DOT/FAA/CT-89/19

FAA Technical Center
Atlantic City International Airport
N.J. 08405

Proceedings and Minutes of the National Interagency Coordination Group Meeting

(February 21-24, 1989)

Michael S. Glynn

March 1989

DOT/FAA
CT-89/19

U.S. Department of Transportation
Federal Aviation Administration

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15. Supplementary Notes

The meeting was held at the Howard Johnson Plaza-Hotel, Cocoa Beach, Florida.

16. Abstract

This publication is a composite of the minutes and presentations given at the annual National Interagency Coordination Group on Lightning and Static Electricity meeting held in Cocoa Beach, Florida, on February 21-24, 1989. Mr. William Jafferis, NASA Kennedy Space Center was the host.

The presentations encompassed both the active and anticipated programs from each agency.

NOTE: Considerable latitude was exercised in the literal transcription of the proceedings to alleviate extensive delays in the publication of the document.

17. Key Words	18. Distribution Statement
Lightning Characterization Electromagnetic Compatibility P State Rocket Triggered Lightning	This document will have limited distribution which will include members of the National Interagency Coordination Group and guest speaker only.

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Table of Contents

1989 International Conference on Lightning and Static Electricity

University of Bath, UK
26-28 September 1989

Our ref: 0 8 FEB 19[illegible]

SUBJECT: 1989 Meeting of the National Interagency Coordinating Group (NICG) of the National Atmospheric Electrical Hazards Protection Program (NAEHP)

FROM: Michael S. Glynn
Secretariat

TO: SEE DISTRIBUTION

My apologies for not following up by January 13 like I stated in my first letter, but travel, vacation, and numerous other tasks took most of my time.

Bill Jafferis has made arrangements with a hotel in Cocoa Beach to provide rooms at a Government rate ($46) and also accommodations for a meeting room. Reservations should be secured at the earliest time as there is a normal cut-off date approximately one week prior to February 14. Hotel contact is:

Howard Johnsons Plaza Hotel
2080 N. Atlantic Avenue
Cocoa Beach, FL
POC: Meridith (407) 783-9222

A general outline of the agenda attached.

As you can see, there is a full schedule and I feel it is a very important meeting in that we are going to be discussing the future goals and directions of the group.

In an effort to finalize plans and an agenda, please make your hotel reservations as soon as possible, and advise me of your intended topic/time requirements for the presentation to the full committee.

Responses, and any questions concerning the subject matter, can be addressed directly to the secretariat, Michael S. Glynn (609) 484-4138/FTS 482-4138, or the host of the 1991 conference, Bill Jafferis, (407) 867-4438, FTS 823-4438.

Michael S. Glynn

Attachments

All correspondence should be addressed to:
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Cleeve Road
Leatherhead
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Telex: 264045 ERALHD G Fax: 0372 374496

The following members of the Steering Committee can also be contacted to answer technical questions on the Conference:

Bob Squire
AES 23b, DAES
Ministry of Defence (PE)
St Giles Court
1-13 St Giles High Street
London WC2H 8LD, UK
Telephone: 01-632 6551

Michael Glynn
NICG Secretariat
Technical Center, ACT-340
Federal Aviation Administration
Atlantic City Airport
New Jersey 08405, USA
Telephone: 609 484 4138

PROPOSED AGENDA

1989 INTERNATIONAL CONFERENCE ON LIGHTNING AND STATIC ELECTRICITY

February 14-17, 1989

Tues.	1 - 4 PM	NICG Conference Committee	
Wed.	9 - 11:30 AM	Presentations	NASA/FAA
	11:30 - 1 PM	Lunch	
	1 - 5 PM	Presentations	NAVY/NASA/NOAA
Thurs.	9 - 11:30 AM	Presentations	USAF/NAVY/ARMY
	11:30 - 1 PM	Lunch	
	1 - 5 PM	NICG Organizational Topics & Presentations (as required)	
Fri.	9 - 12 PM	NICG Conference Committee Tour candidate facilities	

Executive Summary

The annual meeting of the National Interagency Coordination Group (NICG), sponsored by the National Aeronautics and Space Administration (NASA) Kennedy Space Center (KSC) was held in the Howard Johnson Plaza Hotel, Cocoa Beach, Florida on February 22, 1989. In addition, the day prior and the following morning were used to initiate the planning phase for the 1991 Lightning Conference to be held in the KSC area. Both meetings were chaired by Mr. Michael S. Glynn, FAA Technical Center and hosted by Mr. Bill Jafferis, NASA-KSC.

The primary purpose of the NICG annual meetings is to aid in the integration of the research and development efforts of the group members in the field of lightning and static electricity protection for both military and civil aircraft. It is the intent of the forum to efficiently utilize available national resources and present a unified front to congress during the budgetary process.

Business

Mike Glynn opened the meeting by introducing the participants and their organizations:

Michael S. Glynn	FAA Technical Center
Bill Jafferis	NASA Kennedy Space Center
Don MacGorman	National Severe Storm Lab.
Mike Whitaker	Naval Air Test Center
Sam Frazier	Naval Air Test Center
Enrico Clemente	U.S. Army, Ft. Monmouth, NJ

Old Business - None

New Business -

- Bill Jafferis discussed the planning to date for the 1991 Lightning Conference to be held in the KSC area. The time frame which appeared to meet our needs and conform to the rotation of sites was April to June, 1991. This allows for approximately 18 months after the conference in Bath, England and is during a "good weather-wise" period in central Florida. Ideas for a logo for the conference will be developed by the FAA with final design coordination with Mr. Jafferis. Other plans put into motion were the 18-month milestone schedule, local transportation needs, unique extracurricular activities (cruise), plus guidance from those who have sponsored/managed a conference in the past. After the meeting, Ms. Jean Homan, Sales Manager for Howard Johnson, gave us a tour of the convention/ conference facility.

- On February 22 the presentations which are listed in the table of contents were presented. Mr. Clemente also gave a short presentation on his roll at Avionics Research and Development Activity, Ft. Monmouth, NJ. Following the afternoon session, Ms. Alice Cockrell, Sales Manager, Hilton Cocoa Beach, gave us a tour of their convention/conference facilities.

o In the evening of February 22, the members present met to discuss the future of the NICG and what direction it should take. It appears that the primary function that NICG has been accomplishing over the last few years is the sponsorship of the lightning conference. Since 1983, the NICG has successfully organized and directed conferences in Dallas, Orlando, Daytona and Oklahoma City. This has been no small feat, but all agreed the charter/ mission of the NICG should have a re-look and at the next meeting, concrete discussion for future efforts should be at center stage. Ideas brought up by members to initiate thought were - broaden to more than just lightning and ground, get federal coordination involved, hazard warning research and forecasting. The following decisions/tasks were enumerated:

  - At a minimum continue to support NICG Conference

  - Current membership

    DOD (USAF, USN, USA)
    NASA
    FAA

  - Expand membership

    DOE
    DNA

  - Review Charter and be prepared to discuss changes at next meeting.

  - Contact Federal Coordination to discuss possible assistance available at a National level.

  - Consider rotation of conference between US and Europe (1 to 1, or 2 to 1).

  - Tentative date for the 91 conference is April 16-17-18. A handout/ advertisement will be made available for the Bath Conference. This will be followed shortly thereafter with a call for papers.

o On the morning of February 24, the committee toured the remaining two facilities selected as candidates for consideration - Ms. Ellen Berkowitz, Sales Manager, Holiday Inn, Cocoa Beach, and Ms. Candace Carlson, Director of Sales, Holiday Inn, Melbourne, Indialantic, FL.

With no further discussions and all facilities surveyed, the meeting was adjourned at 12:30 p.m.

ROCKET TRIGGERED LIGHTNING

BILL JAFFERIS

NASA-KSC

HISTORY

- PLAN ESTABLISHED 1963 BY CENTER DIRECTOR
- REQUIRES THEORETICAL STUDIES BE CONFIRMED BY KSC FIELD DATA
- CONSIDERS ASSESSMENT OF HAZARD FROM CHARGED CELLS CAPABILE OF PRODUCING LIGHTNING - A CRITICAL ELEMENT IN IMPROVED LAUNCH OPERATIONS
- REQUIRES CONTINUING LIGHTNING INSTRUMENTATION UNDER DIRECTION OF THE LIGHTNING PROTECTION COMMITTEE

PROGRAM OBJECTIVES

- ADDITIONAL LIGHTNING MEASURING AND DETECTION DATA
- IMPROVED ACCURACY OF LIGHTNING WARNING (ONE QUARTER-MILE WITHIN FIVE-MILE RADIUS OF LAUNCH SITE)
- SUPPORT FROM LIGHTNING EXPERTS

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KSC FORM 4-607 (REV. 1/88)

OPERATIONS LESSONS TO BE LEARNED

- APOLLO (12/15)
  - LIGHTNING VULNERABILITY - GROUND/VEHICLE
  - WORK STOPPAGES
- SHUTTLE (51L)
  - FORECASTING RELIABILITY - EFFECTS ON CREW/MANAGEMENT
  - EFFECTIVENESS OF LPMS AND LDWS
- ATLAS CENTAUR (43/67)
  - VULNERABILITY TO LIGHTNING EFFECTS ALL AGNECY
  - NEED FOR TECHNOLOGY TRANSFER - LIGHTNING/FORECASTING

INTEGRATION OF STUDIES - ELECTRICAL ATMOSPHERE AND CLOUD PHYSICS - SUPPORTED BY ALL USERS

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ROCKET TRIGGERED LIGHTNING PROGRAM

- ATMOSPHERIC SCIENCES FIELD LABORATORY LIGHTNING PROGRAM (ASFL/RTLP)
  - USED TO DEMONSTRATE A PERMANENT KSC ASFL
  - ADEQUACY OF KSC LIGHTNING PROTECTION AND MEASURING SYSTEM
  - DEVELOPMENT OF A COST-EFFECTIVE LIGHTNING DETECTION AND HAZARD WARNING SYSTEM
  - IMPROVED WEATHER FORECASTING
- FUNDING GOAL - TO ATTRACT SUPPORT FROM OTHER GOVERNMENT AGENCIES, UNIVERSITIES, AND INDUSTRY SOURCES.

ROCKET TRIGGERED LIGHTNING PROGRAM - AIRBORNE RESULTS

- PARTICIPANTS - FAA, AFWAL, NRL, ONERA, KSC/ESMC

	1984	1985	1986	1987	1988
- DURATION	6/11>9/28	6/15>8/28	7/15>8/30	7/15>8/30	7/15>8/30
- MISSIONS FLOWN	27	17	DNA	DNA	17
- NATURAL LIGHTNING	21	27	DNA	DNA	1
- TRIGGERED LIGHTNING	6 NEARBY	1 NEARBY			1 WB

- DATA - SUBSTANTIAL AIRBORNE AND GROUND COORELATIONS PRESENTED AT PARIS, DAYTON, AND OKLAHOMA LIGHTNING AND STATIC ELECTRICITY CONFERENCES.

ROCKET TRIGGERED LIGHTNING PROGRAM - GROUND-RESULTS

O PARTICIPANTS - KSC/ESMC, AFWAL, NAVY, ONERA, CENG, CENS, CNET, LLNL, UA, UF SUNYA, ATT BELL LAB, SNAL, EPRI, BAC

		1984	1985	1986	1987	1988
-	DURATION	7/10>8/20	6/15>8/20	7/18>8/28	7/15>8/30	7/15>8/30
-	STRIKE OBJECT	-	AFWAL-LSO	LLNL-LIDS	BOEING RADOME/EPRI	BAC RADOME EPRI
-	STORM DAYS	3	13	7	6	16
-	TRIGGERED LIGHTNING	8	34	29	26	28
-	ROCKETS LAUNCHED	19	40	39	36	48
-	STRIKE DATA	30	103	112	94	58
-	PEAK IMAX (KA)	30	50	52	62	30
-	PEAK DI/DT (KA/W)	-	260	115	411	230

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KSC FORM 4-607 (REV. 1/88)

PAST FIVE YEAR ACCOMPLISHMENTS

USING NASA-KSC PT ADVANCE PROGRAM AND TECH UTILIZATION FUNDS KSC HAS

- MANAGED LIGHTNING OCCURRENCE IN A FIELD ENVIRONMENT USING LAND, WATER AND AIRBORNE LAUNCHING PLATFORMS
- ACQUIRED A PORTABLE LIGHTNING SIMULATOR FOR FUTURE USE
- MEASURE LIGHTNING CURRENT CHARACTERISTICS AND ELECTROMAGNETIC FIELDS OF ROCKET TRIGGERED, SIMULATED AND NATURAL LIGHTNING
- SUPPORT RESEARCH CONDUCTED BY NATIONAL AND INTERNATIONAL AGENCIES, ACADEMIA AND COMMERCIAL INTERESTS
- ACHIEVEDWORLD RECOGNITION THAT NASA-KSC CAN CONTRIBUTE TO THE IMPROVED UNDERSTANDING OF ATMOSPHERIC ELECTRICITY
- IMPROVED AN UNDERSTANDING OF THE POTENTIAL OF CLOUD HAZARDS TO PREVENT A CATASTROPHIC EVENT TO MANNED OR UNMANNED SPACE VEHICLES

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KSC FORM 4 607 (REV. 1/80)

SIGNIFICANT FINDINGS/ACCOMPLISHMENTS

- MEASURED THE LARGEST LIGHTNING CURRENT DERIVATIVE 411 KA/MICROSECOND. BELIEVED TO BE WITHIN THE LARGEST THAT CAN EXIST 500 KA/MICROSECOND
- COLLECTED A SIGNIFICANT NUMBER OF LIGHTNING CURRENT CHARACTERISTICS THAT DEMONSTRATES THAT THE FIRST STROKE OF A LIGHTNING FLASH IS NOT NECESSARILY THE LARGEST
- LIGHTNING CAN BE TRIGGERED UNDER AN ANVIL AT LOW FIELD LEVEL WITH NO ACTIVE LIGHTNING WITHIN 30 MILES (SUMMER AND WINTER STORMS)
- PROVIDED GROUND TRUTH DATA FOR LIGHTNING LOCATION SYSTEMS
- PROVIDED LIMITED MEASURE OF CHARGE GENERATION REGIONS USING MAXWELL CURRENT SENSORS
- LIMITED DATA RELATIVE TO LIGHTNING (TRIGGERED) INITIATING PROCESS (UPWARD AND DOWNWARD) STEPPED LEADER PROCESS
- SUCCESSFULLY MEASURE ELECTRIC FIELDS ABOVE SPACE CHARGE

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KSC FORM 4-607 (REV. 1/88)

SIGNIFICANT FINDINGS/ACCOMPLISHMENTS (CONTINUED)

- SUCCESSFULLY TESTED VARIOUS LIGHTNING STRIKE OBJECTS VULNERABILITY TO LIGHTNING:

  AEROSPACE CYLINDER (AFWAL)

  LIGHTNING INVULNERABLE DEVICE SYSTEM (LIDS) LLNL/SNAL

  AIRCRAFT RADOME (BOEING)

  ELECTRIC POWER HI-VOLTAGE LINE, ARRESTER, VOLTAGE DIVIDER AND WAVE FORM MEASUREMENT RECORDER

  ONERA FURNISHED CYLINDER SUSPENDED 150 METERS ABOVE THE WATER SITE. ONE LSO LAUNCHED ROCKET TRIGGERED LIGHTNING (WIRE BURN)

- TRANSFERRED KNOWLEDGE OF LIGHTNING PROTECTION, MEASUREMENTS, DETECTION AND HAZARD WARNING (UF & EPRI) TO ACADEMIA AND FISH AND WILDLIFE (FOREST FIRE INTEREST)

- TRIGGERED LIGHTNING FROM A BALLOON SUSPENDED LSO (AEROSPACE VEHICLE SIMULATOR)

- INTERNATIONAL FACILITY RECOMMENDED FOR USE BY NATIONAL RESEARCH COUNCIL (NRC), AIR FORCE SPACE CMD/AEROSPACE, AIR FORCE GEOPHYSICAL LAB/WORKSHOP/BARNES (AFGL)

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ROCKET TRIGGERED LIGHTNING PROGRAM - RESULTS

- O PROVIDE LIGHTNING PROTECTION FOR CRITICAL WORK AREAS
  - ROCKET TRIGGERED LIGHTNING ~~WILL~~ may VERIFY ~~VARIOUS~~ IED DESIGNS

- O IMPROVED ADVERSE WEATHER WARNING RELIABILITY (LIGHTNING WITHIN 5 MILES)
  - EXPANDED MEOS NETWORK ~~WILL~~ may IMPROVE SHORT TERM FORECAST (30 MINUTES)

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ROCKET TRIGGERED LIGHTNING PROGRAM - FUTURE

- LONG RANGE PLANNING
  - PARTICIPANTS - NASA, FAA, AIR FORCE, NAVY, FRENCH, UNIVERSITIES, LLNL/SNAL, EPRI AND COMMERCIAL INTEREST
  - GOALS
    - LIGHTNING SIMULATION/HI VOLTAGE FACILITY
    - DATA PROCESSING AND ANALYSIS FACILITY
    - MEASURE NATURAL LIGHTNING CURRENT CHARACTERISTICS FROM GROUND REMOTE STATIONS
    - PERMANENT NASA KSC/UNIVERSITY FACILITY TO STUDY ATMOSPHERIC PHENOMENA
    - CATALYST FOR IMPROVING NATURAL AND TRIGGERED LIGHTNING PHENOMENA UNDERSTANDING RELATIVE TO LIGHTNING PROTECTION OF AEROSPACE AND GROUND FACILITIES AND OF FORECASTING OF METEROLOGICAL EVENTS
    - IMPROVED UNDERSTANDING, BY ALL LEVELS OF MANAGEMENT, THE UNDERSTANDING OF LIGHTNING TO RECOGNIZE AND PROTECT AGAINST THESE HAZARDS

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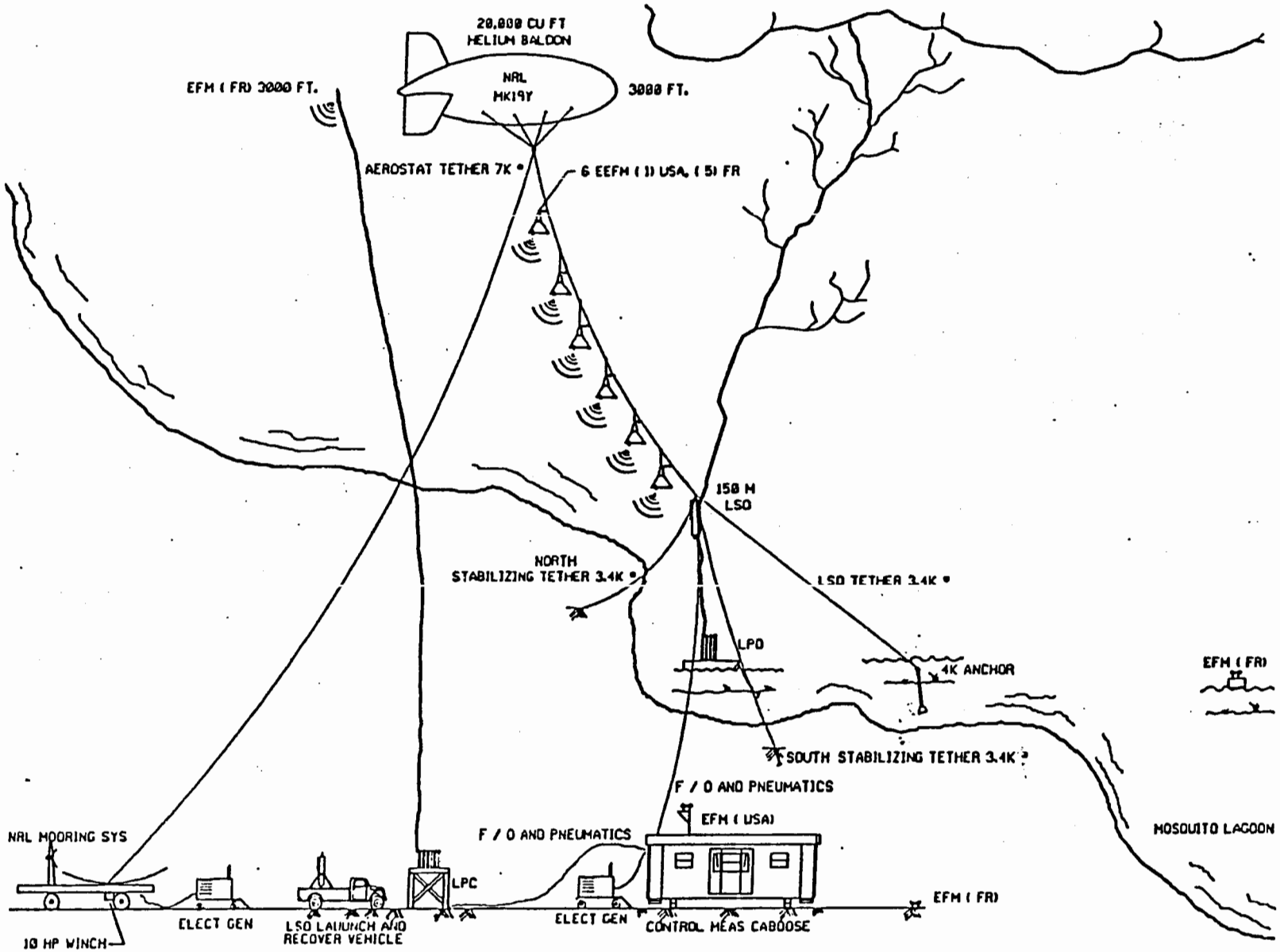

1989 RTLP

RTLP 89 LIGHTNING EXPERIMENTS - TETHERED BALLOON EXPERIMENT

- BALLOON

  NAVY 20,000 FT^3 85' X 25'
  WALLOPS ISLAND 40,000 FT^3 100' X 40'

- LIGHTNING STRIKE OBJECT (LSO)

  ONERA/CENG
  LENGTH 3M
  DIAMETER .5M
  WEIGHT 80 TO 90 KG

- ALTITUDE

  BALLOON 1000M
  LSO 150M

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13

RTLP 89 LIGHTNING EXPERIMENTS - FRANCE

- OFFICE NATIONAL D'ETUDES RESEARCHES AEROSPATIALES (ONERA)

  PIERRE LAROUCHE

- CENTRE D'ETUDES NOCLAIDES - GRENOBLE (CENG)

  ANDRE-EUBERT BERARD
  LOUIS BARRETT
  JEAN-PIERRE BERLANIOS
  TERRIER GERARD

- CENTRE NATIONAL D'ETUDES DES TELECOMMUNCATIONS (CENT)

  CHRISTIANNE LETEINTURIER
  JEAN UVES LESADOUT

- LABORATOIRE PHYSIQUE DE'ATMOSPHERIQUE (LPA)

  SERGE CHAURY
  SERGE SOULAT

RTLP 89 LIGHTNING EXPERIMENTS TETHERED BALLOON EXPERIMENT CONTINUED

- LSO SENSORS

  (2) CURRENT (I) *4 ROCKETS ON LSO
  PRECURSOR
  RETURN STROKE
  ELECTRIC FIELD
  ELECTRIC FIELD DERIVITIVE DE/DT
  MAGNETIC FIELD

- TETHERED SENSORS

  (5) ELECTRIC FIELD (LPA) ROCKET BORNE SENSOR
  (1) ELECTRIC FIELD (WSC) - BILL WI NN VERTICAL SOUNDER (LAUNCHED PRIOR TO RTL)

RTLP 89 LIGHTNING EXPERIMENTS - MEASUREMENTS

- WATER PAD/LAND PAD

  I, DE/DT (AS 88)
  $\vec{E}$ LAND, $\vec{E}$ WATER, $\vec{E}$ TETHERED BALLOON BORNE
  FAST ROCKET SOUNDING FOR $\vec{E}$ VETICAL AND ALTITUDE
  RF TO GRD (vertical)
  CALIBRATION OF 6 $\vec{E}$ (TETHERED) SENSOR

- OPTICS, VIDEO, STILL (video, still)

LIGHTNING EXPERIMENT IN FLORIDA- JULY- AUGUST 1989

CNET PARTICIPATION
(CENTRE NATIONAL D'ETUDES DES TELECOMMUNICATIONS -
LAB/ MER/ GER - LANNION - FRANCE)

LIGHTNING RETURN - STROKES

PURPOSE:

TO CHARACTERIZE LARGE AMPLITUDES AND FAST TRANSITIONS OF LIGHTNING CURRENTS

TO CHARACTERIZE LARGE AMPLITUDES AND FAST TRANSITIONS OF ELECTROMAGNETIC FIELDS

TO IMPROVE MODELS WHICH RELATE CURRENT AND ELECTROMAGNETIC FIELDS

I - RETURN - STROKE di/dt MEASUREMENTS

SENSOR : INDUCTIVE LOOP

WATER PAD

FIBER OPTICS FROM THE PAD TO THE SHELTER (100 M RANGE) - SIGNALS RECORDED BY CENG ,

di / dt AND i SYNCHRONIZED

DYNAMIC RANGE : A FEW KA/ MICRO SECOND TO 400 KA/ MICRO SECOND

SAMPLING RATE : 100 MHz

II - ELECTROMAGNETIC FIELD MEASUREMENTS

SITE :

1 KM FROM THE LAUNCHING PAD, WITH PROPAGATION ABOVE THE LAGOON
(THE ATTENUATION IS MINIMIZED)

MEASUREMENTS :

FOR EACH RETURN STROKE :

dE / dt : 100 MHz SAMPLING RATE
E : 10 MHz SAMPLING RATE
] ← CAPACITIVE ANTENNAS

B : 10 MHz SAMPLING RATE] ← 2 MAGNETIC CROSSED SENSORS

II - ELECTROMAGNETIC FIELD MEASUREMENTS (CONT'D)

DATA :

1. EVOLUTION OF E.M. FIELD WITH RANGE :

   CORRELATION WITH CENG MEASUREMENTS : dE/ dt 100M

   IF J. WILLETT PARTICIPATES, CORRELATION WITH E AND dE/ dt MEASUREMENTS, 5 KM

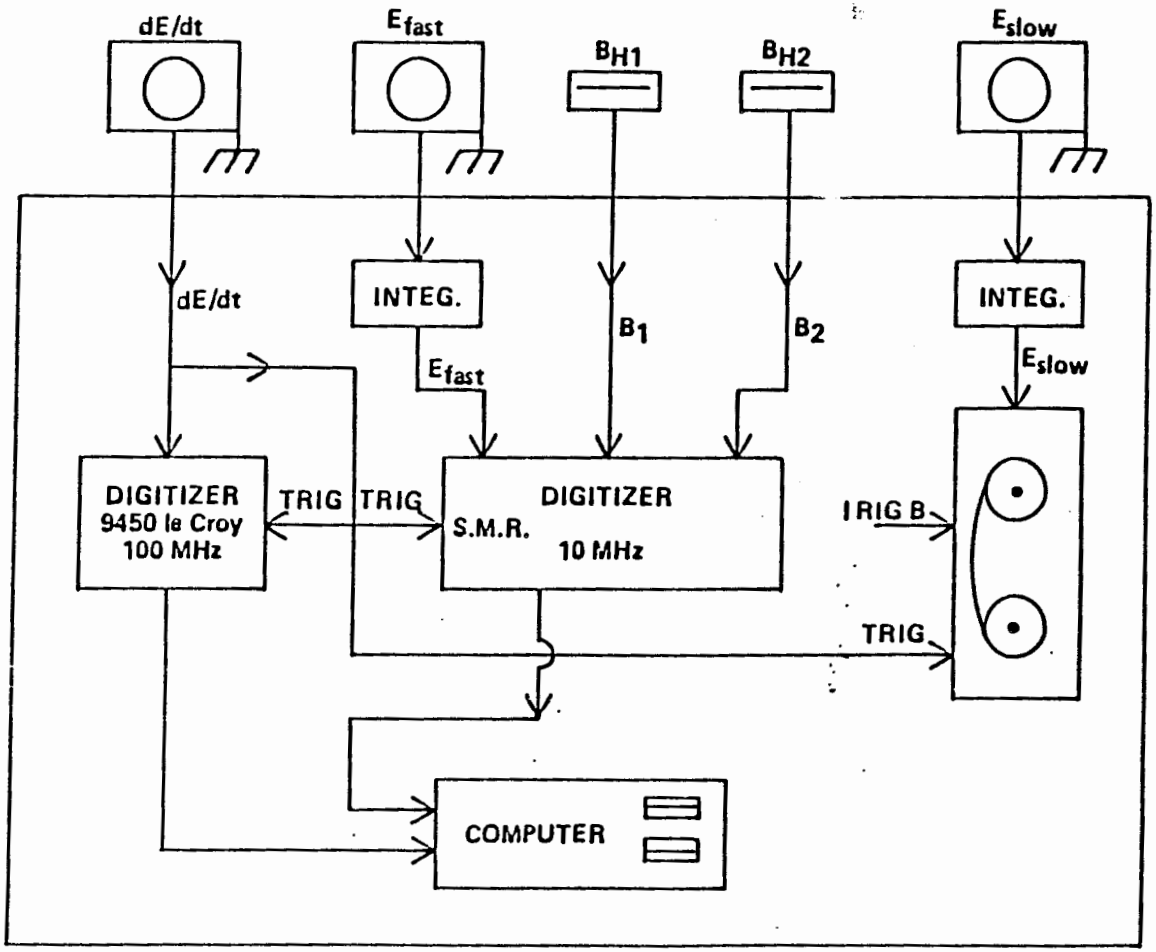
2. CORRELATION WITH CURRENT - MEASUREMENTS :

   WITH i GROUND OR i L.S.O.

   WITH d i / dt GROUND

3. COMPARISON BETWEEN FLASHES TRIGGERED FROM THE GROUND AND FROM THE L.S.O.

SITE - 1km - E.M. FIELD MEASUREMENTS



NASA

KSC FORM 4-607 (REV. 1/88)

WHY THE FRENCH?

BATTERY OPERATED SENSORS 6 @ $ 3K 6 @ 1.5K	27,000
14 CH. INSTR. RECORDER W/ CP INTERFACE	80,000
COMPUTER & PERIPHERAL	8,000
4 DIGITAL RECORDERS	24,000
STRIP / X-Y RECORDERS	20,000
PNUEMATIC SYSTEM FIRING CONSOLE, SOLENOIDS, TRANSMISSION LINES	40,000
75 ROCKETS W/ WIRE @ 300 EA.	22,500
12 FIBER OPTIC LINKS @ 14.5K EA.	174,000
FILM AND VIDEO CAMERA SYSTEMS	25,000
5 ENGINEER / TECHNICIANS 10 HR DAY 7 WKS $ 31HR	54,250
RTLP COST WITHOUT THE FRENCH	474,750

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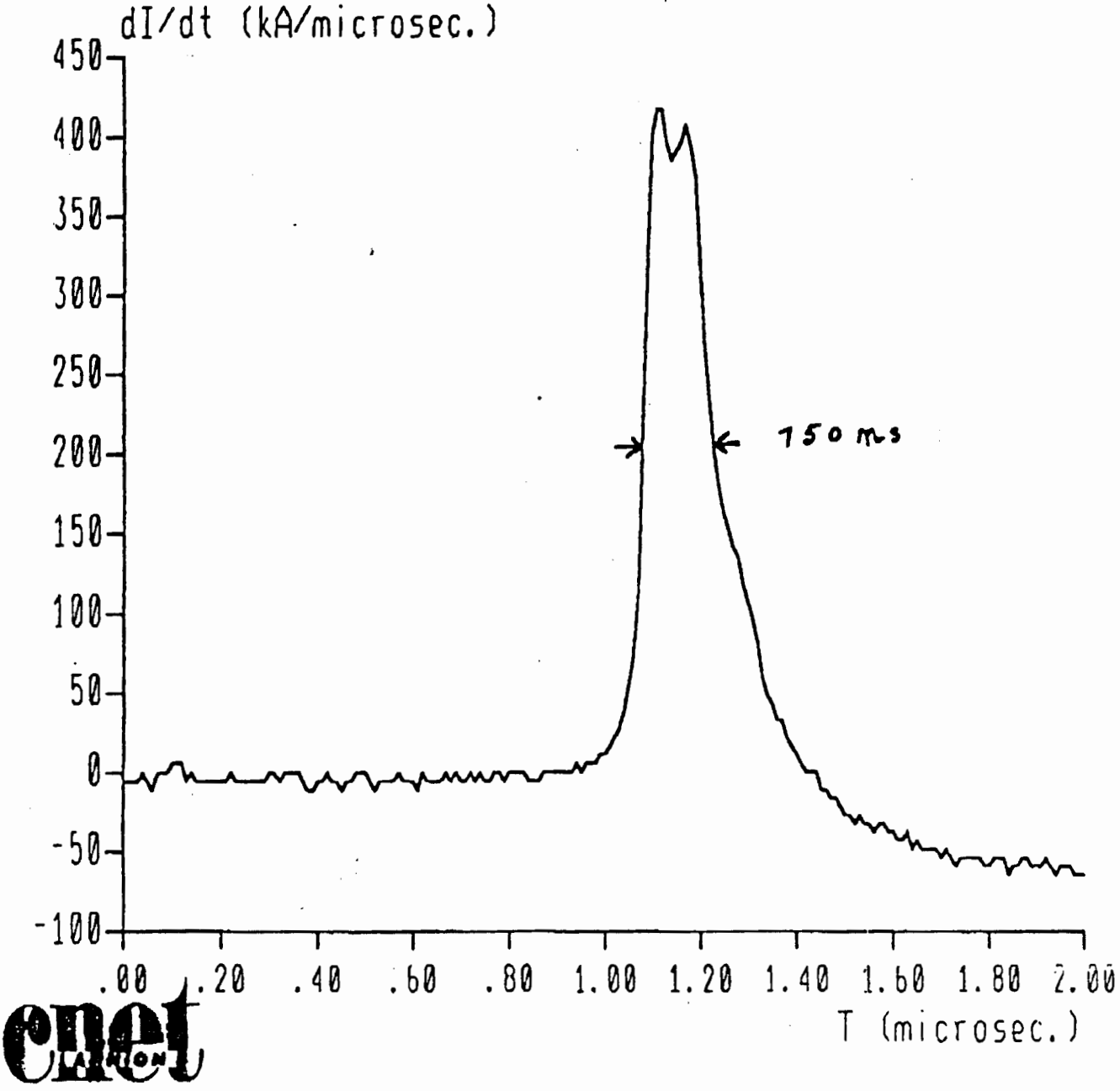
CURRENT-DERIVATIVE 8717 9TH STROKE



FAA FLIGHT SAFETY RESEARCH

MICHAEL GLYNN

FAA TECHNICAL CENTER

FLIGHT SAFETY RESEARCH BRANCH

MISSION STATEMENT

Provides Engineering and Scientific Leadership to Plan, Develop, Implement, and Manage Complex/Sophisticated Research Efforts in Atmospheric Hazards and Advanced Technology as Related to the Airworthiness, Certification, and Operational Safety of Civil Fixed/Rotary Wing Aircraft.

- F-106 PROGRAM
  - -- HIGH ALTITUDE
    - -- NASA-LANGLEY
      - -- STRIKES
        - CLOUD-TO-CLOUD
        - INTRA-CLOUD

- C-580 PROGRAM
  - -- LOW ALTITUDE (UP TO 20K)
    - -- FLORIDA AND NEW MEXICO
      - -- STRIKES
        - CLOUD-TO-GROUND

- ROCKET TRIGGERING PROGRAM
  - -- LOW ALTITUDE
    - -- FLORIDA
      - -- STRIKES
        - CLOUD-TO-GROUND

GEOGRAPHIC STUDY

CRMI

PURPOSE - CENTRALIZED DATA BASE

APPROACH - PROJECT PLAN
IDENTIFY ALL DATA BASES
COMPUTERIZE
ANALYZE

RESULTS - PROJECTED
VALIDATION OF MODELS

AIRCRAFT/SYSTEMS PROTECTION CRITERIA

AC 20-53A (4/85)

PROTECTION OF AIRPLANE FUEL SYSTEMS AGAINST FUEL VAPOR IGNITION DUE TO LIGHTNING

USERS MANUEL FOR 20-53A (10/84)

AC 20-53A (UPDATE) LTI

AIRCRAFT FUEL SYSTEM LIGHTNING PROTECTION DESIGN AND QUALIFICATIONS TEST PROCEDURES DEVELOPMENT.

SAE-AE4L-87-3

PROTECTION OF AIRCRAFT ELECTRICAL/ELECTRONIC SYSTEMS AGAINST THE INDIRECT EFFECTS OF LIGHTNING

USERS MANUEL 20-XX

HIGH ENERGY RF

PURPOSE:

SURVEY MAXIMUM ELECTRICAL FIELD INTENSITIES FROM EMITTERS IN UNITED STATES

APPROACH:

CURRENT EMITTERS
DATA BASES

RESULTS:

WORST CASE CONDITION
MAXIMUM MAINBEAM GAIN
MAXIMUM CUMMULATIVE FIELD STRENGTH
REVIEW ECAC DATA BASE
CONSTRUCT GROUND REFLECTIONS
2-30 MHz
NEAR-FIELD CORRECTIONS

Federal Aviation Administration
Technical Center
Atlantic City Airport, New Jersey 08405

ADVANCED TECHNOLOGY ASSESSMENT

LIGHTNING PROTECTION HANDBOOK

DIGITAL SYSTEM VALIDATION HANDBOOK WORKSHOP

DIGITAL SYSTEMS

HANDBOOK

WORKSHOP

DIGITAL FLIGHT CONTROLS

FAULT INSERTION
EXPERIMENTATION
VALIDATION

REDUNDANCY ASSESSMENT

SOFTWARE SPECIFICATIONS

SOFTWARE DEPENDABILITY

BUSS CERTIFICATION

RECOVERY SPECIFICATIONS

DOT/FAA/CT-87/38

FAA Technical Center
Atlantic City International Airport
N.J. 08405

Lightning Simulation Test Technique Evaluation

William W. Cooley
Deborah L. Shortess

Science & Engineering Associates, Inc.
701 Dexter Avenue N., Suite 400
Seattle, Washington 98109

October 1988

Final Report

U.S. Department of Transportation
Federal Aviation Administration

DOT/FAA/CT-86/8

FAA TECHNICAL CENTER
Atlantic City International Airport
N.J. 08405

Determination of Electrical Properties of Grounding, Bonding and Fastening Techniques for Composite Materials

William W. Cooley

Science & Engineering Associates, Inc.
701 Dexter Avenue N., Suite 400
Seattle, Washington 98109

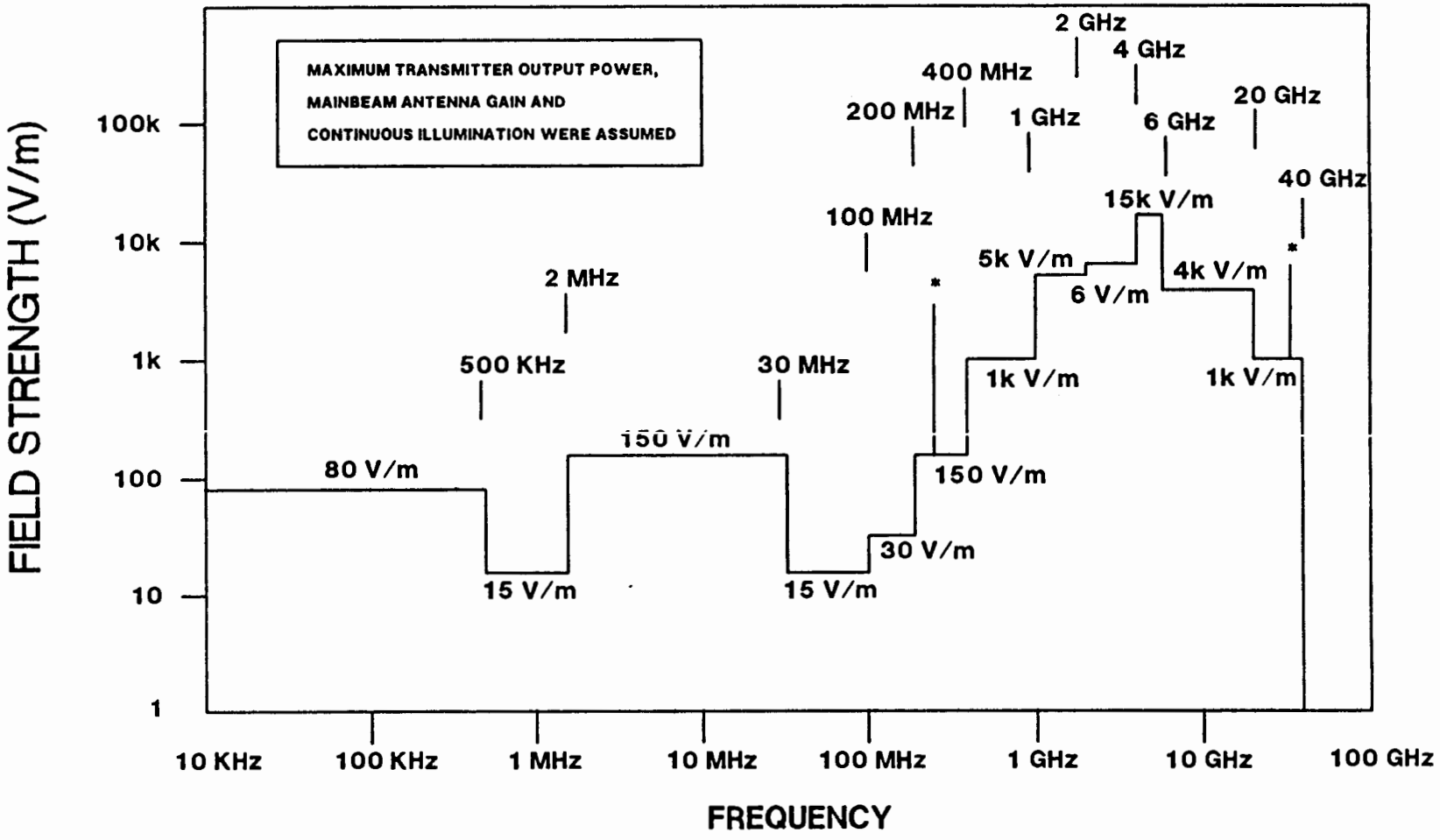
April 1987

Final Report

U.S. Department of Transportation
Federal Aviation Administration

AIRCRAFT EME-RESULTS

PREDICTED MAXIMUM PEAK FIELD STRENGTH LEVELS FROM GROUND EMITTERS (ALTITUDE FLIGHT AT 500 FT AGL)



AIRCRAFT EME-RESULTS

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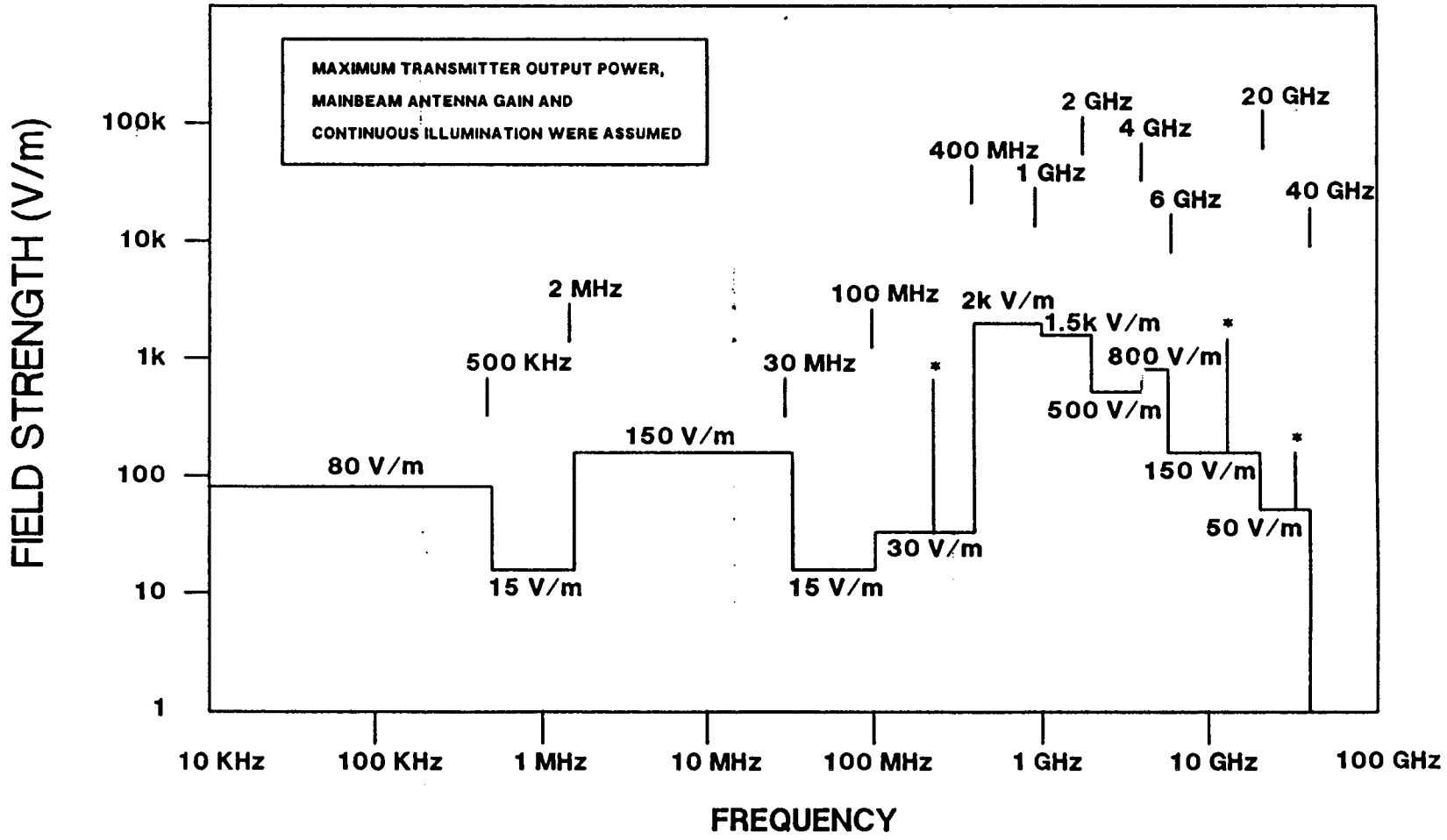
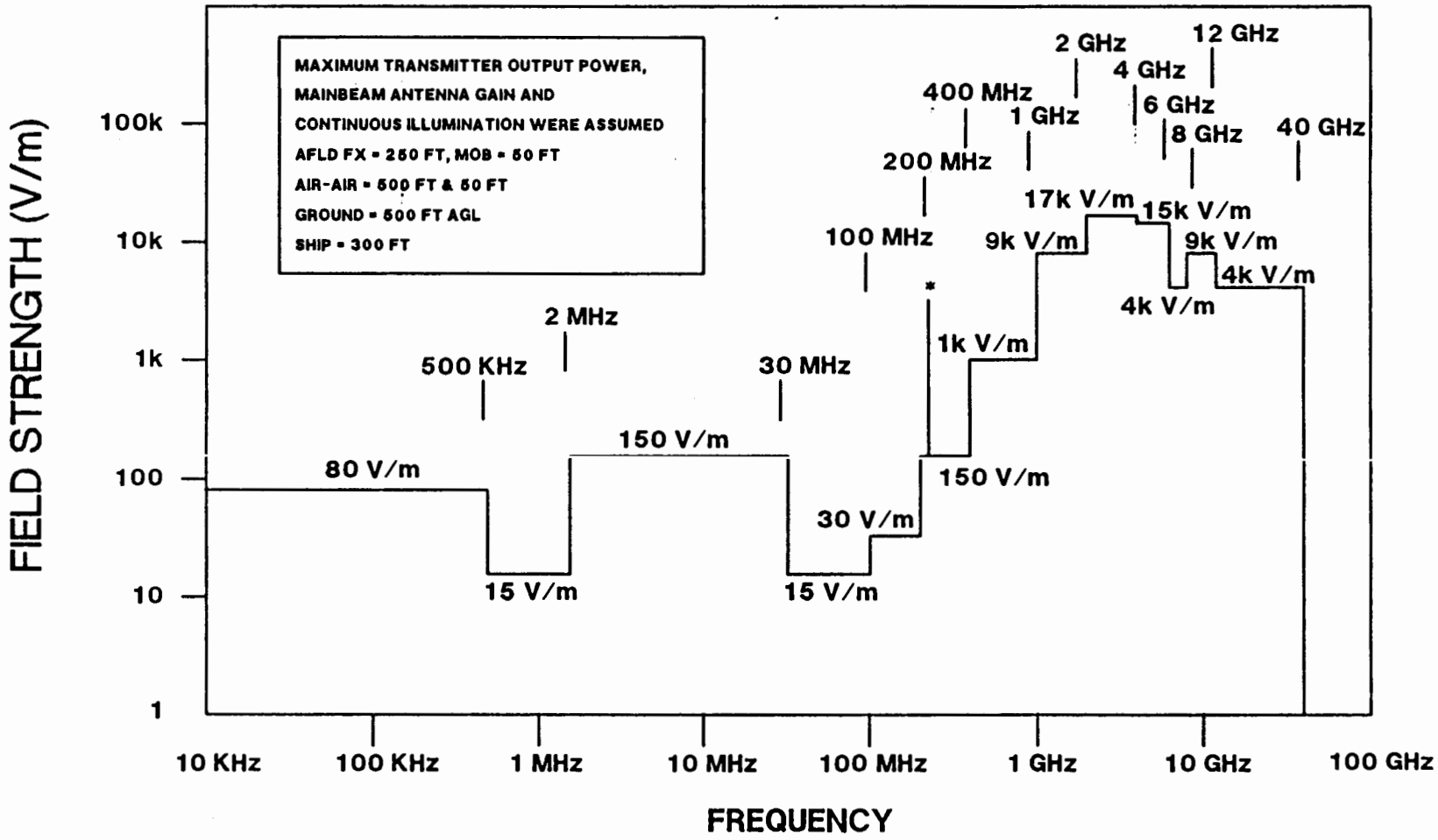


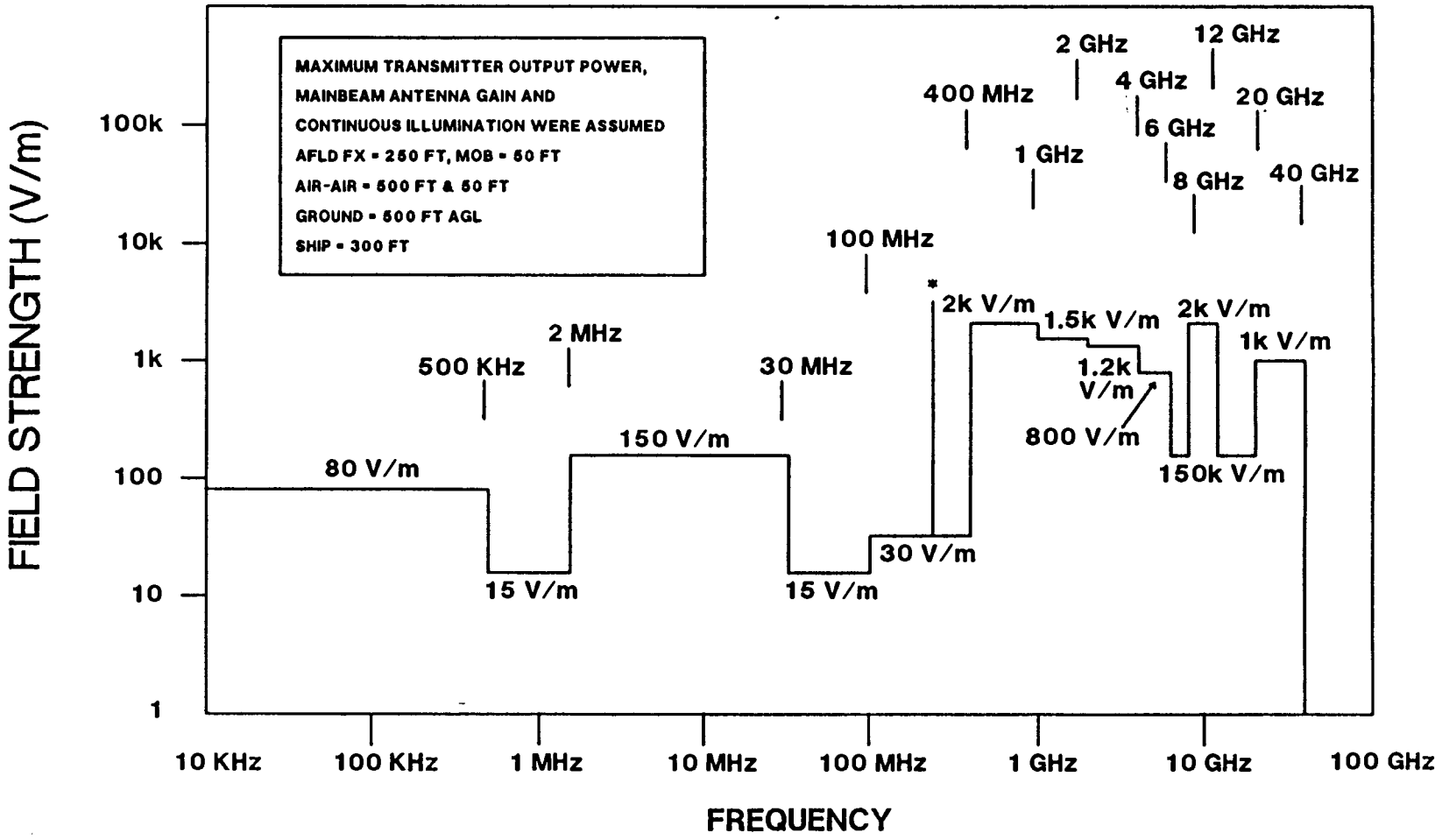
AIRCRAFT EME-RESULTS

PREDICTED MAXIMUM PEAK FIELD STRENGTH LEVELS
COMPOSITE OF US EMITTERS



AIRCRAFT EME-RESULTS

PREDICTED MAXIMUM AVERAGE FIELD STRENGTH LEVELS
COMPOSITE OF US EMITTERS



NSSL/ONERA FIELD PROGRAM

1990

DON MAC GORMAN

NSSL

NSSL/ONERA field program, 1990
Research objectives

- Relationship of storm structure and kinematics with
  (a) regions of lightning initiation
  (b) patterns of lightning propagation
  (c) electric field and charge distribution (model).
- Evolution of IC and CG rates and locations throughout storm life cycle.
- Initiation and development of positive CG in stratified rain regions.
- Lightning activity as an indicator of microbursts, hail, and tornadoes.
- Positive leader-continuous current process and recoil streamers in air discharges.

OPERATION, FACILITY, PEOPLE

- 3-D motion and reflectivity structure of a storm (Ed Brandes, Mike Eilts).
  (a) NEXRAD radar in continuous volume scanning
  (b) CIM radar in a sector volume scanning

- 3-D reproduction of radiation sourses patterns of IC and CG flashes in post analysis and 2-D reproduction in real time within dual Doppler area (ONERA/France).

- Locating of negative and positive CG with LLP system (Don MacGorman)

- Electric field measurements inside and near storms (David Rust, Monte Bateman, Tom Marshall/U.Mississippi, Ralph Markson, Earle Williams/MIT, Marx Brook/NMIMT)
  (a) One or two Mobil Labs
  (b) Network of corona probes (30x30 km)
  (c) Drop sounds from aircraft flying above storms
  (d) Wide band E-field measurements on the ground

OPERATION, FACILITY, PEOPLE (cont.)

- Modeling charge and electric field distribution within a storm using method of the microphysical continuity retrieval (Conrad Ziegler)

- Simultaneous optical, visual and electrical measurements of air discharges (Vlad Mazur)
  (a) Single station E-field and optical instruments at SEB
  (b) High rate video system in the SEB cupola
  (c) Interferometric data

- Forecast of storm formation in the dual Doppler area in cooperation with NWS (Don Burgess)
  (a) weather briefings and monitoring
  (b) special soundings for forcasts

P-STATIC

MIKE WHITAKER

NATC

P-3B/ARC-182
UPDATE

15 FEBRUARY 1989

MIKE WHITAKER
NATC/SY84

CONTENTS

- PHASE I FINDINGS
  - P-STATIC
  - FM INTERFERENCE
  - FREQUENCY DRIFT
- PHASE II PLANNING
  - TEST SCHEDULE
  - TEST ORGANIZATION
  - TEST PROCEDURES
  - LOGISTICS ISSUES

SY84/2-89

PHASE I
FINDINGS

PHASE I FINDINGS
P-STATIC

- FLIGHT #1 (BEFORE FIXES)
  - MINOR AIRCRAFT CHARGING
  - LOW ALTITUDE ICING
- FLIGHT #2 (BEFORE FIXES)
  - SEVERE AIRCRAFT CHARGING
  - MEDIUM ALTITUDE ICING

PHASE I FINDINGS
P-STATIC

- FLIGHT #2 IN SEVERE P-STATIC CONDITIONS (BEFORE FIXES)

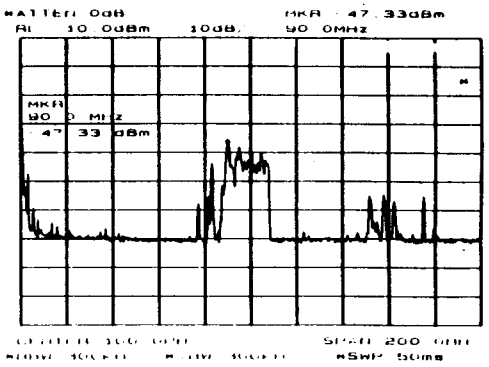
  (AUDIO DEMONSTRATION)

  - ALTITUDE = 16,000 FT
  - OUTSIDE AIR TEMPERATURE = -16°C (ACTUAL)
  - AIRSPEED = 235 KNOTS
  - DISCHARGE CURRENT
    - MAD BOOM = 70 ua
    - WING TIP = 50 ua
    - FIN CAP = 50 ua

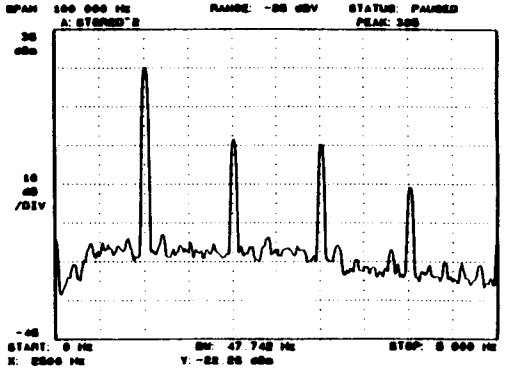
PHASE I FINDINGS
P-STATIC

CONDITION: TYPICAL AMBIENT BACKGROUND NOISE

FIN-CAP ANTENNA

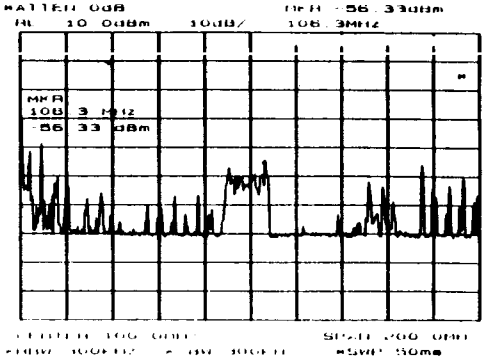


RF SPECTRUM ANALYZER

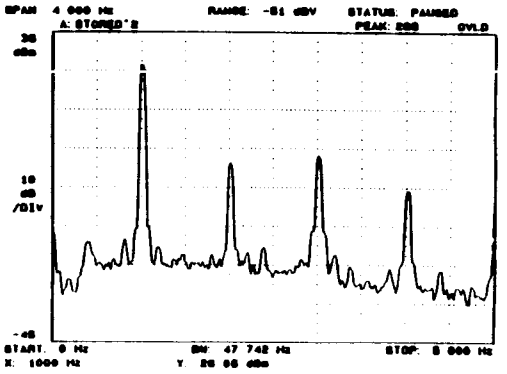


AUDIO ANALYZER

LOWER BLADE ANTENNA



RF SPECTRUM ANALYZER



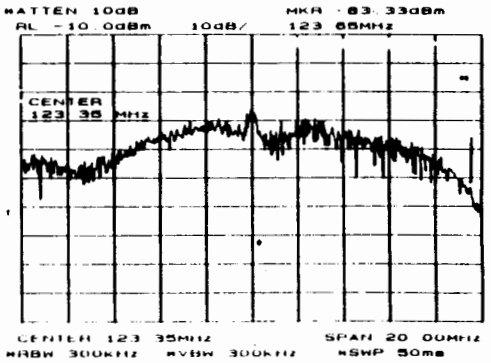
AUDIO ANALYZER

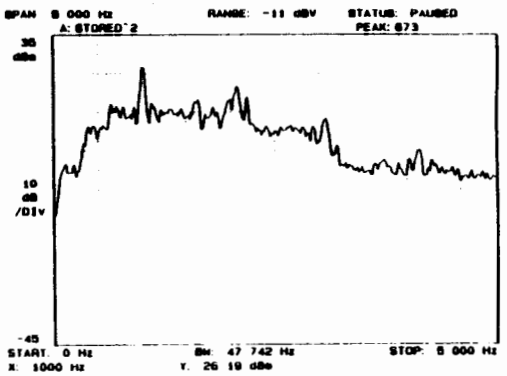
SY84/2-89

PHASE I FINDINGS
P-STATIC

CONDITION: SEVERE P-STATIC NOISE (BEFORE FIXES)

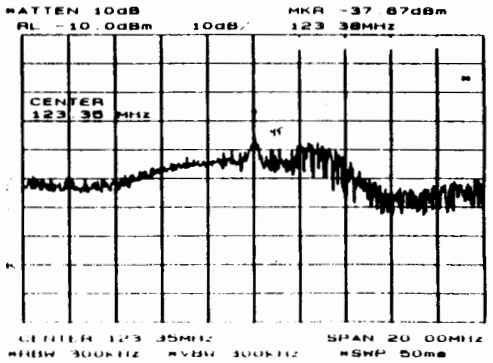
FIN-CAP ANTENNA

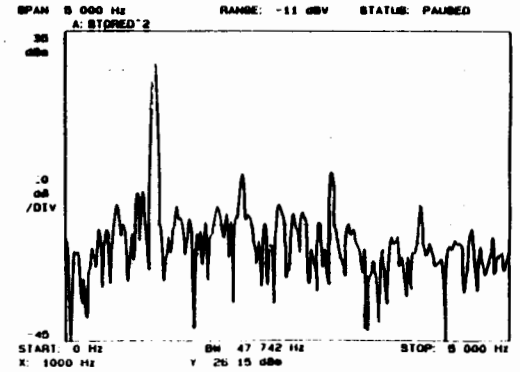




RF SPECTRUM ANALYZER | **AUDIO ANALYZER**

LOWER BLADE ANTENNA





RF SPECTRUM ANALYZER | **AUDIO ANALYZER**

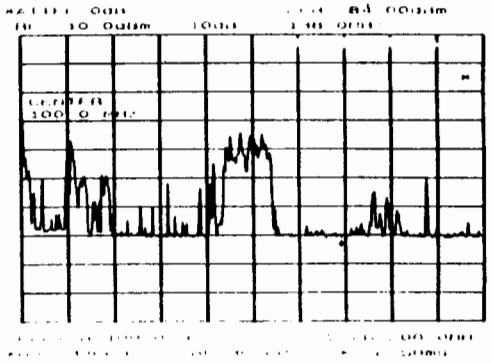
PHASE I FINDINGS
P-STATIC

- **FLIGHT #3 (AFTER FIXES)**
  - **CLEAN AIRPLANE**
  - **VERY LIMITED CHARGE DURATION**

PHASE I FINDINGS
P-STATIC

CONDITION: SEVERE P-STATIC NOISE (AFTER FIXES)

FIN-CAP ANTENNA



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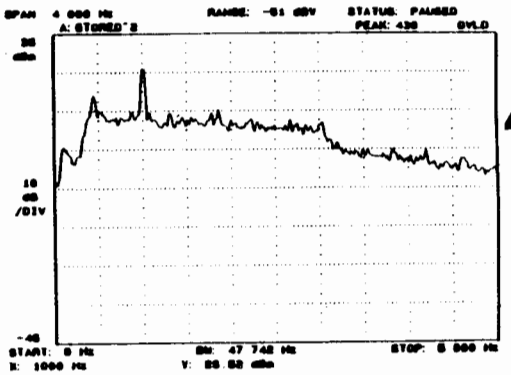
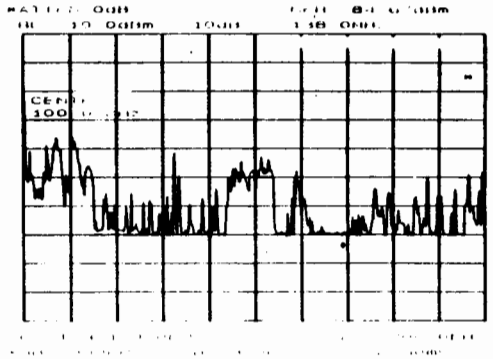


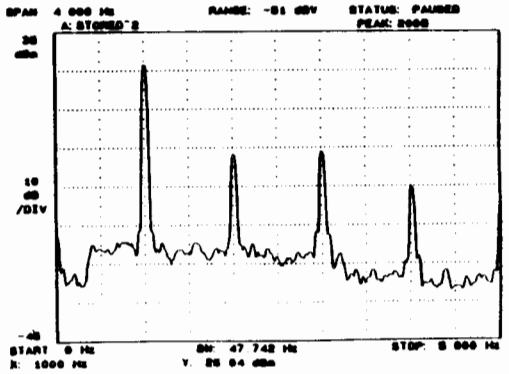
AMPLITUDE DUE TO BLADE ANTENNA

AUDIO ANALYZER

LOWER BLADE ANTENNA



RF SPECTRUM ANALYZER



AUDIO ANALYZER

SY84/2-89

PHASE I FINDINGS
P-STATIC

- CONCLUSIONS:
  - P-STATIC CLEANED UP
  - BONDING ON FINCAP HAS BEEN CORRECTED
  - ONE MORE TEST FLIGHT SCHEDULED

PHASE I FINDINGS
FM INTERFERENCE

- **FLIGHT #2 IN SEVERE FM INTERFERENCE CONDITIONS**

  (AUDIO DEMONSTRATION)

  - **ALTITUDE = 0 to 4,000 FT**

  - **DISCHARGE CURRENT**

    - **MAD BOOM = 10 ua**
    - **WING TIP = 10 ua**
    - **FIN CAP = 10 ua**

PHASE I FINDINGS
FM INTERFERENCE

- **EMEGS ADDED TO TEST PROGRAM**
  - **STABLE BACKGROUND**
  - **RADIATED:**
    - **CH 6 @ 82-88 MHz**
    - **FM @ 88-108 MHz**

PHASE I FINDINGS
FM INTERFERENCE

- **EMEGS RESULTS:**
  - **TEST STILL IN PROGRESS**

PHASE I FINDINGS
FREQUENCY DRIFT

- "DID NOT OCCUR ON TEST AIRCRAFT"

PHASE I RECOMMENDATIONS

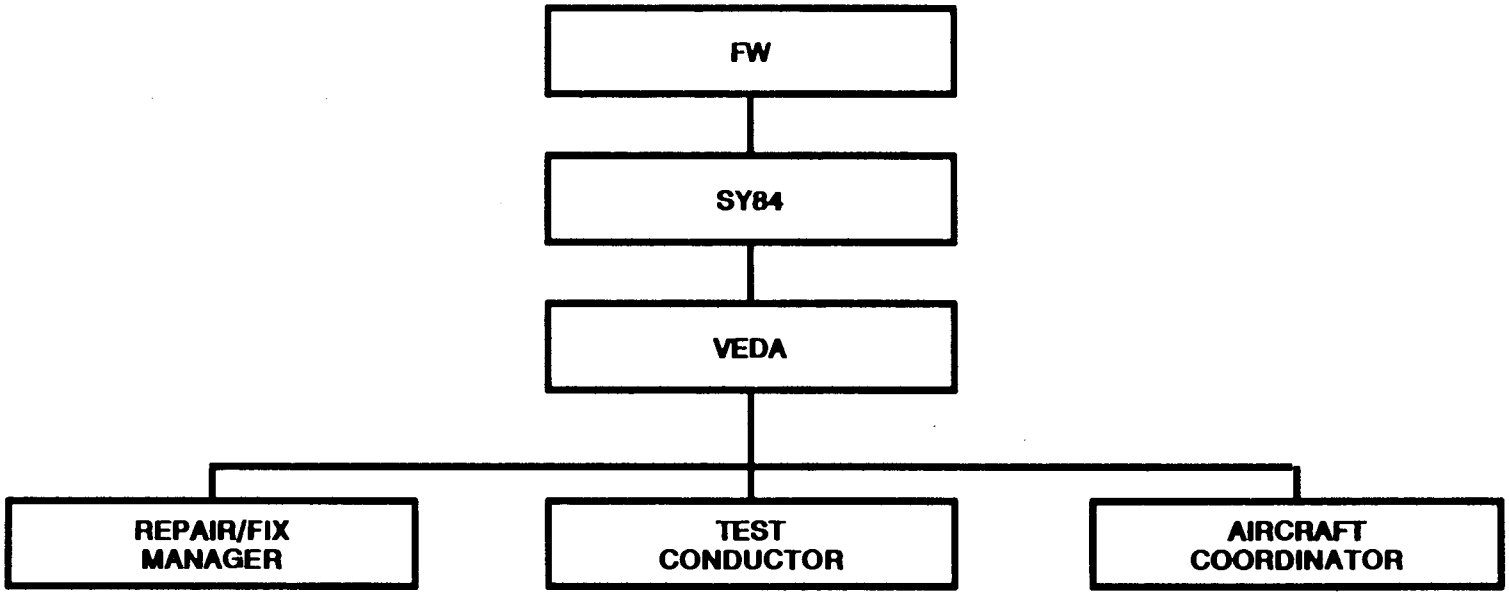
- P-STATIC RELATED PROBLEMS CAN BE SOLVED BY GROUND TESTING

• FILTER	AWAITING EMEGS RESULTS
• 10 dB PAD	AWAITING EMEGS RESULTS
• COAX TO FIN-CAP	INSPECT ONLY
• COAX TO LOWER ANTENNA	LOSSY, BUT ACCEPTABLE
• LOWER BLADE ANTENNA	ACCEPTABLE
• WIRING FROM RT TO CH	NO PROBLEMS NOTED

PHASE II
PLANNING

PHASE II PLANNING

- **TEST ORGANIZATION**



- o SQUADRON INTERFACE
- o CONFIGURATION CONTROL
- o INSTRUMENT INTEGRATION
- o COMMUNICATION SYSTEM OPERATOR
- o EQUIPMENT CONTROL
- o FIX INSTALLATION

- o INSTRUMENT CONTROL
- o SIMULATOR OPERATIONS
- o TEST CONDUCT
- o PROBLEM AREA IDENTIFICATION
- o TEST SAFETY
- o DOCUMENTATION/LOGS
- o SUMMARY REPORT

- o PROBLEM AREA RESEARCH
- o DOCUMENTATION/PUB RESEARCH
- o RECOMMEND FIXES
- o COORDINATE FIX/INSTALLATION
- o DOCUMENT FIXES
- o PREPARE MESSAGE REPORTS

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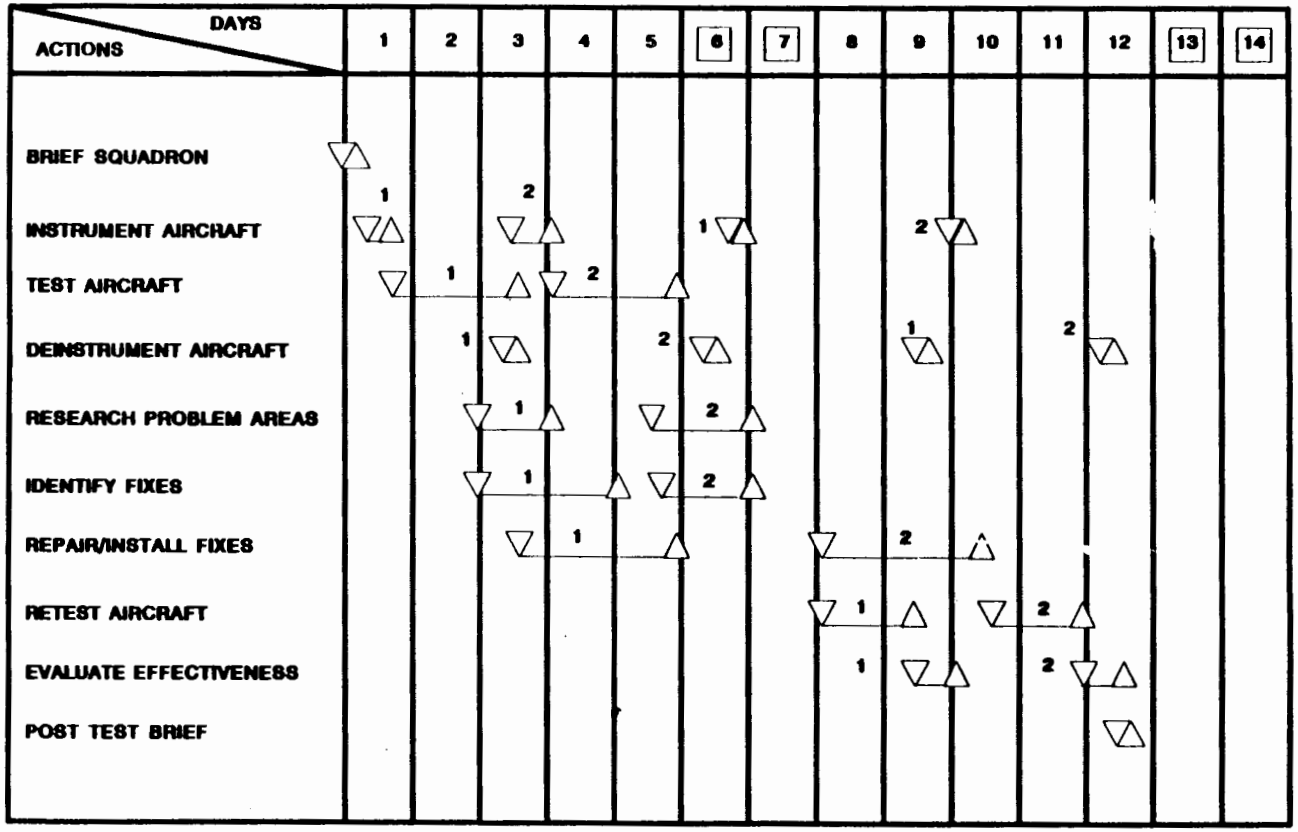
PHASE II PLANNING

- **TEST SCHEDULE**
  - **MARCH = ANDREWS (VP68)**
  - **APRIL ?**
  - **MAY ?**
  - **JUNE ?**

PHASE II PLANNING

- **TEST SCHEDULE:**



LEGEND

▽ START

△ STOP

1 AIRCRAFT #1

2 AIRCRAFT #2

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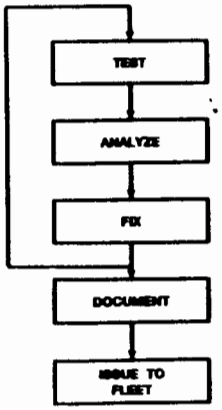
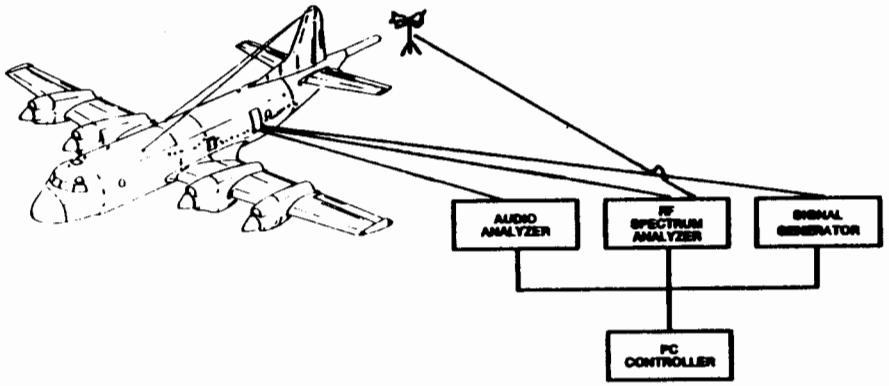
PHASE II PLANNING

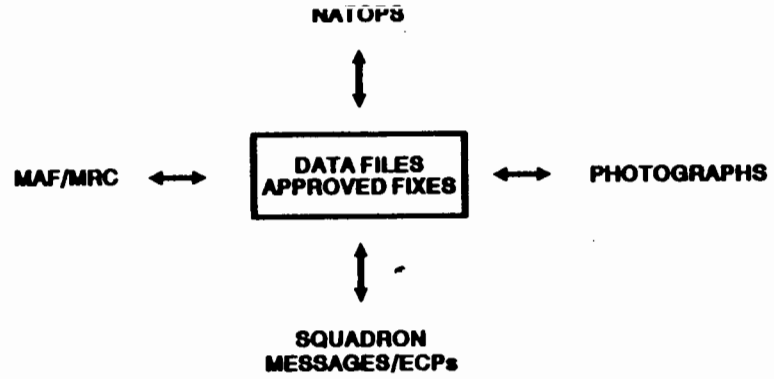
- **TEST PROCEDURES:**



TYPICAL TEST SET-UP



RESEARCH/RECOMMEND/DOCUMENT FIXES



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PHASE II PLANNING

- **LOGISTICS:**
  - **SUGGESTED INPUTS TO SQUADRON PREPARED**
  - **SQUADRON APPOINTS POINT OF CONTACT**
  - **SQUADRON POC & SURVEY TEAM POC RESOLVE LOGISTICS ISSUES**

SUMMARY

- P-STATIC UNDER CONTROL
- INTERFERENCE RECOMMENDATIONS MADE
- INSTALLATION HAS BEEN EVALUATED

SY84/2-89

ELECTROMAGNETIC PULSE AND LIGHTNING

TESTING AT NATC

NATC

ELECTROMAGNETIC PULSE

AND LIGHTNING TESTING

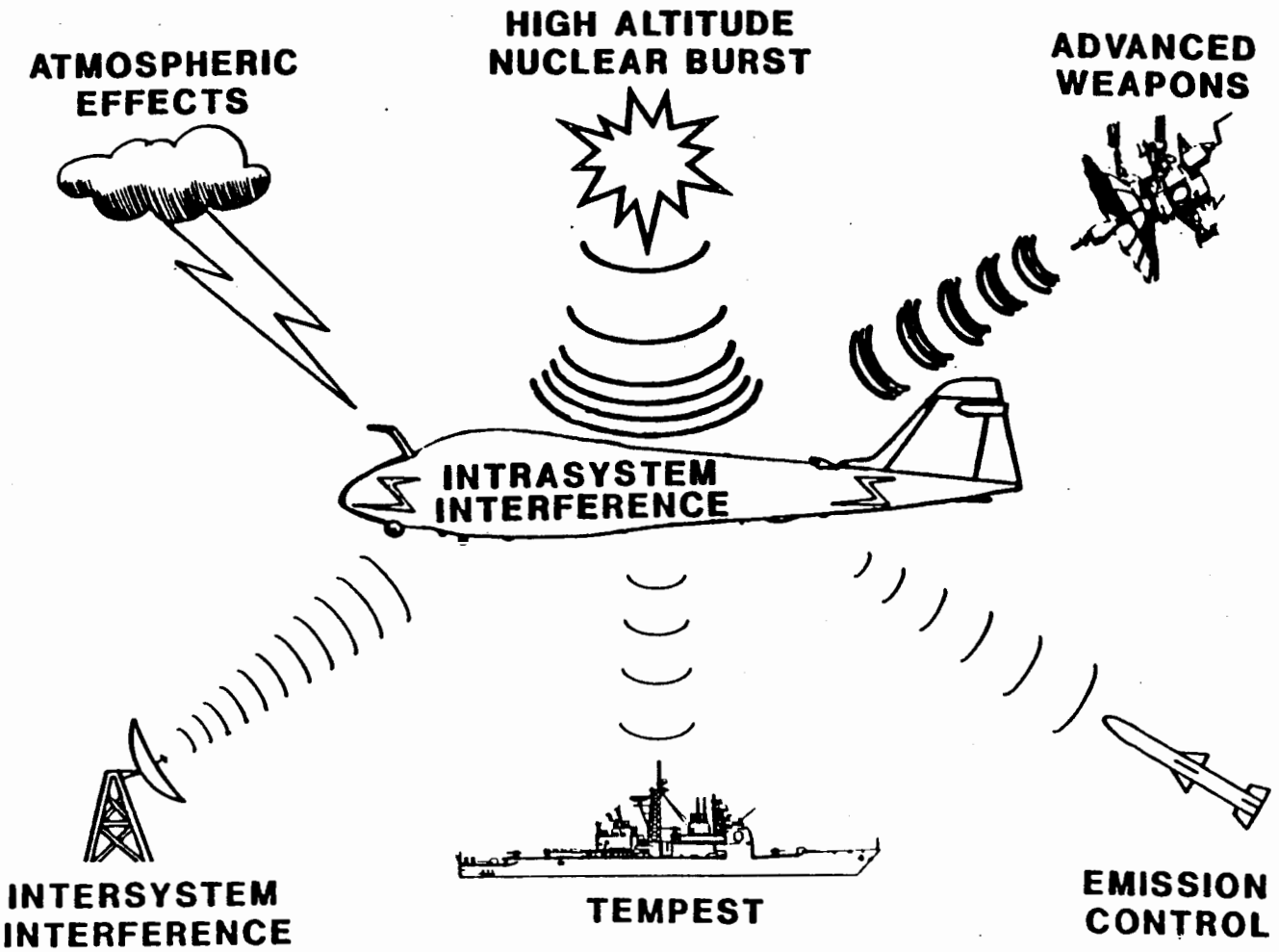
AT THE

NAVAL AIR TEST CENTER

PRESENTED BY

SAM FRAZIER
NAVAL AIR TEST CENTER
PATUXENT RIVER, MD

ELECTROMAGNETIC THREAT ENVIRONMENT



SY84-12/88

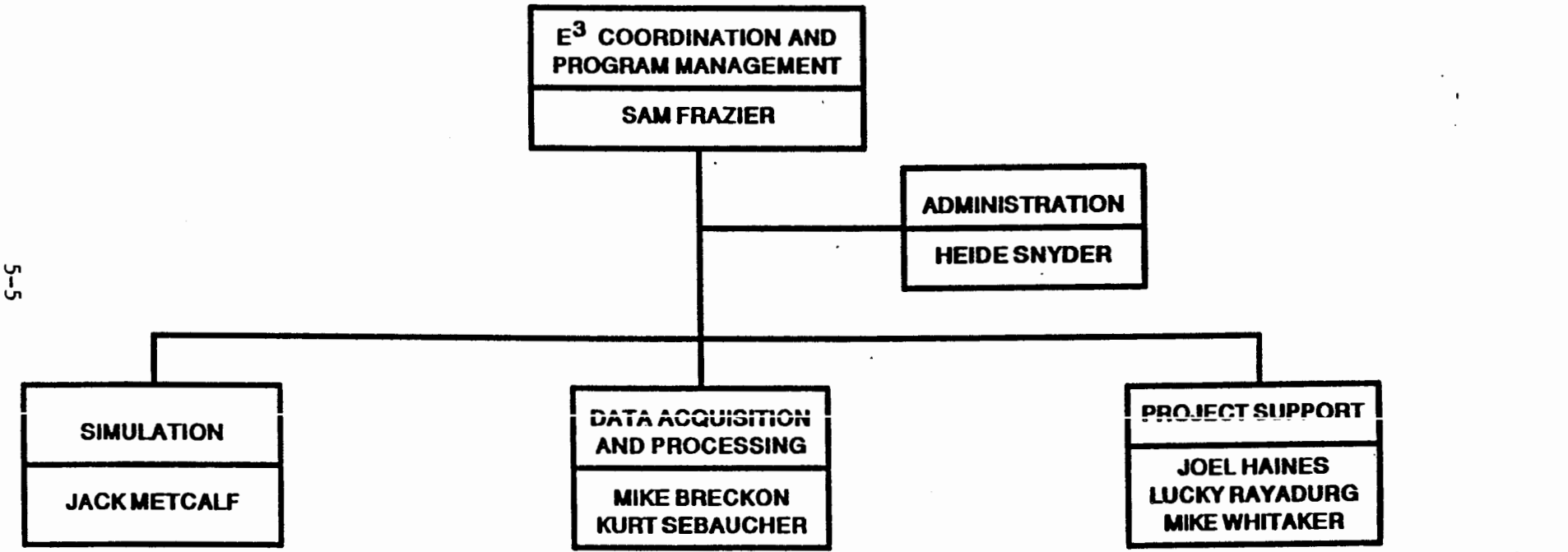
NAVAL AIR TEST CENTER

E^3 EMP SECTION

- AIRCRAFT LIFE-CYCLE TEST AND EVALUATION FOR EMP AND LIGHTNING EFFECTS THROUGH:
  - IN-HOUSE TECHNICAL EXPERTISE
  - TEST DIRECTION AND CONDUCT
  - COMPLETE FACILITIES AND INSTRUMENTATION

NAVAIRTESTCEN - EMP SECTION

NUCLEAR EMP - LIGHTNING - ATMOSPHERIC HAZARDS



SIMULATION/FACILITIES

- TES
- NAVES
- PORTABLE LIGHTNING
- 200 KA LIGHTNING
- FREE FIELD CONTINUOUS WAVE (FFCW)
- DIRECT DRIVE
- P-STATIC

DAPS LABORATORY

- TES DAPS
- LAN
- uTASK/SLEET
- PORTABLE DAS

PROJECTS/ADVANCED TECHNOLOGY

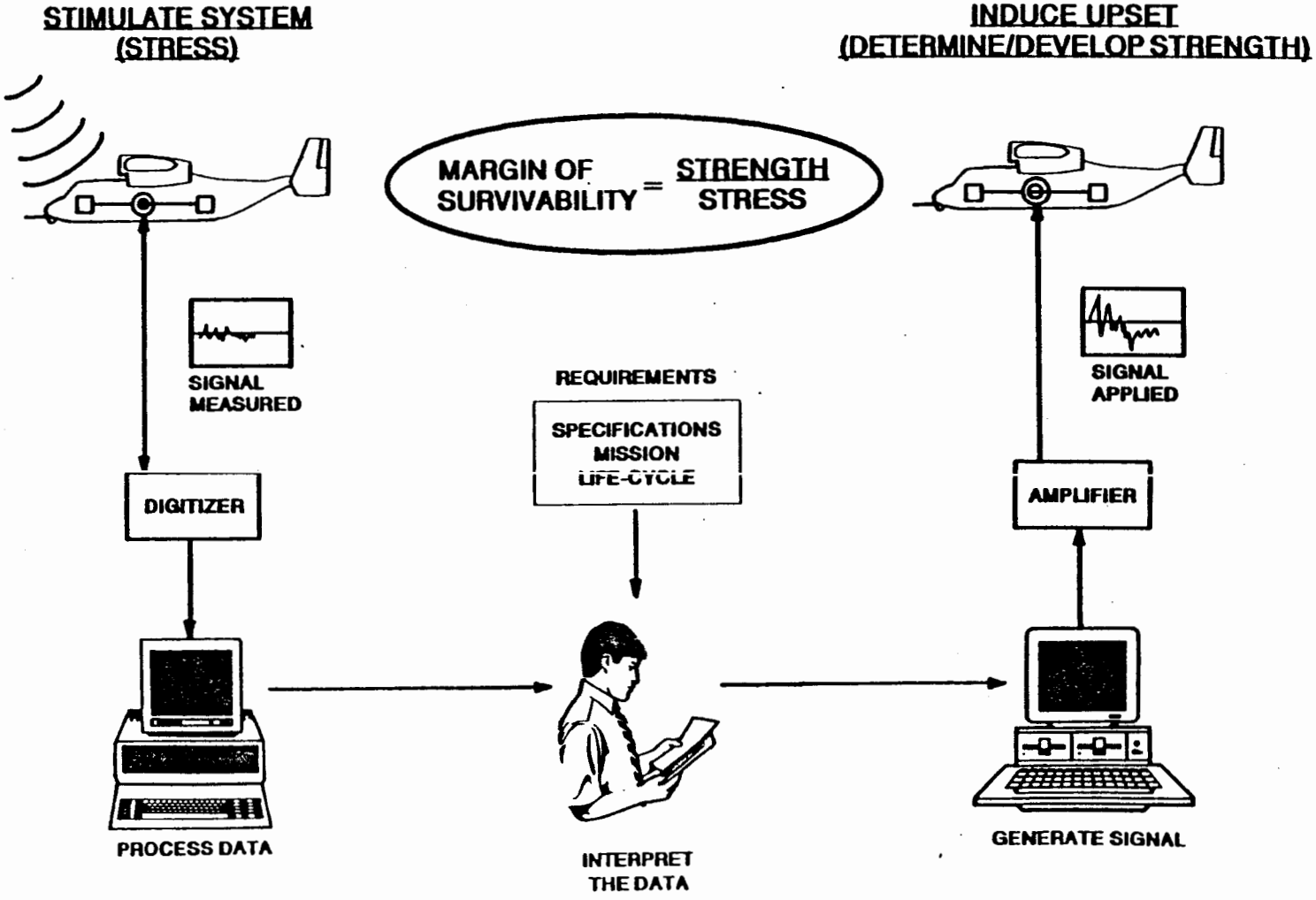
- TACAMO
- VH-60
- FAANTAEL
- ASEMICAP
- FSD - ie. ES-3A, V-22
- SOF
- DoD LIGHTNING

SY84-12/88

MAJOR PROGRAMS AND TECHNOLOGY SPONSORS

- TACAMO - E-6A/EC-130 LIFE-CYCLE RDT&E
- VH-60 - QUALIFICATION TEST
- FAANTAEL - NAVAIR EMP TECHNOLOGY BASE
- ASEMICAP - FLEET LIFE-CYCLE SUPPORT
- FSD, SOF AND MAJOR MODIFICATIONS
  V-22, F-14D, A-6, ES-3A, P-3
- OTHER SERVICES
  C-17, EC-135, HARRY DIAMOND, ATF, DNA
- DoD LIGHTNING CHARTER EVOLVING

NAVAIRTESTCEN ELECTROMAGNETIC TRANSIENT EFFECTS EVALUATION TECHNIQUE



SY84-12/88

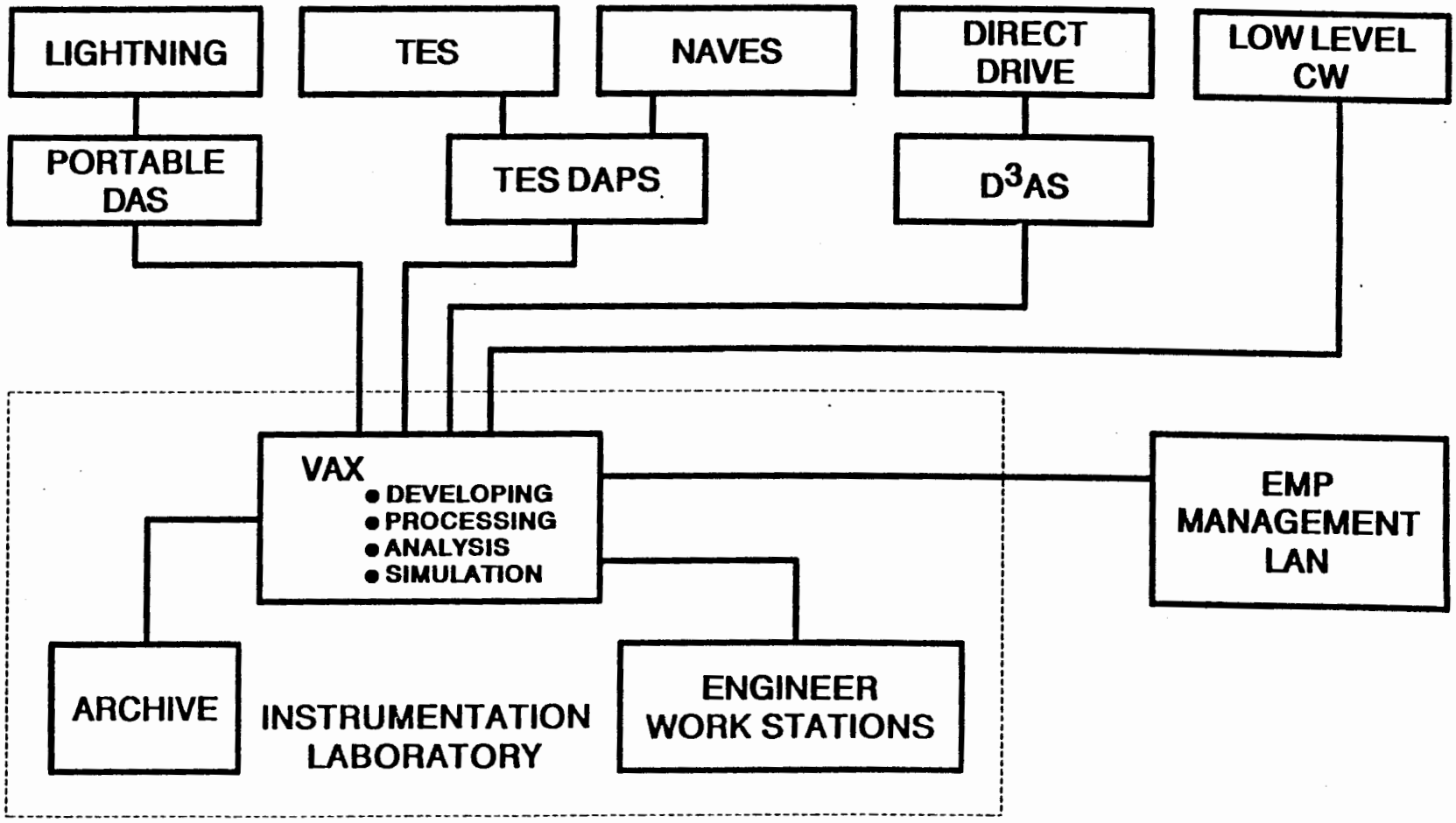
NAVAIRTESTCEN
EMP AND LIGHTNING SIMULATORS

SYSTEM	TYPE	OUTPUT	STATUS
THREAT LEVEL EMP			
TES	HPD	60 kV/M @ 7.5 ns	DEPLOYED
NAVES	VPD	40 kV/M @ 8.0 ns	DEPLOYED
THREAT LEVEL LIGHTNING			
NALES	SEVERE THREAT	<200 kA MIL-STD-1795	OPERATIONAL
NAPLES	PORTABLE MOD. THREAT	<100 kA MIL-STD-1757	LIMITED OPERATIONAL CAPABILITY
LOW LEVEL			
FFCW	HPD/VPD	5 V/M, 100 kHz - 150 MHz	OPERATIONAL
SCIT	LIGHTNING	20 A, 10 kHz - 10 MHz	UNDER DEVELOPMENT
DIRECT DRIVE			
EMP	CIRCUIT/CABLE DIRECT-INJECT	MIL-STD-461/COMPOSITE UP TO 20 A @ 20 kW	DEPLOYED
LIGHTNING	CIRCUIT/CABLE DIRECT-INJECT	MIL-STD-461/COMPOSITE UP TO 50 A @ 100 kW	INITIAL PLANNING
P-STATIC	CORONA/STREAMER	0-100 kV @ 0-25 MA	DEPLOYED

EMP AND LIGHTNING DATA ACQUISITION AND PROCESSING SYSTEM

- MEASURE EMP AND LIGHTNING PHENOMENON
- INSTRUMENT 160 TEST POINTS SIMULTANEOUSLY
- HIGHLY AUTOMATED THROUGHOUT TEST SEQUENCE
- PORTABLE SYSTEM
- TAKE-HOME ANALYTICAL SOFTWARE

EMP AND LIGHTNING INSTRUMENTATION SUITE



SY84-12/88

DOD LIGHTNING DEVELOPMENT PLAN

SAM FRAZIER

NATC

DoD LIGHTNING DEVELOPMENT PLAN

PRESENTED TO: CAPTAIN BOB FULLER
OP 983

19 JANUARY 1989

BY
SAM FRAZIER
NATC CODE SY84
(301) 863-3868

AGENDA

- BACKGROUND
- PLANS & RESOURCES
- ANALYSIS AND RECOMMENDATION

ATMOSPHERIC HAZARDS

BACKGROUND

- RDT&E EMPHASIS IS SHIFTING
- LIGHTNING THREAT IS INCREASING
- USD CONCERNED OVER DoD LOSS OF CAPABILITIES
- NATC TASKED TO DEVELOP PLAN

EXISTING CAPABILITIES

- DoD
  - WRIGHT PATTERSON AFB
  - NAVAIRTESTCEN
  - REDSTONE
- GOVERNMENT
- INDUSTRY
- INTERNATIONAL COMMUNITY

MEETING DoD LIGHTNING SHORTFALL

PROVIDE FOCAL POINT FOR LIGHTNING RDT&E

- PROVIDE/MAINTAIN RDT&E LABORATORY FOR AEROSPACE VEHICLES
- PROVIDE RDT&E EXPERTISE
- MAINTAIN CORPORATE KNOWLEDGE (LIBRARY/DATABASE)
- RDT&E COORDINATION BETWEEN:
  - DoD
  - GOVERNMENT
  - INDUSTRY
  - INTERNATIONAL COMMUNITY

NATC STATUS

- **CURRENT:**
  - ONLY SINGLE SITE AIRCRAFT RF ENVIRONMENT TEST LABORATORY
  - LIGHTNING PROGRAM VERY STRONG
  - ALREADY HAS TACIT DoD T&E LEAD
- **FUTURE:**
  - MRTFB HEPL I&M INCLUDES LIGHTNING
  - MILCON P-411 BEING REDEFINED TO INCLUDE LIGHTNING
  - DoD CENTER OF EXCELLENCE FOR LIGHTNING ?

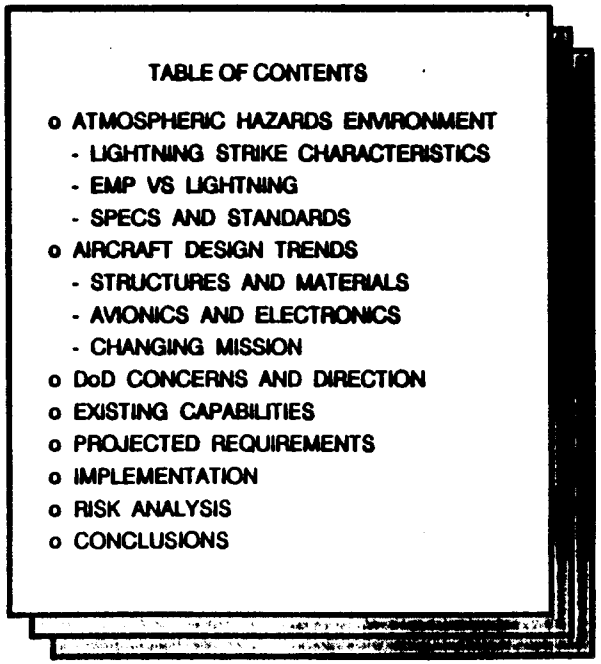
CHANGING NATC PLANS TO MEET DoD REQUIREMENTS

- ACQUIRE CIVIL SERVICE PERSONNEL TO SUPPORT NON-NAVY REQUIREMENTS
- OBTAIN ADDITIONAL CORPORATE KNOWLEDGE

CURRENT I&M AND MILCON PLANS ADEQUATE

DoD LIGHTNING DEVELOPMENT PLAN

- PRIMARILY A TECHNICAL DOCUMENT
- REVIEW ENVIRONMENT AND TECHNOLOGY
- MAKES SPECIFIC RECOMMENDATIONS



RISKS

- SLIGHT EXPANSION OF CHARTER
- EXTREME WORKLOAD
- HIGH VISIBILITY
- PRIORITY

POTENTIAL BENEFITS

- DoD SUPPORT FOR FACILITIES
- EXPANDED KNOWLEDGE BASE
- INCREASED TEST ECONOMY
- HIGH VISIBILITY
- INCREASED FUNDING

RECOMMENDATIONS

- **OBTAIN OSD COMMITMENT**
  - **DoD PLAN (PEOPLE, $)**
  - **NAVY HEPL I&M PLAN**
  - **MILCON P-411 (REPLACEMENT)**

DISTRIBUTION: (A/O 3/15/89)

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