METEOROLOGY

Meteorology – Airborne Radar

General

- Airborne radar installed in Key Lime Air aircraft will be utilized for severe weather avoidance, and whenever possible, used in conjunction with ground radar to avoid severe weather. When airborne or ground radar indicates potential thunderstorm activity, the pilot in command will alter his / her route of flight to avoid the core of the cell by a minimum of 20 miles.
- When attempting to use ground radar as a primary source of severe weather avoidance, it is important to understand that frequently the center radar is in the horizontal polarization mode to gain maximum attenuation of primary targets and may not paint all the cellular activity encountered in flight.
- Should airborne radar become inoperative in forecast severe weather conditions, the pilot in command will ascertain from the controller if his / her radar is in fact in the horizontal mode and request radar vectors out of the areas of severe weather. PIC will land as soon as practicable.
- No pilot will begin a flight under IFR unless current weather reports indicate that thunderstorms or other potentially hazardous weather conditions that can be detected with airborne thunderstorm detection equipment may reasonably be expected along the route to be flown unless the airborne thunderstorm detection equipment is in satisfactory operating condition.
- If the airborne thunderstorm detection equipment becomes inoperative enroute while IFR and no potentially hazardous weather conditions can be expected along the route to be flown, the pilot(s) may continue the flight to a point where repairs can be made or the equipment can be deferred.

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- During flight, use any means available to avoid thunderstorms by at least:
  - 20 nautical miles [at or above flight level (FL) 230]
  - 10 nautical miles below FL 230, in order to minimize exposure to thunderstorm hazards when approaching or departing an airport in an area where thunderstorms are occurring or are forecast
  - Attempt to maintain visual meteorological conditions (VMC)
  - Maintain at least 5 nautical miles separation from heavy rain showers
  - Avoid areas of high lightning potential, i.e., clouds within ± 5,000 feet of the freezing level
- **NOTE: Approaches or departures may be accomplished when thunderstorms are within 10 nautical miles. The thunderstorms must not be producing hazardous conditions (such as hail, lightning, strong winds, gust fronts, heavy rain wind shear, or microburst) at the airport, and must not be forecast or observed to be moving in the direction of the route of flight (to include the planned missed approach corridor, if applicable).**

Meteorology – Airborne Radar

Path Planning

- Plan a deviation path early. Simply skirting the red or magenta portion of a cell is not enough. Plan an avoidance path for all weather echoes which appear beyond 100 miles since this indicates they are quite intense.
- The most intense echoes are severe thunderstorms. Remember that hail may fall several miles from the cloud, and hazardous turbulence may extend as much as 20 miles from the storm. Avoid the most intense echoes by at least 20 miles, that is, echoes should be separated by at least 40 miles before you fly between them. As echoes diminish in intensity, you can reduce the distance by which you avoid them.

Path Planning Considerations

- Avoid cells containing magenta and red areas by at least 20 miles.
- Do not deviate downwind unless absolutely necessary. Your chances of encountering severe turbulence and damaging hail are greatly reduced by selecting the upwind side of a storm.
- If looking for a corridor, remember corridors between two cells containing magenta and/or red areas should be at least 40 miles wide from the outer fringes of the radar echo. The magenta displays areas of very heavy rainfall and statistically indicates a high probability of hail.

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Inoperative Weather Radar Procedures

- PIC will determine if forecast severe weather conditions exist along his route by:
- Contacting ATC; or
- Contacting Dispatch via company radio; or
- Other aircraft reports/PIREPs
- PIC will follow the appropriate procedure below based on forecast weather conditions.
  - *Forecast Severe Weather conditions*
    - PIC will contact ATC to determine if his radar is in horizontal mode.
    - PIC will request vectors from ATC to exit area of severe weather.
  - *No potentially hazardous weather conditions*
    - PIC may continue the flight to a point where repairs can be made or the equipment can be deferred

Meteorology – Adverse Weather Phenomena

Through primary weather sources, dispatchers have direct access to meteorological conditions which, if encountered in-flight or during ground operations, could directly diminish safety. Dispatchers will evaluate adverse weather information and inform flight crews and operations personnel through primary communications channels (telephone, VHF radio) of the following meteorological conditions: [121.101(d)]

- Strong surface winds (exceeding 30 knots)
- Widespread low ceilings and/or visibilities which affect selection of destination and alternate airports
- Active thunderstorms (particularly those with increasing VIP levels)
- Moderate or severe inflight icing
- Icing which affects ground operations (including snow, freezing rain or drizzle, ice fog, or sleet)
- Severe or extreme turbulence (including clear air and mountain wave)
- Low altitude windshear (below 2000 feet AGL)
- Occurrence of un-forecast weather conditions below landing or takeoff minimums
- Volcanic ash
- Sandstorms and dust storms
- Meteorological conditions which contaminate a runway surface and adversely affect aircraft performance or prohibit use of a runway

- When Key Lime Air dispatcher, DO, or PIC becomes aware of conditions, including airport and runway conditions, that are a hazard to safe operations, they shall restrict or suspend operations until those conditions are corrected.
- Dispatchers will not release, and the PIC will not accept, a dispatch release into hazardous or unsafe conditions or allow any flight to continue into unsafe conditions until those conditions are corrected. Unsafe conditions could encompass the airport, the runway, adverse meteorological conditions or any other condition that could affect safety of the flight.

Meteorology – Adverse Weather Phenomena

AIRMETs

- Hazardous weather advisories of moderate intensity will be issued as AIRMETs. AIRMETs are issued when the following conditions are expected to cover an area of at least 3000 square miles:
- Moderate icing.
- Moderate turbulence.
- Sustained surface winds of 30 knots or more.
- Ceilings less than 1,000 ft. and/or visibility less than 3 miles affecting 50% of an area at one time.
- Extensive mountain obscuration.

SIGMETs

- Hazardous weather advisories of severe intensity will be issued as SIGMETs. SIGMETs are reported as convective or non-convective:
- Convective SIGMETs report only thunderstorms and related phenomena (tornadoes, heavy precipitation, hail and high surface winds).
- Non-convective SIGMETs are issued when the following conditions occur or are expected to cover an area of at least 3,000 square miles:
- Severe or clear air turbulence not associated with thunderstorms.
- Severe icing not associated with thunderstorms.
- Widespread dust storms, sandstorms, or volcanic ash lowering surface or in flight visibility to less than 3 miles.
- Volcanic eruption.

Meteorology – Adverse Weather Phenomena

Thunderstorms

- Thunderstorms are potentially the most hazardous condition to flight as they contain some, or all, of the hazardous meteorological conditions including lightning, hail, turbulence and icing. When planning flights through areas of convective activity, Dispatchers must review deferred maintenance items to ensure the aircraft's weather radar is operable. Dispatchers will not release flights without operable weather radar when current or forecast reports indicate that thunderstorms or other potentially hazardous weather conditions can reasonably be expected along route of flight. If weather radar becomes inoperative in-flight and thunderstorms are present, the PIC should call the Dispatcher to discuss:
  - The ability to stay clear of thunderstorms visually;
  - Change of route;
  - Diversion to an adequate airport where repairs can be made or the flight can be delayed until the weather dissipates.
- Departure and arrival gust fronts in advance of thunderstorms frequently contain high winds and strong vertical and horizontal wind shear, capable of causing loss of control near the ground. A frontal gust can affect an approach corridor or runway without affecting other areas of the airport. Under these conditions, tower reported winds and the altimeter setting could be misleading.
- When significant thunderstorm activity is approaching within 15 miles of the airport, the PIC should consider conducting the departure or arrival from a different direction or delaying the takeoff or landing. The PIC will use all available information for this judgment, including PIREP's, ground radar, airplane radar, tower reported winds and visual observations.

Meteorology – Adverse Weather Phenomena

Low-Level Windshear

- Aircraft are not capable of safely penetrating all intensities of low-level wind shear. Dispatchers and the PIC must be constantly alert to potential low-level wind shear conditions by a careful analysis of weather reports, pilot reports, ATIS broadcast and low-level wind shear alert systems at airports. The most prominent meteorological condition(s) conducive to wind shear are:
  - Convective storm shear (airmass and frontal thunderstorms, down burst, wet and dry microburst)
  - Non-convective frontal systems (cold and warm fronts)
  - Wind shear associated with strong gusty surface winds
  - Strong sea breeze, mountain wave or other temperature inversions

Meteorology – Adverse Weather Phenomena

Turbulence

- Dispatchers shall not plan flights at flight levels within areas of known severe or greater turbulence.
- Turbulence information is provided to Dispatchers in the form of Convective SIGMETS, SIGMETS, AIRMETS, US Low-Level Significant Prognostic Chart, US High-Level Significant Weather Prognostic Chart and WSI produced Turbulence Charts.

Intensity	Aircraft Reaction	Reaction Inside Aircraft
Light	Turbulence that momentarily causes slight erratic changes in ;altitude and/or attitude (pitch, roll, yaw). Report as Light Turbulence or Turbulence that causes slight, rapid and somewhat rhythmic bumpiness without appreciable changes in altitude or attitude. Report as Light Chop.	Occupants may feel a slight strain against seat belts or shoulder straps. Unsecured objects may be displaced slightly. Food service may be conducted and little or no difficulty is encountered in walking.
Moderate	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. It usually causes variations in indicated airspeed. Report as **Moderate Turbulence;** [1] or Turbulence that is similar to Light Chop but of greater intensity. It causes rapid bumps or jolts without appreciable changes in aircraft altitude or attitude. Report as **Moderate Chop.**[1]	Occupants feel definite strains against seat belts or shoulder straps. Unsecured objects are dislodged. Food service and walking are difficult.
Severe	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. Report as **Severe Turbulence.** [1]	Occupants are forced violently against seat belts or shoulder straps. Unsecured objects are tossed about. Food Service and walking are impossible
Extreme	Turbulence in which the aircraft is violently tossed about and is practically impossible to control. It may cause structural damage. Report as **Extreme Turbulence.** [1]	

Meteorology – Adverse Weather Phenomena

Preventing Injuries to Passengers - AC120-88A

- The data strongly suggests that having passengers and F/As seated with seatbelts fastened is an effective measure during a turbulence encounter. From 1980-2003, only four people who were seated with seatbelts fastened received serious injuries during turbulence, excluding cases of other people falling onto and injuring properly secured occupants.

PROCEDURES KNOWN TO BE EFFECTIVE AGAINST TURBULENCE.

The following procedures have been identified by the CAST and are suggested as standard operating procedures for voluntary implementation by U.S. air carriers. Maximize the information about your flight conditions as follows:

- a. Inform air traffic control (ATC) of turbulence at check in with new controller.
- b. Inform ATC when unforecasted turbulence is encountered en route.
- c. Inform company via ACARS or dispatch frequency so that following flights will be aware of the flight conditions or be planned on another route.
- d. Inform/query other aircraft operating in the area on a common frequency.
- e. Query ATC about "the rides" when you check in with a new controller/sector.

Meteorology – Adverse Weather Phenomena

WHEN INFORMED OF TURBULENT FLIGHT CONDITIONS

- a. Prior to departure, seek alternate routing to avoid the affected areas or delay departure until conditions improve.
- b. Change en route altitudes or routes to avoid the turbulence.
- c. Slow to the manufacturer's recommended turbulence penetration speed.
- d. Prior to descent, seek alternate routing to avoid the affected areas or, if severity dictates, hold or divert to alternate.
- e. Avoid any convective activity en route [at or above FL 230] by at least 20 nautical miles and 10 nautical miles below FL 230.

Meteorology – Adverse Weather Phenomena

GENERAL TURBULENCE PROCEDURES.

- a. If flight into forecast turbulence is unavoidable, timely notification to the cabin crew is crucial to their safety.
- b. If turbulence is expected before the flight departs, the preflight briefing to the lead F/A must include turbulence considerations. The briefing can be the same as an in-flight briefing for expected turbulence including:
  - • Actions the captain wants the cabin crew to undertake any time turbulence is expected,
  - • Intensity of turbulence expected,
  - • Methodology for communicating to the cabin the onset or worsening of turbulence, e.g., cabin interphone or public address (PA),
  - • Phraseology for the cabin crew to communicate the severity of turbulence, and
  - • Expected duration of the turbulence and how an "all-clear" will be communicated.
- c. Utilize a positive signal of when cabin crew may commence their duties after takeoff and when they should be seated and secured prior to landing.
- d. Passengers will be informed of routine turbulence via the PA system. Do not rely on the seatbelt sign alone.
- e. Cabin crew will be informed of routine turbulence via the interphone.
- f. If at any time the cabin crew experiences uncomfortable turbulence without notice from the flight crew, they must immediately take their seats and inform the flightcrew.
- g. All service items must be properly stowed and secured when not in use.

Meteorology – Adverse Weather Phenomena

TURBULENCE ONSET CATEGORIES AND INJURY AVOIDANCE ACTIONS.

a. **Expected Turbulence**. Advance notice exists for the captain to brief the cabin crew either prior to the flight or in-flight via the interphone.

- (1) The captain can thoroughly brief the cabin crew on the expected turbulence level and its duration.
- (2) Clearly articulate expectations from the cabin crew and request confirmation of completed actions.
- (3) Instruct the cabin crew to immediately and plainly report any deviations from the expected turbulence level.
- (4) Develop a method to inform the cabin crew of the completion of the turbulence event.

b. **Little Warning**. Sufficient warning exists to seat the passengers and for the cabin crew to perform their duties.

- (1) The captain turns on seatbelt sign and makes a PA announcement, "F/As stow your service items and take your seats. Passengers please remain seated until this area of turbulence has passed and I have cleared you to move about the cabin."
- (2) Cabin crew stows all applicable service items, performs cabin compliance check, and secures themselves in their jump seats.
- (3) Lead F/A informs captain of the completion of these items.
- (4) When conditions improve, captain uses the PA system to advise the cabin crew that they may resume their duties and whether or not the passengers may move about the cabin.

c. **Imminent Turbulence or Turbulence Occurring**. Sudden, unexpected or imminent turbulence requiring immediate action to protect cabin crew and passengers.

- (1) Captain turns on seatbelt sign and makes a PA announcement, "F/As and passengers be seated immediately. Passengers please remain seated until this area of turbulence has passed and I have cleared you to move about the cabin."
- (2) Cabin crew take first available seat and secure themselves.
- (3) No compliance checks are performed and items are secured only if they present no delay in securing a person in a seat.
- (4) When conditions improve, captain makes PA announcement advising the cabin crew that they may resume their duties and whether or not the passengers may move about the cabin.

Meteorology – Adverse Weather Phenomena

TURBULENCE TYPES.

- a. Thunderstorm Turbulence. Turbulence associated within and in the vicinity of thunderstorms or cumulonimbus clouds. A cumulonimbus cloud with hanging protuberances is usually indicative of severe turbulence.
- b. Clear Air Turbulence. High level turbulence (above 15,000') not normally associated with cumuliform cloudiness. Typically windshear turbulence even when in cirrus clouds.
- c. Mountain Wave Turbulence. Turbulence as a result of air being blown over a mountain range or a sharp bluff causing a series of updrafts and downdrafts.

  The atmosphere needs three elements for Mountain Wave to propagate:
  - Wind flow perpendicular to the mountain range, or nearly so, being within about 30 degrees of perpendicular.
  - An increasing wind velocity with altitude with the wind velocity 20 knots or more near mountaintop level.
  - Either a stable air mass layer aloft or an inversion below about 15,000 feet.
- The most distinctive characteristic of the mountain wave is the lenticular cloud. This signpost generally indicates mountain wave activity.
- When mountain wave is present or forecast, Dispatchers should:
  - Try to avoid planning flights through areas of mountain wave activity.
  - If a detour is not possible, plan or advise the flight crew to maintain FL at least 50% higher than the mountain range.
  - Severe turbulence with abrupt FL changes of +/- 2500ft can be anticipated in areas of reported mountain wave activity.

Meteorology – Severe Weather Avoidance

- No Key Lime Air aircraft, under IFR, will fly into areas of known or forecast light or moderate icing conditions, unless the aircraft is certified for operations in known ice conditions. Anti-icing procedures recommended in the appropriate pilot aircraft handbook or aircraft flight manual will be utilized.
- No Key Lime Air aircraft is ever to deliberately penetrate a thunderstorm. A thundershower is at best very difficult to determine. Pilots will base their decisions on all available information, i.e., forecasts, availability of radar, cloud formations, amount of precipitation with particular attention to forecast severe thunderstorm and tornado areas.
- No pilot will be criticized for not flying in such areas when ceilings and visibility are poor and thunderstorms are being reported all along the route. All pilots should be mentally prepared for inadvertent penetration of a thunderstorm and should act in a careful deliberate manner.

Weather Hazards Video