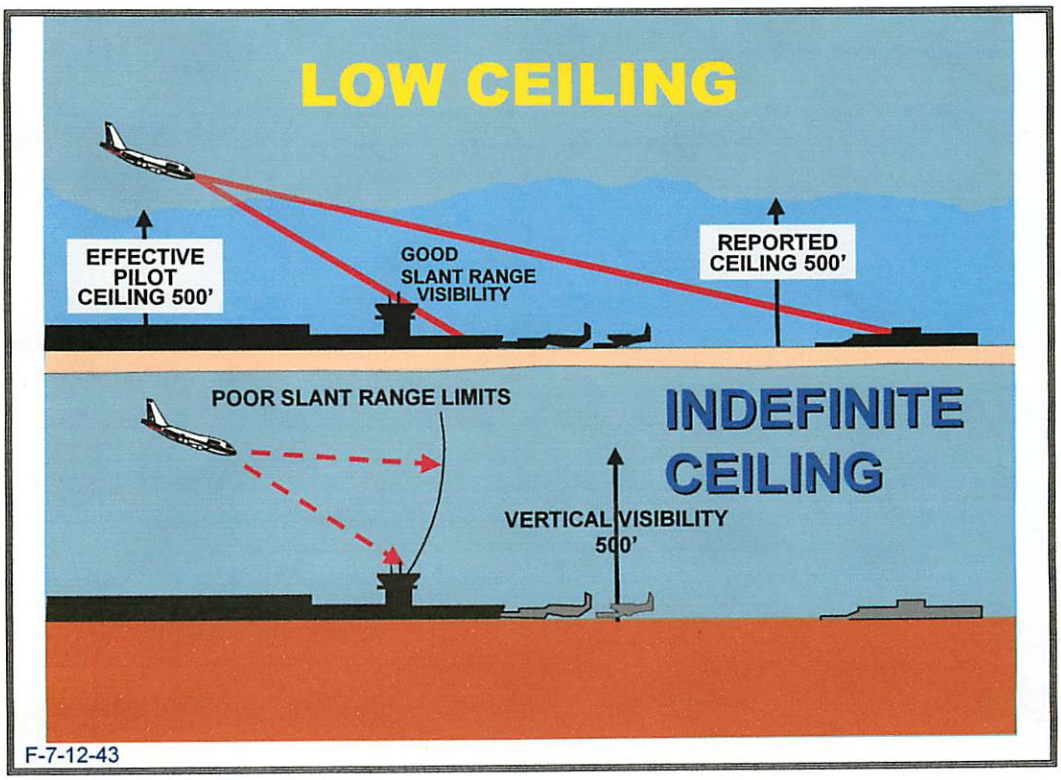
RESTRICTIONS TO VISIBILITY *(Continued)*

Indefinite Ceiling



Indefinite Ceiling:

Definition

Indefinite ceiling is the ceiling classification that is applied when the reported ceiling value represents the vertical visibility upward into a surface-based atmospheric phenomenon (except precipitation).

Indefinite Ceiling:

Character-istics

- The air-to-ground visibility is often more restricted than the surface visibility.
  - The pilot's slant-range view, which results from a combination of aircraft altitude and horizontal distance, only allows a limited view of the ground.
- More restrictive than an equal cloud ceiling.
  - Pilot must be below the indefinite ceiling altitude before seeing the ground.

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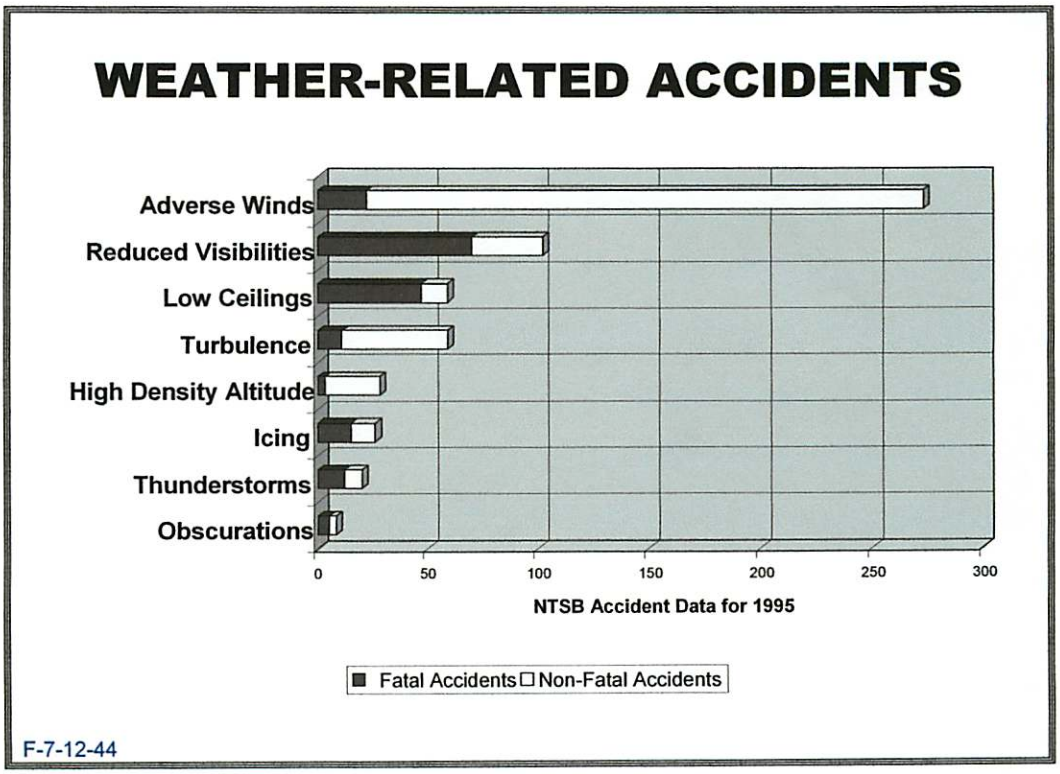
RESTRICTIONS TO VISIBILITY *(Continued)*

Adverse Effects to Flight



Adverse Effects to Flight: Can Cause Accidents

- ⊙ Restrictions to visibility can cause accidents
  - About 69% of which are fatal

CLASS NOTE: Can also increase workload and stress.

Adverse Effects to Flight:

Restricts all three types of Visibility

- ⊙ The three types of visibility can be restricted
  - Air-to-air
  - Air-to-ground (slant-range)
  - Surface
- ⊙ Visual contact with the ground and horizon is diminished
- ⊙ Often worse at sunrise and sunset
  - Especially when looking toward the sun.

CLASS NOTE: A VFR report can be an IFR flying condition.

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RESTRICTIONS TO VISIBILITY *(Continued)*

Adverse Affects to Flight:

Limits VFR Flights

- ⊙ Diminishes visual contact with the ground and horizon
  - Necessary for VFR pilots to maintain positive control of aircraft and navigation.
- ⊙ Diminish effective visual traffic separation
- ⊙ VFR flight is prohibited by below-minimum visibility and/or obscuration ceilings.
- ⊙ Both terminal and/or en route is affected

Adverse Affects to Flight:

Limits IFR Flights

- ⊙ Visual runway acquisition is more difficult during approach and landing.
  - Inflight visibility is often more restrictive than surface visibility report.
- ⊙ IFR flights are restricted by below-minimum conditions at airports.
  - Restricted by ceiling and/or visibility
  - En route conditions are generally not a factor.
- ⊙ An alternate may be required
  - Depends on the particular flight's requirements
  - Increases fuel requirements

Adverse Effects to Flight:

Solid Particle Phenomena Can Damage Aircraft and/or Cause Accidents

- ⊙ Dust and blowing dust
- ⊙ Volcanic ash
- ⊙ Blowing sand

CLASS NOTE: All flights are affected.

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