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Session V. TDWR Data Link / Display

N91-24176

TDWR Information on the Flight Deck
Dave Hinton, NASA Langley

TDWR INFORMATION ON THE FLIGHT DECK

DAVID A. HINTON
NASA, LANGLEY RESEARCH CENTER

THIRD COMBINED MANUFACTURERS' AND TECHNOLOGISTS' AIRBORNE WINDSHEAR REVIEW MEETING

Hampton, VA
Oct 16 - 18, 1990

BACKGROUND

- FAA INTEGRATED WINDSHEAR PROGRAM ADDRESSES BOTH GROUND AND AIRBORNE ASPECTS OF HAZARD REDUCTION. NASA ROLE HAS BEEN IN AIRBORNE SIDE

- FAA EFFORTS HAVE DEVELOPED TERMINAL DOPPLER WEATHER RADAR FOR MICROBURST DETECTION - TDWR HAS PROVEN CAPABILITIES IN OPERATIONAL DEMONSTRATIONS

- CREW COMMUNICATIONS ISSUES HAVE SURFACED DURING DEMONSTRATIONS

- NASA ASKED TO EXPAND SCOPE OF EFFORT TO INCLUDE INTEGRATION OF GROUND-DERIVED WINDSHEAR INFORMATION ON THE FLIGHT DECK

AIR / GROUND WIND SHEAR INFORMATION INTEGRATION RESEARCH

GOAL

TO SUPPORT FAA AVIATION POLICY INITIATIVE TO REDUCE WIND SHEAR RISK THROUGH INTEGRATION OF TDWR TECHNOLOGY AND AIRBORNE DETECTION SYSTEM CAPABILITIES

APPROACH

PERFORM GROUND SIMULATIONS AND CONDUCT A SERIES OF FLIGHT EXPERIMENTS COLLATERAL WITH AIRBORNE SENSOR DEMONSTRATIONS AT LOCATIONS COVERED BY TDWR

- DETERMINE THE BENEFIT OF REAL-TIME AIRBORNE PROCESSING OF DATA LINK TDWR INFORMATION
- DEVELOP EXECUTIVE-LEVEL CREW ALERTING PROTOCOLS AND OPERATING PROCEDURES REQUIRED TO DETECT AND AVOID WIND SHEAR
- DEVELOP INFORMATION-LEVEL SENSOR FUSION CONCEPTS CONSISTENT WITH OPERATIONAL REQUIREMENTS

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AIR / GROUND WIND SHEAR INFORMATION INTEGRATION RESEARCH

GROUND RULES

- DON'T CHANGE THE GROUND SYSTEMS OR CURRENT ATC ROLES
- IDENTIFY GROUND PRODUCTS NEEDED FOR UPLINK TO SUPPORT TIME CRITICAL INFORMATION PROCESSING AND DISPLAY
- DOWNLINK STATUS OF AIRBORNE WARNING TO ATC
- TASK TAILORED AIR / GROUND ROLES
  - GROUND - CLASSIFY AND LOCATE
  - AIRBORNE - QUANTIFY AND ANNUNCIATE
- KEEP OPERATIONAL PROCEDURES SIMPLE e.g., STRAIGHT UP AND OUT AVOIDANCE
- FOCUS PROGRAM ON TECHNOLOGY INTEGRATION / EVALUATION

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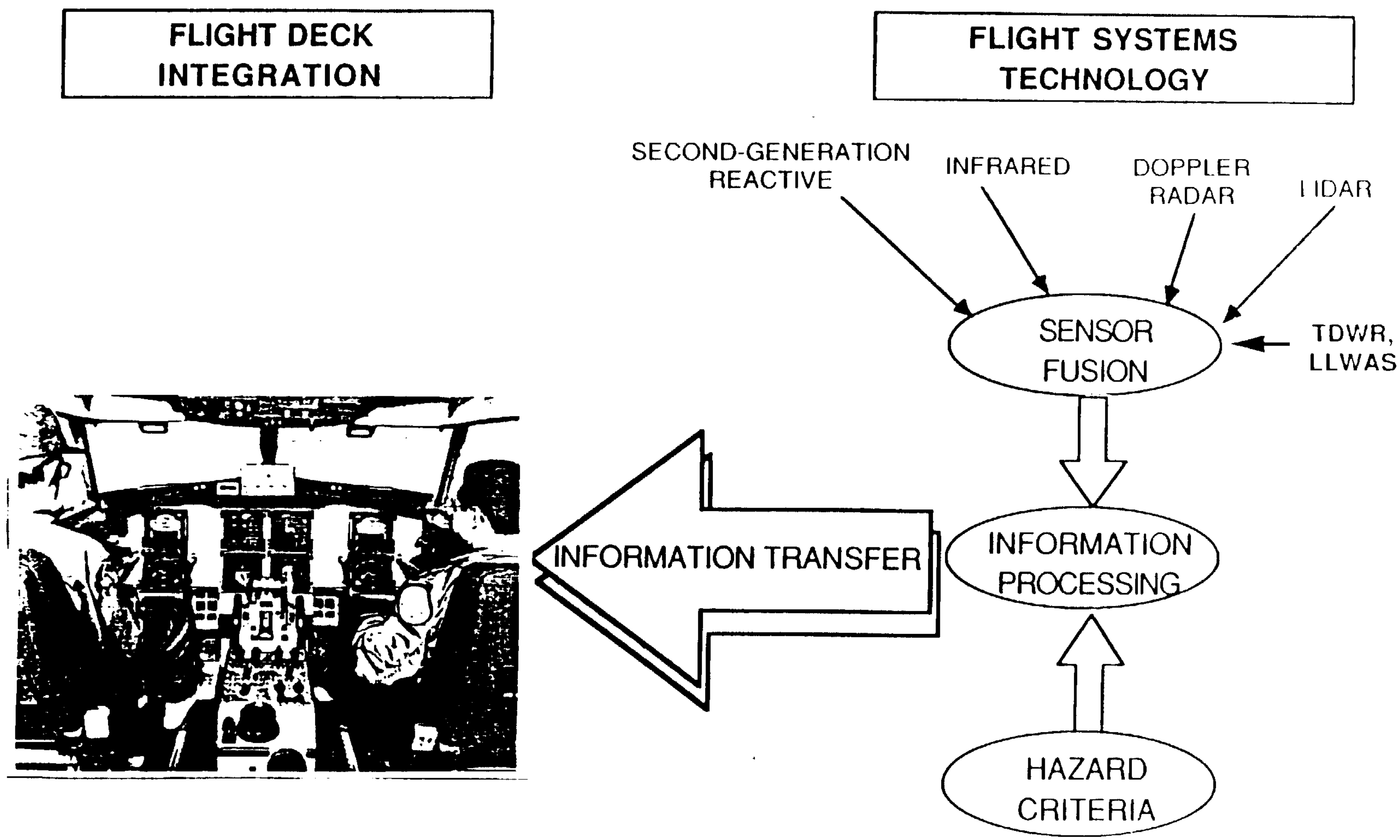
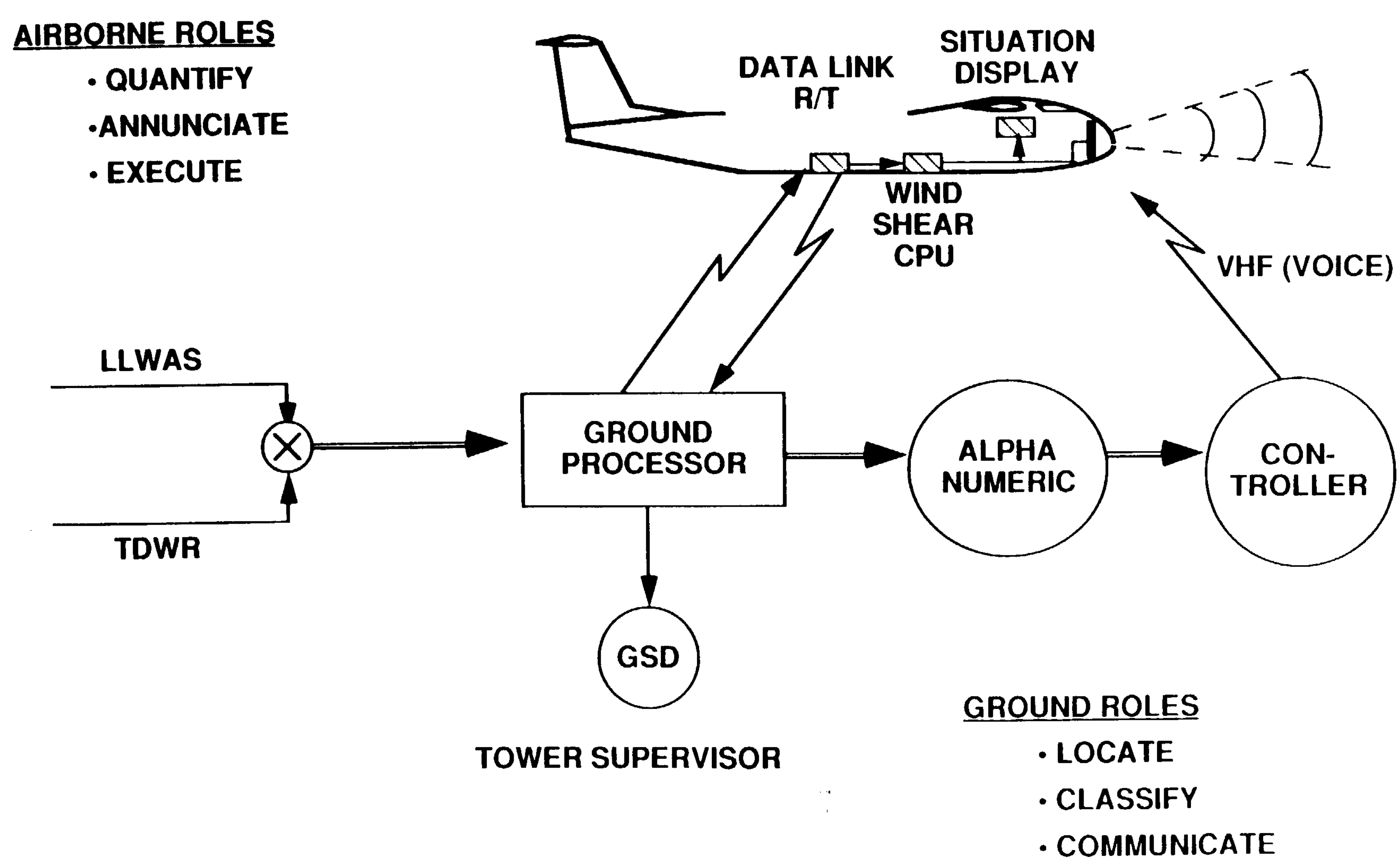
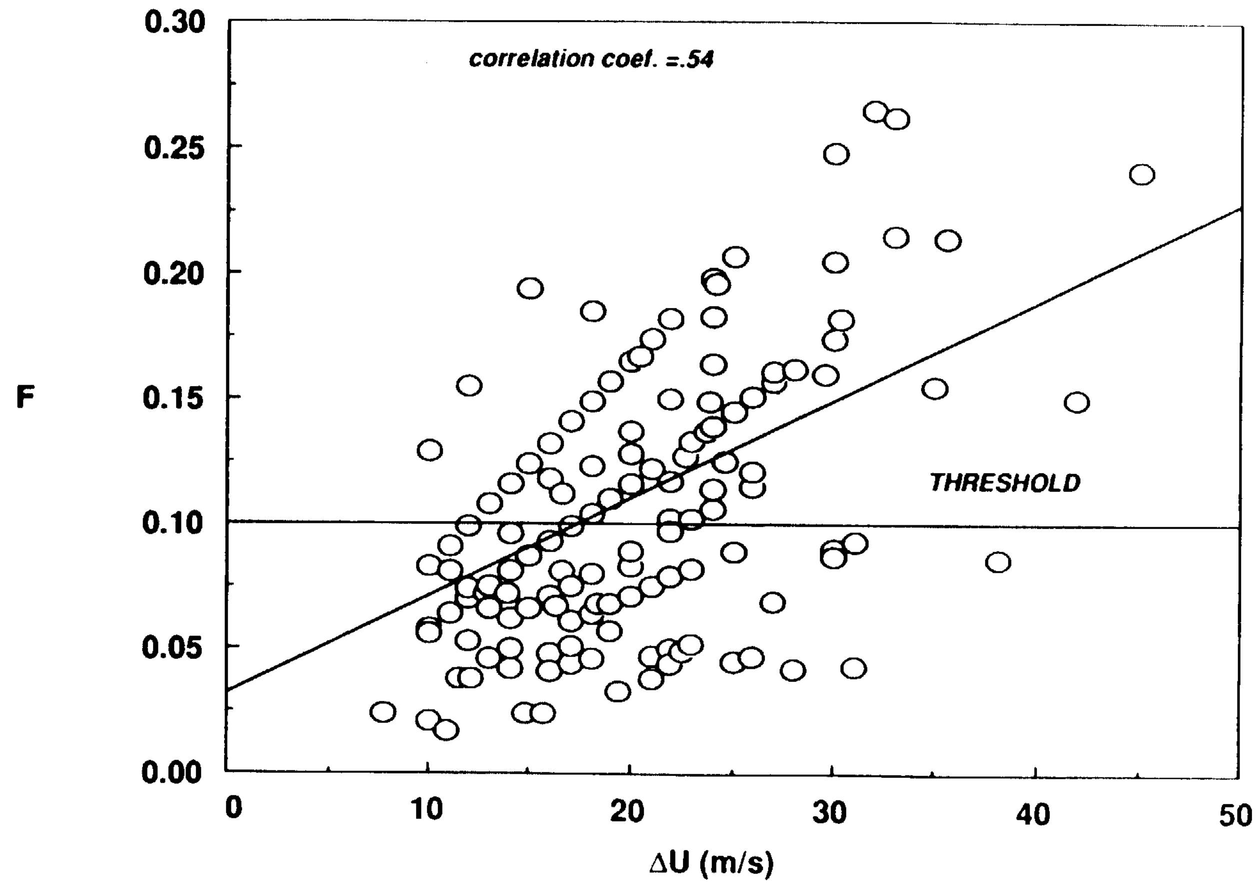
WIND SHEAR DETECTION/WARNING AND AVOIDANCE SYSTEM



AIR / GROUND WIND SHEAR INFORMATION INTEGRATION INTEGRATION CONCEPT



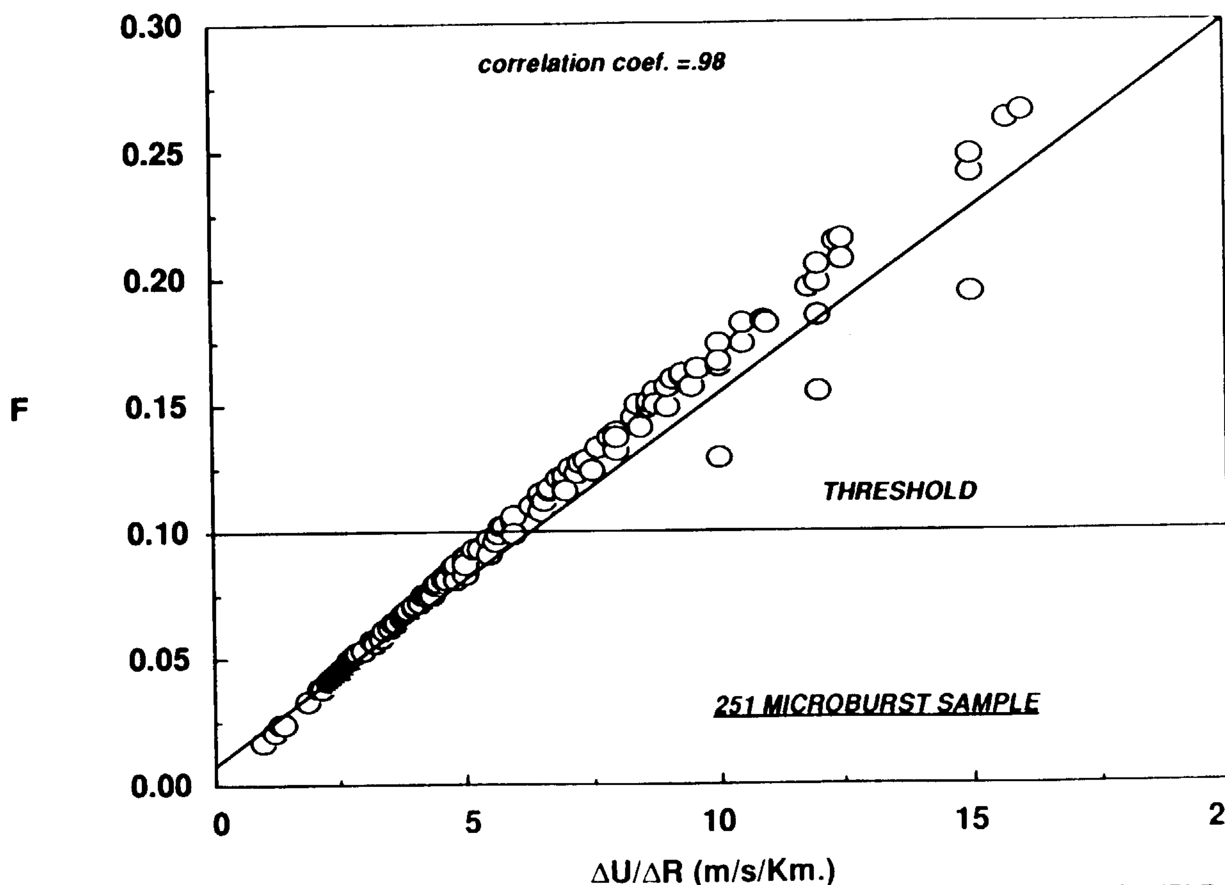
CORRELATION OF F-FACTOR WITH MICROBURST WIND DIVERGENCE



251 MICROBURST SAMPLE

- *39 JAWS (NCAR)*
- *27 FLOWS (LINCOLN LAB)*
- *29 CINDE (NOAA)*
- *156 DENVER TDWR (LINCOLN LAB)*

CORRELATION OF MICROBURST F-FACTOR WITH $\frac{\text{WIND DIVERGENCE}}{\text{MICROBURST RADIUS}}$



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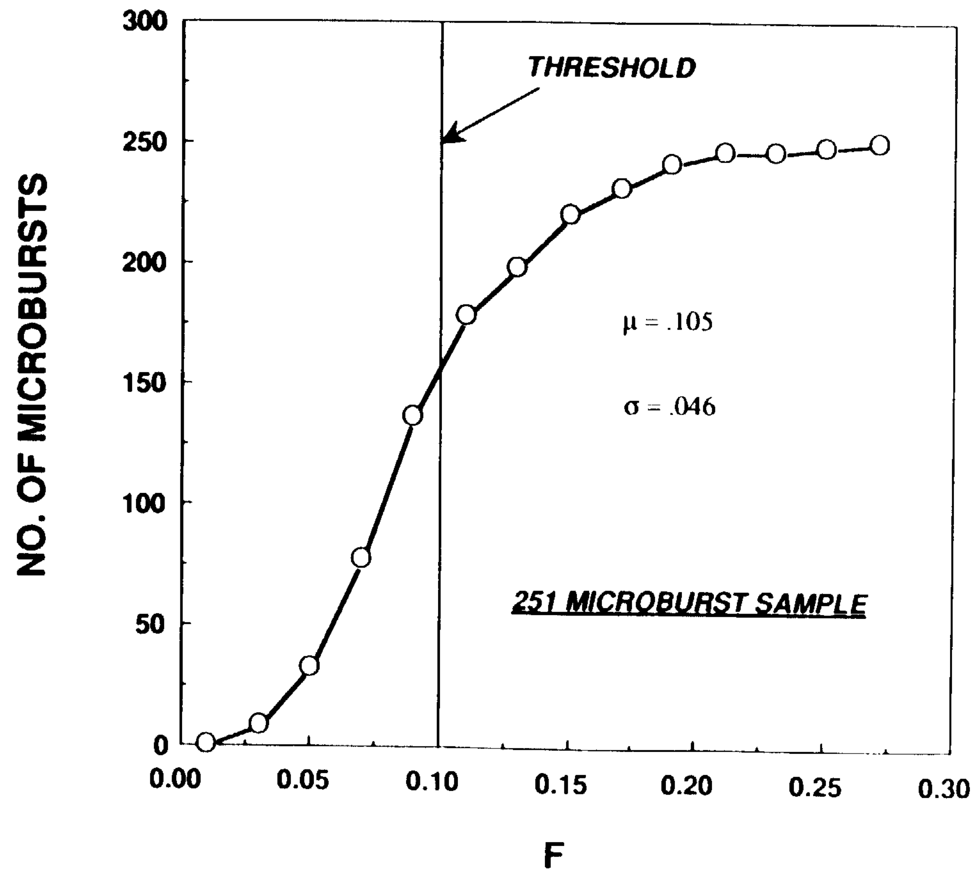
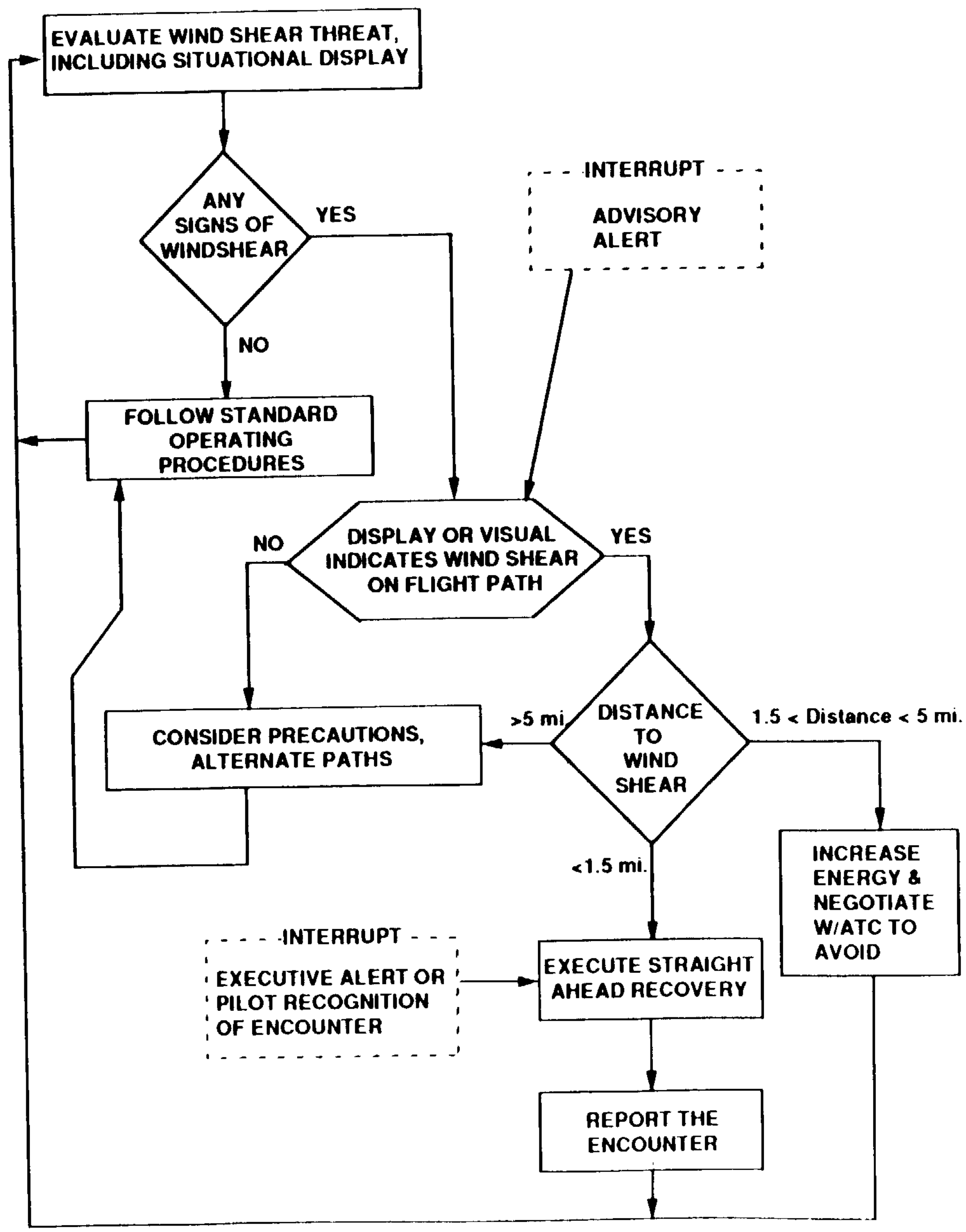
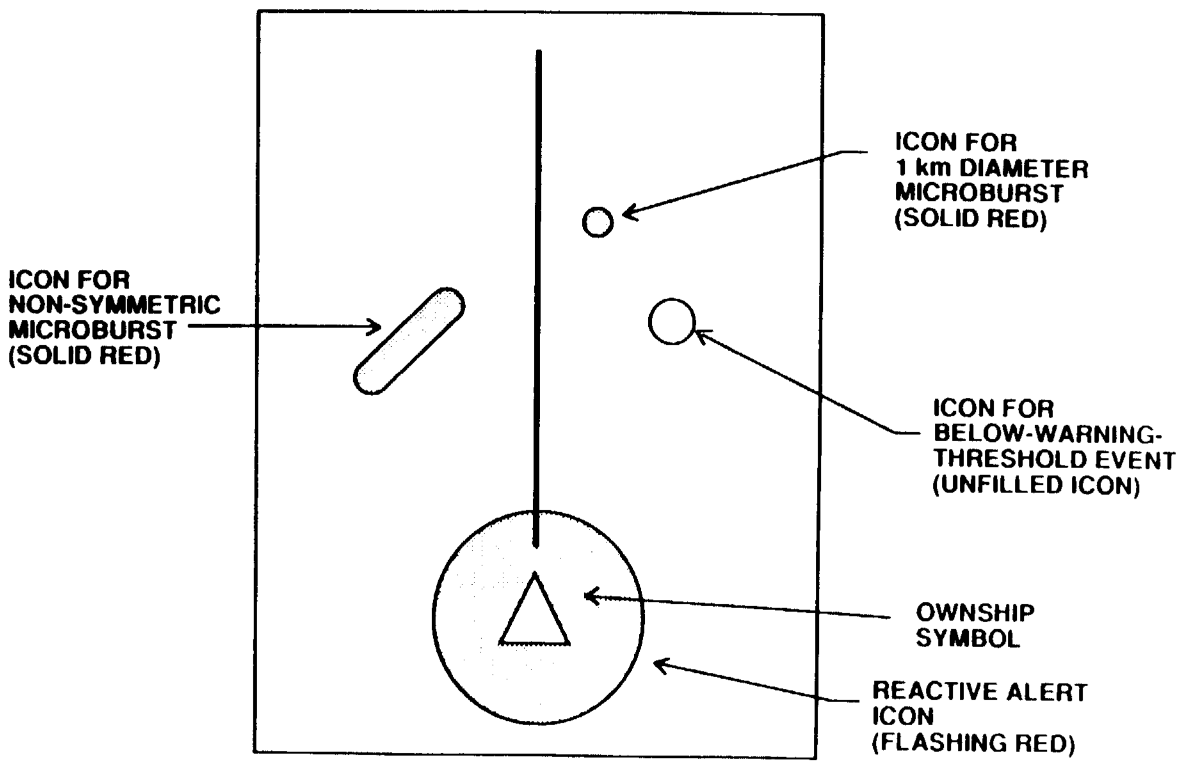
MICROBURST SAMPLE CUMULATIVE DISTRIBUTION



WINDSHEAR CREW PROCEDURE



CREW DISPLAY CONCEPT



COCKPIT MOVING
MAP DISPLAY

INITIAL EXPERIMENT

- CONDUCT FLIGHT EXPERIMENT WITH TDWR DEMO AT ORLANDO - SUMMER 1990
  - CONTRACT TO MIT LINCOLN LAB
  - DATA LINK OF TDWR INFORMATION TO UND CESSNA CITATION
  - EVALUATE NASA F-FACTOR ALGORITHM FOR TDWR APPLICATION
  - CORRELATE TDWR, AIRBORNE IN SITU, AND INFRARED WINDSHEAR DATA
- RESULTS
  - NUMEROUS MICROBURSTS DETECTED BY TDWR AND ENCOUNTERED BY CITATION
  - ANALYSIS OF JULY 7 MICROBURST CORE PENETRATION SHOWED EXCELLENT AGREEMENT BETWEEN TDWR, INFRARED, AND IN SITU F-FACTORS
  - ANALYSIS OF OTHER EVENTS TO FOLLOW IMPLEMENTATION OF DATA PROCESSING AIDS

FUTURE PLANS

- CONDUCT ANALYTICAL AND PILOTED SIMULATION OF CANDIDATE CREW PROCEDURE
- REFINE F-FACTOR ALGORITHM AND HAZARD CRITERIA
- PROVIDE DATA LINK AND DISPLAY OF TDWR INFORMATION TO NASA B737 FOR COMBINED SENSOR RESEARCH FLIGHTS AT ORLANDO AND DENVER (NCAR & MIT LINCOLN LAB)

TDWR Information on the Flight Deck - Questions and Answers

Q: FRED REMER (University of North Dakota) - The climatology of F-factor from JAWS, flows and TDWRs is impressive, but I'm troubled by some of the assumptions used to calculate F-factor, such as the downdraft, the true airspeed, etc. Would it make more sense to use aircraft data?

A: DAVE HINTON (NASA Langley) - Certainly, where it's available we would like to have aircraft data. The number of cases where an aircraft went through the core of a microburst while being examined by a radar is very, very small. I don't believe the true airspeed assumption is invalid, as a matter of fact, it is probably more valid to assume a typical transport category aircraft approach speed rather than the airspeed that you would go through in the Citation. You're going through quite a bit faster than a transport would. The estimation of the downdraft is obviously an area that needs more research.

Q: FRANK DREW (Lockheed Austin Division) - There is lots of looking at detection, interpretation, and integration. Basic systems such as LLWAS and TDWRs use different I/O parameters. Ground people and air crews have varying information needs. Cockpit real estate is very limited. Pilots must make their own decisions - not react to safety of flight decisions made from the ground. You say that future work includes display development. Given the situation the question is: is anyone in charge of developing cockpit display requirements, specs and standards? Should there be standardized displays? Who is in charge? What kind of aviator interaction (ALPA, airline operations people, NASA, DOD, MAC)? What kind of industry interaction? And a timetable for all of the above?

A: DAVE HINTON (NASA Langley) - I think we're getting into the realm here of the S7 committees, the various processes that are used to formulate industry specs, aviation practices and TSOs. NASA is certainly not in charge of developing display standards for the flight deck. We can provide guidelines. We can do the research to tell you what the forward looking systems are capable of doing. We can develop candidate crew procedures that can be supported by these forward looking systems. We can certainly develop display concepts and provide all the guidelines we get from research. We as an industry, again the S7, the airlines, the airframers and FAA certification, have to get together as a team to iron out the standards and specs. Timetable? I don't know. We're talking now about the formulation of an S7 committee on forward looking systems. I don't know of any being formed on displays. We'll be able to show you what you can do with a forward look system, but additional work has to be done to integrate this information with the displays given all the other requirements on the displays, such as ground prox, TCAS, etc., etc.

Q: WALT OVEREND (Delta Airlines) - You mentioned second generation reactive wind shear systems. What do you see as a better design to achieve a second generation system?

A: DAVE HINTON (NASA Langley) - I believe the current generation systems have two problems. One is a false alarm problem that can be induced by the turbulence rejection filtering that must be done, the lack of appropriate filtering or any misphasing of the various aircraft inputs. Secondly, aircraft maneuvering, thrust changes by the pilot, flap, spoilers, or gear position changes, all tend to ripple through or feed back as an F-factor on a reactive system. NASA has been involved in some simulation research over the past year and we're just now moving it into our airplane, to develop a second generation insitu system to be used as a truth measurement for our combined sensor flight test. The F-factor equation I showed this morning is a very simplified form of the F-factor and only holds true while the airplane is flying in the vertical plane. If you bank the airplane and start turning, a lot of other parameters fall into that equation. These parameters have to be included and we're now doing that.

Q: WALT OVEREND (Delta Airlines) - Do any of the conducted studies look at prevailing atmospheric and/or geographic formation to be able to predict how rapidly microburst form and move or decay and dissipate?

A: DAVE HINTON (NASA Langley) - There is a great deal of experience and documentation on that problem. The JAWS, Flows and CINDE data, similar to what we've presented today, show the microburst to be a very dynamic event. They can grow very rapidly from an insignificant event to a full strength microburst in a 3, 4 or 5 minute period, then they tail off relatively slowly. When do they cease to be a microburst, and when do you call off the alarm, is another question. As far as one dedicated reference on that particular topic, I didn't know of any out there. But, the data is buried in a number of reports; the information is available.