|  |
| --- |
|  |
| EDR Turbulence Implementation Plan |
| DRAFT |
|  |
| **Gregory Meymaris, NCAR** |
| **February 14, 2014** |

|  |
| --- |
|  |

# Introduction

In the U.S., and presumably elsewhere in the world, unexpected turbulence encounters are a leading source of occupant injuries. Costs from injuries, aircraft damage. inspection and maintenance, and delays are significant. Because turbulence is often invisible to both pilots and remote sensing devices (e.g. radar), *in situ* aircraft observations are a critical piece of the turbulence mitigation puzzle. Reliable turbulence observations are essential for the development, running, and verification of any turbulence nowcast and forecast product, or can be used like a pilot report (PIREP/AIREP) for situational awareness for tactical turbulence avoidance.

Traditionally, the only *in situ* aircraft observations of turbulence are provided by pilots (PIREP/AIREP). While useful, there are significant problems with pilot generated turbulence reports including:

* subjectivity of the turbulence intensity
* substantial errors of the reported time and position
* a pilot’s experience of turbulence depends on the aircraft type and flight conditions
* severe under-reporting of smooth conditions

An ideal observation would be objective, accurate with respect to time, position, and intensity, independent of the aircraft (i.e. solely atmospheric), and would provide an unbiased sampling of turbulence where aircraft fly. To address this, under the sponsorship if the U.S. Federal Aviation Andministration (FAA), the National Center for Atmospheric Research developed an *in situ* turbulence reporting algorithm, which reports eddy dissipation rate. Technically, EDR (defined as the cube root of the eddy dissipation rate) is what is reported. MacCready (1964) first suggested the use of EDR as a metric of turbulence intensity. It is particularly useful operationally, since EDR along the vertical direction is proportional to the RMS (root-mean-square) vertical acceleration experienced by an aircraft for specific flight conditions (MacCready 1964; Cornman et al. 1995). Further, EDR has been adopted as the standard metric for atmospheric turbulence reporting by ICAO (2001).

## Implementations

There are three “flavors” of operational EDR algorithms: the vertical acceleration-based (NCAR1, TAPS), the true airspeed-based (TAMDAR), and the vertical wind-based (NCAR2).

# Aims

* Encourage and enable EDR software deployment and downlink capabilities within the AMDAR program with the goal of providing EDR data access to airlines, turbulence forecasting/nowcasting entities, NWP entities, etc.
* Provide guidance on EDR data usage

# Stakeholders

* Airlines
* Turbulence Forecasting/Nowcasting entities (research, operational, etc.)
* Government Agencies (e.g. FAA)
* Flight management entities (e.g. weather display)
* NWP entities
* Wake vortex community?

# Scope

* EDR software availability and implementation
	+ Current (NCAR2) software is available as C library (requires integration into ACMS), as C library with accompanying Teledyne interface software (requires assistance from Delta), or a software application for Honeywell ACMS (-02 and -50 boxes; only for B737-700/-800/-900) (requires assistance from Honeywell)
	+ Should consider working with Teledyne to ease future deployments on Teledyne systems.
	+ New aircraft types require ability to record high-rate input data for tuning and verification
	+ FAA has funded NCAR to update software and documentation package to allow an entity to integrate EDR into ACMS with little or no support. The package would include requirements checking, tuning, and testing. First phase is to be finished by end of Q3 14. A partner airline would take this package and implement, providing feedback which, funding permitting, would be incorporated into a phase 2 sometime after Q4 14.
* integration of EDR reporting into AMDAR software
	+ Update ARINC 620 specification as needed
	+ Handling of triggered as well as routing reporting
* Engagement with existing partner airlines (extension in the USA, expansion globally, commencing with Europe)
* Engagement with data users (mainly aviation meteorology) regarding requirements for application/data use
* Pilot projects (e.g. Air France)
* Develop guidance for airline usage of EDR data.

# Strategy

Encourage and coordinate implementation of EDR outside of USA by initially focusing on development in Europe. In particular, seek out willing European airline to partner with on a pilot EDR implementation.

# Key Tasks

# Timeline

# Risks

The largest known technical risk is the implementation of the EDR software on an aircraft. The current (NCAR) software has been successfully installed on B737-700/800/900 (Honeywell and Teledyne ACMS) and B767-300/400 (Teledyne ACMS). Costs for deployment on different configurations vary substantially.

# Bibliography

Cornman, L. B., C. S. Morse, and G. Cunning, 1995: Real-time estimation of atmospheric turbulence severity from in-situ aircraft measurements.  *J. Aircraft*, **32,** 171-177.

International Civil Aviation Organization (ICAO), 2001: Meteorological service for international air navigation. – Annex 3 to the Convention on International Civil Aviation, 14th Edition, 128 pp. [pdf file available from authors]

MacCready, P. B. Jr., 1962: The inertial subrange of atmospheric turbulence. *J. Geophys. Res.*, **67**, 1051–1059.