N88-17628

A PRESENTATION TO THE FIRST COMBINED MANUFACTURERS' AND TECHNOLOGY AIRBORNE WIND SHEAR REVIEW MEETING

INFRARED
LOW-LEVEL WIND SHEAR
WORK

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OCTOBER 22, 1987

TS823435

TURBULENCE PREDICTION SYSTEMS
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This presentation contains results of field experiments for detection of Clear Air Turbulence and Low Level Wind Shear utilizing an infrared airborne system. The hits, misses and nuisance alarms score and presented for the encounters. The infrared spatial resolution technique is explained and graphs are presented.

The popular index of aircraft hazard $\left(F = \frac{WX}{g} - \frac{VN}{AS}\right)$ is developed for a remote temperature sensor.

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THE PROBLEM

- WIND SHEAR
  - 1 accident per 5,000,000 T + L @A
  - 1 strong shear per 65,000 T + L @B
- SOURCES OF WIND SHEAR
  - downbursts
  - microbursts
- DURATION @C
  - severe winds - 2 to 4 minutes
  - life span - 5 to 15 minutes
- SIZE COLUMN @D
  - 4km or 2.5 miles
- EFFECTIVE DIAMETER OF OUTFLOW @C,D
  - > 2 x column diameter
- DIFFERENTIAL VELOCITY ACROSS BURST @C
  - > 56 knots average
- MICROBURSTS OFTEN HAS LATERAL MOTION

REFERENCE:

A R. Bowles NASA Langley; FAA/NASA Airborne Predictive Meeting; Feb 198

B Uary-Durham NASA Langley; AIAA 22nd Aerospace Sciences Meeting; Jan 1984

C McCarthy-Serafin NCAR; Weatherwise; June 1984

D Fujita University of Chicago; THE DOWNBURST Microburst and Macroburst: 1985

TURBULENCE PREDICTION SYSTEMS

C-4

FAA WIND SHEAR PLAN

- EXCELLENT PROGRAM
  - TRAINING
  - GROUND SENSORS
  - AIRBORNE SENSORS

- SECTION 5.3

THE ELEMENTS THAT CAN IMPROVE THE FLIGHT CREW'S ABILITY TO RELIABLY DETECT AND AVOID HAZARDOUS WIND SHEAR INCLUDE:

THE DEVELOPMENT OF FORWARD-LOOKING WIND SHEAR SENSORS FOR AIRCRAFT.

THE IMPROVED UTILIZATION AND INTEGRATION OF PRESENT-POSITION SENSORS.

REFERENCE: "INTEGRATED FAA WIND SHEAR PROGRAM PLAN"; U.S. DEPARTMENT OF TRANSPORTATION; FEDERAL AVIATION ADMINISTRATION; APRIL 1987; DOT/FAA/DL-87/1; DOT/FAA/VS-87/1; DOT/FAA/AT-87/1.

TURBULENCE PREDICTION SYSTEMS

REMOTE SENSING TECHNIQUES FOR WIND VELOCITY ARE NO PANACEA

—ALL REMOTE SENSORS INFER

TABLE 4 LISTS SOME ADVANTAGES AND DISADVANTAGES OF THE REMOTE-SENSING TECHNIQUES FOR WIND. IN GENERAL, LONG-RANGE MEASUREMENTS REQUIRE RADAR, AND SHORT-RANGE APPLICATIONS USE LIDAR OR SODAR DEPENDING ON WHETHER SPATIAL RESOLUTION OR LOW COST IS A PRIMARY CRITERION FOR SELECTION. FOR SOME REQUIREMENTS, SUCH AS A LOW-COST SENSOR FOR AIRCRAFT USE, THERE MAY NOT BE AT PRESENT A SUITABLE REMOTE-SENSING TECHNIQUE. (Emphasis added)

TABLE 4
Techniques for Velocity Measurement

	Advantages	Disadvantages
Sodar	Bistatic signal strength depends on turbulent microstructure Comparatively inexpensive	Flow tracers not uniformly distributed; i.e., sometimes only senses w in special layers Sensitive to noise from precipitation, high wind, and vehicles
Radar	Long range with appropriate tracers 3-D vector fields available with multiple sensors	Systems comparatively large and expensive Antenna side lobes limit usefulness close to the ground Clear-air targets nonconservative (e.g., temperature fluctuations) and require high transmitter power
Lidar	Very narrow beam widths Uses conservative tracers	Possible danger to eyes Beam attenuated by cloud and fog

REFERENCE: "A COMPARATIVE OVERVIEW OF ACTIVE REMOTE-SENSING TECHNIQUES"; BY R. L. SCHWIESOW; IN D. H. LENSCHOW, EDIT. PROBING THE ATMOSPHERIC BOUNDARY LAYER, 1986; AMERICAN METEOROLOGICAL SOCIETY; P. 135.

TURBULENCE PREDICTION SYSTEMS

AIRBORNE SENSORS ARE NEEDED

- ISLAND CONCEPT
  - AIRCRAFT CAN TAKE CARE OF ITSELF

MANY AIRPORTS WILL NEVER HAVE ENOUGH SOPHISTICATED EQUIPMENT

- CASPER, WYOMING
- GREENSBOROUGH, NORTH CAROLINA
- FARMINGTON, NEW MEXICO

INFORMATION HAS MINIMAL LINKAGE TO AIR CREW

TURBULENCE PREDICTION SYSTEMS

HISTORICAL CAT RESEARCH RESULTS

NASA LEAR - MOLETRON - 1979
NASA C-141A - BARNES - 1979
NASA CV 990 - ADAMSON - 1979

TEST PROTOCOL:

A HIT IF THE ALARM SOUNDS AND A SHEAR OF GREATER THAN 0.2 G ACCELERATION WAS ENCOUNTERED, OTHERWISE A MISS

RESEARCH RESULTS: ≈ 700 HOURS

- WITH MOLECTRON/BARNES RADIOMMETER

247 ENCOUNTERS	84.62% HITS
MISSED ENCOUNTERS	15.38%
NUISANCE ALARMS	14.00%

- WITH ADAMSON RESEARCH INSTRUMENT

119 ENCOUNTERS	98.32% HITS
MISSED ENCOUNTERS	1.68%
NUISANCE ALARMS	8.51%

ADVANCE WARNING RESULTS: 700 HOURS

AVERAGE WARNING	4 MINUTES

REFERENCE: "FINAL STATISTICAL REPORT ON AVIATION SAFETY TECHNOLOGY (IN-FLIGHT DETECTION AND PREDICTION OF CLEAR AIR TURBULENCE)"; BY LOIS STEARNS AND VALERIE NOGAY, NOAA; FOR NASA AMES RESEARCH CENTER; DECEMBER 1, 1979.

$$F = \underset{\text{horizontal component}}{\frac{\dot{wx}}{g}} - \underset{\text{vertical component}}{\frac{vw}{AS}}$$

Reference:

R. A. Greene, Safe Flight Instrument Corp; Journal of Aircraft; 12/79.

R. Bowles, NASA Langley; FAA/NASA Airborne Predictive Meeting; 2/24-25/87

Definitions:

$\dot{wx}$ = kts/sec – horizontal wind rate
g = kts/sec – gravity
vw = kts – vertical wind velocity
AS = kts – air speed

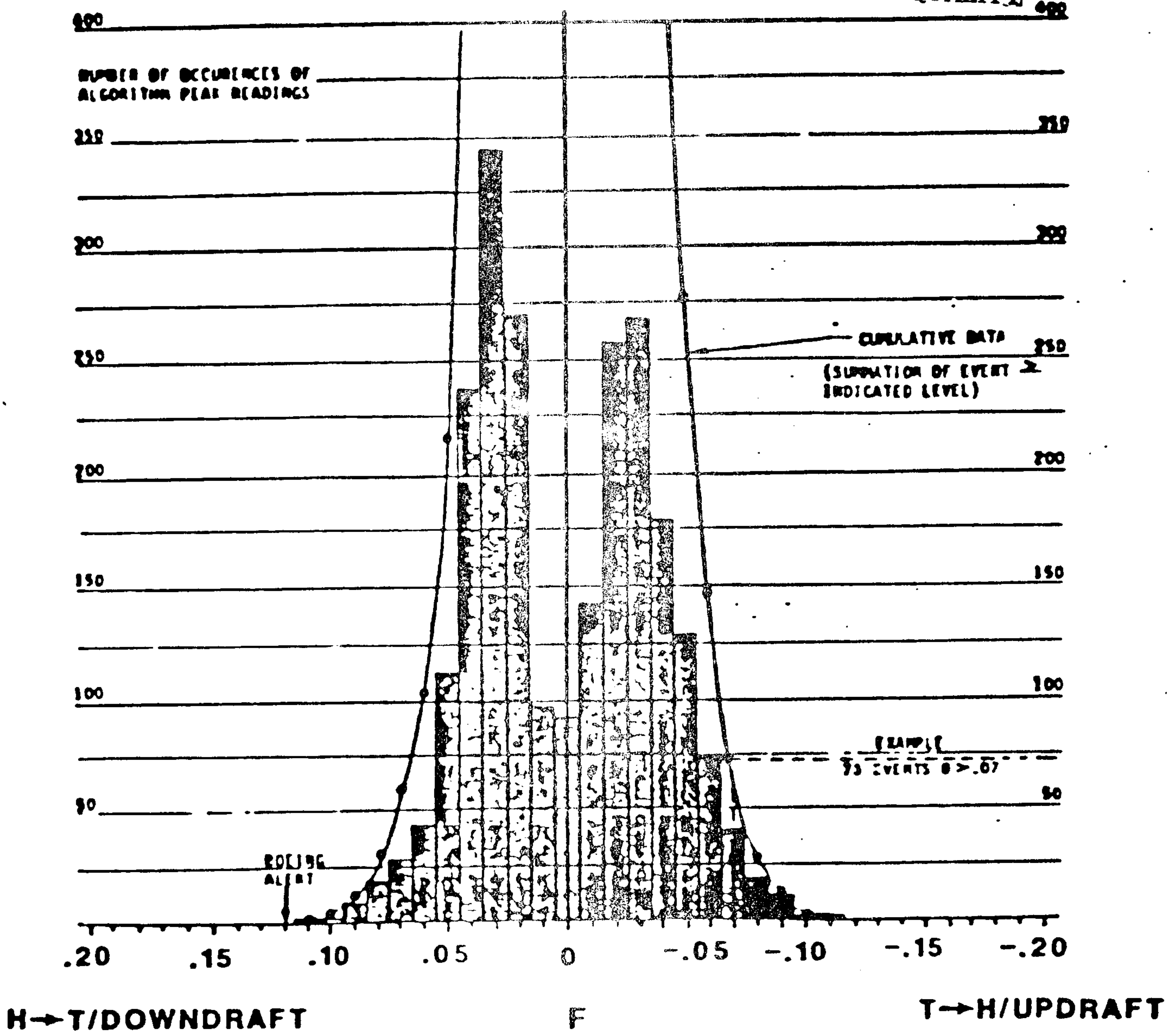
Sign Convention:

$\dot{wx}$ = + kts/sec when tailwind
vw = – kts when downdraft

TURBULENCE PREDICTION SYSTEMS

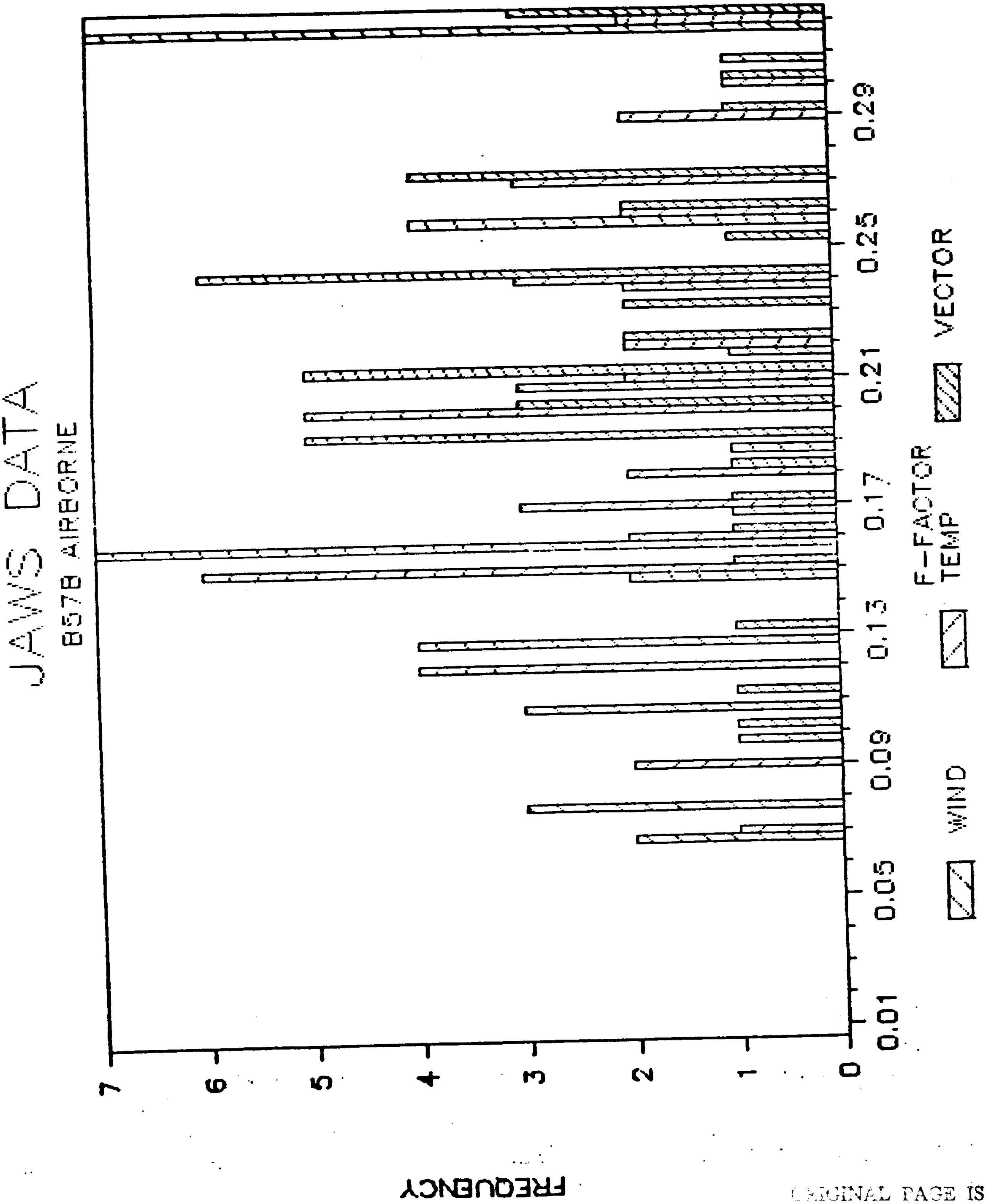
SOUTHWEST 737-300 IN-SERVICE DATA

TAKEOFF



NO WIND SHEAR EVENTS REPORTED BY PILOTS

INDUSTRY REVIEW OF FORWARD LOOKING SENSOR TECHNOLOGY FOR DETECTION OF WIND SHEAR
NASA Langley Research Center 24-25 Feb. 1987, Roland L. Bowles



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HISTORICAL LLWS RESEARCH RESULTS

NASA LEAR - 1978 CALIFORNIA
NASA B57B - JAWS - 1982 DENVER, CO

TEST PROTOCOL:

A HIT IF THE ALARM SOUNDS AND A VERTICAL SHEAR GREATER THAN 0.1 SEC^{-1} (=10 KNOTS /100 FEET) WAS ENCOUNTERED, OTHERWISE A MISS
REFERENCE: SNYDER

RESEARCH RESULTS:	∼300 HOURS
42 ENCOUNTERS	100.0% HITS
MISSED ENCOUNTERS	0
NUISANCE ALARMS	0

ADVANCE WARNING RESULTS:	
MINIMUM WARNING	14 SECONDS
AVERAGE WARNING	46 SECONDS
MAXIMUM WARNING	68 SECONDS

REFERENCE: "APPLICATION OF INFRARED RADIOMETERS FOR AIRBORNE DETECTION OF CLEAR AIR TURBULENCE AND LOW LEVEL WIND SHEAR"; BY P.M. KUHN; FINAL REPORT DECEMBER 31, 1982 - MARCH 31, 1985.

"ANALOG STUDY OF THE LONGITUDINAL RESPONSE OF A SWEPT-WIND TRANSPORT AIRPLANE TO WIND SHEAR AND SUSTAINED GUSTS DURING LANDING APPROACH"; BY C.T. SNYDER, NASA AMES RESEARCH CENTER; NASA TN D4477; 1968.

TURBULENCE PREDICTION SYSTEMS

HISTORICAL LLWS RAIN RESEARCH

NASA B57B - JAWS	-	1982	DENVER, CO
CESSNA 207	-	1985	HUNTSVILLE, AL

TEST PROTOCOL:

A HIT IF THE ALARM SOUNDS AND A VERTICAL SHEAR OF GREATER THAN .15 SEC^{-1} (15 KNOTS /100 FEET) WAS ENCOUNTERED, OTHERWISE A MISS

A SUCCESSFUL PREDICTION REQUIRED AN ADVANCE WARNING OF GREATER THAN 40 SECONDS

RESEARCH RESULTS: 19 TRACTS FLOWN

8 ENCOUNTERS	75.0% HITS
MISSED ENCOUNTERS	25.0%(2<40S)
NUISANCE ALARMS	4

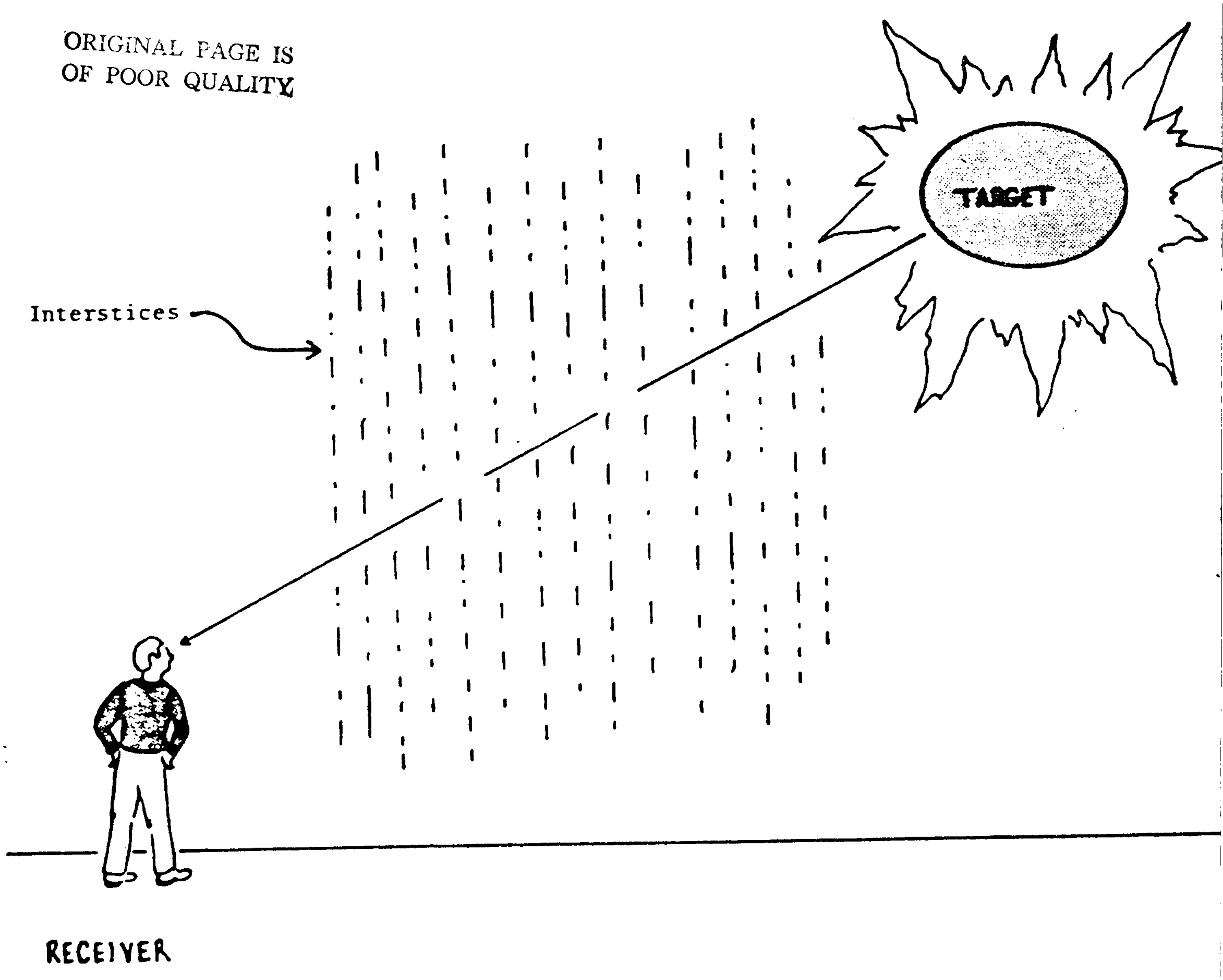
ADVANCE WARNING RESULTS:

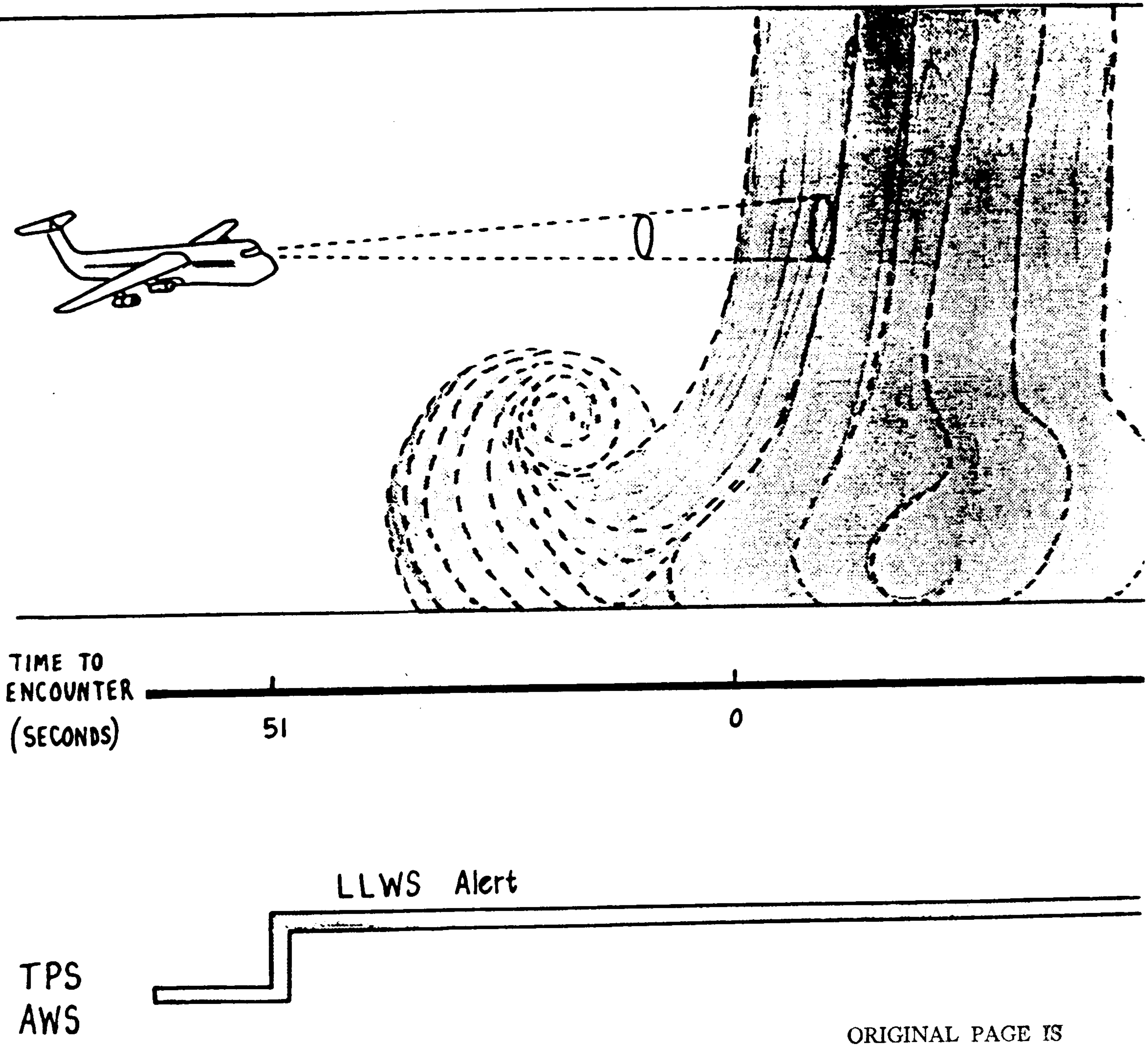
MINIMUM WARNING	5 SECONDS
AVERAGE WARNING	32 SECONDS

REFERENCE: "AIRBORNE INFRARED WIND SHEAR DETECTOR PERFORMANCE IN RAIN OBSCURATION"; BY P.M. KUHN AND P.C. SINCLAIR, ARIS, INC.; PAPER PRESENTED AT AIAA MEETING JANUARY 18, 1987; RENO, NEVADA.

TURBULENCE PREDICTION SYSTEMS

INFRARED SENSING TECHNIQUE





TPS's Infrared LLWS Advance Warning Diagram

TBC

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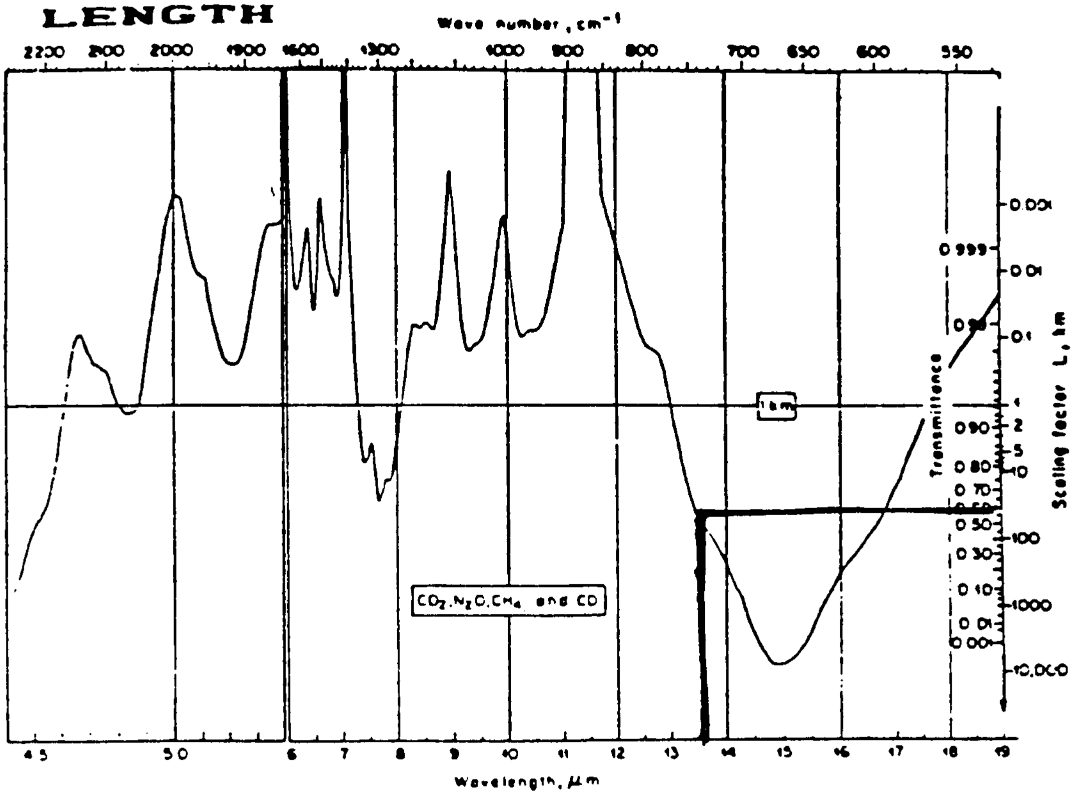
UNIFORM DISTRIBUTED GASES

INFRARED IS ABSORBED BY THE UNIFORM DISTRIBUTED GASES AS A FUNCTION OF WAVE LENGTH



(b)

Fig. 17 *(Continued)*

NOTE: TRANSMITTANCE/KILOMETER

FOR EXAMPLE:

@ 13.5 MICRONS

TRANSMITTANCE = .60/KM

@ 5 KM

TRANSMITTANCE = (.60)^5 = 7.8%

REFERENCE: HANDBOOK OF OPTICS; WALTER G. DRISCOLL, EDITOR; McGRAW-HILL BOOK COMPANY; 1978; FIGURE 17, PAGE 14-43.

Radiative transfer Theory via the transfer equation (RTE) demonstrates that a "horizontally looking" infrared (IR) radiometer can easily detect temperature changes as small as 0.3C at a distance of 10 km. The IR pass band for such observations is the carbon dioxide (CO_2) band. In this instance we refer to transfer calculations in the 695 to 725 cm^{-1} pass band.

The RTE expresses the radiant emission received through a horizontal path in the atmosphere at an IR detector through a filter, $\phi(\nu)$, as

$$\overleftarrow{N} = - \int_{\nu} \int_{z} B(\nu,T)\phi(\nu) \frac{\partial\tau(u(CO_2))}{\partial z} dz\, dz), \qquad (2)$$

where N and B are radiance ($w\ cm^{-2} sr^{-1}$); ν is wave number (cm^{-1}); T is temperature (^{o}K); u is the optical mass of CO_2 ($g\ cm^{-2}$); z is distance (cm).

The filter function, $\phi(\nu)$, in equation (2) determines the IR pass band to which the CO_2 band low altitude wind shear radiometer responds. Since the CO_2 portion of the spectrum is broad, ranging from nominally 630 to 710 cm^{-1}, it is necessary to choose a passband of a width of 20 to 30 cm^{-1}, within the broad band which will provide a suitable range capability. The absorption (and emission) across the CO_2 band varies considerably thus allowing a greater or lesser horizontal atmospheric penetration. For example the CO_2 Q-branch centered near 667 cm^{-1} would permit a range of only a few meters.

Weighting functions are defined by

$$\frac{d\tau_{\Delta\nu}}{d\ln z} = \frac{-\overline{K}_{\Delta\nu} p\overline{q}\ z}{RT} \exp \frac{-1}{RT} \int_{o}^{z} \overline{K}_{\Delta\nu}\ p\overline{q}\ dz \qquad (3)$$

where τ is the atmospheric transmission (dimensionless); $\Delta\nu$ is the wave number interval (cm^{-1}); $\overline{K}_{\Delta\nu}$ is the CO_2 absorption coefficient ($cm^2 g^{-1}$); p is pressure (cgs); $\overline{q}$ is mass mixing ratio of CO_2 (dimensionless); R is the universal gas constant (cgs).

The weighting function describes the ranging characteristics of the filter, and thus the range of the radiometer. Figure 3 illustrates weighting or ranging functions for various center frequency passbands either 20 cm^{-1} wide for CO_2. The position of the peak of the weighting function defines the "look" distances or range of the instrument. As an example we employed the weighting function of Fig. 3 at a center frequency for the CO_2 filter of 685 cm^{-1} (20 cm^{-1} wide). We assumed a horizontal temperature constant at 288K in one instance and 286K from 1.0 to 1.6 km distance in the other calculation. The CO_2 mixing ratio (mass) was assumed 5.28×10^{-6} $w\ cm^{-2} sr^{-1}$. This corresponds to a temperature difference of 2K.

aboard NASA's Learjet Laboratory is ± 0.3K. Hence it is feasible to determine downdraft temperature changes this small at distances of 10 km or more during glide path approach with a horizontally stabilized radiometer system.

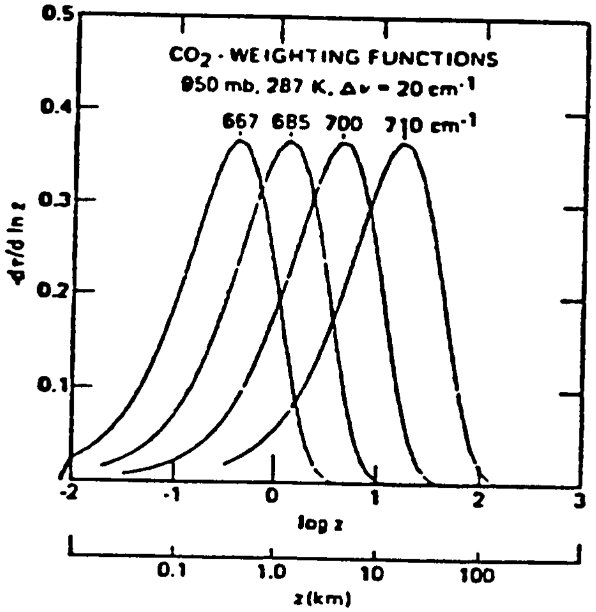


Figure 3. Carbon dioxide horizontal weighting functions centered at the indicated frequencies.

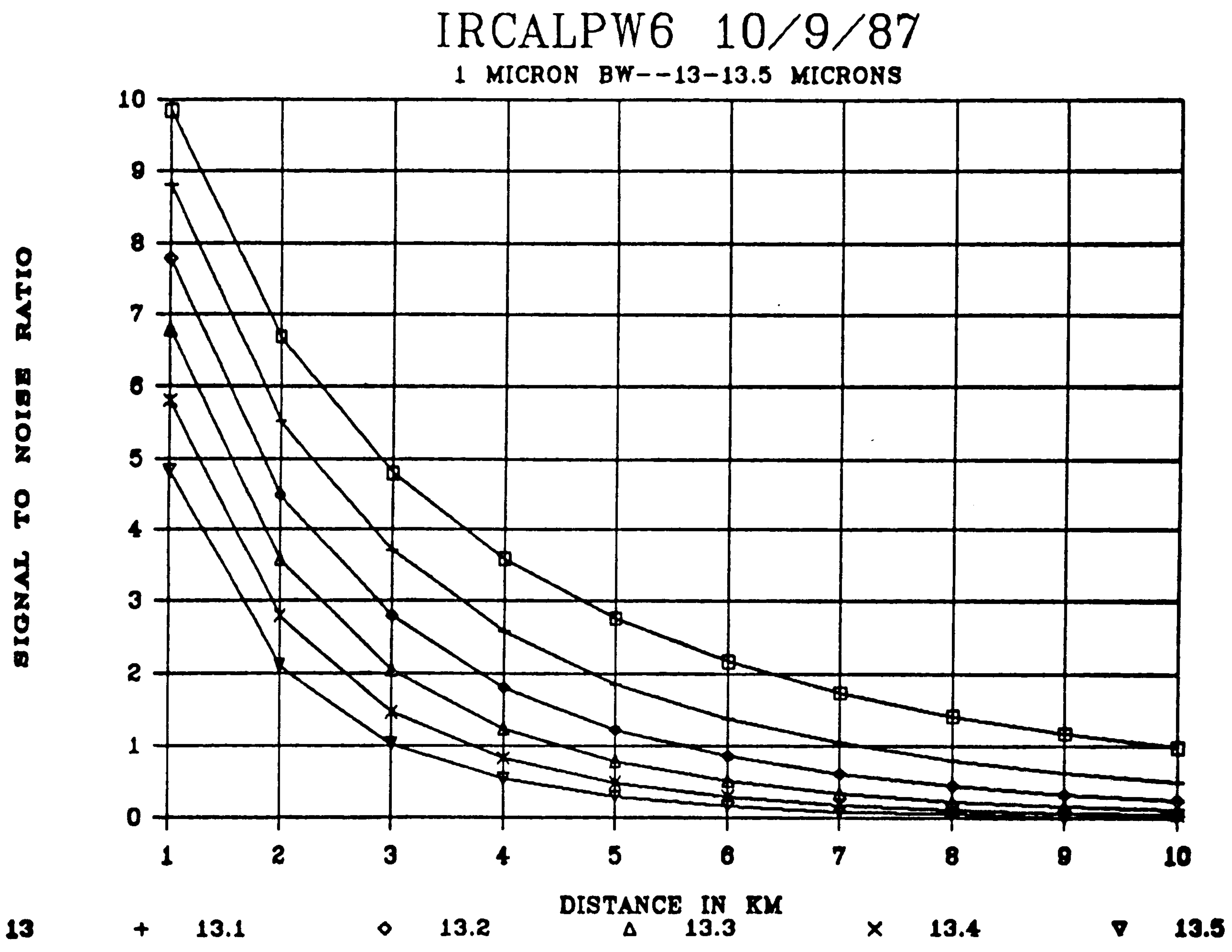
REFERENCES

Fawbush, E. J. and R. C. Miller (1954): A Basis for Forecasting Peak Wind Gusts in Non-Frontal Thunderstorms. Bulletin Amer. Met. Soc., 35, 14-19.

Foster, Donald S. (1958): Thunderstorm Gusts Compared with Computed Downdraft Speeds. Mon. Wea. Rev., 86, 91-94.

Fujita, T. T. (1976): Spearhead Echo and Downburst Near the Approach End of A John R. Kennedy Runway, New York City. SMRP Research Paper, 137, 51 pp.

Infrared Remote Sensing and Radiative Transfer in Wind Shear Detection. P.M. Kuhn, F. Caracena, I.G. Nolt, J.V. Radostitz. Reprint from Preprint Volume: 3rd Conference on Atmospheric Radiation June 28-30, 1978.

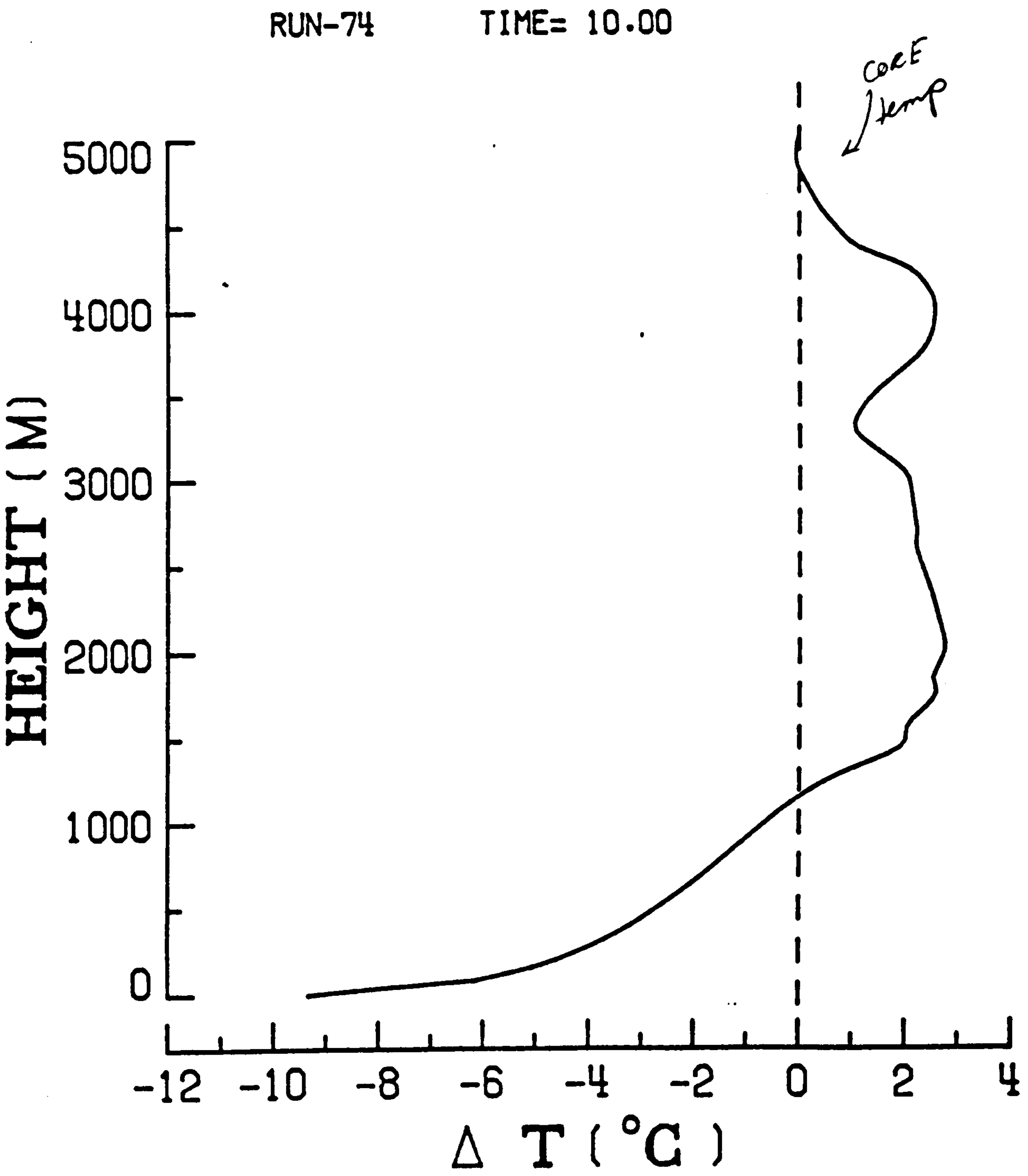

IRCALPW6 10/9/87
1 MICRON BW--13-13.5 MICRONS
SIGNAL TO NOISE RATIO
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
5
6
7
8
9
10
DISTANCE IN KM
13
+ 13.1
◇ 13.2
△ 13.3
× 13.4
▽ 13.5

VALIDATION OF INFRARED WEIGHTING FUNCTION

IN 1979, RESEARCHER DR. PETER KUHN AND NASA TEST PILOT MR. GLEN STINNET FLEW THE NASA LEAR JET #705 OVER THE SANTA BARBARA CHANNEL ALTERNATING BETWEEN LAND (40° C) AND THE CHANNEL (15° C) TO VALIDATE THE WEIGHTING FUNCTION

THIS VALIDATION INVOLVED USING A BARNES PRT5 RADIOMETER AND INTERCHANGING 6 CO_2 FILTERS UNTIL THE WEIGHTING FUNCTION WAS VALIDATED

REFERENCE: PERSONAL CORRESPONDENCE DR. PETER KUHN; AUGUST 1987



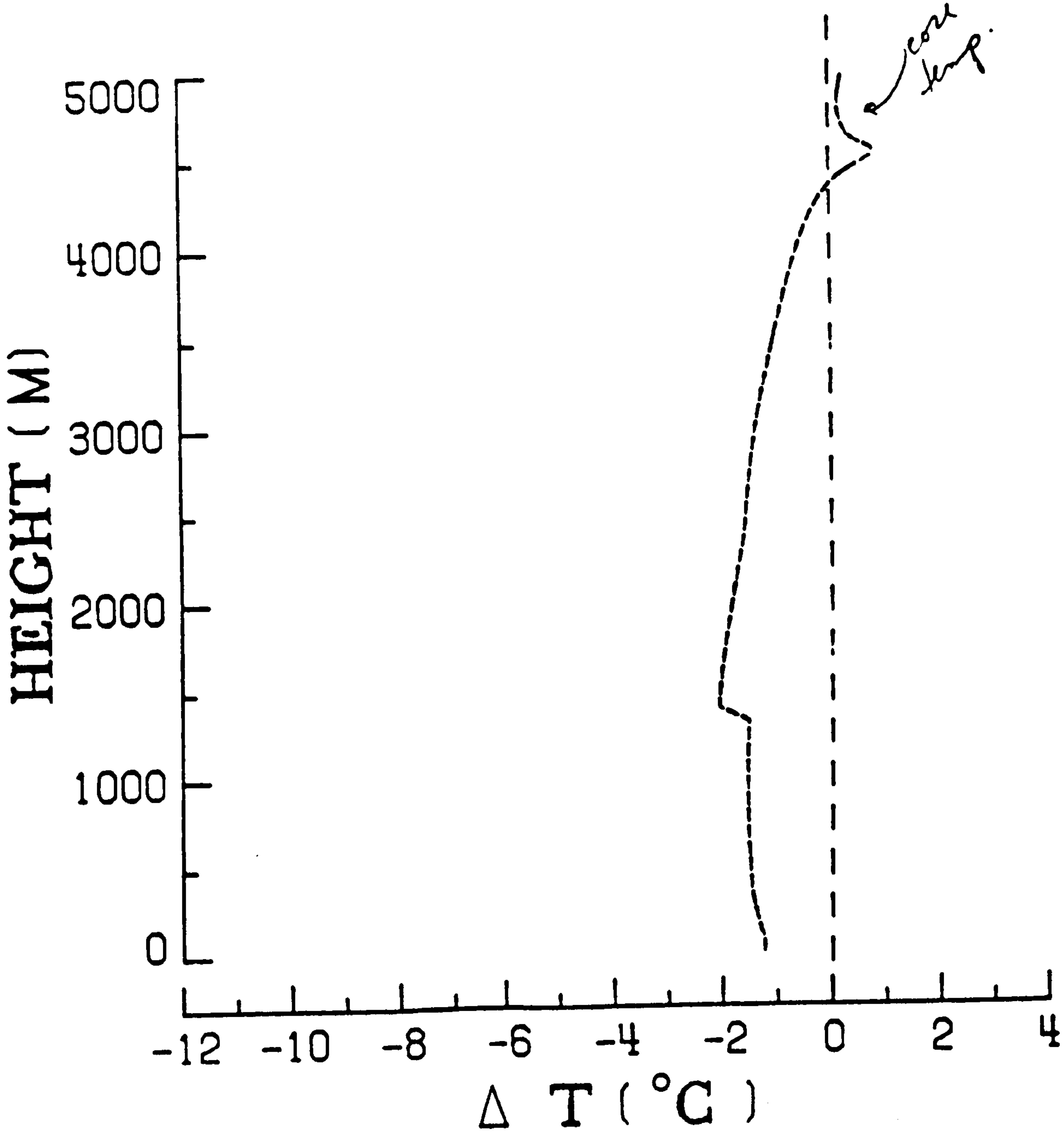
WET CASE 10/13/87

RECEIVED AT NASA
LANGLEY FROM
F. PROCTOR

SNOWDRIVEN CASE 10/13/87

RECEIVED AT NASA LANGLEY
FROM F. PROCTOR

RUN-10 TIME= 25.01



THE END PRODUCT OF AIRBORNE IR SENSOR

IS:

$$\frac{\Delta \Phi_e \quad \text{(change in radiant flux)}}{\Delta t \quad \text{(time)}}$$

FROM WHICH WE GET:

$$\frac{\Delta T \quad \text{(temperature)}}{\Delta t \quad \text{(time)}} \quad \text{OR} \quad \sum_{t_1}^{t_2} \Delta T$$

FROM THIS WE WILL CALCULATE A HAZARD INDEX WHICH APPLIES TO THE AIRCRAFT'S FLIGHT PATH.

TURBULENCE PREDICTION SYSTEMS

WIND SHEAR "HIT"

- HAZARD INDEX $F = \frac{\dot{W}_x}{g} - \frac{W_h}{V}$
- ALERT AND WARNING THRESHOLD DETERMINED BY MAX. PERMISSIBLE F IN RELATION TO AIRCRAFT PERFORMANCE CAPABILITY
- F IS A SENSED QUANTITY
- HAZARD INDEX APPLICABLE TO BOTH INSITU–SENSED INFORMATION AND REMOTE–SENSED WIND SHEAR

INDUSTRY REVIEW OF FORWARD LOOKING SENSOR TECHNOLOGY FOR DETECTION OF WIND SHEAR
NASA Langley Research Center 24-25 Feb. 1987, Rowland L. Bowles

F FACTOR

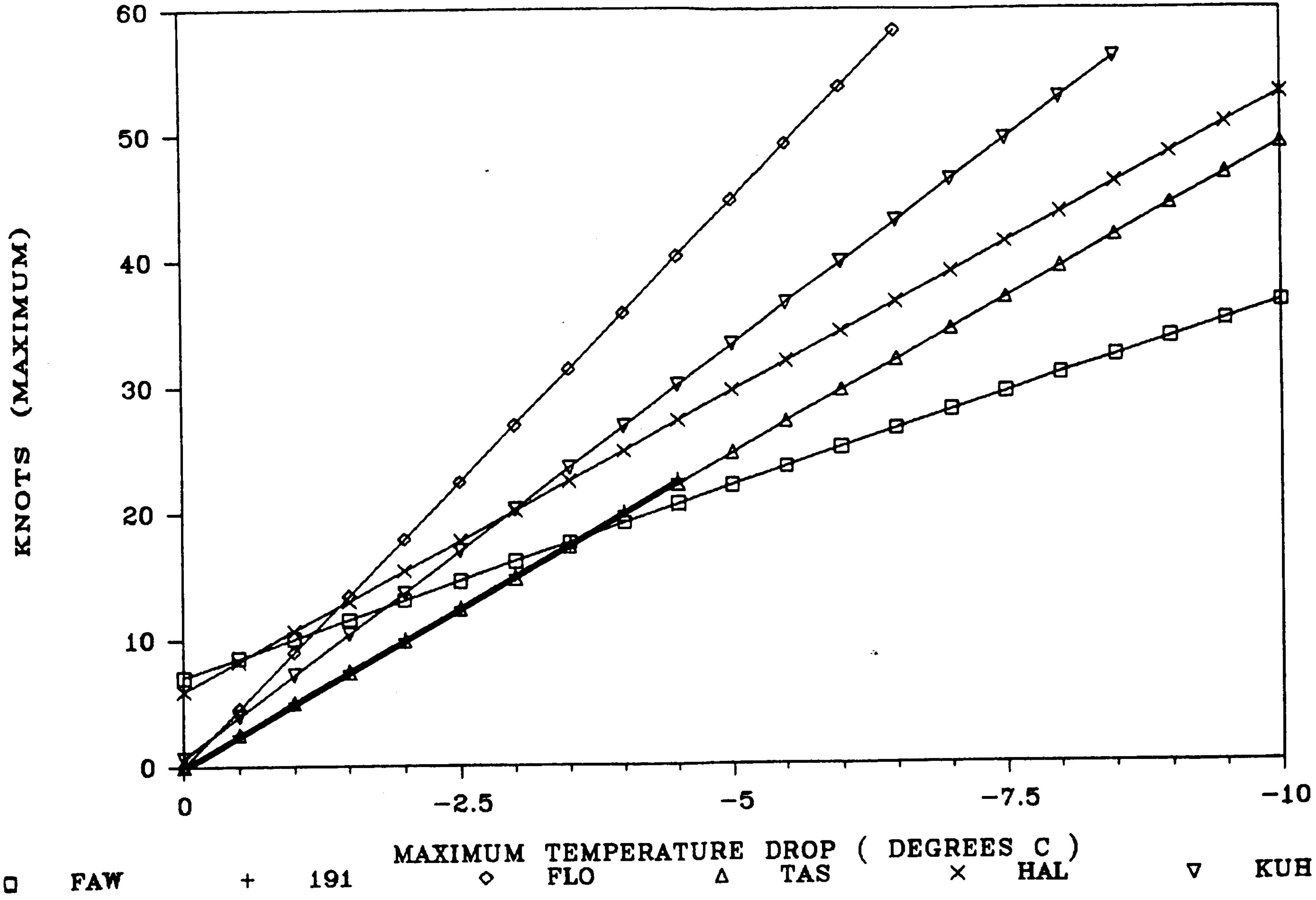
WE NEED TO ASSESS THE THREAT TO THE AIRCRAFT IN BOTH THE HORIZONTAL AND VERTICAL WIND COMPONENTS.

—HORIZONTAL CASE

THERE IS A GOOD EMPIRICAL RELATIONSHIP BETWEEN TEMPERATURE DROP AND HORIZONTAL WIND VELOCITY.

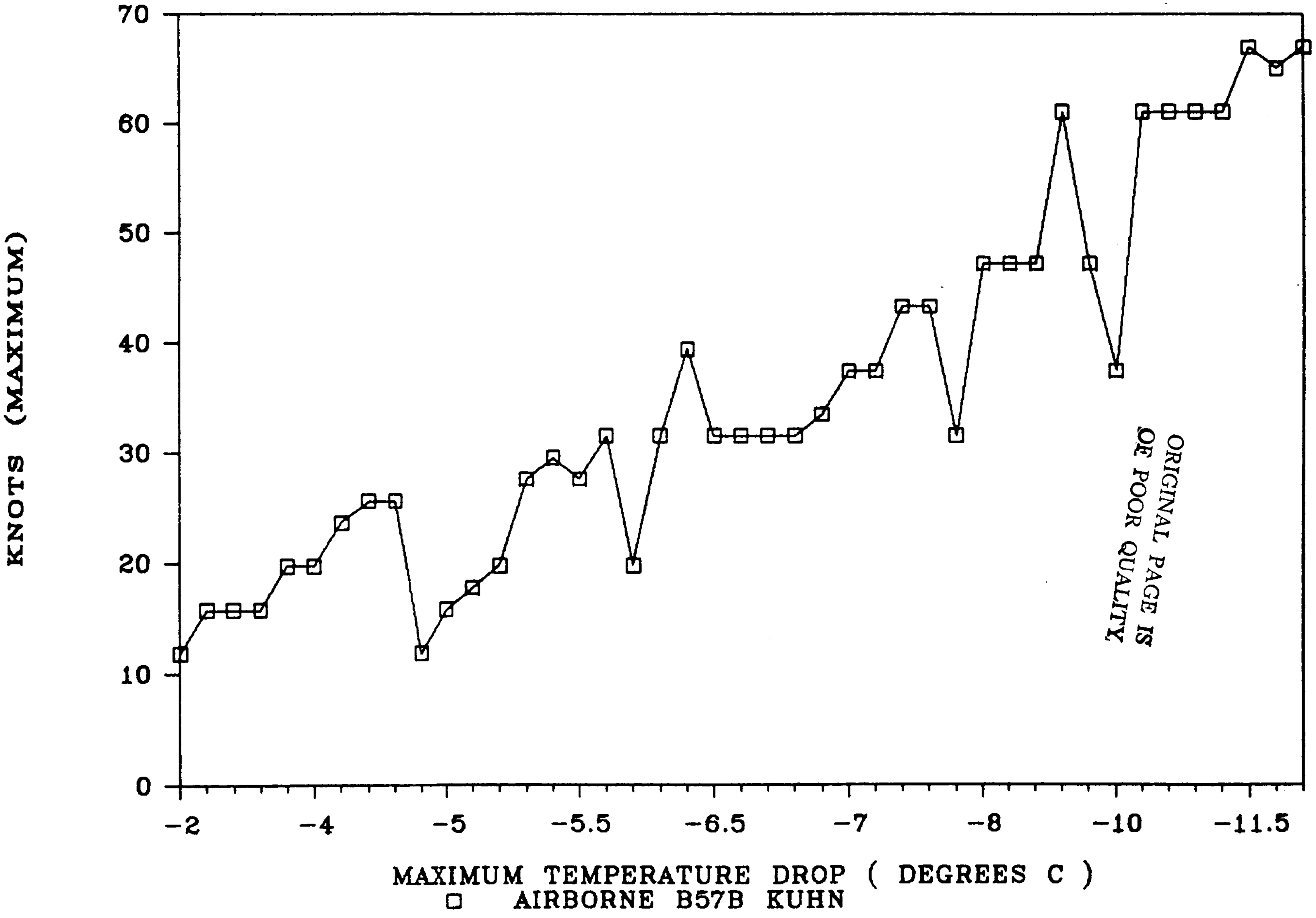
U WINDS VERSUS TEMPERATURE DROP

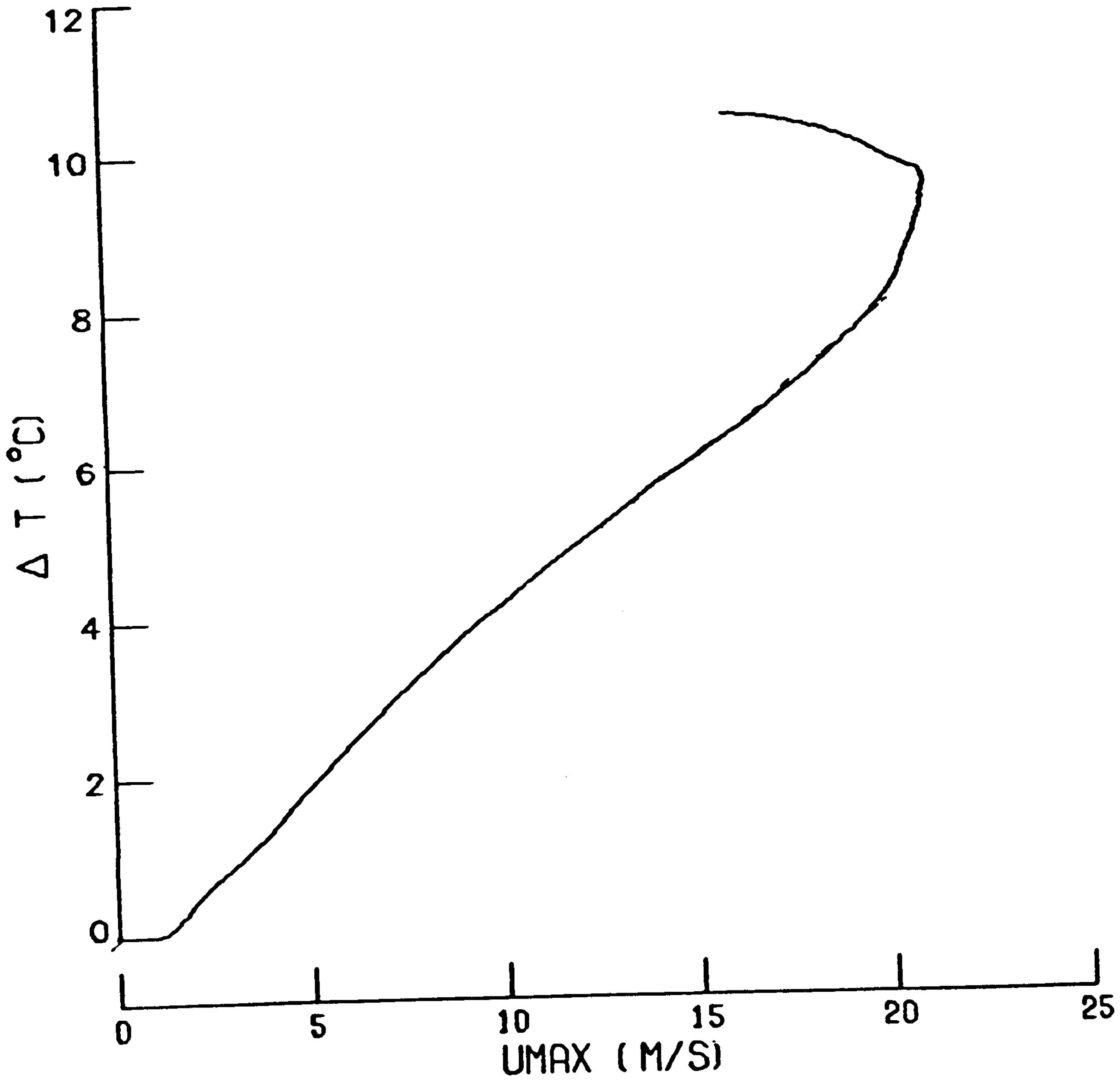
HORIZONTAL WINDS



U WINDS VERSUS TEMPERATURE DROP

HORIZONTAL WINDS





REFERENCE: F. PROCTOR/R. BOWLES, NASA LANGLEY RESEARCH CENTER

FROM THE NASA TASS MODEL THE RELATIONSHIP IS:

$$\Delta U_{m/s} \cong 2.5 * - \Delta T^{\circ}{}_{C}$$

SO TO GET HORIZONTAL PORTION OF F FACTOR

WE GET:

$$F_{H} = \frac{-\Delta T * 2.5}{g}$$

T IN DEG C
G IN m/s

WHICH THEN IS THE TEMPERATURE EQUIVALENT

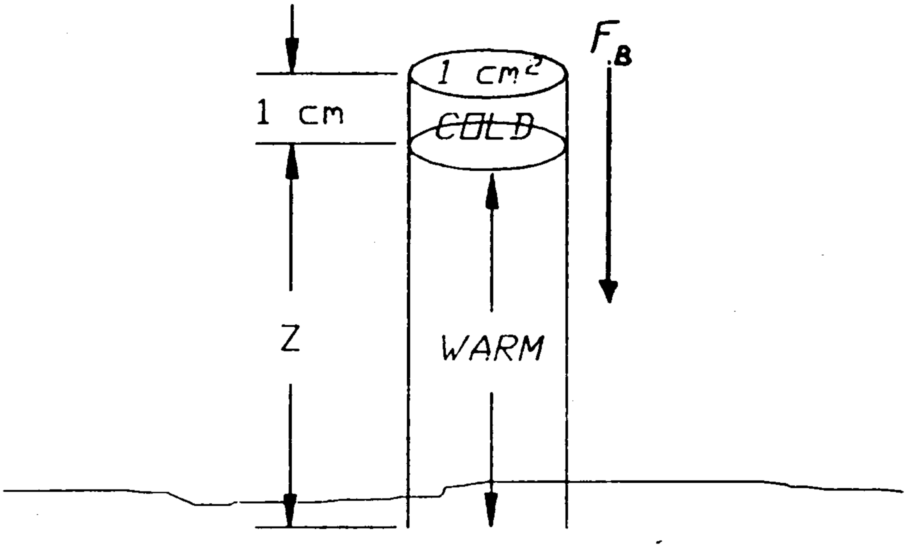
OF:

$$F_{H} = \frac{\dot{W}X}{g}$$

REFERENCE: "THE TERMINAL AREA SIMULATION SYSTEM"; BY FRED PROCTOR; REPORT NO. DOT/FAA/PM-86/50, I NASA CR-4046, VOLUME I: THEORETICAL FORMULATION; APRIL 1987.

—VERTICAL PORTION OF F FACTOR

NEGATIVE BUOYANCY HAS LONG BEEN RECOGNIZED AS THE MAJOR FORCING FACTOR IN DOWNBURSTS.



THE BUOYANT FORCE IS:

$$F_B = g * \frac{\Delta T^\circ}{T_m}$$

WHEN $\Delta T = T - T_m$

WHERE

T = TEMPERATURE OF AIR PARCEL

T_m = AMBIENT TEMPERATURE

TURBULENCE PREDICTION SYSTEMS

FOSTER'S WORK ALLOWS US TO CALCULATE THE VERTICAL VELOCITY FROM THE TEMPERATURE DROP

$$W \int_{W_0}^{0} dW = \frac{g * \Delta T^{\circ}}{T_m} \int_{0}^{Z} (1 - z / Z) \; dz$$

WHICH REDUCES TO

$$W_{(0)}^{2} = - \frac{g * z * \Delta T^{\circ}}{T_m}$$

AND

$$W_{(0)} = \sqrt{\frac{-g * z * \Delta T^{\circ}}{T_m}}$$

SEE PLOT OF FOSTER VS 191

TEMPERATURE DROP RELATED TO VERTICAL WINDS

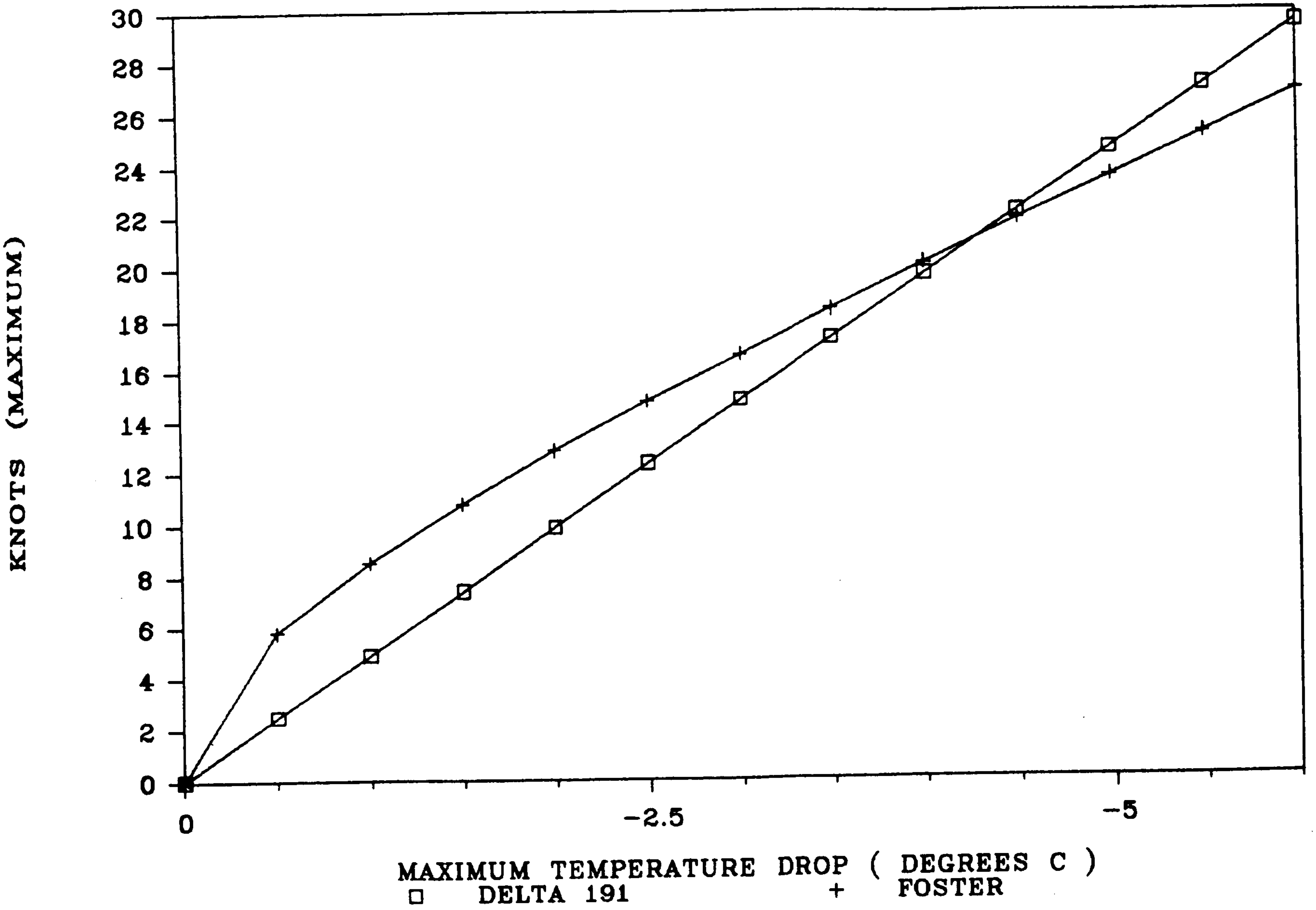
REFERENCE: "THUNDERSTORM GUSTS COMPARED WITH COMPUTED DOWNDRAFT SPEEDS"; BY DONALD FOSTER; MONTHLY WEATHER REVIEW, MARCH 1958, PP. 91-94.

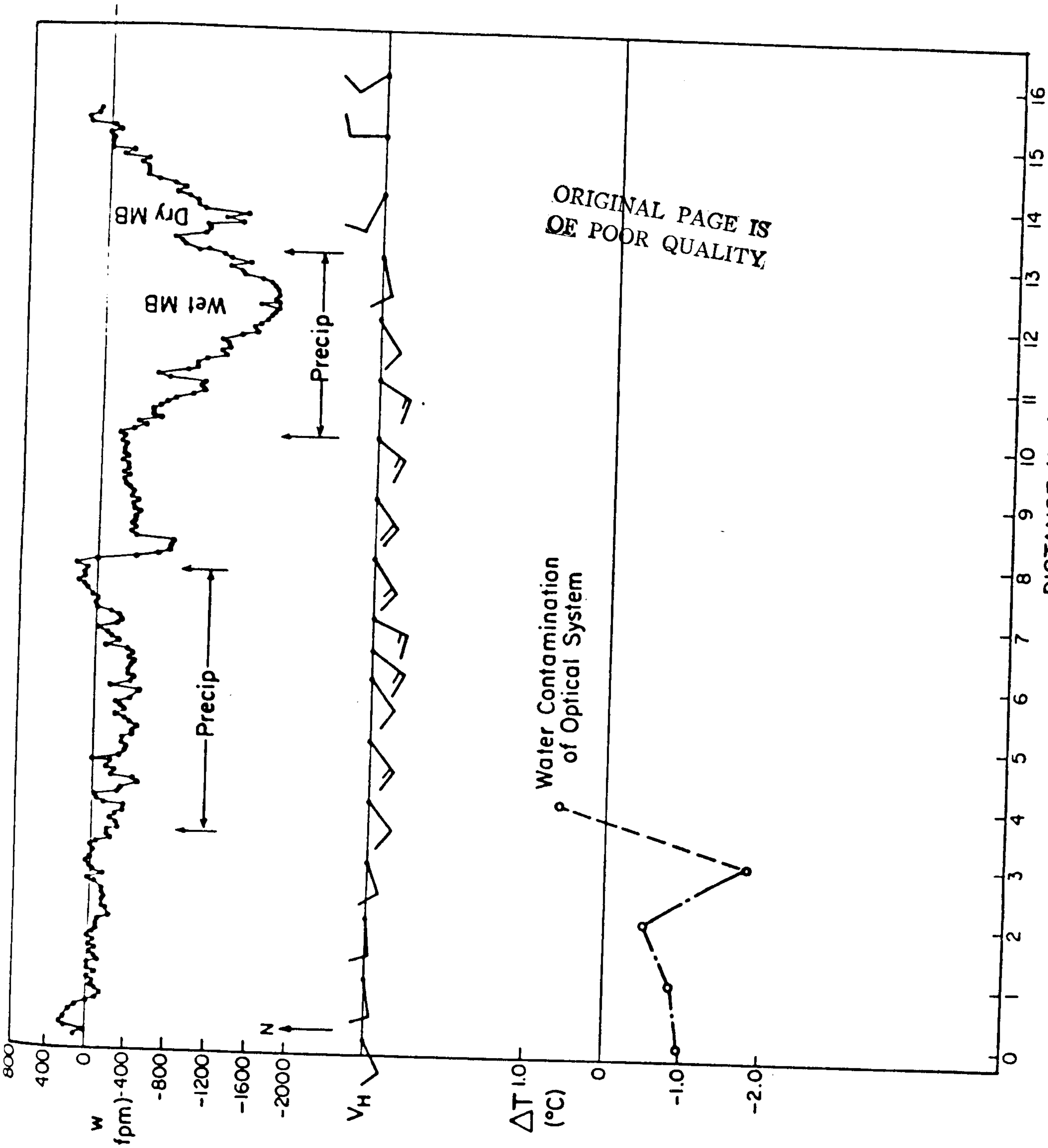
REFERENCE: "A SHORT COURSE IN CLOUD PHYSICS"; BY R.R. ROGERS; 2ND EDITION; INTERNATIONAL SERIES IN NATURAL PHILOSOPHY VOLUME 96; 1979.

TURBULENCE PREDICTION SYSTEMS

W WINDS VERSUS TEMPERATURE DROP

VERTICAL DOWNDRAFT





Sinclair, Kuhn
9/87

Figure 8

WE CAN THEN ASSUME SOME Z (ALTITUDE)

AND

$$Fv = \frac{\sqrt{\dfrac{-g * Z * \Delta T^{-}}{Tm}}}{\text{AIRSPEED}}$$

WHICH IS THE TEMPERATURE EQUIVALENT OF

$$Fv = \frac{Vw}{As}$$

SO COMBINED HAZARD FACTOR AS A FUNCTION OF TEMPERATURE IS:

$$F = \frac{2.5 * -\Delta T}{g} + \frac{\sqrt{\dfrac{-g * Z * \Delta T^{-}}{Tm}}}{\text{AIRSPEED}}$$

TURBULENCE PREDICTION SYSTEMS

CONCLUSIONS:

NOW WE HAVE COVERED BOTH ASPECTS OF CONCERN TO THE AIRCRAFT FROM THE

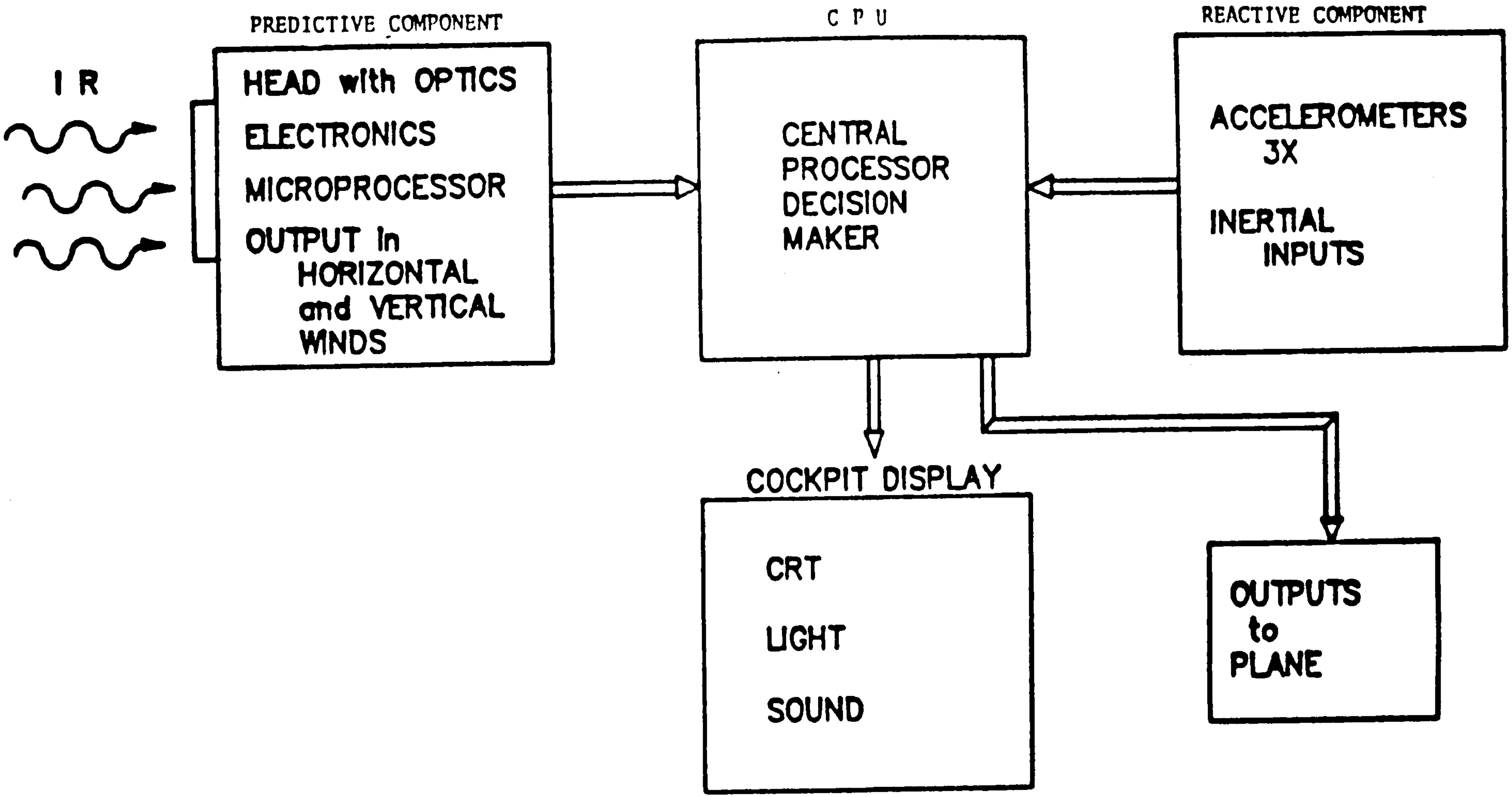
HORIZONTAL WIND RATE OF CHANGE AS A FUNCTION OF EMPIRICAL AND MODELLED WORK RELATED TO TEMPERATURE DROP.

VERTICAL WIND VELOCITY FROM A WELL ACCEPTED FORCING FACTOR RELATED TO TEMPERATURE DROP

THIS CALCULATED HAZARD INDEX HAS RELEVANCE TO THE IN SITU SYSTEMS PRESENTLY IN USE

TURBULENCE PREDICTION SYSTEMS

INTEGRATED SYSTEM



BLOCK DIAGRAM of
TURBULENCE PREDICTION SYSTEMS
ADVANCE WARNING SYSTEM

WHERE TO NOW:

THEORETICAL WORK IN PROGRESS

- NUISANCE ALARMS
  - COLD FRONTS
  - GUST FRONTS
  - SPECIAL CASES
    - SNOW DRIVEN WITH STABLE LAYER
    -

DEFINITION OF STANDARD TEMPERATURE NOISE FIELD

PROBABILITY OF NUISANCE ALARMS FOR INFRARED SYSTEM

PROBABILITY OF NUISANCE ALARMS FOR AN INTEGRATED SYSTEM

TURBULENCE PREDICTION SYSTEMS

OPERATIONAL ENVIRONMENT

WE HAVE OBTAINED WIDE-SCALE USER INTEREST TO ASSIST US IN EVALUATING OUR SYSTEM

WE ARE PROCEEDING WITH A PRIVATELY FUNDED IN-SERVICE EVALUATION OF OUR SYSTEM (12 MONTH PROGRAM)

QUESTIONS WE WANT TO ANSWER

WILL OUR OPERATIONAL SYSTEM PROVE AS RELIABLE AND ACCURATE AS THE RESEARCH INSTRUMENTS DID?

IF NO:

REEVALUATE INFRARED AS A VIABLE CANDIDATE

IF YES:

THE NATION WILL HAVE INCREASED AIR SAFETY NOW

TPS IN-SERVICE EVALUATION

GOALS:

- PROVE TPS'S ADVANCE WARNING SYSTEM PERFORMS WELL IN AN OPERATIONAL SETTING
- HELP ESTABLISH INDUSTRY EVALUATION CRITERIA
- ASSIST IN OBTAINING FAA CERTIFICATION

TPS'S FUTURE

GOAL: FAA CERTIFIED SYSTEM (1988)

METHOD: IN-SERVICE EVALUATION

- INDUSTRY PARTNERS
  - * PIEDMONT AIRLINES - 4 SYSTEMS 1988
  - * HONEYWELL/SPERRY CORPORATION
- TIMETABLE FOR ALL IN-SERVICE EVALUATIONS
  - * 1988
  - * EXPECTED AIR TIME

    12 SYSTEMS - 24,000 FLIGHT HRS
- POST ANALYSIS OF IN-SERVICE DATA
  - * TPS (HONE ALGORITHMS AS WE LEARN)
  - * INDUSTRY PARTNERS
  - * FAA

QUESTIONS AND ANSWERS

JIM EVANS (MIT Lincoln Labs) - Your program sounds like a good way to start trying to address some of the false alarms. On the other hand, one hopes they don't penetrate microburst very often. How are you working at trying to establish what the detection probability is for this combined system?

PAT ADAMSON (TPS) - One of the things we are going to do--and that was part of my last slide--Since the hazard index is applicable to both systems assuming that everybody did their math correctly, we will time tag the data. Part of our data gathering technique will be to look for shears or hazard index such that they may not be terribly hazardous to the aircraft. And it will look for a similar event to occur at some time after that in the reactive system. That is what we are hoping to do. If we get shears over the year that is bad or good, I don't know which.

JIM EVANS (MIT Lincoln Labs) - Again, I understand how you can do that comparison, what I meant was how will you? This plane could fly all summer and never see a microburst. How will you establish whether it detects microbursts or not, in this situation? Wouldn't you really have to have the same system and get a plane out and try to fly it around and try to fly it through microburst?

PAT ADAMSON (TPS) - Well, I don't think so. I mean, I think that has already been proven. I think for example, the report I just showed from Quinn and Sinclair was a completely equipped plane that the B57B was a completely equipped plane--I think they worked properly, it showed they worked in the optimum research section. I don't think we are every going to get proof that they work in the operational setting--nobody is going to take that chance.