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Session VII. 2nd Generation Reactive Systems

N91-24183

Status of Sundstrand Research
Don Bateman, Sundstrand

STATUS
of
Windshear R and D

at
Sundstrand Data Control, Inc.
17 October, 1990

Windshear Detection Status

- 2nd Generation Detection System is Here
- 3rd Generation Detection System is in Work
- Look-Ahead is in Research and Development

SECOND GENERATION DETECTION

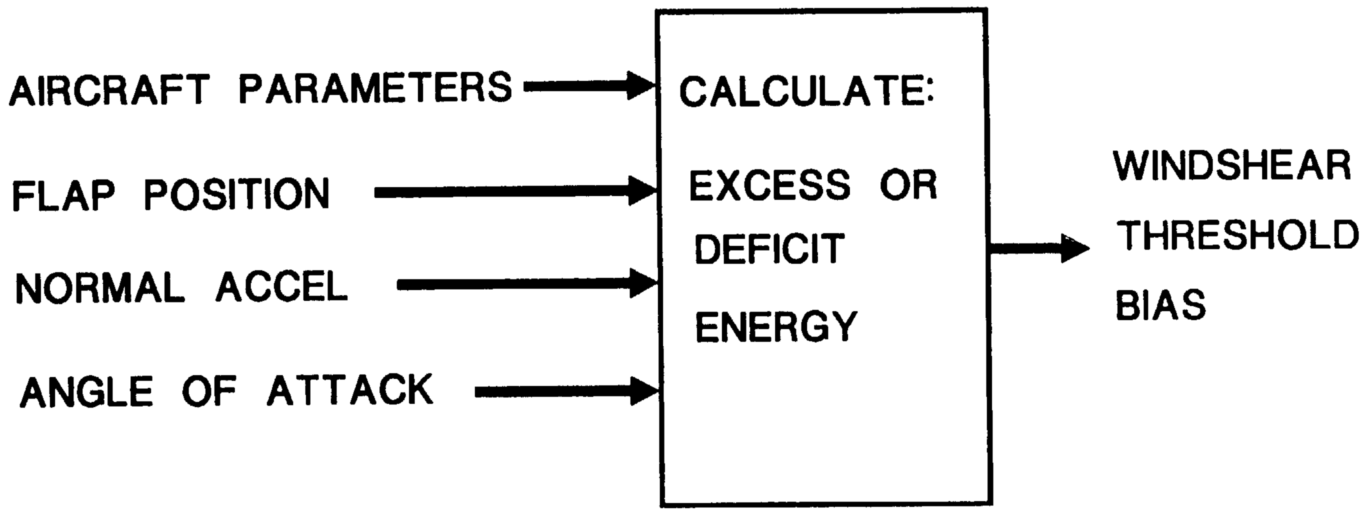
IMPROVE RATIO OF:

$$\frac{\text{USEFUL ALERTS}}{\text{UNWANTED ALERTS}}$$

- Q-BIAS
- GAMMA BIAS
- TEMP BIASES
- MANEUVERING FLIGHT MODULATION
- ALTITUDE MODULATION

— CERTIFIED 1988 ! —

Q - BIAS



- REDUCES UNWANTED ALERTS FOR APPROACH INTO HIGH SURFACE WIND WHEN AIRCRAFT HAS HIGH ENERGY
- SENSITIZES SYSTEM WHEN ENERGY IS LOW

TEMPERATURE BIASES

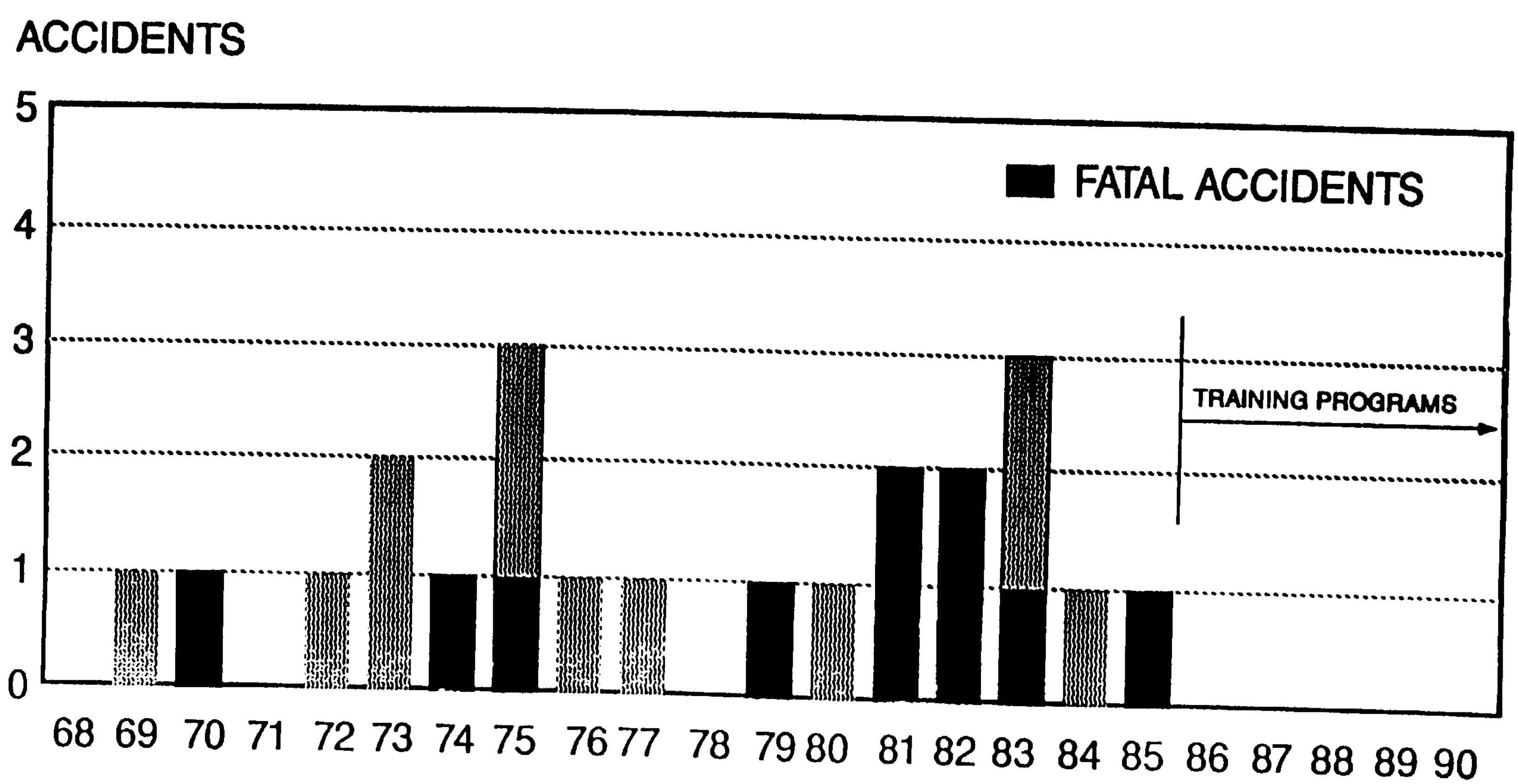
LAPSE RATE .... IMPROVES USEFUL ALERT TIME

TEMPERATURE VALUE .... REDUCES UNWANTED ALERTS

CURRENT SYSTEM PERFORMANCE

- VALID WARNINGS ARE OCCURING WORLDWIDE
- CREWS ARE RESPONDING PER APPROPRIATE PROCEDURE
- RATE OF UNWANTED WARNINGS IS LESS THAN 1 IN 3500 SEGMENTS
- WINDSHEAR "CAUTION" (POSITIVE SHEAR) > F = -0.1 ARE PROCEEDING NEGATIVE SHEARS BY 10 TO 15 SECONDS
- PREDICTIVE SENSORS WILL AUGMENT POSITIVE SHEAR DETECTION
- TEMP. LAPSE RATE BIAS IS PROVIDING 3 - 5 SECONDS IMPROVEMENT IN WARNING TIME

Windshear
WORLDWIDE COMMERCIAL JET FLEET



SOURCE: BOEING/FSF

Updated Chart Taken From Flight Safety Foundation, 42nd IASS, Athens, 1989, Page 33.

attle Post-Intelligencer Sunday, August 26, 1990 · K 3

ICE

SYLVIA /Nicole Hollander

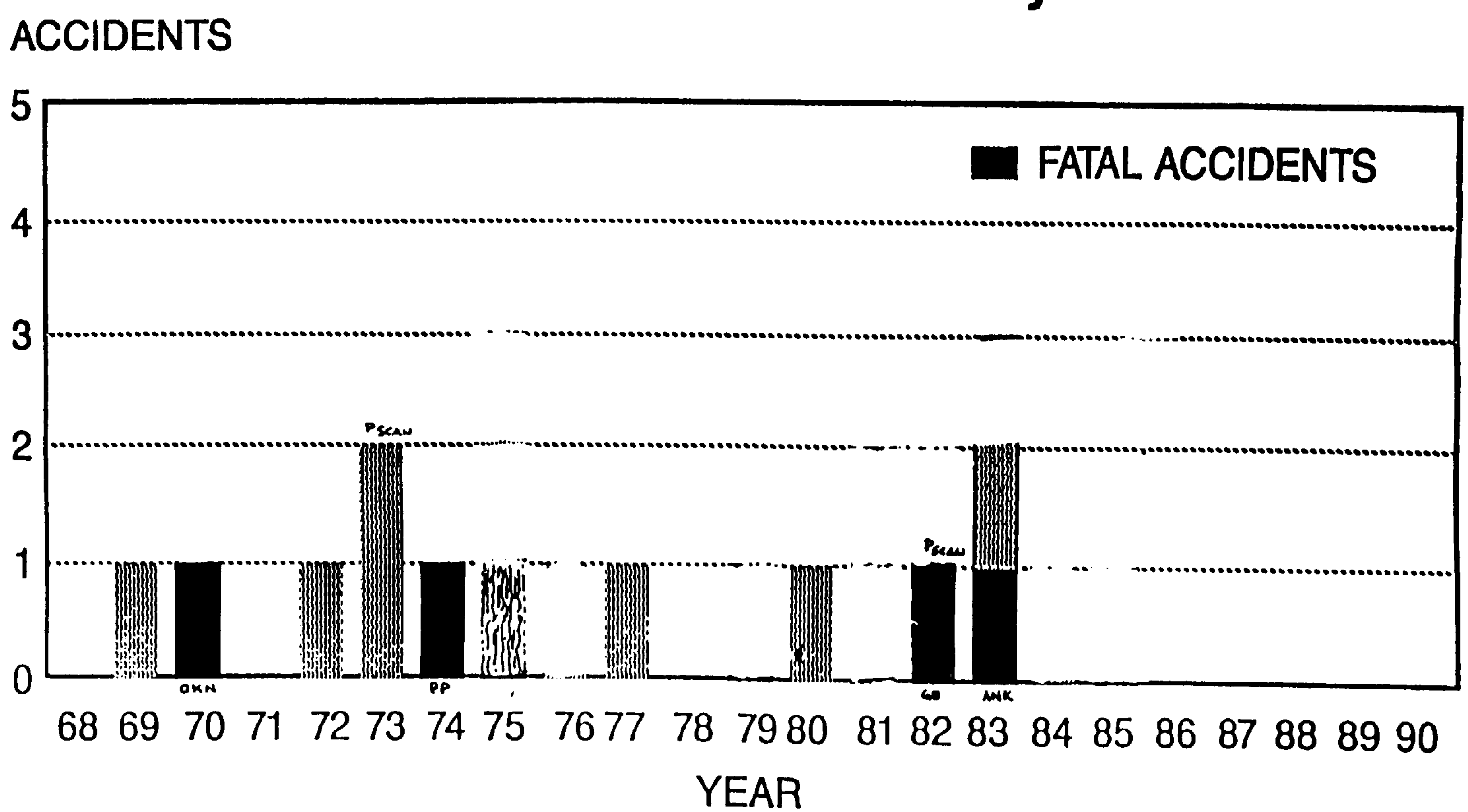
-- That because of the effectiveness of our pilot training programs

Sylvia appears Tuesday through Sunday in The Times

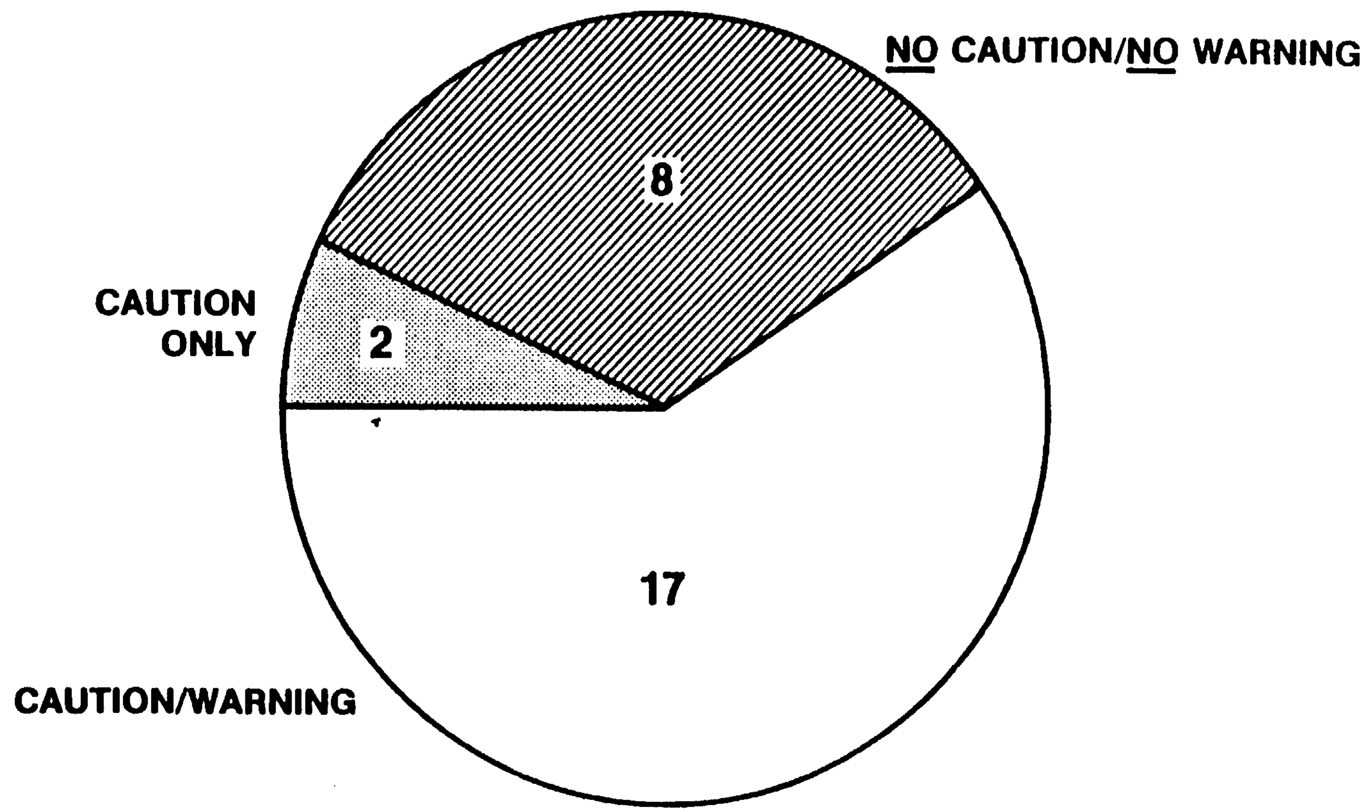
Third Generation Windshear Detection

Windshear

Accidents with no Warning For Current Detection Systems

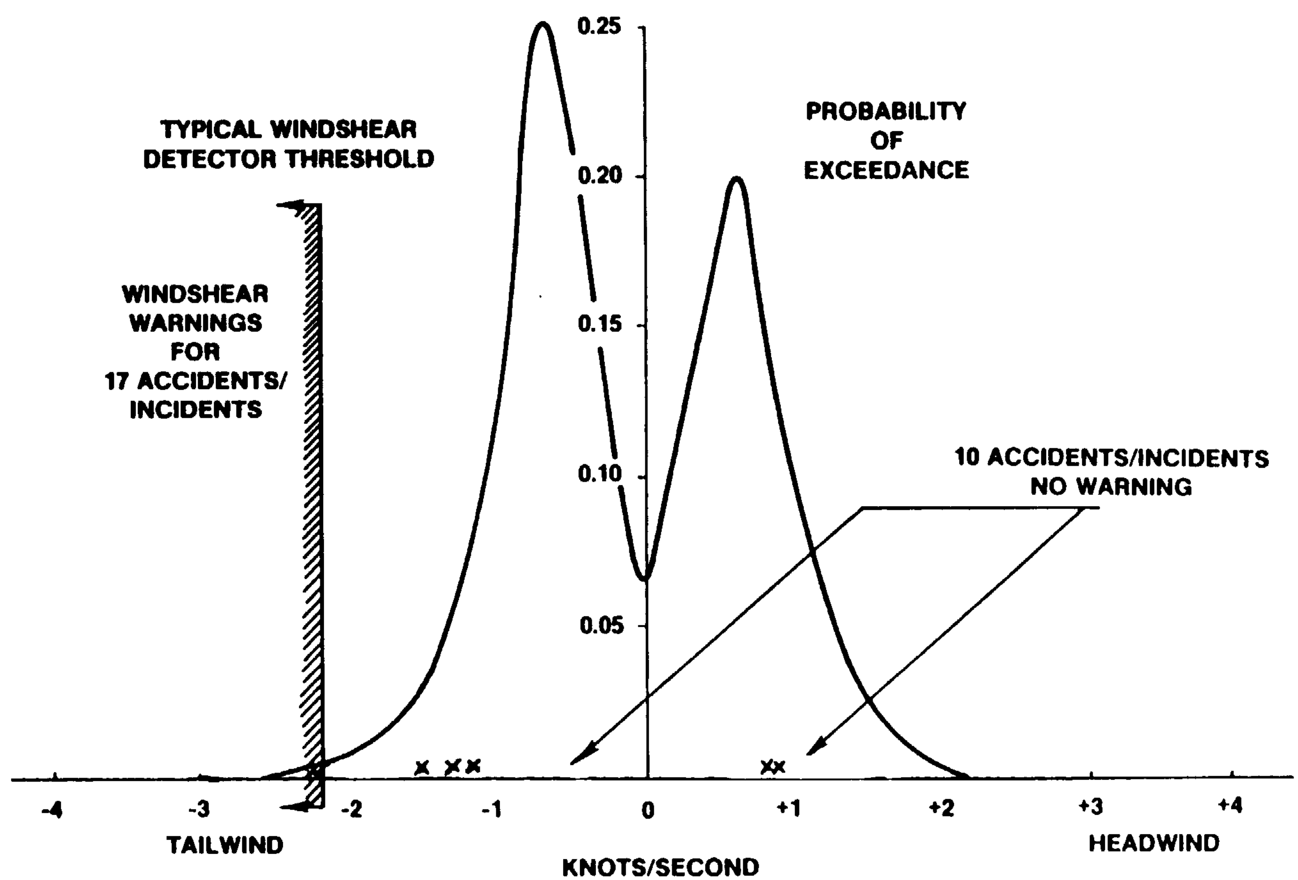


Effectivity of Second Generation Windshear Systems



27 WINDSHEAR RELATED ACCIDENTS/INCIDENTS
(NATIONAL ACADEMY OF SCIENCES DATA BASE)
1 MARCH 1964 - 28 JULY 1982

Windshear Threshold



Accident Examples Where Windshear Was

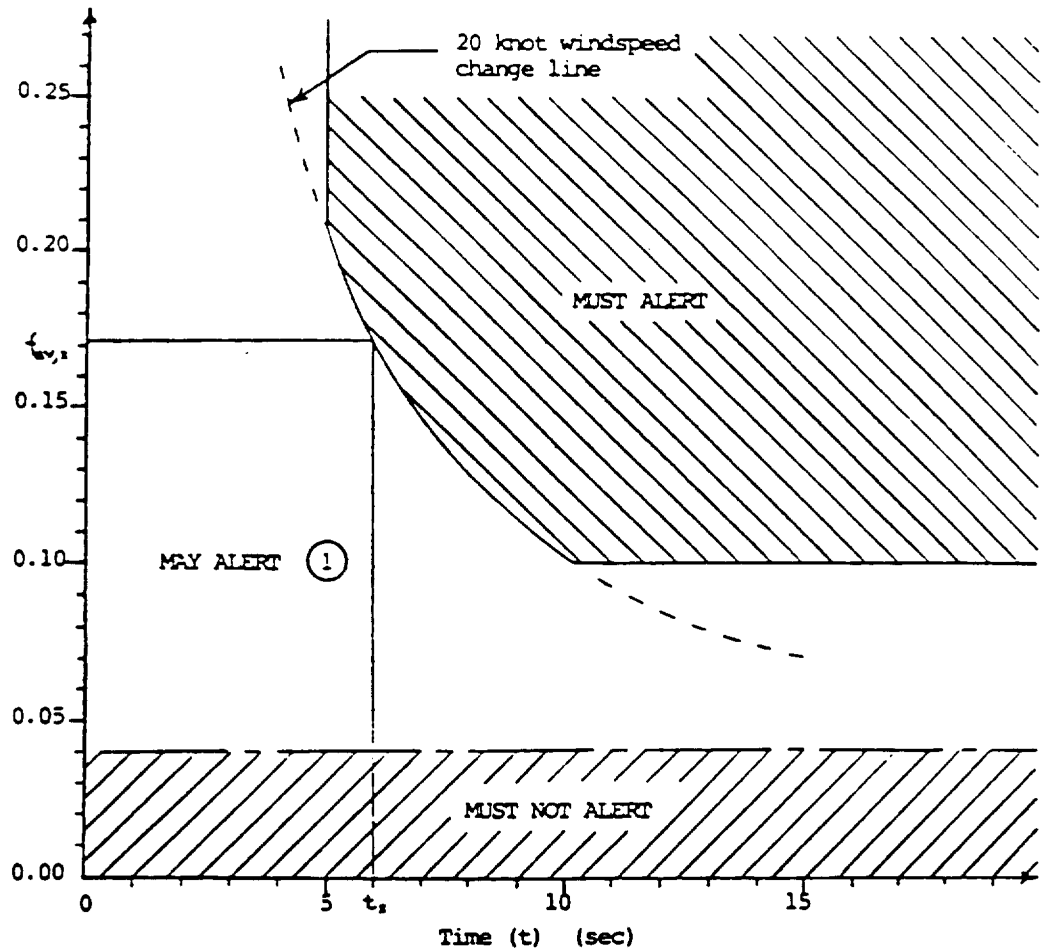
A Contributory Cause and The Estimated Windshear Values Are Less Than TSO-C117 Warning Requirements, or the Aircraft Performance Capability.

- Okinawa DC-8 -1.2 Kts/Sec for 12 Seconds
- Pago Pago B707 -1.3 Kts/Sec for 10 Seconds
- Boston DC-10 +0.8 Kts/Seç for 15 Seconds
- Ankara B727 +0.8 Kts/Sec for 36 Seconds
- Dade-Collier DC-8 -1.5 Kts/Sec for 10 Seconds

+ Increasing Energy Windshear

FIGURE 1

SHEAR INTENSITY CURVE



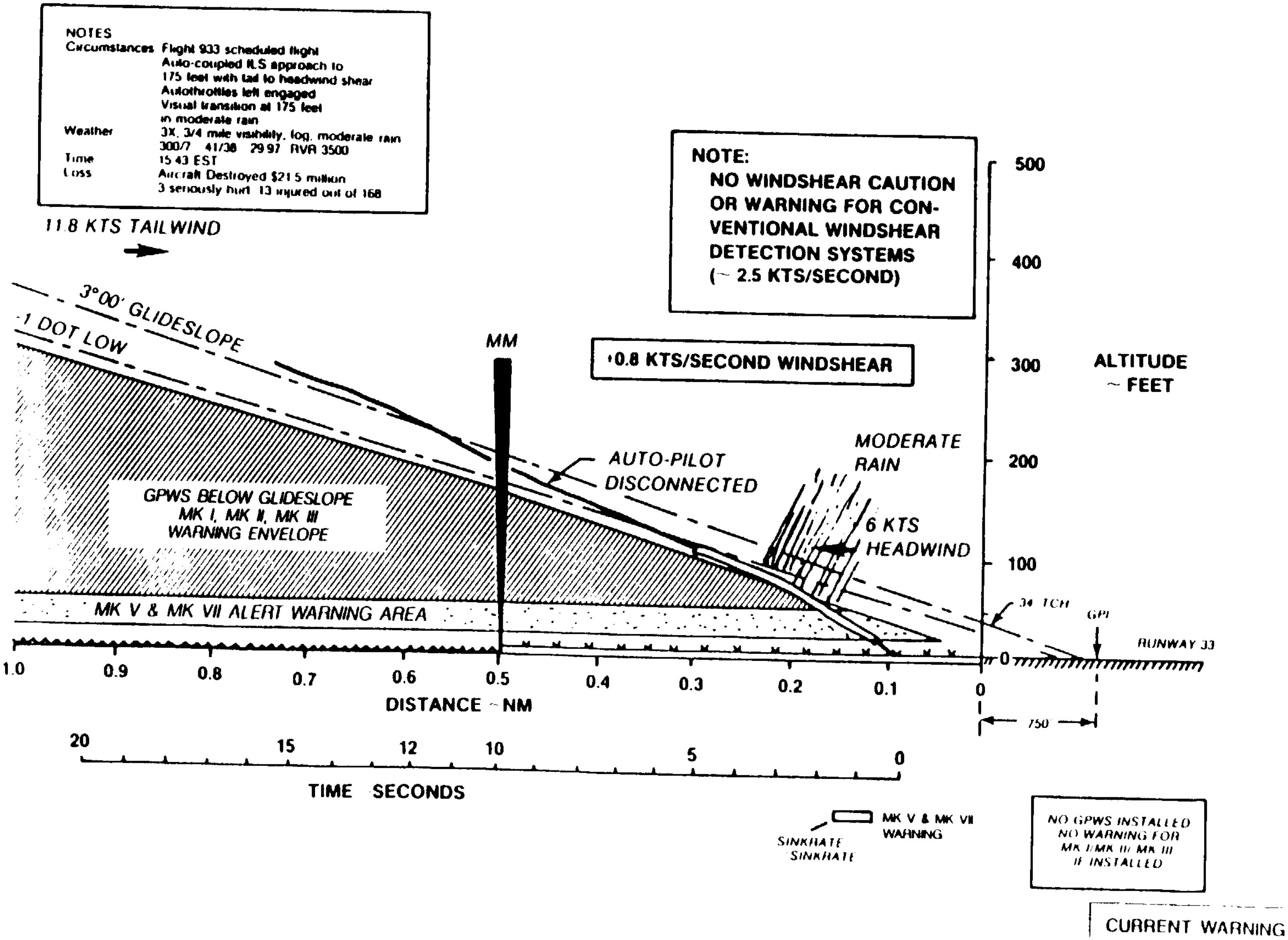
$f_{av,x}$ = average shear intensity to cause a warning at time t_x (resulting in a 20 knot windspeed change, bounded as shown; applies to horizontal, vertical, and combination shear intensities)

$$= \frac{\int_0^{t_x} f(t)dt}{t_x}$$ whereby $f(t)$ = instantaneous shear intensity at time t

1 A nuisance warning test utilizing the Dryden turbulence model and a discrete gust model are conducted independently from alert threshold tests to verify the acceptability of potential nuisance warnings due to turbulence or gusts.

Flight Path Profile

DC-10-30
BOSTON, MASS.
17 DECEMBER, 1973



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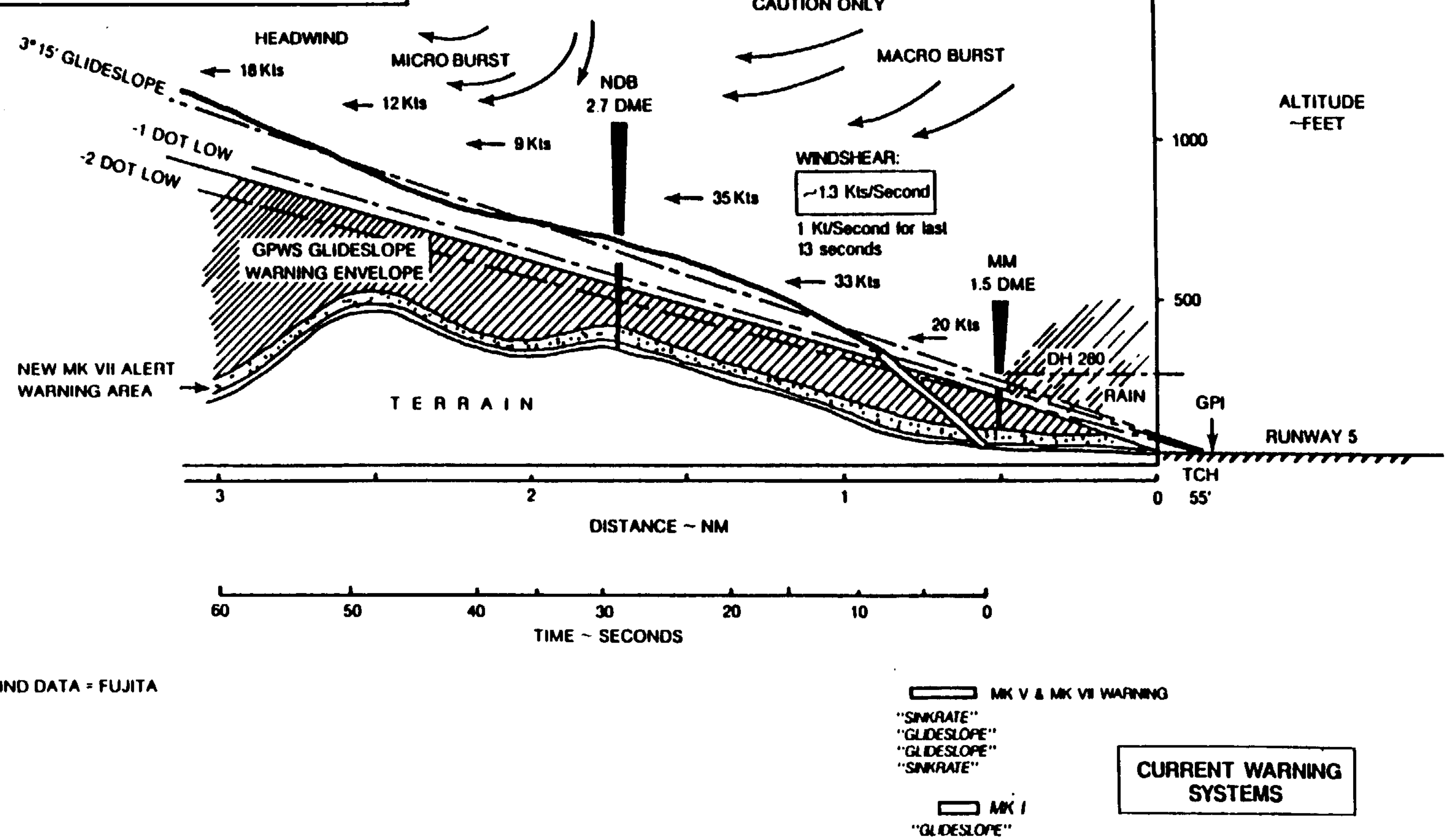
FLIGHT PATH PROFILE

B-707-300B
Pago Pago, American Samoa
31 January 1974

NOTE:
Circumstances: ILS Approach. Encountered micro burst–macro burst in rain at night and hit 3800 feet short of runway at 23:40 local time.
Weather: 16 ● 40 ● 110 ● 10 miles
Wind 030/20 kts 25 gust. Light rain.
Heavy rain shower near.
Loss: Aircraft destroyed $5.5 million
97 fatalities of 101 on board
$20 million liability.

NOTE:
NO WINDSHEAR WARNING
FOR CONVENTIONAL WINDSHEAR
SYSTEMS (App. 2.5 Kts/Second)



WIND DATA = FUJITA

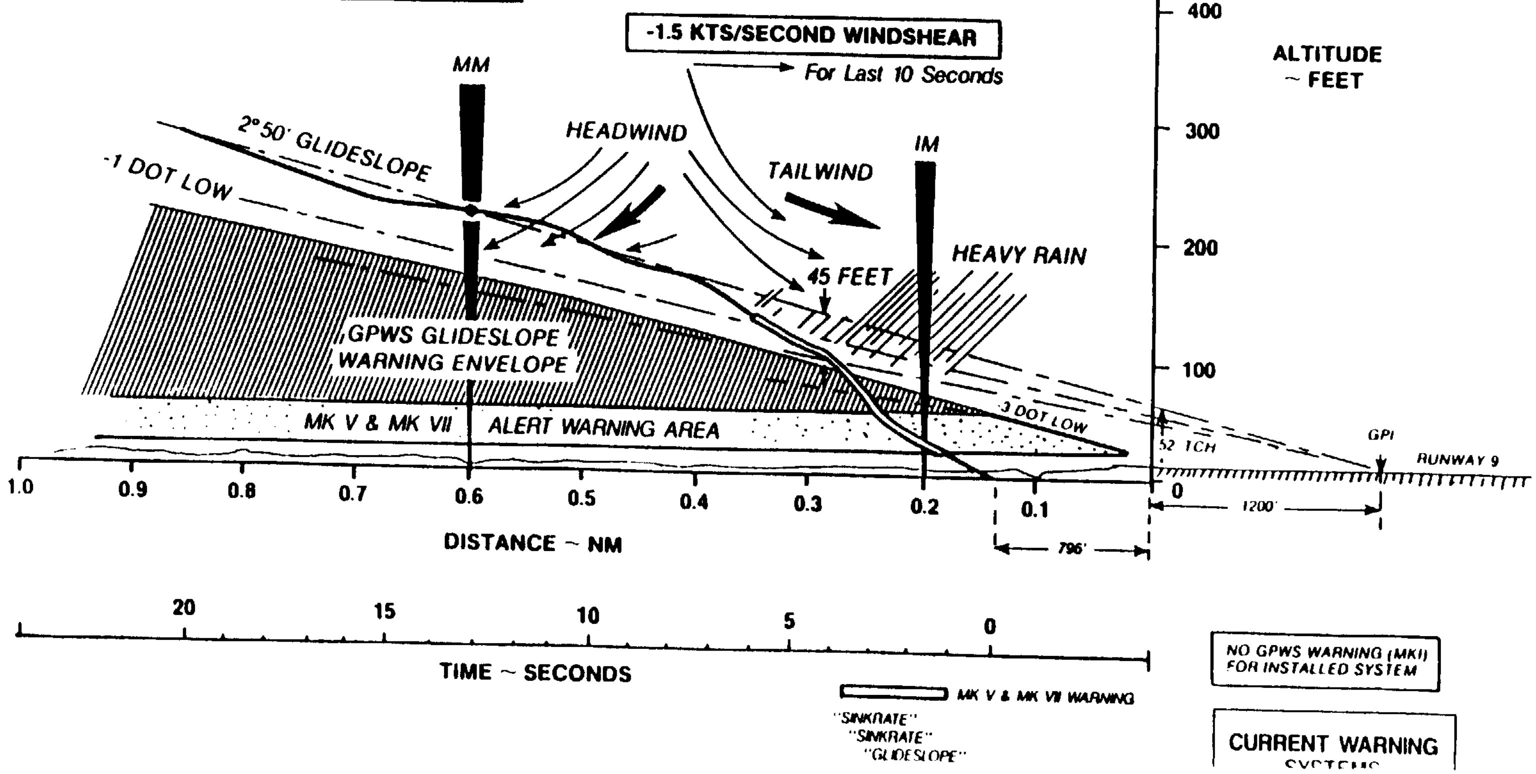
CURRENT WARNING SYSTEMS

Flight Path Profile

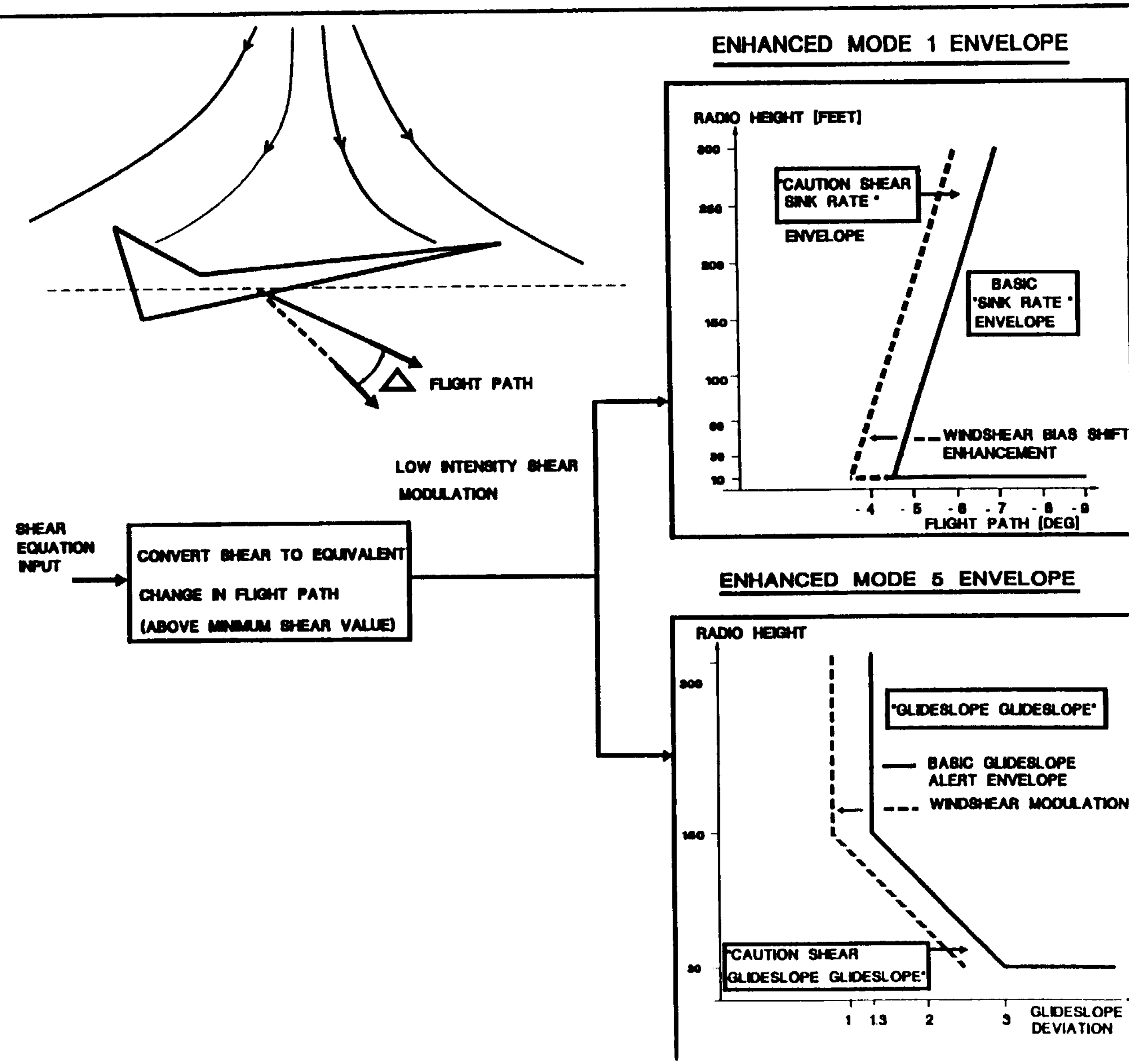
DC-8-62
DADE-COLLIER, FLORIDA
10 MAY, 1977

NOTES	
Circumstances	Pilot training incident Auto-coupled ILS approach to 150 feet. Windshear Missed approach initiated in heavy to moderate rain Airplane touched down short at 1120 EDT
Weather	1115 EDT E15 3 T 76 36/02 29 84 1121 EDT E15 1 TRW 74 29/08 29 84
Loss	$0 15 Million

NOTE:
NO WINDSHEAR CAUTION OR WARNING FOR CONVENTIONAL WINDSHEAR DETECTION SYSTEMS (~2.5 KTS/SECOND)



WINDSHEAR MODULATION OF MODES 1 AND 5



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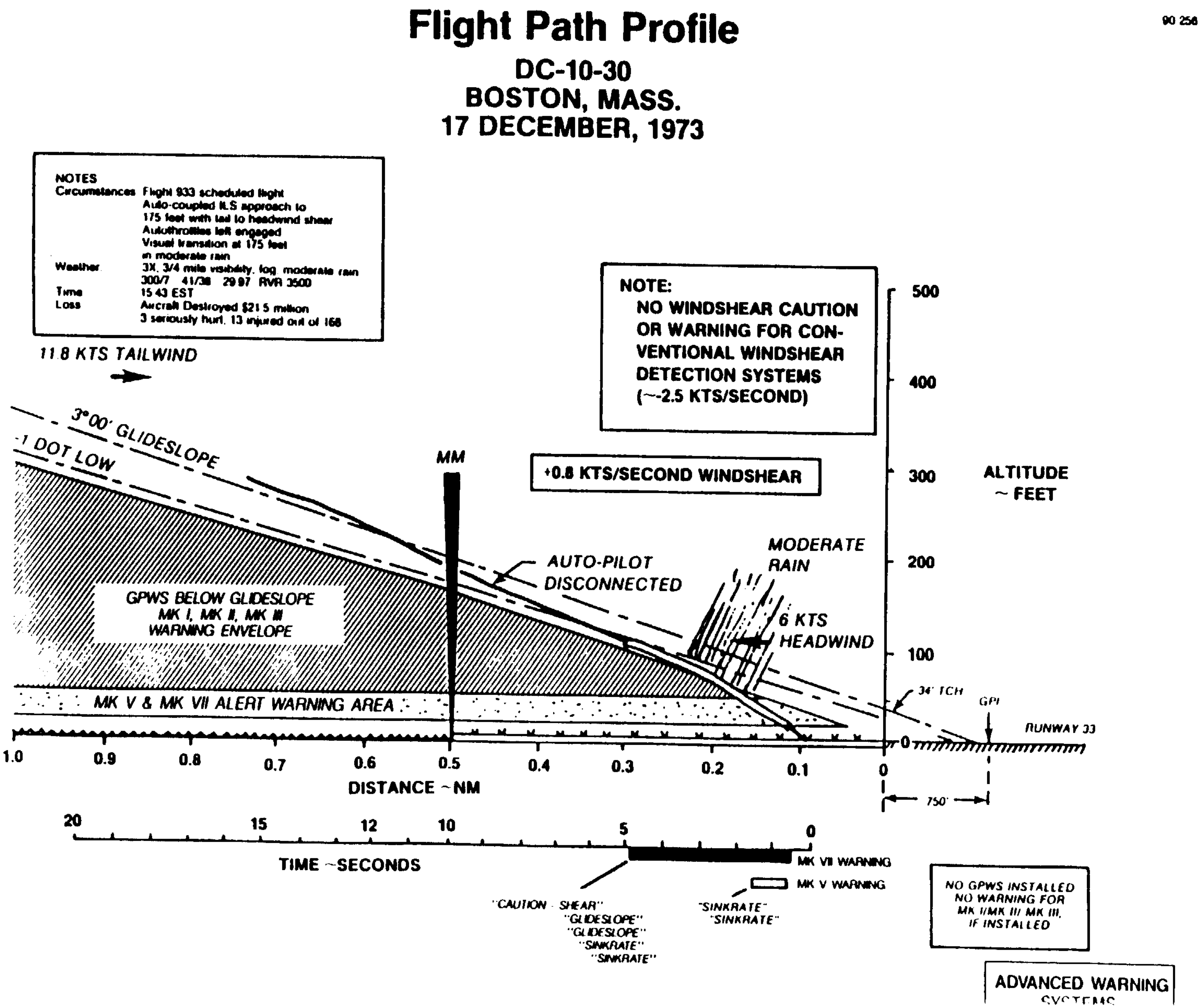

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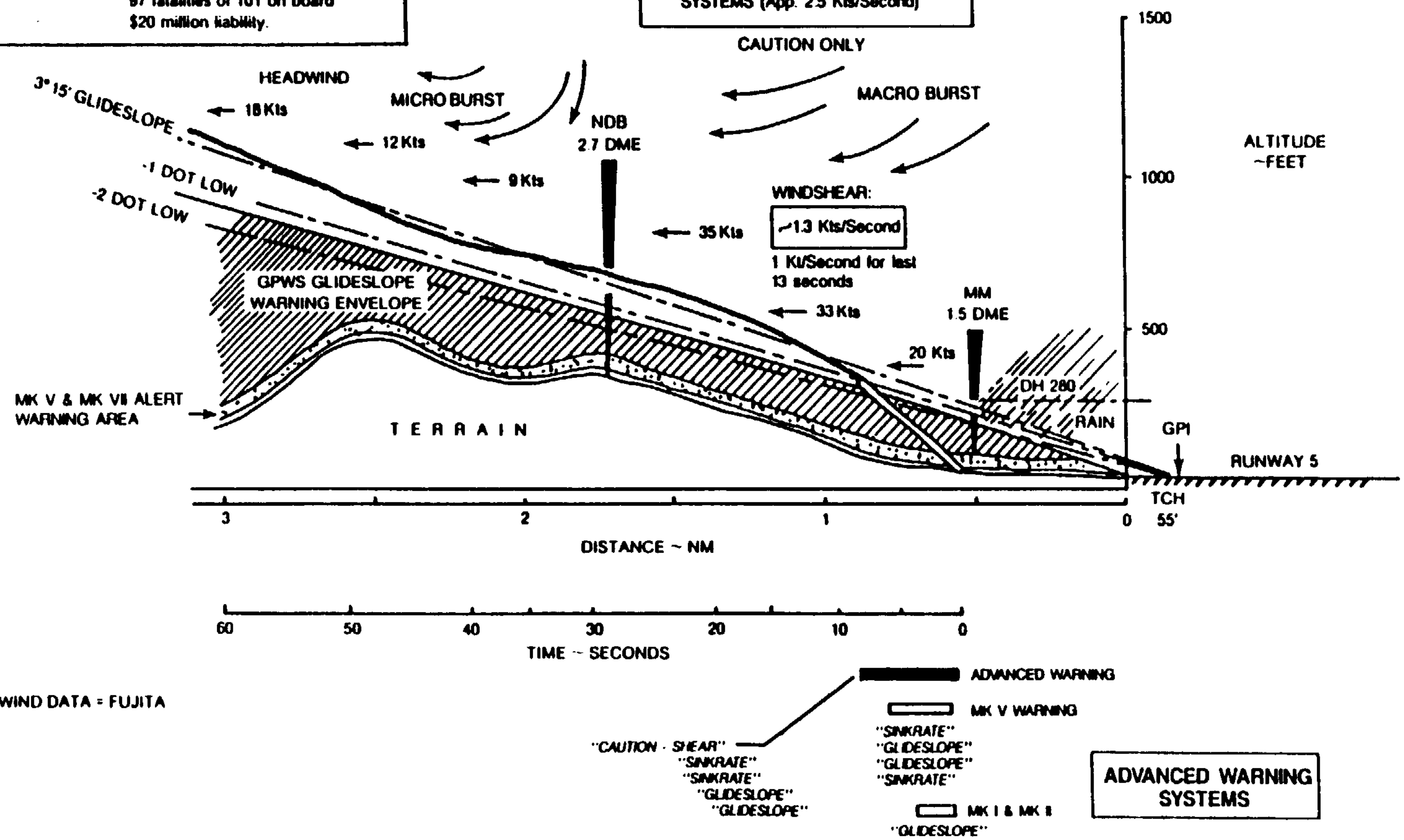
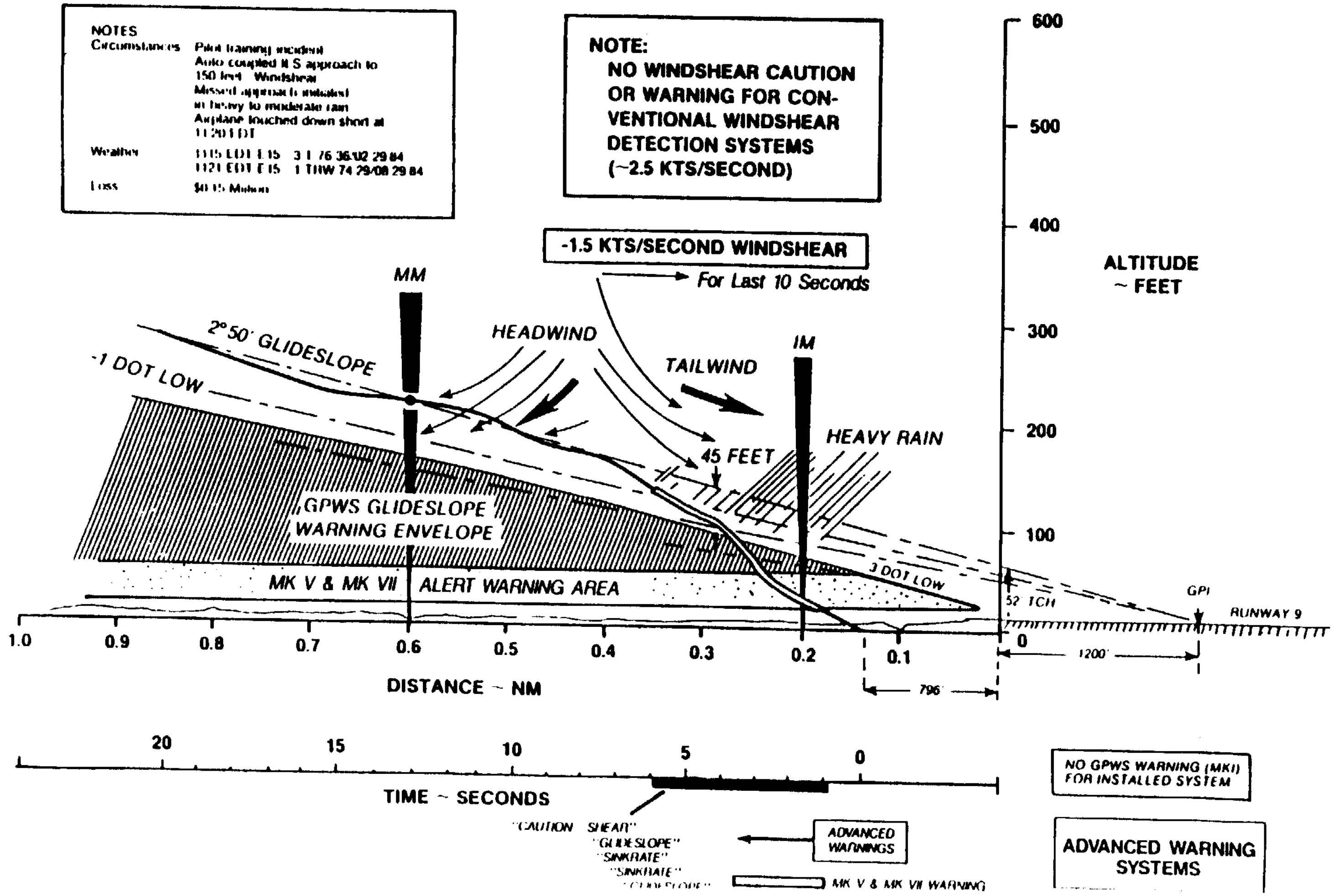


WIND DATA = FUJITA

90-256

Flight Path Profile

DC-8-62
DADE-COLLIER, FLORIDA
10 MAY, 1977



THIRD GENERATION SYSTEM

- USE WINDSHEAR COMPUTATION TO AUGMENT FLIGHT PATH AND TERRAIN ALERTS
- MODULATION OF ALERT THRESHOLDS BASED ON WIND/TERRAIN DATA BASE
- INCORPORATE WINDSHEAR/TERRAIN ALERT ENHANCEMENTS FROM PREDICTIVE SENSOR DATA

Status of Sundstrand Research - Questions and Answers

Q: JOHN McCARTHY (NCAR) - Are you aware of a Cuban Allusion 62 fatal accident? Havana, Cuba, September, 1989. There was 125 killed. Departure profile similar to Pan Am 759. The Cuban Civil Aviation Authority blamed (1) microburst, (2) crew training, (3) pilot actions. So the record is not clean since 1985.

A: DON BATEMAN (Sundstrand) - The chart I presented did not include any Soviet Union, Eastern bloc countries or Cuba. To me, this illustrates that the value of having an open society of nations where people trade back and forth accident information. As everyone knows in this room it was very difficult to get any information at that time, back in the 60s, the cold war, which really meant anything. Obviously if we put the Cuban and Russian and the other countries on the chart, we would probably have a continuing accident profile all the way across. Again I say the training programs, the education, avoidance, has really paid off. It's paying off everywhere in the world and I'm very proud that a lot of it came from the United States. I should say that since 1988 things are really changing. Mr. Gorbachev, who got the Nobel Prize yesterday, has really helped change that. Cuba still is very, very difficult, so close to us, yet so far in communicating with each other. Even Mr. Gorbachev hasn't been able to convince that openness that we need.

Q: PAUL KELLY (21st Century Technology) - What is the logic behind a wind shear alerting system that simply tells the crew somewhere in the vicinity is a wind shear? Without qualitative and quantitative data on the shear characteristics? Is not the only logical approach to crew alert some format that indicates the nature of the shear, its relevant position in respect to that aircraft as well as information on advisable maneuvering options? What's the good of spending money on any alerting system that does not address these three factors?

A: DON BATEMAN (Sundstrand) - Well, I wish we could give the pilot pictures. I think the speakers yesterday talking about the TDWR data transmittal to the airplane and displaying that, that adds another breadth to this, for the pilot to be able to really see what's going on out there. But this is nothing new. You have to start somewhere. I believe when a wind shear warning is given, the pilot is not asked what the picture is, or what the characteristics of the shear are, he is asked to leave. Perhaps with time maybe we'll get the pictures that the pilot really needs to see to help. I myself believe in not treating the pilot like a monkey, but to give him some information.

PAUL KELLY (21st Century Technology) - A very relevant adjunct to that question was as we saw this morning, sometimes a shear or the focal point of a microburst is not lined up with the longitudinal axis of the aircraft and it can be such that if the aircraft resorts to standard evasive maneuver by going on to standard missed approach path for that airport, it could very well end up putting himself into a tail wind, which of course will have the maximum danger. So, what is so important I believe, is that pilot needs to have some idea with regard to the physical characteristics of the microburst because standard evasive action could lead to him getting into a more dangerous situation which he would otherwise avoid if he had some information that made him realize that factor.

TERRY ZWEIFIL (Honeywell Sperry) - Yes, ideally that's what we would have. There would be some kind of situational display. Unfortunately there is 3000 commercial airplanes out there who have no capability to do that. The second point is, the reactive type systems are not predictive. That is, they only detect shears when you are in them. So it's going to be almost moot in terms of what part of the shear that you're in. It will either say you are in a shear or it will not. It's all one red light that comes on and says, "wind shear, wind shear, wind shear." The standard guidance procedure, no matter who's system you're looking at, in terms of roll, is to keep the wings level. Therefore, we are never instructing the pilot to turn one way or the other where he might in fact turn into the shear. Actually the real reason we do that is to keep the drag on the airplane down. So unless you just happen to have a very bad day and you just happened upon the shear just as it moves across as you're coming into it, you could in fact get into a worse condition. But the reactive systems, as they're designed today, have no way of anticipating what that is. Like I say, in the future we hope to change all of that and that's why we have all of these forward looking guys with the TDWRs and LLWAS and those sort of things. But for right now, we need to protect the airplane population that's out there without any of these display capabilities, which even if we could generate the display, we have no where to put it. So they're kind of at the mercy right now of a simpler system.