Turbulence Avoidance Technologies

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The information contained herein is advisory only in nature.
What on-board turbulence avoidance technologies do Gulfstreams employ?

- Gulfstreams are equipped with both strategic and tactical turbulence avoidance equipment.
- This briefing will discuss both types, as well as a deeper dive into Eddy Dissipation Rate “nowcasting.”
All Aircraft | Turbulence Avoidance Technologies

Strategic Turbulence Avoidance

- The XM graphical weather interface provides a graphical depiction of turbulence for North America.

- Clear air turbulence is included in this depiction.

- Magenta outlines on the image to the left signify moderate turbulence.

- Using the Cursor Control Device (CCD), various altitudes may be transposed onto the Map display (altitude window outlined in yellow).
Strategic Turbulence Avoidance

- Universal Datalink graphical weather provides worldwide turbulence coverage.

- The image to the left shows turbulence depiction centered over India on a Multi-Function Window.
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Strategic Turbulence Avoidance

- In addition to graphical turbulence, winds aloft and satellite imagery may also be viewed.

- Evaluating large shifts in wind direction/velocity and cloud height will aid in ride-planning.
**Tactical Turbulence Avoidance**

- Gulfstream on-board radar provides precipitation-related turbulence detection modes.

- Enhanced Turbulence measures severe and ride-quality turbulence out to 40 NM. When the new FAA standards for severe turbulence are met, solid magenta is displayed. When the radar detects less severe ride-quality turbulence consisting of light to moderate chop, then speckled magenta is displayed.
Turbulence - EDR

Overview

- Turbulence, especially Clear Air Turbulence, continues to pose a major hazard to aircraft in cruise flight.

- Eddy Dissipation Rate (EDR) is a relatively new technology that assists in both turbulence forecasts and nowcasts.

- This briefing provides an overview of EDR and how Gulfstream Flight Ops can access this information to strategically and tactically mitigate the threat of turbulence.

Formula for EDR from a Deep Dive. See following pages for a pilot-friendly overview.

\[
\varepsilon = 15 \nu \left( \frac{du}{dx} \right)^2 = 7.5 \nu \left( \frac{du}{dy} \right)^2
\]
What is EDR?

Objective, aircraft-independent, universal measure of turbulence. ICAO and NEXTGen Standard

- Based on rate at which energy dissipates in the atmosphere: using aircraft sensors/avionics, EDR value will be the same across aircraft types. Removes PIREP subjectivity.

- *In situ* calculation (determined by an aircraft while in flight): Delta Air Lines and United Airlines have outfitted a portion of their fleets with this automatic reporting capability (this is where the data actually comes from). 44,000+ reports a day with 10km average certainty versus 300-500 pireps/day with only 50km average certainty. Can be converted into root mean square of aircraft loads (RMS-g). Generally only reporting data from above FL200 (equipment limitations).

- Image below depicts EDR data for the described dates (EDR scale discussed on next page):
Turbulence - EDR

**EDR Scales**

- The ICAO-accepted EDR scale ranges from 0 to 1.

- A simplified medium-weight (15,500 - 300,000lbs) aircraft scale is below. Specific sources of information are on the next page.

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**Eddy Dissipation Rate (EDR)**

![EDR Scales Diagram]

- **NOTE:** some academic papers have claimed that a business jet may experience severe turbulence with EDRs as low as 0.40. Practically-speaking, it may be wise to avoid all areas of turbulence above 0.40.
Turbulence - EDR

**Products**

ForeFlight: IMAGERY > TURBULENCE (Provides both current and forecast data).

![Turbulence EDR Products](image-url)
Turbulence - EDR

Products

Schneider Electric (via Arinc Direct): WEATHER > GRAPHICAL WEATHER > LAYERS > ENH FLIGHT HAZARDS > WORLD EDR TURBULENCE

NOTE: This provides global data unlike ForeFlight.
Turbulence - EDR

Products

**ArincDirect iPad App**: if you were filed via Arinc (mostly for domestic operations), your route of flight and EDR hazards will appear:
Flight Situational Awareness Viewer (FSAV) iPad App: Delta Air Lines currently utilizes an iteration of this subscription-based application to provide a profile view of EDR data.
Gulfstream

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