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INTERFACE STANDARDS FOR INTEGRATED FORWARD-LOOKING/PREDICTIVE/REACTIVE WINDSHEAR SYSTEMS

1.0 ABSTRACT

Forward-looking windshear systems are developing to a point (particularly the infrared sensors) where their interface with the cockpit and reactive windshear systems needs to be defined. As airlines retrofit their aircraft with reactive windshear systems, it is important that we recognize that onboard windshear systems of the future will be a combination of both forward-looking and reactive elements. Today's reactive systems need to be built with the capability to interface to the forward-looking systems of tomorrow. This presentation is a first step at looking at the requirements and defining interface standards for integrated forward-looking and reactive windshear systems. Undoubtedly the requirements for interfacing these types of windshear systems will change as the technology changes.

2.0 DEFINITIONS

It is important that we communicate from a common baseline. Therefore, the definitions shown on Slide No. 2 will be used throughout this presentation. The important points to remember are:

1) Each type of windshear system performs a different task. Therefore, forward-looking systems are different from predictive systems which are different from reactive systems.

2) The caution and warning alerts are always controlled by the reactive system. Looking at the best failure modes for the total (forward-looking, predictive, and reactive) system, the forward or predictive systems should not operate without a reactive system. Yet, the reactive system must operate without the forward or predictive systems.

3.0 BLOCK DIAGRAM

What discussion of interfaces would be complete without the block diagram. As can be seen in Slide No. 3, the predictive and reactive systems can be combined into one LRU. Predictive elements (sensors and algorithms) can be readily incorporated into the reactive systems without the need for separate dedicated sensors or LRUs. The forward-looking and reactive/predictive systems will communicate over standard ARINC 429 data busses. The reactive/predictive system will supply the forward-looking system with data to help it perform it's function. The forward-looking system will then supply the reactive/predictive system with data to activate the alerts or perform some precise threshold adjustment.

The forward-looking system will interface to a situational display which allows the flight crew to see the position of the event relative to the aircraft position or to display additional data (winds) concerning the event. It is foreseen that this would only be used by the flight crew when the aircraft was not in takeoff roll, takeoff, approach, or go-around.

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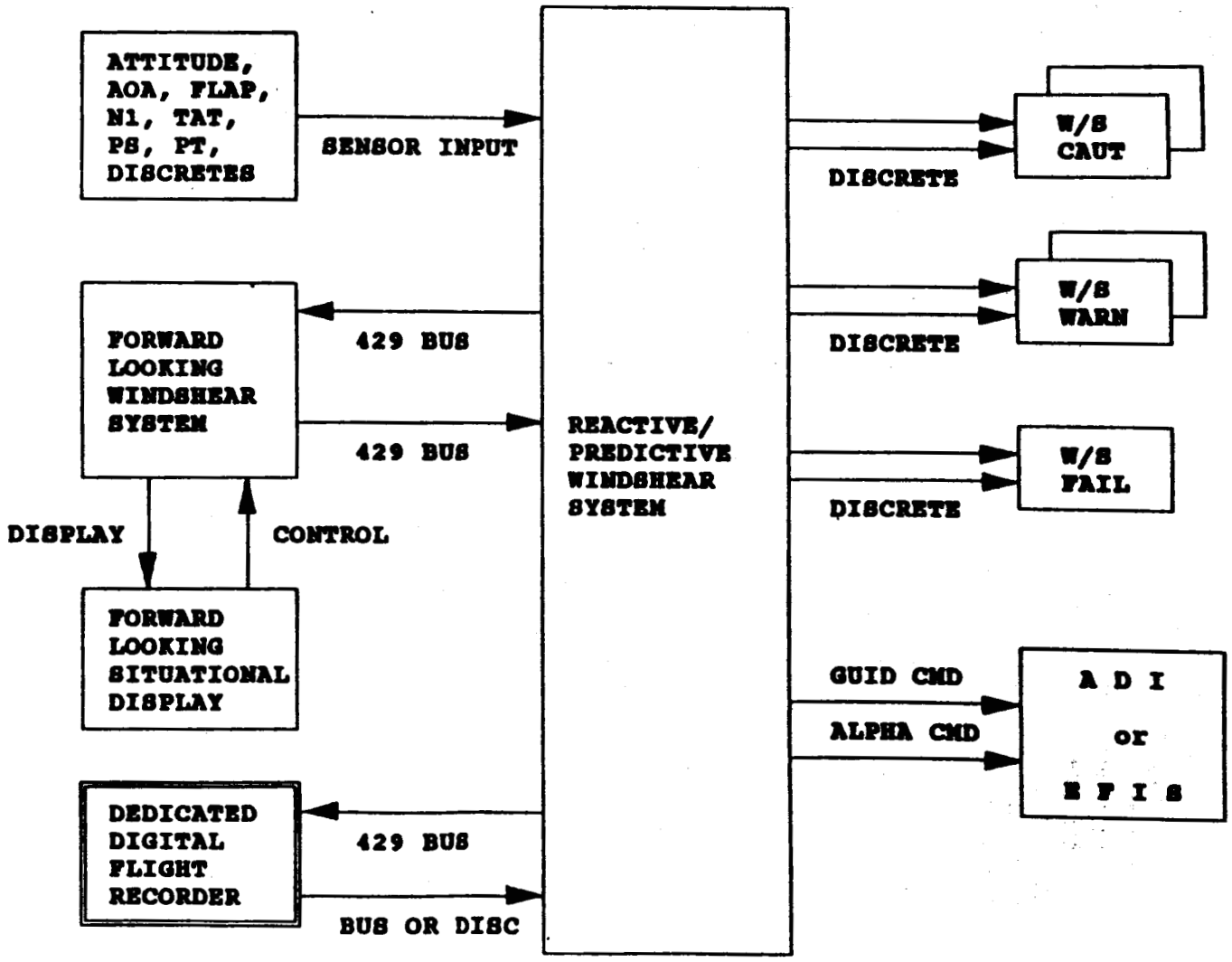
INTERFACE STANDARDS FOR INTEGRATED FORWARD-LOOKING/PREDICTIVE/REACTIVE WINDSHEAR SYSTEMS

DEFINITIONS:

REACTIVE SYSTEM	-	A SYSTEM WHICH UTILIZES INSITU TECHNIQUES TO MEASURE WINDSHEAR
PREDICTIVE SYSTEM	-	A SYSTEM WHICH UTILIZES METEOROLOGICAL DATA (TEMPERATURE LAPSE RATE, FREEZING POINT ALT, DEW POINT, ETC.) TO DETERMINE THE PRESENCE OF AN UNSTABLE AIR MASS
FORWARD-LOOKING SYSTEM	-	A SYSTEM WHICH UTILIZES FORWARD-LOOKING TECHNIQUES (INFRARED, DOPPLER RADAR, LIDAR) TO MEASURE WINDSHEAR
CAUTION ALERT	-	THE CAPTAIN'S AND FIRST OFFICER'S AMBER CAUTION LAMPS ACTIVATED BY THE REACTIVE SYSTEM
WARNING ALERT	-	THE CAPTAIN'S AND FIRST OFFICER'S RED WARNING LAMPS ACTIVATED BY THE REACTIVE SYSTEM
AURAL ALERT	-	THE AURAL MESSAGE ACTIVATED BY THE REACTIVE SYSTEM
SITUATIONAL DISPLAY	-	THE DISPLAY UTILIZED BY THE FORWARD-LOOKING SYSTEM TO INDICATE THE POSITION OF THE COMPUTED EVENT

INTEGRATED FORWARD-LOOKING/PREDICTIVE/REACTIVE WINDSHEAR SYSTEM BLOCK DIAGRAM



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The dedicated digital flight recorder is shown to emphasize the need for a recorder interface which will be used in the certification of any of the three (reactive, predictive, or forward-looking) windshear systems. Data that is gathered as part of the development process and flight test of the forward-looking system would be used to demonstrate the nuisance characteristics and possibly the determination of valid windshear detections.

4.0 ANNUNCIATION OPTIONS

Now that we have integrated the systems in the aircraft we need to define and provide the proper annunciations to the flight crew. Current reactive annunciations (as defined in AC25-12) are indicated on Slide No. 4. If we extend this philosophy of flashing amber meaning headwind or updraft (unstable air), then a steady (steady because it's predictive) amber could also mean a detected unstable airmass. Note that this is only valid in approach and although the annunciation activation occurs once a minimum landing configuration is selected, the predictive system is gathering data throughout the entire descent profile.

Forward-looking systems are a bit harder to categorize. Since the IR detects only the cold downflow (decreasing performance), while the DOPPLER or LIDAR can detect only the outflows (increasing and decreasing performance) we can simplify and determine that if any type of forward-looking system has detected a decreasing performance shear and the aircraft is in a potentially low energy state (takeoff roll, takeoff, approach, or go-around) then the action is the same as if the reactive system had detected the shear, ie., activate the flashing red warning lamps along with the windshear aural warning annunciation.

It is recognized that other options are open. The type of information displayed on a situational display when the aircraft is outside of the low energy state, such as outside the outer marker or as a clear air turbulence indication are examples. These displays are separate and independent of the interface to the reactive system.

5.0 DATA BUS PARAMETERS

Slide No. 5 defines the types of data the reactive system has access to and should be sent to the forward-looking system to simplify its interface to the aircraft. The forward-looking system would use these inputs to perform scanning stabilization, sensor cross check, and mode transition, thereby allowing the two systems to work together.

Slide No. 6 defines the typical data that is available from a forward-looking system that could be sent to the reactive system. The hazard index or intensity level would be used to activate the red warning alert.

INTEGRATED FORWARD-LOOKING/PREDICTIVE/REACTIVE WINDSHEAR SYSTEM ANNUNCIATION OPTIONS

LOW LEVEL WINDSHEAR DETECTION

TYPE OF DETECTION	ANNUNCIATION		CANCEL	ACTIVATION
	VISUAL	AURAL		
REACTIVE POSITIVE ENERGY	FLASHING AMBER	OPTIONAL	NO	T/R, T/O, APP*, G/A
REACTIVE NEGATIVE ENERGY	FLASHING RED	WINDSHEAR (3)	NO	T/R, T/O, APP*, G/A
PREDICTIVE	STEADY AMBER	OPTIONAL	NO	APPROACH*
FORWARD-LOOKING	FLASHING RED	WINDSHEAR (3)	NO	T/R, T/O, APP*, G/A

* - MINIMUM LANDING CONFIGURATION (FLAPS/GEAR) OR TBD ALT AGL AS APPLICABLE

INTEGRATED FORWARD-LOOKING/PREDICTIVE/REACTIVE WINDSHEAR SYSTEM DATA BUS PARAMETERS

REACTIVE SYSTEM OUTPUTS

PARAMETER NAME	ARINC LABEL	UPDATE RATE	PRIMARY USE BY FORWARD LOOKING SYSTEM
PITCH - DEGREES	324	16 HZ	STABILIZATION FOR SCANNING FUNCTION
ROLL - DEGREES	325	16 HZ	STABILIZATION FOR SCANNING FUNCTION
TAT - DEG C	211	4 HZ	IR COMPENSATION/SENSOR CROSS CHECK
SAT - DEG C	213	4 HZ	IR COMPENSATION/SENSOR CROSS CHECK
PRESS ALT - FEET	203	16 HZ	MODE LOGIC
TAS - KNOTS	210	8 HZ	MODE LOGIC
WSC MODE/STATUS	TBD	8 HZ	MODE LOGIC/FAILURE MONITORING
WSC DISCRETES	TBD	8 HZ	MODE LOGIC

INTEGRATED FORWARD-LOOKING/PREDICTIVE/REACTIVE WINDSHEAR SYSTEM DATA BUS PARAMETERS

FORWARD-LOOKING SYSTEM OUTPUTS

TYPE OF SYSTEM	MEASURED DATA	COMPUTED DATA	ARINC 429 DATA TRANSFER
INFRARED	NEAR TEMP - DEG C	DELTA TEMP - DEG C	NEW ARINC 429 LABELS ASSIGNED FOR EACH PARAMETER NON STANDARD LABELS COULD BE USED FOR ENG TELEMETRY DATA DURING SENSOR EVALUATION
	FAR TEMP - DEG C	LONG WIND - KNOTS	
		HAZARD INDEX	
		TELEMETRY/MODE	
DOPPLER RADAR	LONG WIND - M/SEC	INTENSITY LEVEL	LOW SPEED 429 WITH FORMAT SIMILAR TO CURRENT ARINC 708 WEATHER RADAR DATA INCLUDES: PREAMBLE, AZIMUTH ANGLE, INTENSITY PER RANGE BIN
		AZIMUTH ANGLE	
		MODE/STATUS	
LIDAR	LONG WIND - M/SEC	INTENSITY LEVEL	PROPOSE SAME AS DOPPLER RADAR
		AZIMUTH ANGLE	
		MODE/STATUS	