Description of document:	Slide Presentations from the National Transportation Safety Board (NTSB) Basic Accident Investigation Course (AS105), 2016
Requested date:	August 2020
Release date:	18-May-2022
Posted date:	12-December-2022
Source of document:	FOIA Request National Transportation Safety Board Attention: FOIA Requester Service Center, CIO-40 490 L'Enfant Plaza, S.W. Washington, DC 20594-2000 Fax: (240) 752-6257 NTSB's FOIA Online Submission Website

National Transportation Safety Board
Washington, D.C. 20594

May 18, 2022

Re: National Transportation Safety Board (NTSB)
Freedom of Information Act (FOIA) No. FOIA-2020-00489

This letter responds to your FOIA request for each slide presentations delivered at the Basic Aircraft Accident Investigation Course, of the type given for DOE as AS105 in the Summer of 2016.

The Safety Board located several responsive documents. Enclosed are 999 pages. However, we withheld certain information partially and in full pursuant to the following exemptions specified below.

Personal information, notably autopsy information and graphic photos, social security numbers, and any personal identifying information, is withheld pursuant to 5 U.S.C. 552(b)(6), which exempts from disclosure "personnel and medical files and similar files the disclosure of which would constitute a clearly unwarranted invasion of personal privacy," to include personal addresses, phone numbers, etc. Pursuant to this exemption, I partially redacted 12 pages with direct business and personal telephone numbers, email addresses, graphic images, and fully withheld 2 pages in full of NTSB staff credentials.

In several documents enclosed with this letter, I determined that exemption(s) to the FOIA required that I redact a limited amount of material. The redactions are clearly marked, and the applicable exemption(s) are noted at the place of the redaction.

The NTSB has concluded processing your FOIA request. If you are not satisfied with the response to this request, you have the right to appeal this determination under the FOIA. You may administratively appeal by writing to the NTSB, Attn: Ms. Dana Schulze, Managing Director, 490 L'Enfant Plaza, SW, Washington, D.C. 20594. Your appeal must be postmarked or electronically transmitted within 90 days of the date of the response to your request.

You may contact our FOIA Public Liaison at 202-314-6540, for any further assistance and to discuss any aspect of your request. Additionally, you may contact the Office of Government Information Services (OGIS) at the National Archives and Records Administration (NARA) to inquire about the FOIA mediation services they offer. The contact information for OGIS is as follows: OGIS, NARA, 8601 Adelphi Road-OGIS, College Park, Maryland 20740-6001, e-mail at ogis@nara.gov; telephone at 202-741-5770; toll free at 1-877-684-6448; or facsimile at 202-741-5769.

Sincerely,

Melba D. Moye

Melba D. Moye
FOIA Officer
Office of the Chief Information Officer
National Transportation Safety Board

Enclosure

National Transportation Safety Board

Investigating Human Factors in Aircraft Accidents Part 1: Concepts

William Bramble, Ph.D.Senior Human Performance Investigator

Part 1: Concepts

- What is human factors investigation?Why bother?Who can do it?What should be investigated?How are the data developed / analyzed?How are the findings reported?How are safety recommendations developed?Human performance investigation around the world

Part 1: Concepts

- What is human factors investigation?Why bother?Who can do it?What should be investigated?How are the data developed / analyzed?How are the findings reported?How are safety recommendations developed?Human performance investigation around the world

What is Human Factors / Ergonomics?

- Understanding interactions among humans and other elements of a systemApplying theory, principles, data and methods to design to optimize human well-being and overall system performance. Contributing to the design and evaluation of tasks, jobs, products, environments and systems to make them compatible with the needs, abilities and limitations of people.

*International Ergonomics Association

What is Human Factors / Human Performance Investigation?

A process involving:Identification of breakdowns in human performance that contributed to a safety-related eventIdentification of hazards stemming from human, machine, environmental, and organizational elements and their interactionThe use of human factors knowledge and investigative findings to identify changes that could improve safety

Part 1: Concepts

√ • What is human factors investigation?Why bother?Who can do it?What should be ~~investigated~~?How are the data developed / analyzed?How are the findings reported?How are safety recommendations developed?Human performance investigation around the world

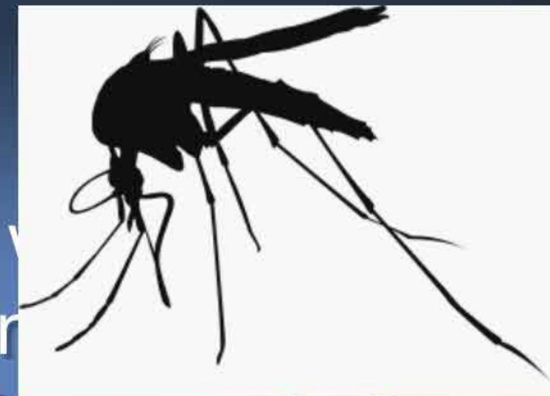
Why Bother?

Historically, 60-80% of aircraft accidents have been attributed to human error

Why Bother?

Data from 20,000 line-oriented safety audits conducted from 1996-2013 indicate an average of 2 errors per flightLittle change from the late 1990's

Why Bother?



Swatting MosquitoesViolated a v
procedureForgot part of a briefi
arming of a deviceFailed to notice a cockpit indicationMissed cues in the environmentDid not adequately control the airplane

Why Bother?

Draining the SwampIncompatible demandsPoorly-designed equipm trainingInadequate proceduresIna supervisionInadequate managem s

Why Bother?

Digging Deeper

Why Bother?

Example:…the probable cause of this accident was the captain's cessation of right rudder input, which was needed to maintain directional control of the airplane, about 4 seconds before the excursion, when the airplane encountered a strong and gusty crosswind

that exceeded the captain's training and experience. Contributing to the accident were the following factors: 1) an air traffic control system that did not require or facilitate the dissemination of key, available wind information to the air traffic controllers and pilots; and 2) inadequate crosswind training in the airline industry due to deficient simulator wind gust modeling.

Part 1: Concepts

√ √ • What is human factors investigation?Why bother?Who can do it?What should be investigated?How are the data developed / analyzed?How are the findings reported?How are safety recommendations developed?Human performance investigation around the world

Who Can Do It?

Investigators with:Aviation-related knowledge and experienceSpecialized training in Human factorsEngineering psychologySystems safety / safety engineering

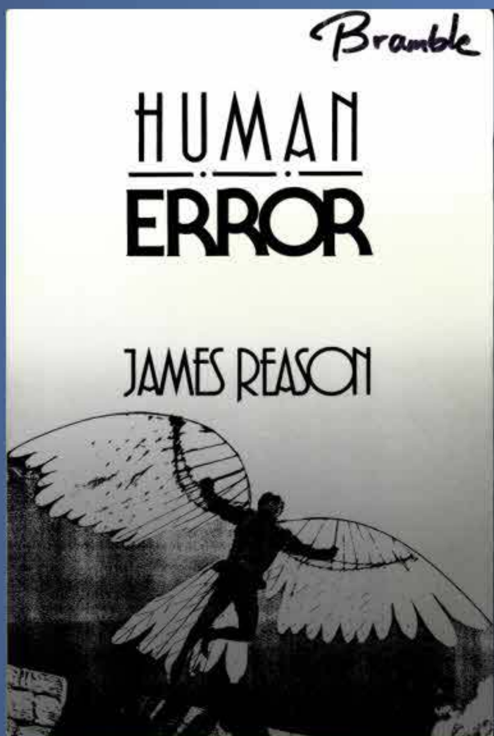
Who Can Do It?

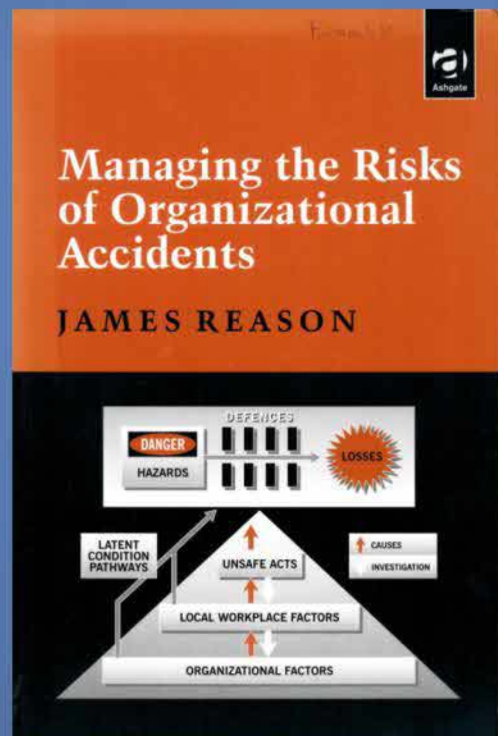
"The measure of the good human factors investigator is not his or her professional qualifications in behavioral sciences, but rather the ability to determine, with the help of specialists if necessary, what information is relevant, to ask the right questions, to listen to the answers and to analyze the information gathered in a logical and practical way."

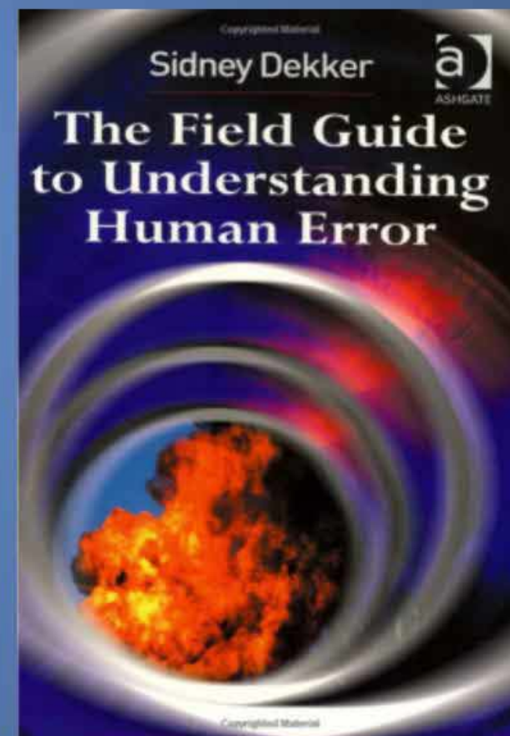
Human Factors Digest No. 7, ICAO Circular 240-AN/144, 1993

Who Can Do It?

Other Guidance

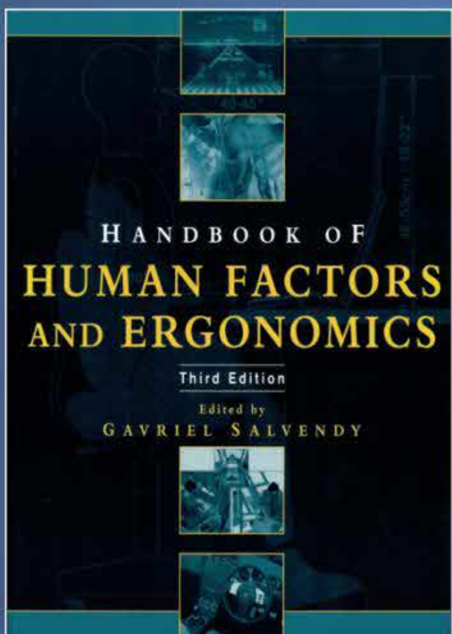


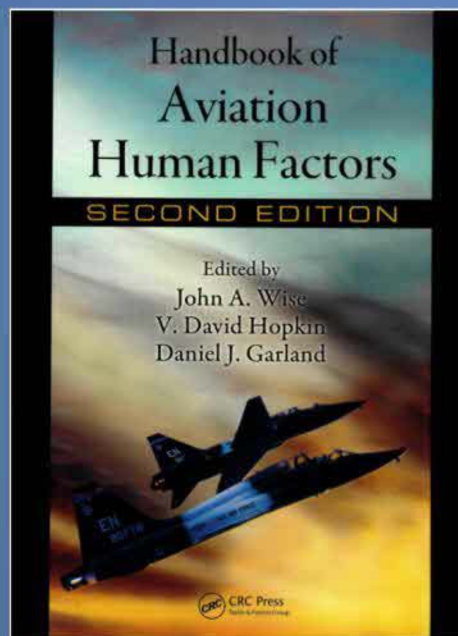


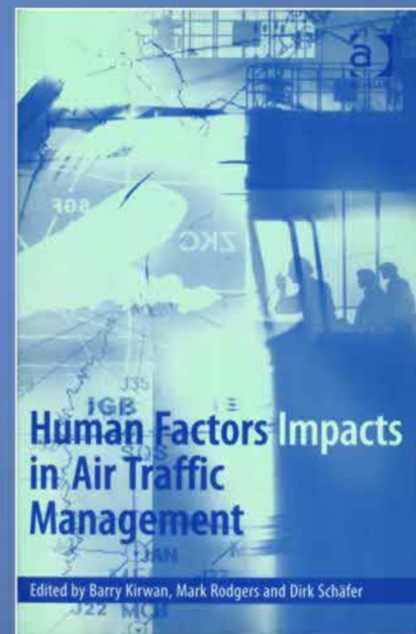


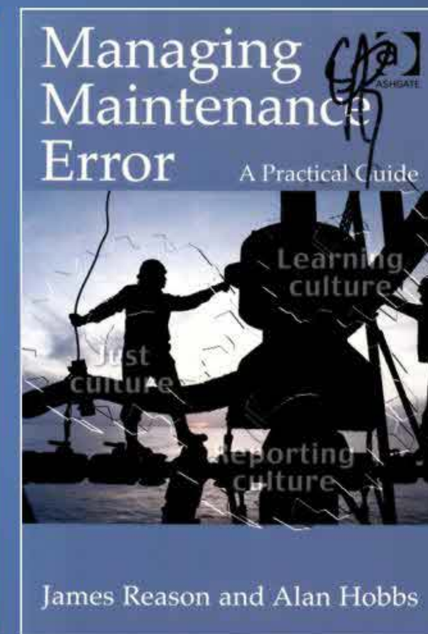
Who Can Do It?

Reference Books





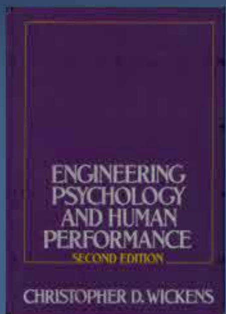


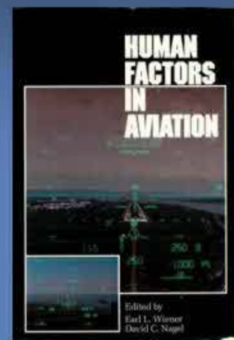


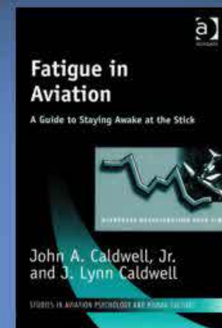
NTSB

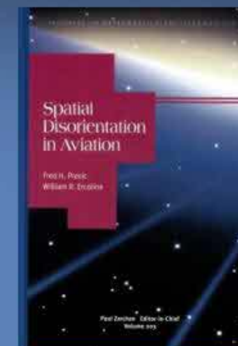
Who Can Do It?

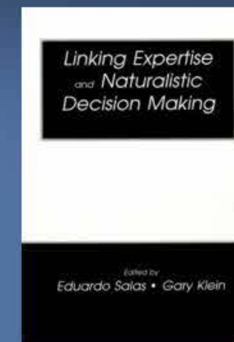
Additional Reference Books

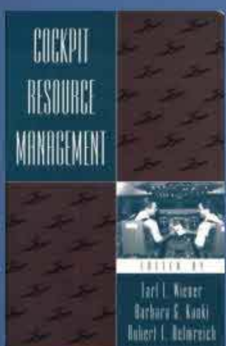


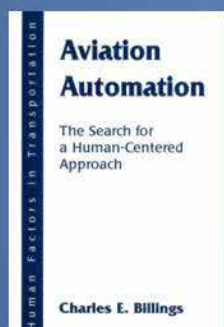


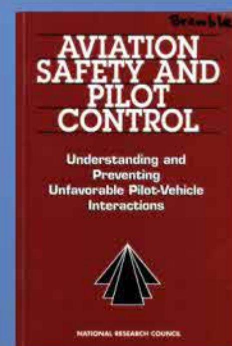


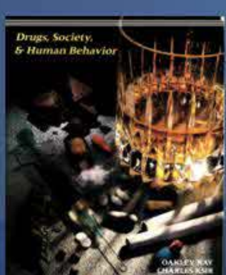


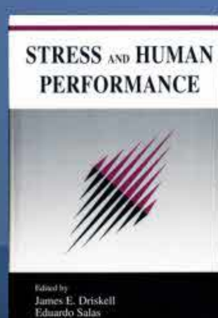


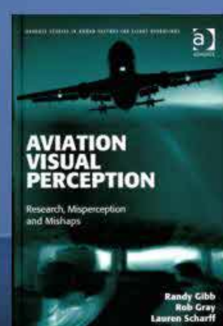






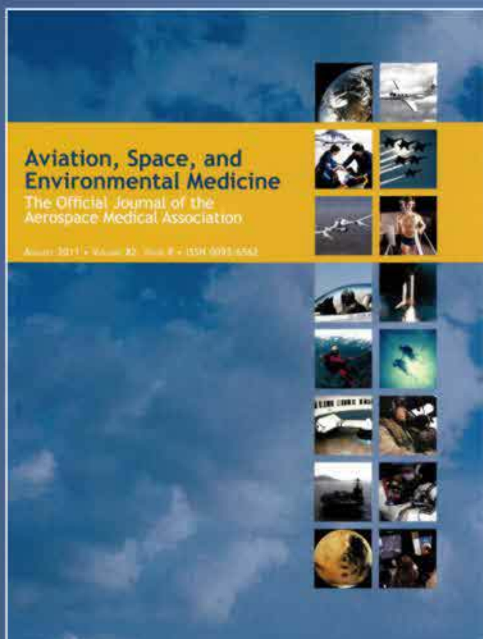






Who Can Do It?

Key Journals



Who Can Do It?

Professional SocietiesHuman Factors & Ergonomics SocietyAerospace Medical AssociationAssociation of Aviation PsychologistsEuropean Association for Aviation Psychology

Part 1: Concepts

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- What is human factors investigation?Why bother?Who can do it?What should be investigated?How are the data developed / analyzed?How are the findings reported?How are safety recommendations developed?Human ~~performance investigation ar~~ound the world

What Should Be Investigated?

- Flight crewsMec ersAir t
  controllersSupe s

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What Should Be Investigated?

- Fitness for dutyBehavioral standardsSignificant behavioral eventsContext of the behaviorsIndividual and organizational goalsLocal rationality

What Should Be Investigated?

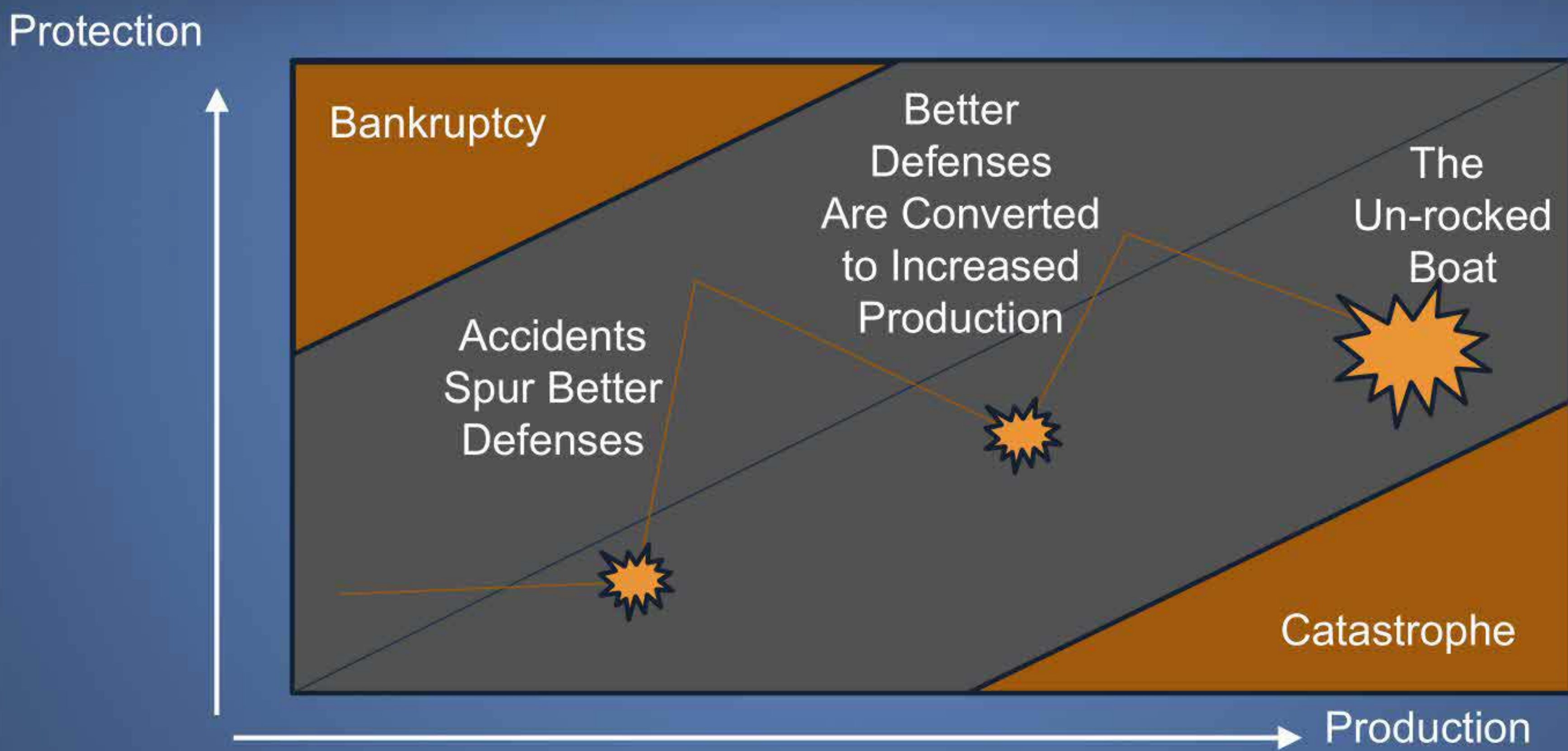
Woods et al. (2010); Cook & Rasmussen (2005)

What Should Be Investigated?

- Task characteristics (real versus ideal)Equipment characteristicsEnvironmental factorsOrganizational characteristics

What Should Be Investigated?

Organizational Drift



Reason (1997) *Managing the Risks of Organizational Accidents*

NTSB

What Should Be Investigated?

Safety Management SystemsSafety accountability, policy, resourcesSafety risk managementSafety assuranceSafety promotion

Part 1: Concepts

√ • What is human factors investigation?Why bother?Who can do it?What should be investigated?How are the data developed / analyzed?How are the findings reported?How are safety recommendations developed?Human performance investigation around the world
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How Are the Data Developed / Analyzed?

Analysis: The core of safety investigationA process of converting data into findingsAn iterative process that involves: Questions, hypothesis testing Investigator judgment Teams

(Walker, 2006)

How Are the Data Developed / Analyzed?

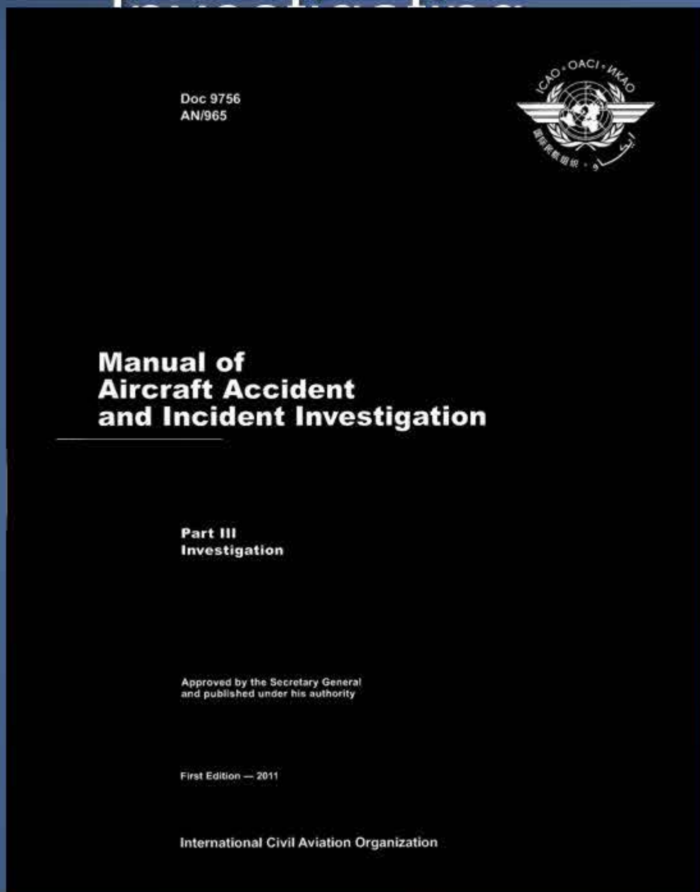
Some Useful TerminologyFailure modeDescription of an error in terms of type / level of performanceBehavioral antecedentFactor that facilitates a particular failure modeDefenseSafeguard instituted to protect against a foreseeable hazardPreconditionFactor that increases the likelihood of errorLatent FailureFlawed management decision, line management deficiency, other preconditions present in the organizational system

How Are the Data Developed / Analyzed?

Analysis Paradigms, Taxonomies and ToolsLevels of cognitive control (Rasmussen)“Swiss cheese” model of defenses (Reason)Tripod-Beta (Shell)Influence Diagrams (Embrey)Human Error Assessment and Reduction Technique (Williams)Maintenance Error Decision Aid (Boeing)

How Are the Data Developed / Analyzed?

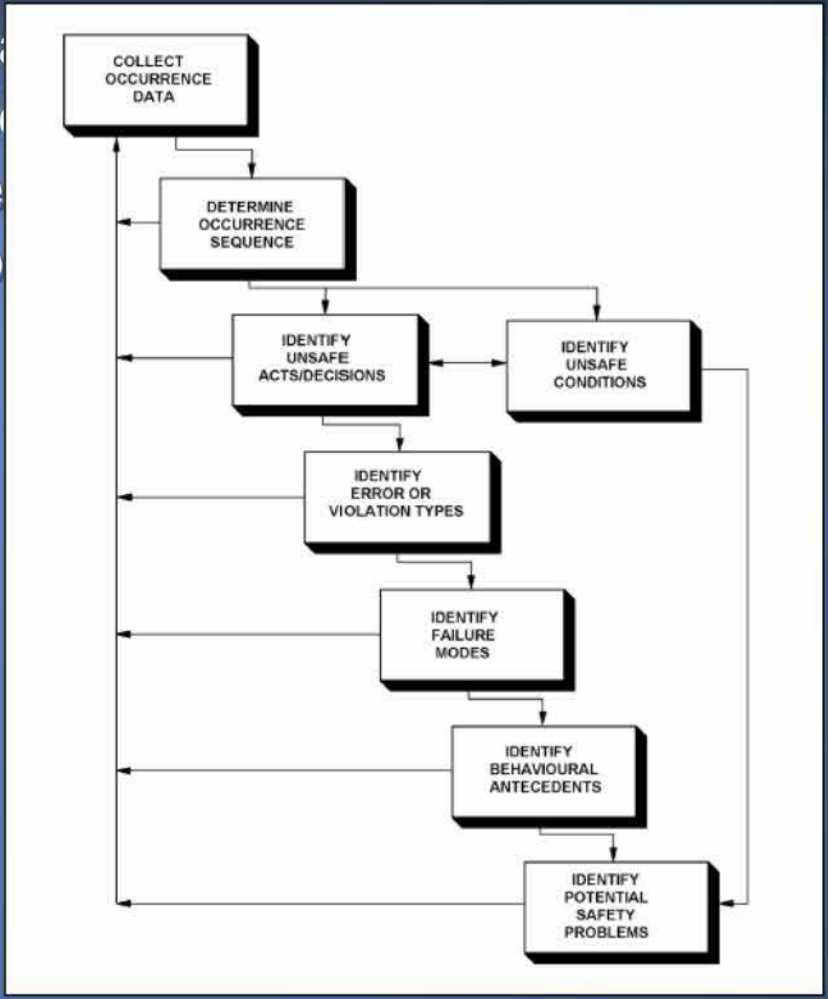
ICAO Guidance Chapter 16



NTSB

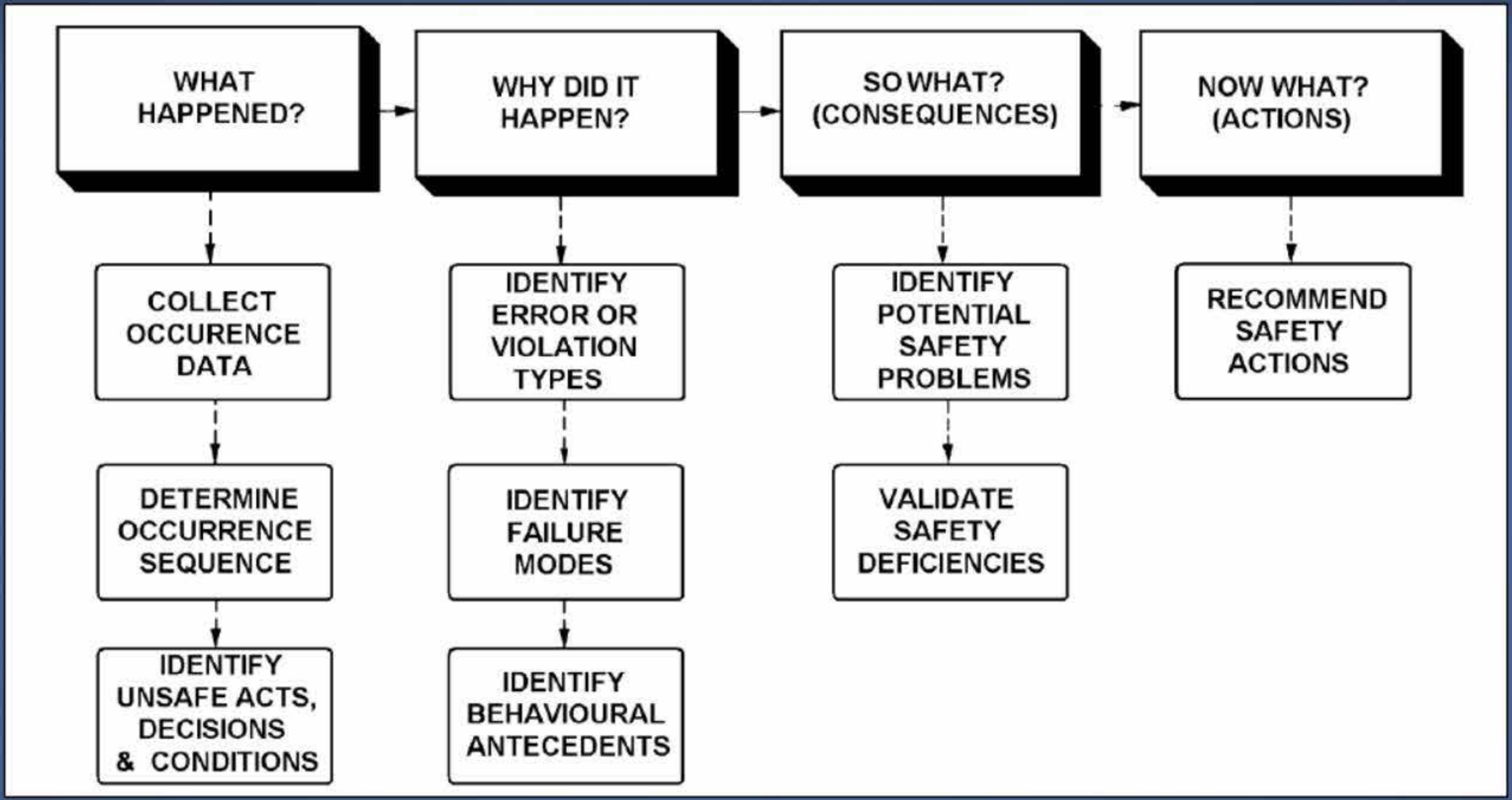
How Are the Data Developed / Analyzed?

ICAO Guidance:Collect occurrence d
sequenceIdentify unsafe acts, conditi
violation typeIdentify the failure mode
antecedentsIdentify potential safety p



ICAO Doc 9756

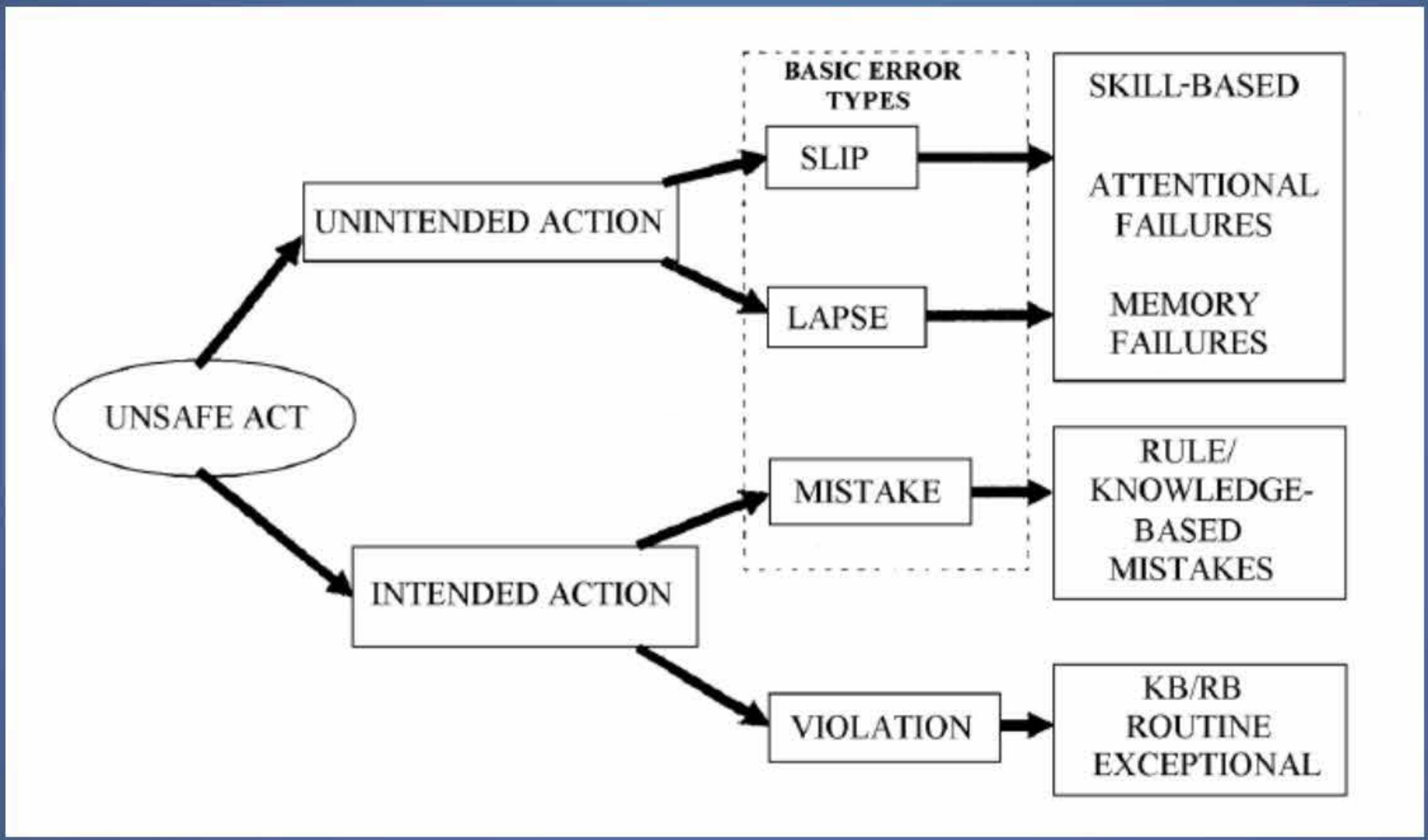
How Are the Data Developed / Analyzed?



ICAO Doc 9756

How Are the Data Developed / Analyzed?

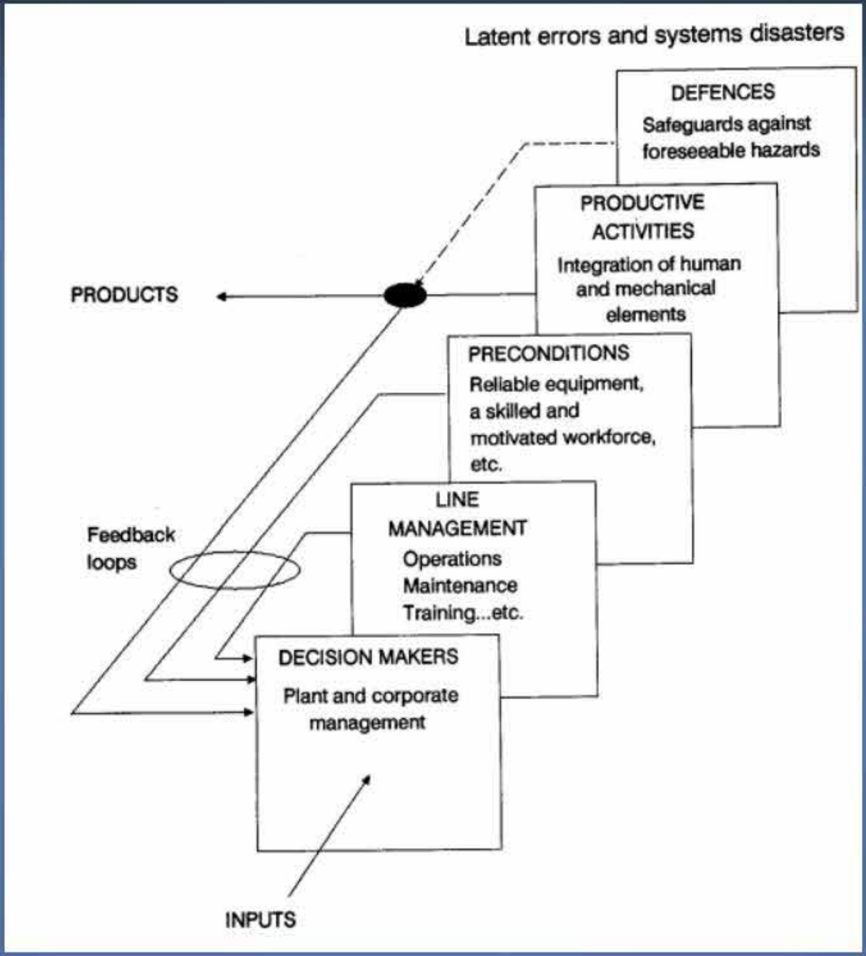
Error Types



(Reason, Rasmussen)

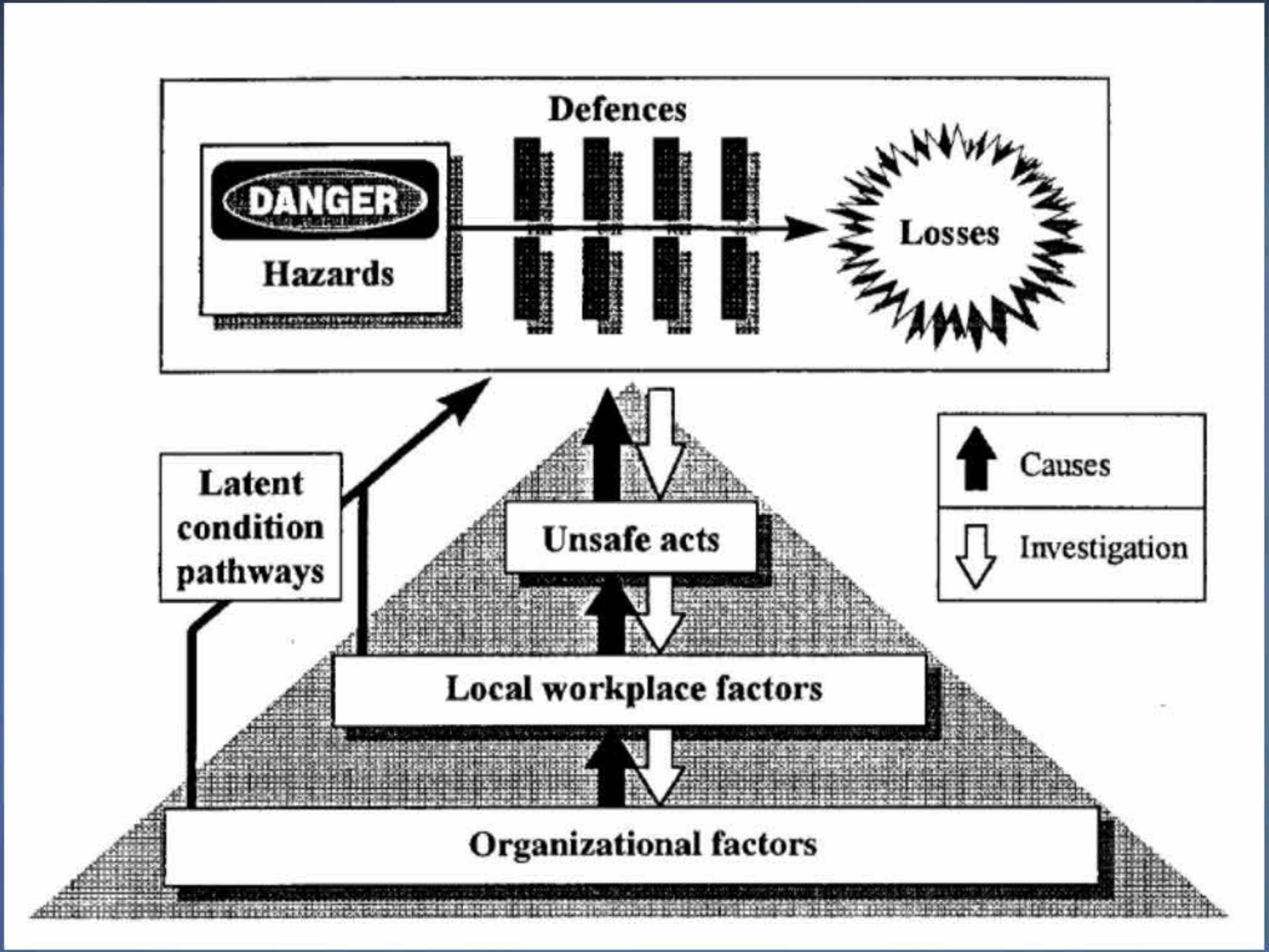
How Are the Data Developed / Analyzed?

Cultural Factors



Reason, *Human Error*, 1990

How Are the Data Developed / Analyzed?



Reason, *Managing the Risks of Organizational Accidents*, 1997

Part 1: Concepts

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√

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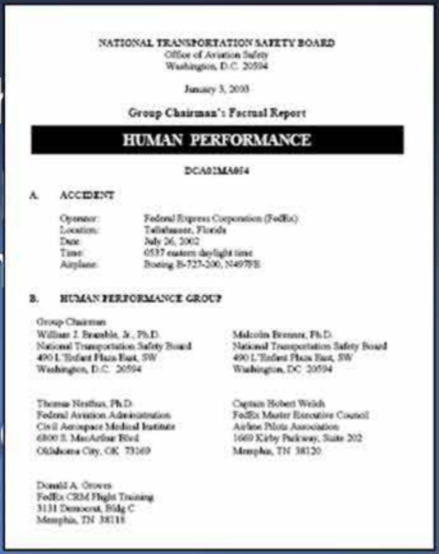
How Are the Findings Reported?

- Group chair's factual report (public)Group ch analysis report (not public)Human factors in the final report1.1 History of flight1.5 Person information1.13 Medical and pathological information1.17 Organizational & managem info1.18 Additional Information2. Analysis3. Conclusions4. Safety Recommendations



NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

January 3, 2003

Group Chairman's Factual Report

HUMAN PERFORMANCE

DCA02MA054

A. ACCIDENT

Operator:	Federal Express Corporation (FedEx)
Location:	Tallahassee, Florida
Date:	July 26, 2002
Time:	0537 eastern daylight time
Airplane:	Boeing B-727-200, N497FE

B. HUMAN PERFORMANCE GROUP

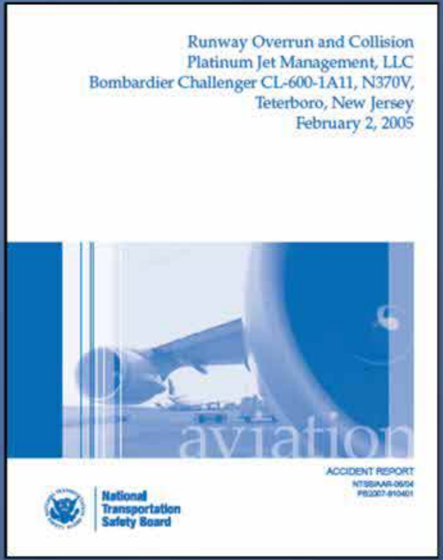
Group Chairman
William J. Bramble, Jr., Ph.D.
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, D.C. 20594

Malcolm Brenner, Ph.D.
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

Thomas Nesthus, Ph.D.
Federal Aviation Administration
Civil Aerospace Medical Institute
6500 S. MacArthur Blvd
Oklahoma City, OK 73169

Captain Robert Welch
FedEx Master Executive Council
Airline Pilots Association
1669 Kirby Parkway, Suite 202
Memphis, TN 38120

Donald A. Groves
FedEx CRM Flight Training
3131 Democrat, Bldg C
Memphis, TN 38118



Part 1: Concepts

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Problems Identified… Now What?

Easier,
Less Effective
Harder,
More
Effective

- Incorporate signage, procedures, trainingProvide warning devicesIncorporate engineered features or safety devicesReduce risk by design alterationEliminate the hazard

(MIL-STD-882D System Safety)

Problems Identified… Now What?

Reprimand / fire / prosecute?Modify Personnel selection criteria?Enhance / modify personnel training?Change company SOPs / regulations?Increase supervision / oversight of personnel?Re-allocate personnel functions, redesign jobs?Modify hardware / software / workplace / environment?

Easier, Less Effective

Harder, More Effective

Part 1: Concepts

√ • What is human factors investigation?Why bother?Who can do it?What should be investigated?How are the data developed / analyzed?Problems have been identified... Now what?How are the findings reported?Human performance investigation around the world

√

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Human Factors Investigation Around the World (Updated 2015)

Number of Specialists Identified by CountryUSA National Transportation Safety Board (7)France Bureau d'Enquêtes et d'Analyses (10)Canada Transportation Safety Board (7)Australia Australian Transport Safety Bureau (7)Norway Accident Investigation Board Norway (1)UK Air Accidents Investigation Branch (0)Germany Bundesstelle für FlugunfalluntersuchungTaiwan Aviation Safety CouncilNZ Transport Accident Investigation Commission

*Counts include specialists in all modal offices

Human Factors Investigation Around the World (2005)

Boeing Survey of Human Performance Guidance Materials Used by 12 Accident Investigation Agencies

4 agencies	Detailed guidance materials
4 agencies	Human performance checklist(s)
4 agencies	No HP guidance materials

Data from Boeing Commercial Airplanes

Part 1: Concepts

√ • What is human factors investigation?Why
√ bother?Who can do it?What should be
investigated?How are the data developed /
√ analyzed?How are the findings reported?How are
√ safety recommendations developed?Human
performance investigation around the world
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National Transportation Safety Board

National Transportation Safety Board

Investigating Human Factors in Aircraft Accidents Part 2: Methods

William Bramble, Ph.D.Senior Human Performance Investigator

NTSB Human Performance Investigators (Aviation)

Evan Byrne, Chief, Human Performance and Survival Factors Division

Human Performance

Survival Factors

BrambleSenior HKatherineWilsonSenior HumanPerformSathya Silva
Investigator

Investigator

Human
Performance
Investigator

Guidance Materials

- Primary guidance is an NTSB major investigations manual appendixHuman performance investigators use various other formal and informal job aidsPractice depends heavily on office lore and tradition, investigator ingenuity and initiative

Initial Notification

- What size investigation?Major teamRegional

NTSB

Travel to the Scene

- FAA airplane (major launch)Commercial jumpseat

Arrival On Scene

Organizational Meeting (Investigator in Charge): E
Identify participants Desig
party coordinators Establ

Parties

- NTSBFAAOperat
  er

NTSB

Formation of Groups

- StructuresSystemsPowerplantsMaintenanceOperationsSurvival factors
- AirportsAir traffic controlAirplane performanceFlight data recorderCockpit voice recorderMeteorology

Where Does Human Factors Belong?

- StructuresSystemsPowerplantsMaintenanceOperationsSurvival factors
- AirportsAir traffic controlAirplane performanceFlight data recorderCockpit voice recorderMeteorology

- (Human Performance)

Human Performance Responsibilities

Collect perishable information first!

Overlapping responsibilitiesRetrieve cockpit paperworkInterview crewInterview other witnessesRequest company, FAA records

Unique responsibilitiesExamine bags for medsArrange for toxicological testing
(if crew are deceased)Collect electronic devices
(if left behind)Request hotel and other activity records (if relevant)Arrange next of kin interviews
(if crew are deceased)

NTSB

Human Performance Investigator Initial Goals

- Find out what happened / what went wrong in enough detail for errors to be placed in contextCollect information about the goals, thoughts, perceptions, and understandings of those involvedCollect sufficient data for later assessment of various aspects of fitness for duty (fatigue, medications, stress, etc.)

Human Performance Investigator Initial Goals

MINIMUM DATA

Actions................. Event circumstances and person's actions

Lookback.............. Activities in days before event & toxicology

Personnel.............. Professional, personal & medical background

Environment

Standards

Human Performance Investigator Initial Goals

Beyond the Initial Launch

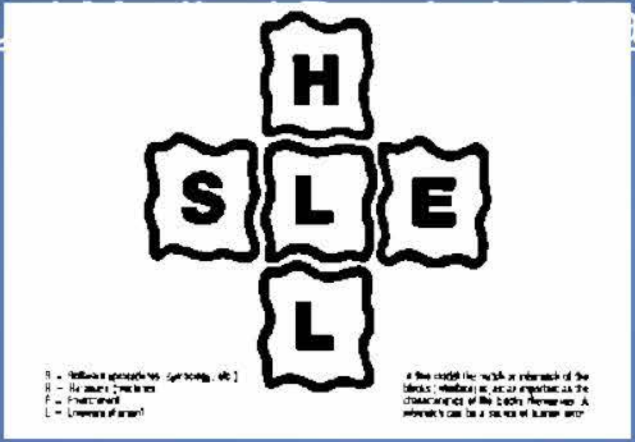
Use the SHEL Model for Inspiration

Liveware- Perceptu[…]al Training Experience Liveware-Hardware D[…] management

controls Automation

Liveware-Software P[…]

procedures Compu[…]



Liveware-Environment Lighting Temperature Vi[…]

Beyond the Initial Launch

More UrgentLess Urgent

Priority of InterviewsThose directly involved in the eventOther witnesses (airborne, on the ground)Those who recently interacted with the personNext of kin / roommates / close friendThose who recently flew / worked with crewThose who recently used the same equipmentSupervisor(s), Instructor(s)Coworkers who know them wellOther employees who hold the same jobCompany managersFormer employers

Beyond the Initial Launch

More UrgentLess Urgent

Priority of Other TasksArrange for collection of toxicological specimensHelp secure personal belongings, cockpit papers, camerasCollect activity evidence (hotel data, etc.)Document equipment / work space / environmentObserve normal operationsReview CVR / FDR / Video / Radar / Radio / PhotoReview simulation studies / perform re-enactmentsReview certification records (technical, medical)Obtain driver / criminal historyReview training recordsReview personnel filesReview regulations, company policies, SOPsReview operating handbooksReview training materials

NTSB Major Investigations Manual

HUMANPERFORMANCEFACTORS

BEHAVIORALMEDICAL OPERATIONALTASKEQUIPMENT DESIGNENVIRONMENTAL

- Behavior during the event24-72 hour historyGeneral habit patternsRecent l eventsGeneral HealthSensory Acuity alcohol ingestionFatigueTrainingExpe familiarity / habitsOperating proceduresCompany policyTask infor componentsTask-time relationWorkloadWorkspace interface instrument panel designControl desig design / configurationExternal conditi conditionsIllumination / visibilityNoise / motion

(Not Included are cognitive, organizational, crew interaction aspects)

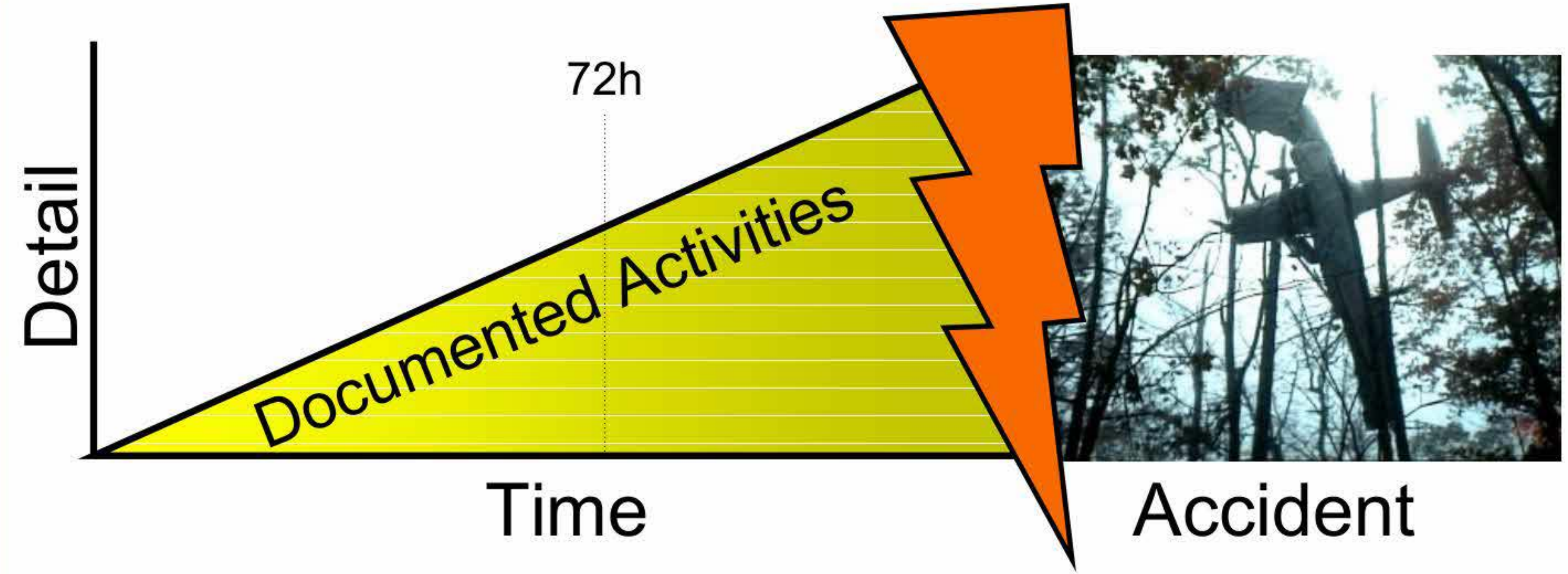
BEHAVIORALMEDICAL ~~OPERATION~~ALTASKEQUIPMENT DESIGNENVIRONMENTAL

HUMANPERFORMANCEFACTORS

- Behavior during the event24-72 hour historyGeneral habit patternsRecent life eventsGeneral HealthSensory AcuityDrug / alcohol ingestionFatigueTrainingExperience / familiarity / habit patternsOperating proceduresCompany policyTask informationTas componentsTask-time relationWorkloadWorkspace interfaceDisplay / instrument panel designControl designSeat design / configurationExternal conditionsInterna conditionsIllumination / visibilityNoise / vibration / motion

Beyond the Initial Launch

Documenting Recent Activities



Why Document Recent Activities?Inadequate rest breaksInadequate sleepRecent per al conflictsRecent stressUse of alcohol or drugsRece ry or illness

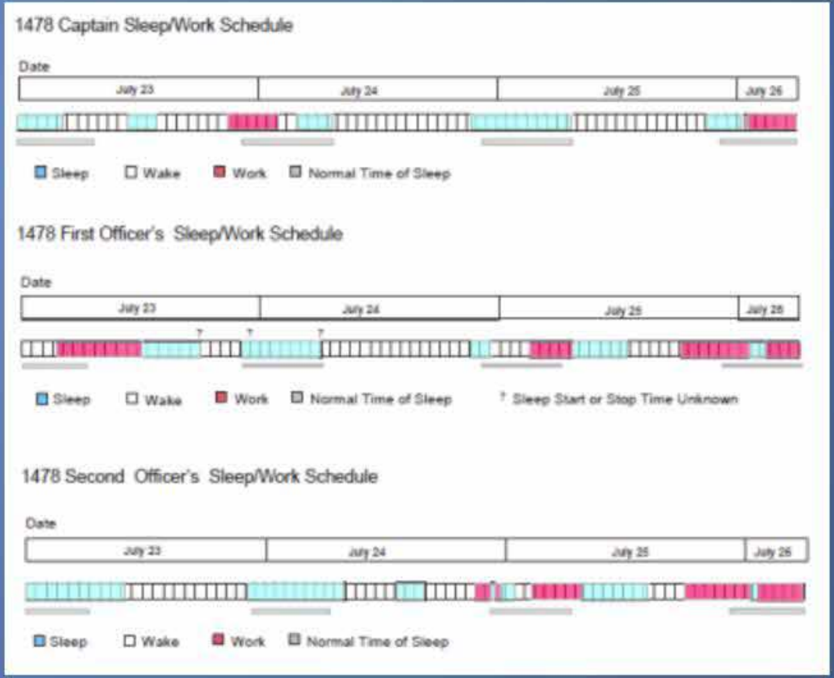
- BEHAVIORAL
  - Behavior during the event24-72 hour historyGeneral habit patternsRecent life events

- InterviewsWork sc ity records (keycards, phone, DR, Video, Radar, Rad

NTSB

Recent Activities

PIC	Wednesday, March 30	Thursday, March 31	Friday, April 1	Saturday, April 2
0:00	0.5	0.5	0.5	0.5
0:30	0.5	0.5	0.5	0.5
1:00	0.5	0.5	0.5	0.5
1:30	0.5	0.5	0.5	0.5
2:00	0.5	0.5	0.5	0.5
2:30	0.5	0.5	0.5	0.5
3:00	0.5	0.5	0.5	0.5
3:30	0.5	0.5	0.5	0.5
4:00	0.5	0.5	0.5	0.5
4:30	0.5	6.5	8.5	8.5
5:00	0508 1-min call			
5:30	Seen in hotel lobby area	Seen in hotel lobby area	Seen in hotel lobby area	Seen in hotel lobby area
6:00			0559 1-min call	
6:30				0641 entered the cockpit
7:00	0701 block start	0707 block start		
7:30			0744 block start	
8:00			Flying	
8:30	0833 block end		0842 block end	0857 Break
9:00				0908 Resume
9:30		0948 block end		Accident
10:00				
10:30				
11:00				
11:30				
12:00		1225 block start	1200	
12:30				
13:00			Preflight briefing	
13:30		Flying		
14:00			1400	
14:30		1447 block end		
15:00			Preflight briefing	
15:30				
16:00				
16:30		1658 Last call		
17:00				
17:30				
18:00				
18:30	1830 outoing text			
19:00	Dinner	Dinner	Dinner	
19:30	1952-1955 outgoing texts	Dinner	Dinner	
20:00			2000 Return hotel, check VM	
20:30		0.5	0.5	
21:00	2122 outgoing text	0.5	0.5	
21:30	2159 outoing text	0.5	0.5	
22:00	2201 outgoing text message	0.5	0.5	
22:30	0.5	0.5	0.5	
23:00	0.5	0.5	0.5	
23:30	0.5	0.5	0.5	



Beyond the Initial Launch

Other Behavioral Info
scheduleDaily slee
characteristics

NTSB

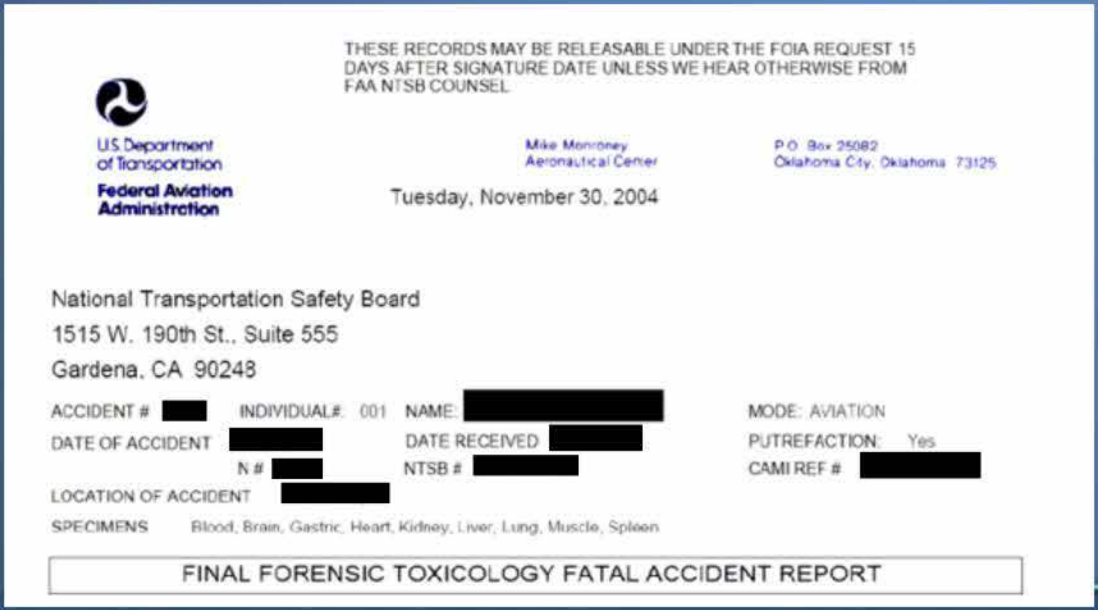
HUMANPERFORMANCEFACTORS

BEHAVIORALMEDICAL
OPERATIONALTASKEQ
UIPMENT
DESIGNENVIRONMENT
AL

- Behavior during the event24-72 hour historyGeneral habit patternsRecent life eventsGeneral HealthSensory AcuityDrug / alcohol ingestionFatigueTrainingExperience / familiarity / habit patternsOperating proceduresCompany policyTask informationTas componentsTask-time relationWorkloadWorkspace interfaceDisplay / instrument panel designControl designSeat design / configurationExternal conditionsInterna conditionsIllumination / visibilityNoise / vibration / motion

- MEDICAL
  - General HealthSensory Ac
    ingestionFatigue

- Toxicological testsAutopsy resultsAviation



THESE RECORDS MAY BE RELEASABLE UNDER THE FOIA REQUEST 15 DAYS AFTER SIGNATURE DATE UNLESS WE HEAR OTHERWISE FROM FAA NTSB COUNSEL

U.S. Department of Transportation
Federal Aviation Administration

Mike Monroney Aeronautical Center

P.O. Box 25082
Oklahoma City, Oklahoma 73125

Tuesday, November 30, 2004

National Transportation Safety Board
1515 W. 190th St., Suite 555
Gardena, CA 90248

ACCIDENT # [redacted] INDIVIDUAL#: 001 NAME: [redacted] MODE: AVIATION

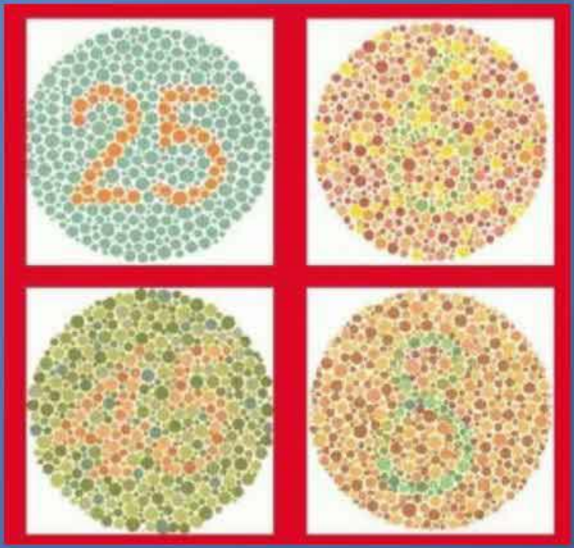
DATE OF ACCIDENT [redacted] DATE RECEIVED [redacted] PUTREFACTION: Yes

N # [redacted] NTSB # [redacted] CAMI REF # [redacted]

LOCATION OF ACCIDENT [redacted]

SPECIMENS Blood, Brain, Gastric, Heart, Kidney, Liver, Lung, Muscle, Spleen

FINAL FORENSIC TOXICOLOGY FATAL ACCIDENT REPORT



– MEDICAL

- General HealthSensory AcuityDrug / alcohol ingestionFatigue

Toxicological TestingCarbon monoxideCyanideEthanolAmphetamineOpiatesMarijuanaCocainePhencyclidineBenzodiazepinesBarbituratesAntidepressantsAntihistaminesMeprobamateMethaqualoneNicotine

Note: Analysis of vitreous fluid from the eyeball is the most effective means of testing for alcohol because it is not contaminated by post-mortem ethanol production resulting from decomposition

- MEDICAL
  - General HealthSensory AcuityDrug / alcohol ingestionFatigue

Other Sources of Medical InformationInterviewsPersonal medical records (Subpoena)Prescription records (Subpoena)Post-accident testing of various kinds

HUMANPERFORMANCEFACTORS

BEHAVIORALMEDICAL
OPERATIONALTASKEQ
UIPMENT
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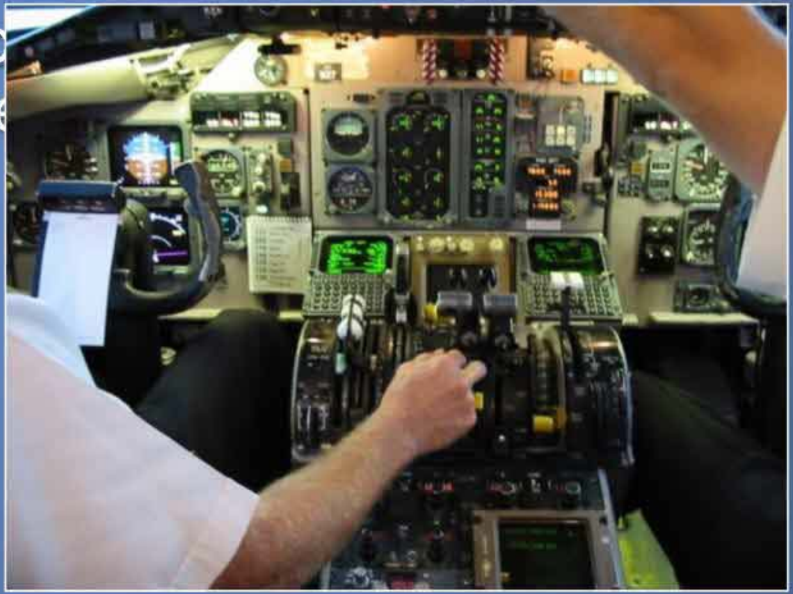
- OPERATIONAL
  - TrainingExperience / familiarity / habit patternsOperating proceduresCompany policy

- LogbooksCertification rec
  recordsPersonnel filesInte



BEHAVIORALMEDICAL
OPERATIONALTASKEQ
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– TASK

- Task informationTask componentsTask-time relationWorkload

- InterviewsSimulations / re-enactment studiesRegulationsCompany guidance materialsCompany training materials

BEHAVIORALMEDICAL
OPERATIONALTASKEQUIPMENT
DESIGNENVIRONMENTAL

HUMANPERFORMANCEFACTORS

- Behavior during the event24-72 hour historyGeneral habit patternsRecent life eventsGeneral HealthSensory AcuityDrug / alcohol ingestionFatigueTrainingExperience / familiarity / habit patternsOperating proceduresCompany policyTask informationTas componentsTask-time relationWorkloadWorkspace interfaceDisplay / instrument panel designControl designSeat design / configurationExternal conditionsInterna conditionsIllumination / visibilityNoise / vibration / motion

— EQUIPMENT DESIGN

- Workspace interfaceDisplay / instrum
designControl designSeat design / co

- InterviewsExamination of equipment / work spaceO
normal operationsAirplane / equipment manualsMe
manufacturer

BEHAVIORALMEDICAL
OPERATIONALTASKEQ
UIPMENT
DESIGNENVIRONMENT
AL

HUMANPERFORMANCEFACTORS

- Behavior during the event24-72 hour historyGeneral habit patternsRecent life eventsGeneral HealthSensory AcuityDrug / alcohol ingestionFatigueTrainingExperience / familiarity / habit patternsOperating proceduresCompany policyTask informationTas componentsTask-time relationWorkloadWorkspace interfaceDisplay / instrument panel designControl designSeat design / configurationExternal conditionsInterna conditionsIllumination / visibilityNoise / vibration / motion

– ENVIRONMENTAL

- External conditionsInternal conditionsIllumination / visibilityNois / motion

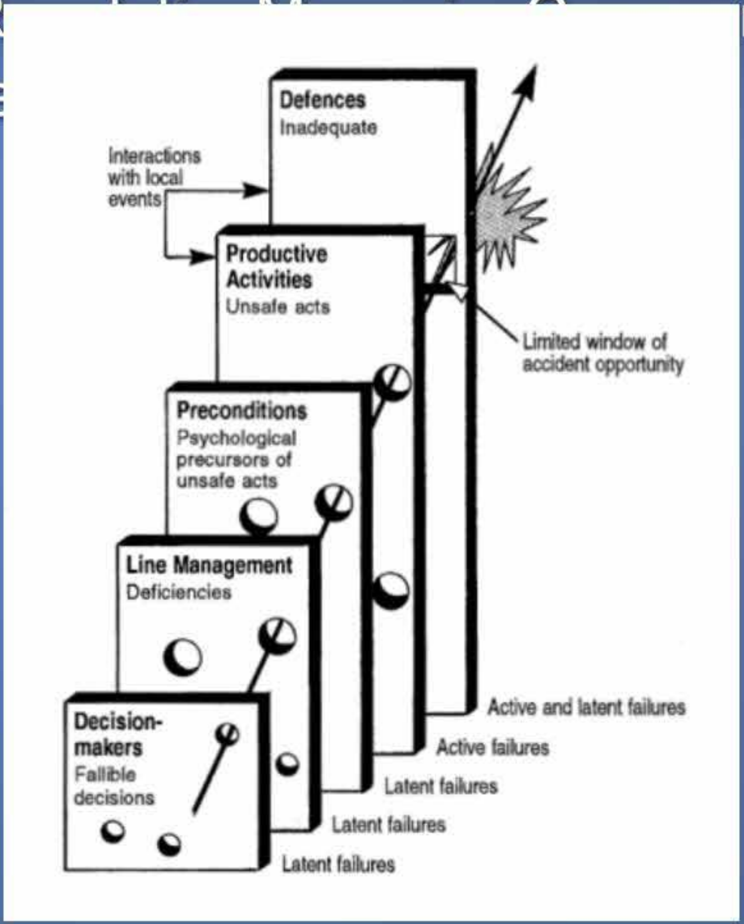
- InterviewsSite visitDirect observations of operational areaPhotos taken before or after an eventCVR / FDR / Video / Radar / Ra forecasts, observations, radar, PIREPsComputer mode position

Organizational Factors

Organizational structurePoliciesProceduresTrainingOversightSafety ManagementINTERVIEWS

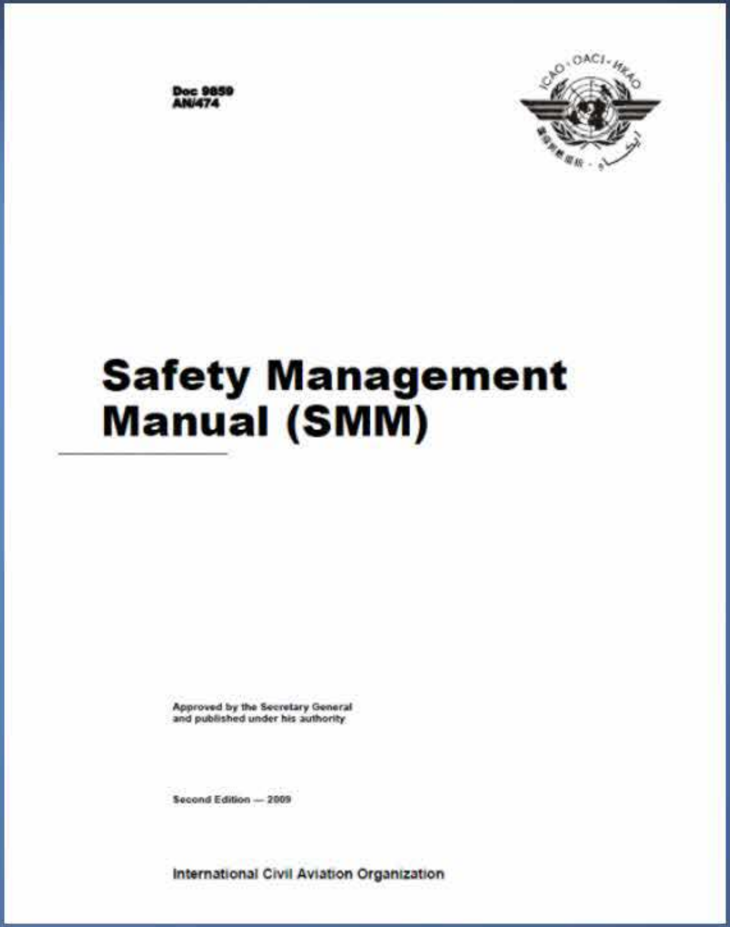
Organizational Factors

Organizational Factors – “Latent Failures”Setting goalsOrganizingR nicatingDesigningBuildingOpe



Organizational Factors

Safety Management GuidanceICAO Doc 9859, Safety Management ManualFAA Advisory Circular 120-92A, Safety Management Systems for Aviation Service Providers


Doc 9859
AN/474

Safety Management Manual (SMM)

Approved by the Secretary General and published under his authority

Second Edition — 2009

International Civil Aviation Organization

Safety Management

- Safety PolicySafety Risk ManagementSafety AssuranceSafety Promotion

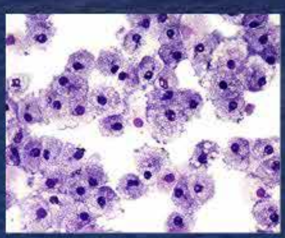
Safety Management

Did the company Have an executive who was accountable for safety performance?Dedicate resources to managing safety?Have safety policies & procedures in place?Investigate accidents, incidents?Proactively collect safety-related information?Encourage openness and safety reporting (just culture)?Reward employees for making safe choices?Try to address known safety issues?

National Transportation Safety Board

NTSB National Transportation Safety Board

CHEMICAL, BIOLOGICAL, RADIOLOGICAL, & EXPLOSIVE HAZARDS 23-June-2016



Dr. Paul F. SchudaDirector, NTSB Training

[redacted]; [redacted]

[redacted]

TRAINING vs. EDUCATION

Training: The goal of workforce "training" is to teach people to follow prescribed procedures and to perform in a standardized manner. It is designed to ensure standardized responses to predicted (expected) situations. It addresses the current needs and problems.

TRAINING vs. EDUCATION

Education: Education is concerned with the development of mind and intellectual capabilities. The goal of education is to create independent problem solvers who have sufficient depth of understanding to figure out what to do when the predicted breaks down and addresses the unexpected occurring.

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TRAINING vs. EDUCATION RESTATED

IN SHORT: You train for things that you know are going to happen. You educate yourself for everything else.

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QUIZ!!!The original Phantom Jet was the McDonnell Aircraft FH-1 Phantom. Only 62 were produced (but they led to the more powerful F2H Banshee). But the McDonnell USAF F4-Phantom 2 was not called by that name! What was the original USAF designation?

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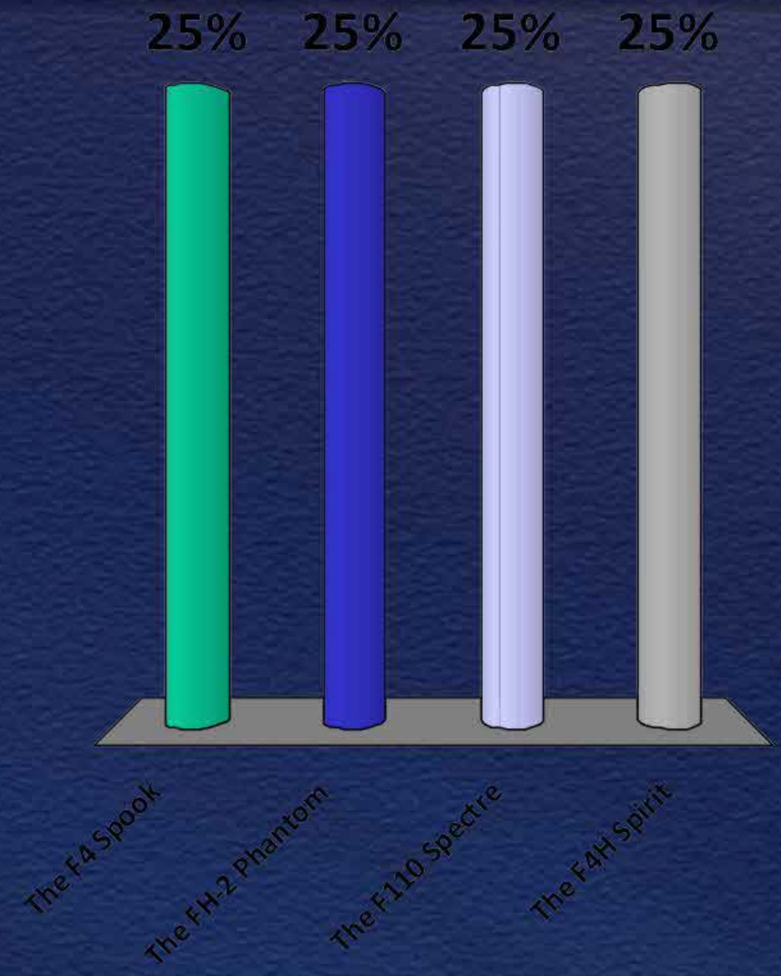
The Ghostly Answers: ☺

A. The F4 SpookThe FH-2 PhantomThe F110 SpectreThe F4H Spirit



ANSWER:

The F110 SPECTRE!!!

WHY, YOU MIGHT ASK (or not!) DID THEY CHANGE IT?

- The F4-Phantom 2 was first designed as a USN Fighter under that name. When the USAF decided to procure it (or it was decided for them☺), they designated it the F110 Spectre. Robert McNamara (SECDEF) asked in a briefing if it was the same aircraft. When it was answered affirmatively, he then asked why the different name. No good answer came forth so he declared that they would all (USAF, USN, Marines) be designated the F4-Phantom 2.

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ACCIDENT SCENE

- Charlotte, NC – 2003Typical Damage…Atypical debris field

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RESPONDER HAZARDS

- As with normal vehicular accidents, overheated brakes and inflated tires can also be a hazard

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RESPONDER HAZARDS

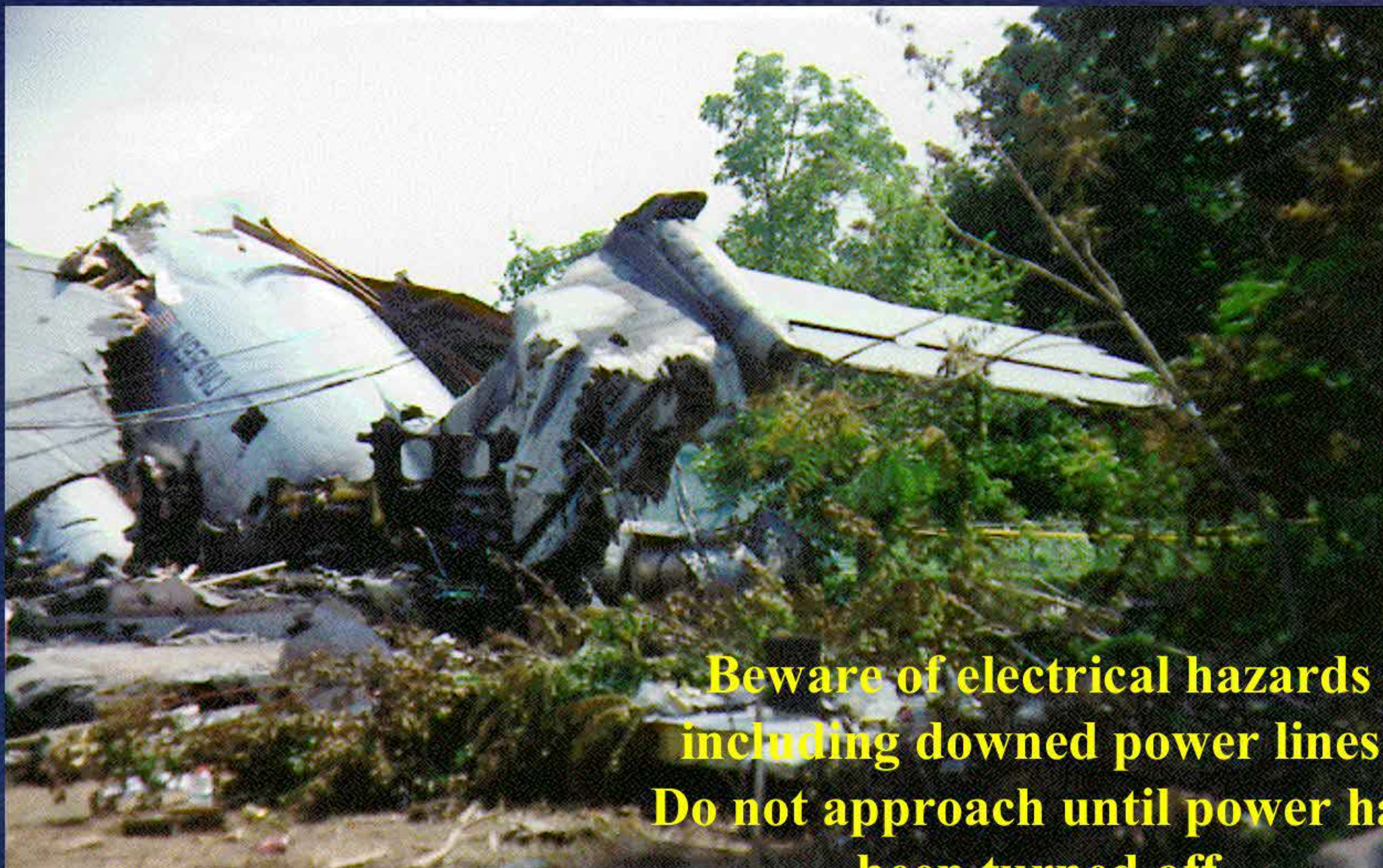
- Beryllium oxides will also be present if the aircraft has been exposed to fire. Beryllium is used in hundreds of components and its oxides are 20 times more toxic than arsenicPlastics such as viton and teflon which contain fluorine when exposed to fire will produce hydrofluoric acid

NTSB

RESPONDER HAZARDS

- Hydrofluoric Acid Burns

RESPONDER HAZARDS



Beware of electrical hazards including downed power lines. Do not approach until power has been turned off

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RESPONDER HAZARDS - TERRAIN

NTSB

RESPONDER HAZARDS

NTSB

RESPONDER HAZARDS

NTSB

RESPONDER HAZARDS

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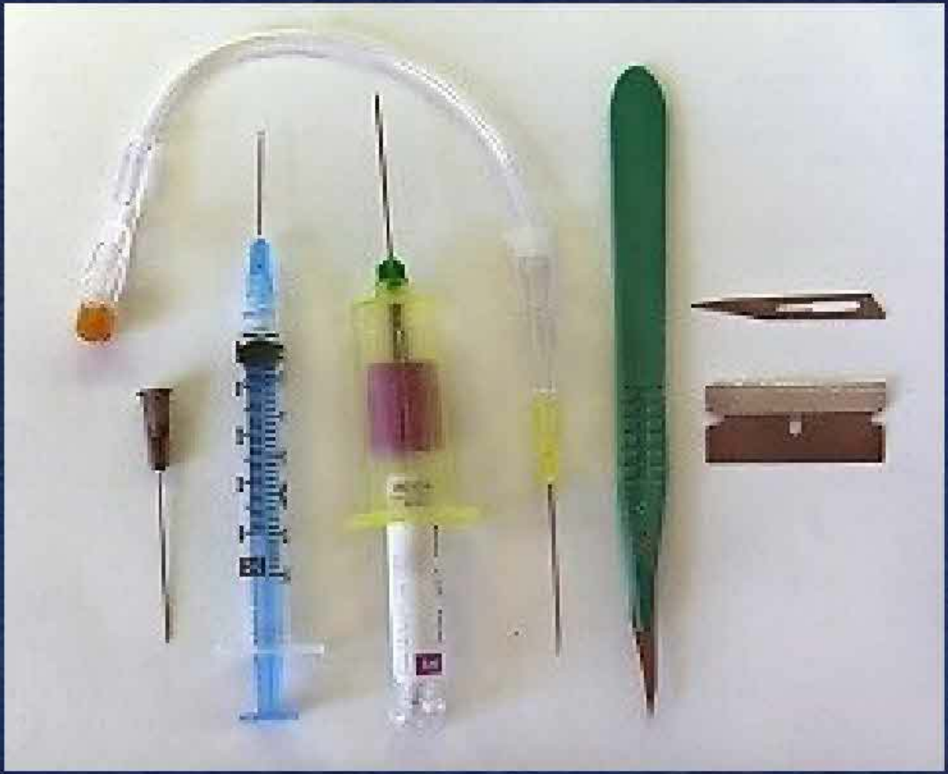
RESPONDER HAZARDS

- Sharps!Work with local ER, Hospitals, ME's to remove



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RESPONDER HAZARDS

- Strobe light units can also be on siteSufficient energy can be stored to injure and or kill the would be rescuerDo not touch or handle these units

Ballistic Recovery Systems

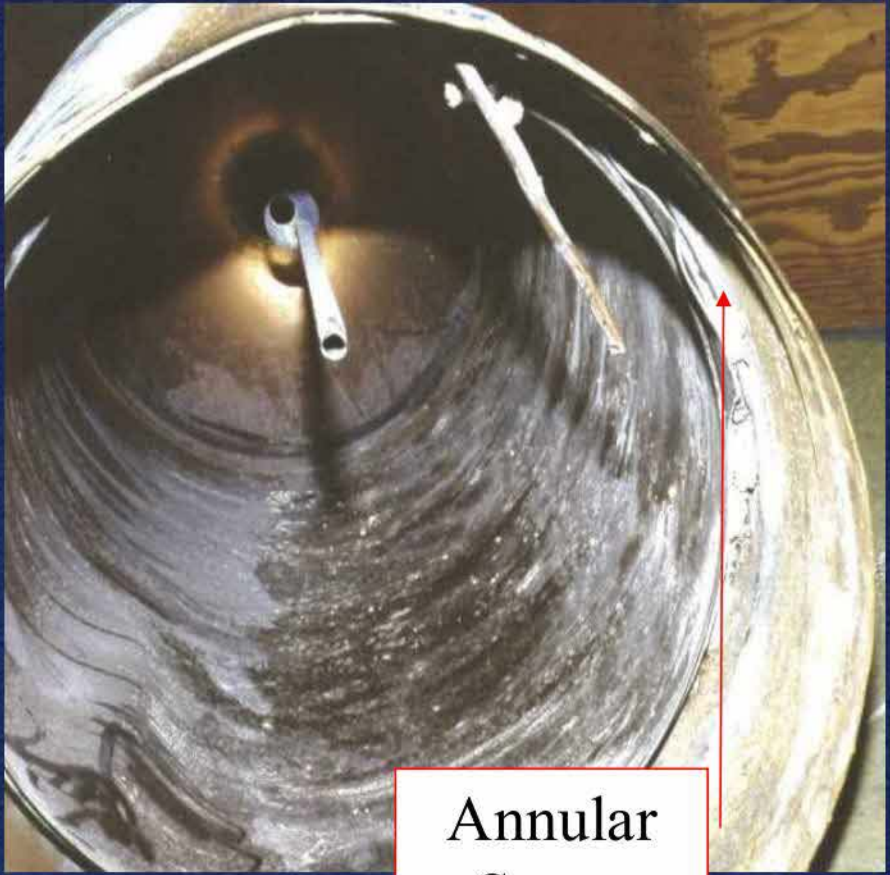
NTSB

RESPONDER HAZARDS

- Pressure? Container Compromised?

RESPONDER HAZARDS

- Responders should be aware that HAZMAT can also be present in the aircraft structure, including:Pressurized cylinders, oxygen bottles and actuators



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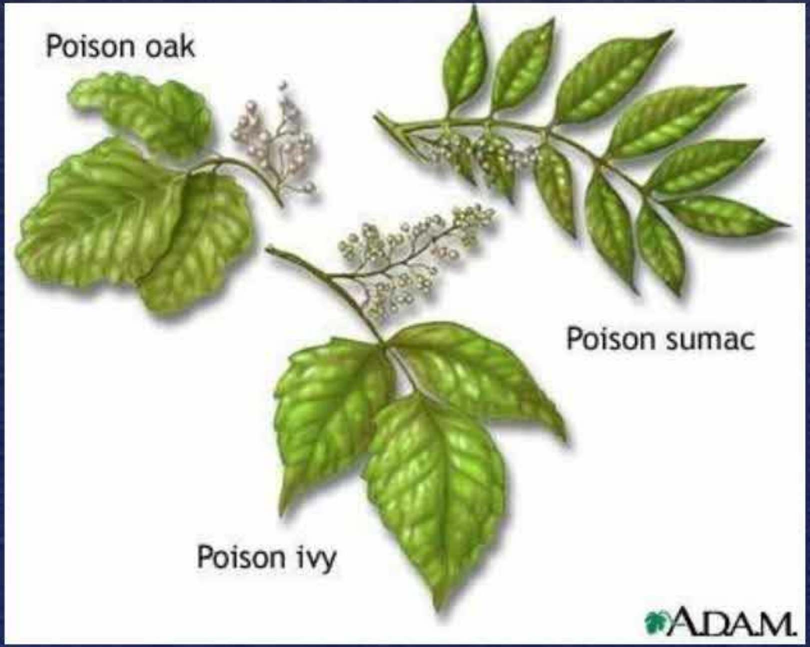
RESPONDER HAZARDS

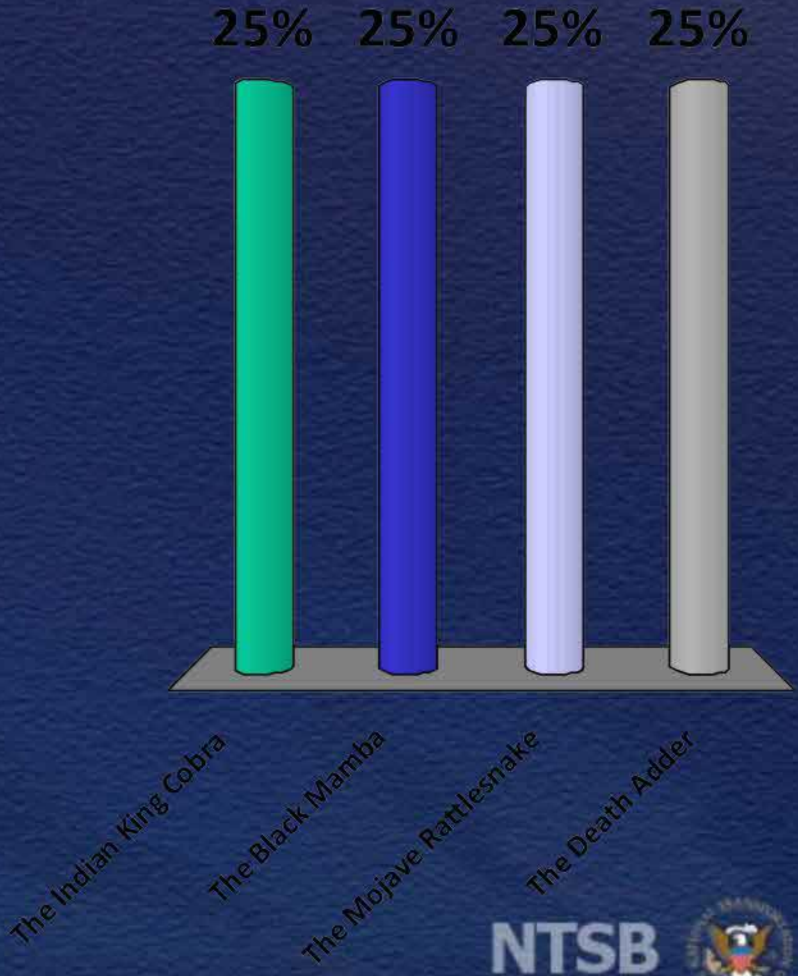
Local FloraLo



NTSB

What is the most deadly snake in the world?

A. The Indian King CobraThe Black MambaThe Mojave RattlesnakeThe Death Adder



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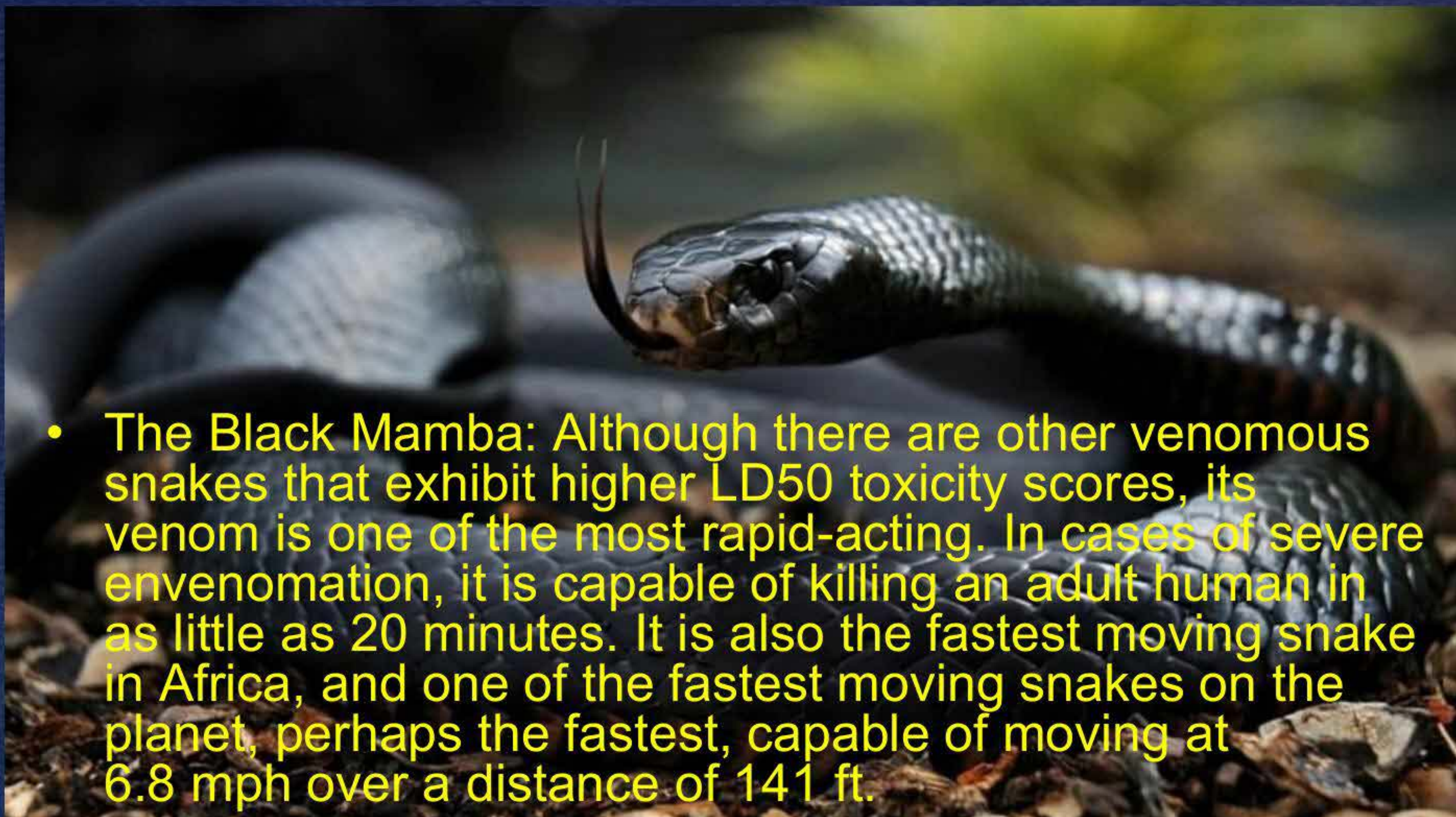
Answer!



- The Black Mamba: Although there are other venomous snakes that exhibit higher LD50 toxicity scores, its venom is one of the most rapid-acting. In cases of severe envenomation, it is capable of killing an adult human in as little as 20 minutes. It is also the fastest moving snake in Africa, and one of the fastest moving snakes on the planet, perhaps the fastest, capable of moving at 6.8 mph over a distance of 141 ft.

BBP SUITS - TYVEK

- Can rip very easily with all the sharp edges. Tyvek is fairly impermeable, but not very strong.

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What We Will Cover

- Routes of ExposureAcute vs Chronic EffectsChemical HazardsBiological HazardsRadiological HazardsExplosive HazardsMitigation of Hazards

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ROUTES OF EXPOSURE

3 Primary Routes for exposure:1) Dermal (through skin)Can be normal contact or through cuts or abrasions2) InhalationGases or fumes; aerosols; particulates3) IngestionSwallowed either directly or through contact with handsAbsorbed through stomach lining

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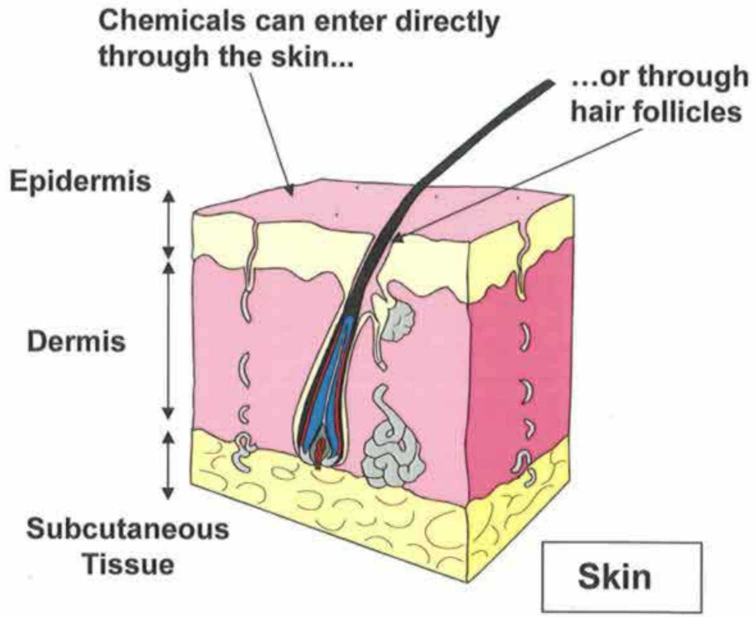
DERMAL EXPOSURE

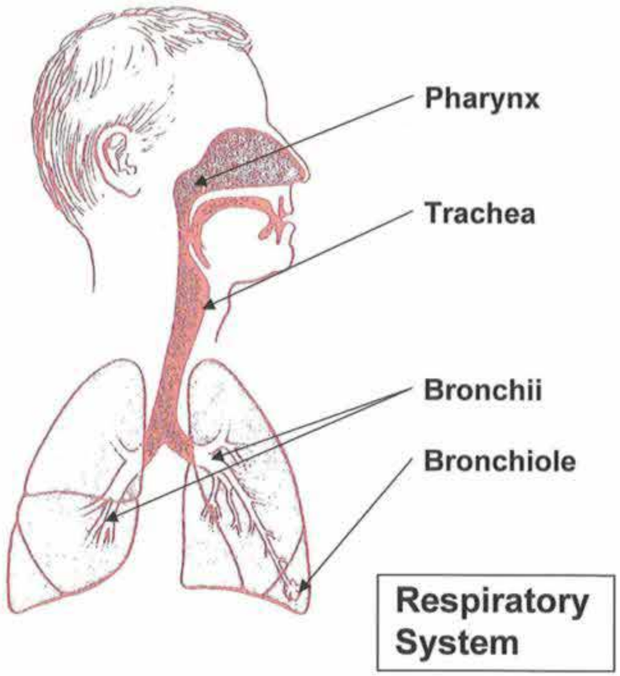
Routes of Exposure: Direct Contact



Transparency 1-2

INHALATION EXPOSURES

Routes of Exposure: Inhalation

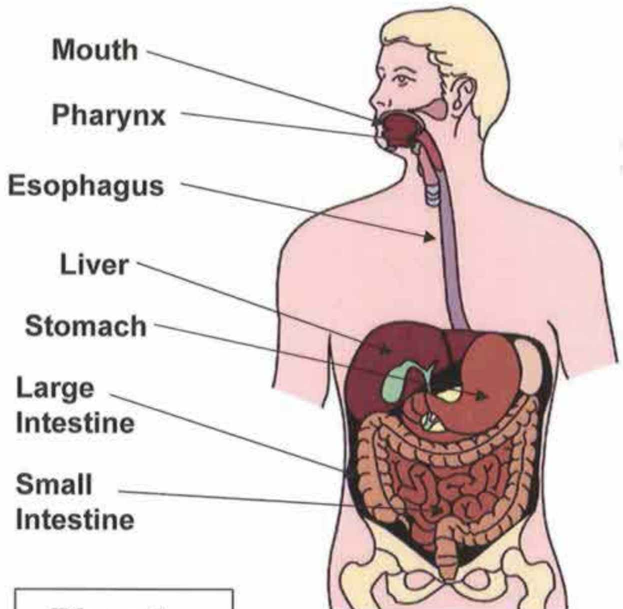


Transparency 1-3

NTSB

INGESTION EXPOSURE

Routes of Exposure: Ingestion



Digestive System

Transparency 1-4

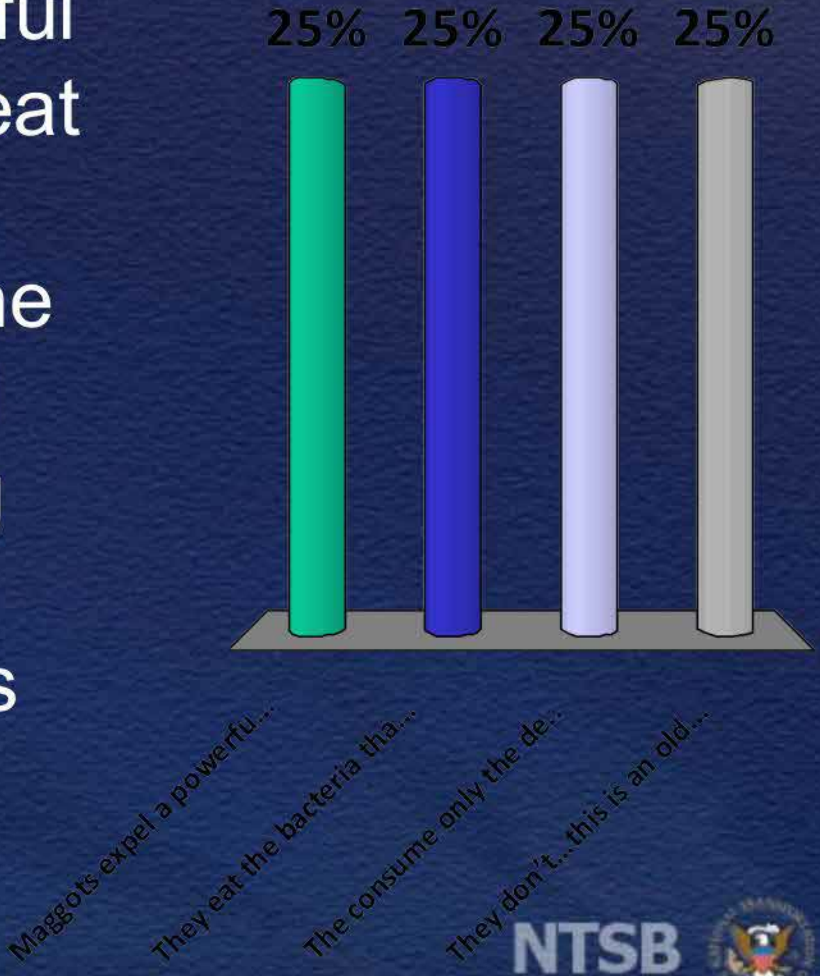
ANOTHER ROUTE OF EXPOSURE

- Penetration

NTSB

Why do wounds treated with maggots heal much more quickly?

A. Maggots expel a powerful natural antibiotic.They eat the bacteria that are causing the infection.The consume only the dead flesh and cells, allowing only healthy tissue to survive.They don't…this is an old wives tale.



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Answer!

- **Maggot therapy** is also known as **maggot debridement therapy** (**MDT**). It is a type of biotherapy involving the introduction of live, disinfected maggots (fly larvae) into the non-healing skin and soft tissue wound(s) of a human or animal for the purpose of cleaning out the necrotic (dead) tissue within a wound. It is particularly useful for wounds from antibiotic resistant bacteria.

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TWO TYPES OF EXPOSURE

- 1) AcuteUsually High ConcentrationShort Exposure Timese.g. spraying insecticides2) ChronicUsually Low ConcentrationLong Exposure Timese.g. coal mines or asbestos removal

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RISK?

- Risk is a quantifiable entityGenerally accepted as:RISK = HAZARD X EXPOSUREBoth are necessary Mitigation of risk is usually most easily accomplished by reducing exposureHazard can sometimes be reduced by engineering solutions

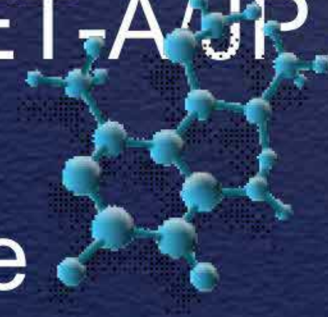
NTSB

ON-SCENE

CHEMICALHA
ZARDS

CHEMICAL HAZARDS ON-SCENE
UBIQUITOUS HAZARDS

- Auto Fuel and AVGASJET-A/JP 4 (Kerosene)Hydraulic FluidsGreasesComposite MaterialsElectrical (Batt Capacitors)Flora and F



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CHEMICAL HAZARDS

- Auto Fuel (No Lead) and AVGAS (100LL)Auto Fuel (No Lead)Made up of mixture of hydrocarbons“Fractions” based on boiling points of petroleumVery FlammableLeaches (extracts) oils from lipid bilayer of skinContains ethyl alcohol (grain alcohol) and minor anti-knock agentsAVGAS (100LL)Made up of mixture of hydrocarbons“Fractions” based on boiling points of petroleumVery FlammableLeaches (extracts) oils from lipid bilayer of skinContains up to 2grams of Tetraethyllead per gallonTwice as toxic as Auto Fuel

CHEMICAL HAZARDS

- Auto Fuel (No Lead) and AVGAS (100LL)Leaching of oils from skin can affect transport properties of the lipid bilayerMay allow substances through the skin that could be hazardous

NTSB

CHEMICAL HAZARDS

- Jet FuelsJET A (Kerosene Based)Less flammable than AVGASHigher boiling “Fraction” (cut) of petroleumMay contain antioxidants, antistatic agents, anti-corrosic
inhibitor

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CHEMICAL HAZARDS

– Military BlendsJP = Jet Propellant

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ENGINE POWER

Lots is good
More is better
Too much is just enough

NTSB

CHEMICAL HAZARDS

- Military Blends (cont.)JP-1 (older ca. 1944; pure kerosene)JP-4 (ca 1951-1995; wider "cut" of petroleum but greater availability; builds up static when moved)JP-5 (1952-present; higher "cut" flash point; for use on Aircraft Carriers where flammability is an issue)

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CHEMICAL HAZARDS

- JP-6 (Only for use on XB-70 Valkyrie; cancelled)JP-7 (Only used in SR-71 Blackbird; not a distillate but combination of hydrocarbons, fluorocarbons and anti-radar Cesium; requires triethylborane to ignite!!!)JP-8 (ca.1990; Air Force equivalent of JP-5; kerosene based but lower flammability)

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INTERESTING FACTS!

- Jet-A or JP FuelsTNT Equivalents of ca. 10.2Use TWA800 as an example; 300lbs (a 55-gallon drum) is the equivalent explosive power of 3060lbs of TNT! Under perfect combustions conditions!!!

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CHEMICAL HAZARDS

- Jet Fuels Routes of ExposureInhalation causes irritation to respiratory tractIngestion caused GI irritation, nausea, vomiting (and potential aspiration)Dermal causes skin irritation, redness and pain. Possible dermatitisLeaching of oils from skin can affect transport properties of the lipid bilayerMay allow substances through the skin that could be hazardous

NTSB

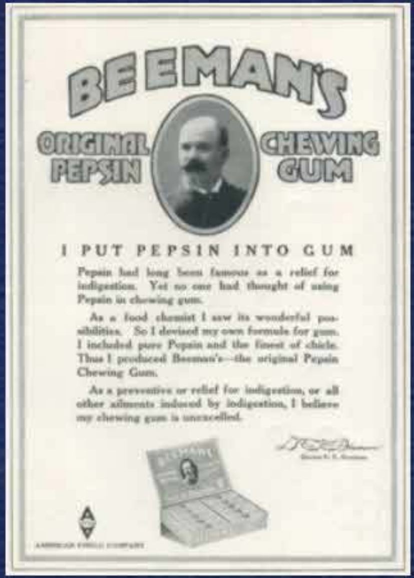
CHEMICAL HAZARDS

- Protective Measures for FuelsGloves (not latex – hydrocarbons dissolve latex – use nitrile gloves)Overboots (not latex)Ventilation (no respirator to be used except positive pressure-full face)GogglesFire extinguisher nearby (Class B)Tyvek suit

NTSB

INTERESTING FACTS!

- BEEMAN'S Chewing Gum; Longtime favorite of aviators! The gum was prominently featured in the movies The Right Stuff, Hot Shots!, and The Rocketeer. It was considered to be the lucky gum of pilots.Charles Lindbergh carried a pack on his transatlantic flight!The original formulation contained Pepsin…an enzyme that facilitates easy digestionALAS! It no longer contains Pepsin!!!



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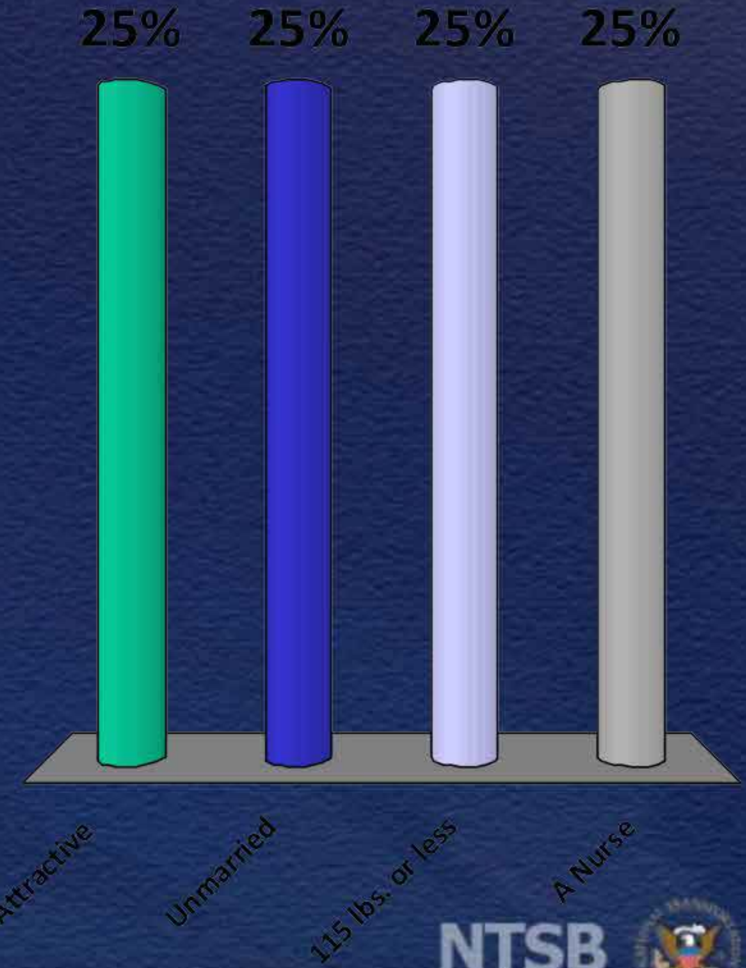
In 1930, which of the following characteristics was NOT required to be a flight attendant?

A. AttractiveUnmarried
115 lbs. or lessA
Nurse



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The ANSWER!

- There was no "Attractiveness" criteria; but they did need to be less than 115 lbs., and an unmarried nurse!

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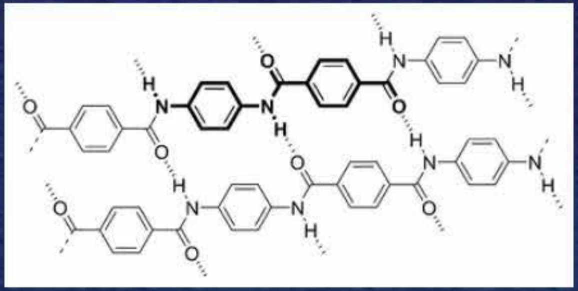
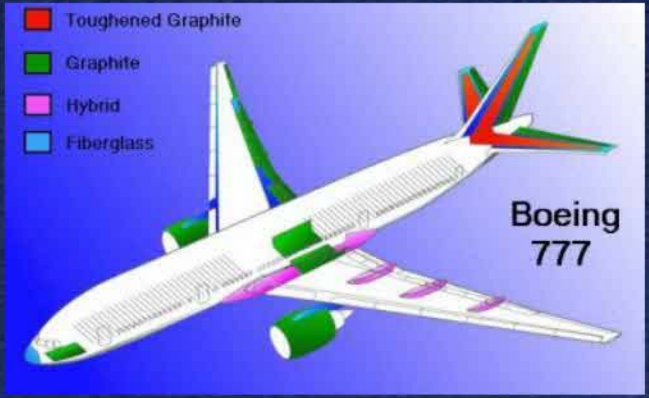
CHEMICAL HAZARDS

- Composite MaterialsFiber + a Resin (glue)Carbon Fiber ----------------→Fiberglass -------→Kevlar ----------------→(polyamid



CHEMICAL HAZARDS

- Two substances present: The composite itself   B777
  B787



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CHEMICAL HAZARDS

- The combustion products from composites

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CHEMICAL HAZARDS

- Composite MaterialTwo major routes of exposureInhalationGreatest potential for exposureCollects in the lungsLittle evidence for damage from chronic exposureDermalMajor effect is skin rash or irritation

CHEMICAL HAZARDS

- Composite combustion productsTwo forms:Gases (largely from resins)No more acutely toxic than burning woodParticulates (from fibers)Generally smaller fibers and particles that can get into lungs and penetrate airwaysLack of scientific data to prove risk from composite particulates are similar to silica (asbestos)Damage normally depends on size of particle and

CHEMICAL HAZARDS

- NOMEX (meta-aramid fibers)Aramid fibers are a class of heat-resistant and strong synthetic fibers.When subjected to intense heat:Carbon dioxide, water nitrogen oxidesSma amounts of carbon monoxide and hydrogen cyanide may be produce depending on conditions.In general, same toxicity as smoke from burning wood

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CHEMICAL HAZARDS

- ParticulatesNeoprene and leather clovesFace mask with proper sized filtersGogglesChemical “fixative”Spray with polyacrylic acidForms thin film over the particulatesBut film is very f easily brokenUnderstand this is physical process and NOT a pe change to the particulate properties or potential hazards

CHEMICAL HAZARDS

- Hydraulic FluidsMost commonly PAO (polyalpha olefins), phosphate esters & mineral oilMost Common Routes of Exposure:DermalSkin irritation (acute
sure)W ss in the
nic exp)

NTSB

CHEMICAL HAZARDS

- Inhalation or aerosolized fluids (not very volatile)Eye & respiratory irritationHeadacheNerve dysfunctionVertigoMiti gloves and overbootsT suitsVentilation

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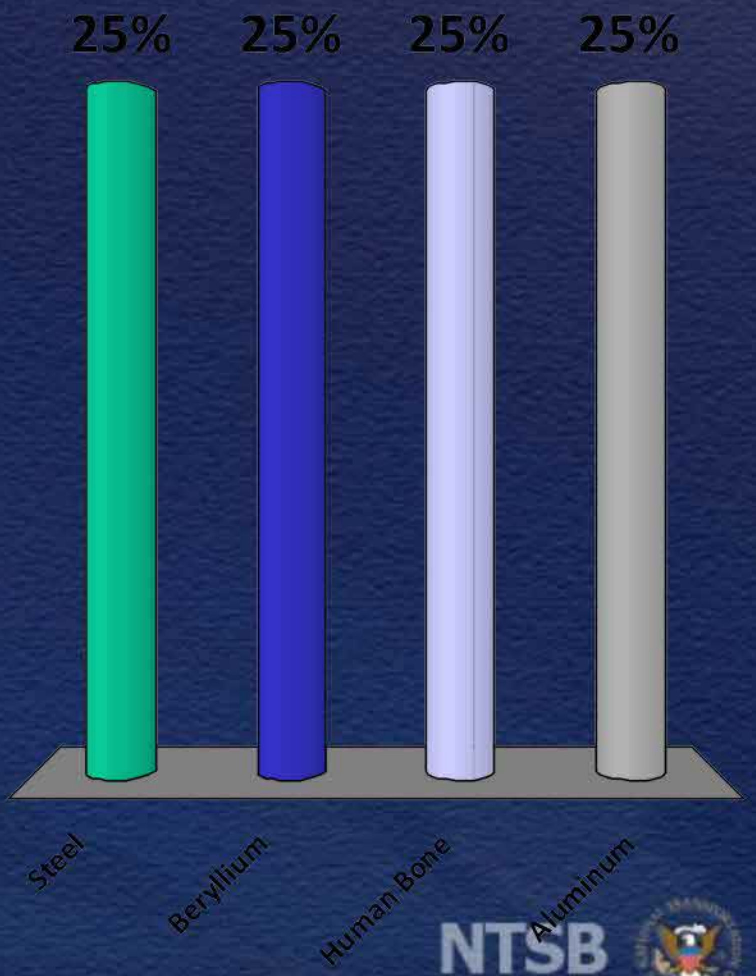
CHEMICAL HAZARDS

- Beryllium (Be)Six times as stiff a steelLightweightDimensional stabilityUsed in parts of aircraft engines and brakesMinor components of these itemsOverall risk is low

Which of the following materials would have the greatest structural strength?

A. SteelBerylliumHuman BoneAluminum



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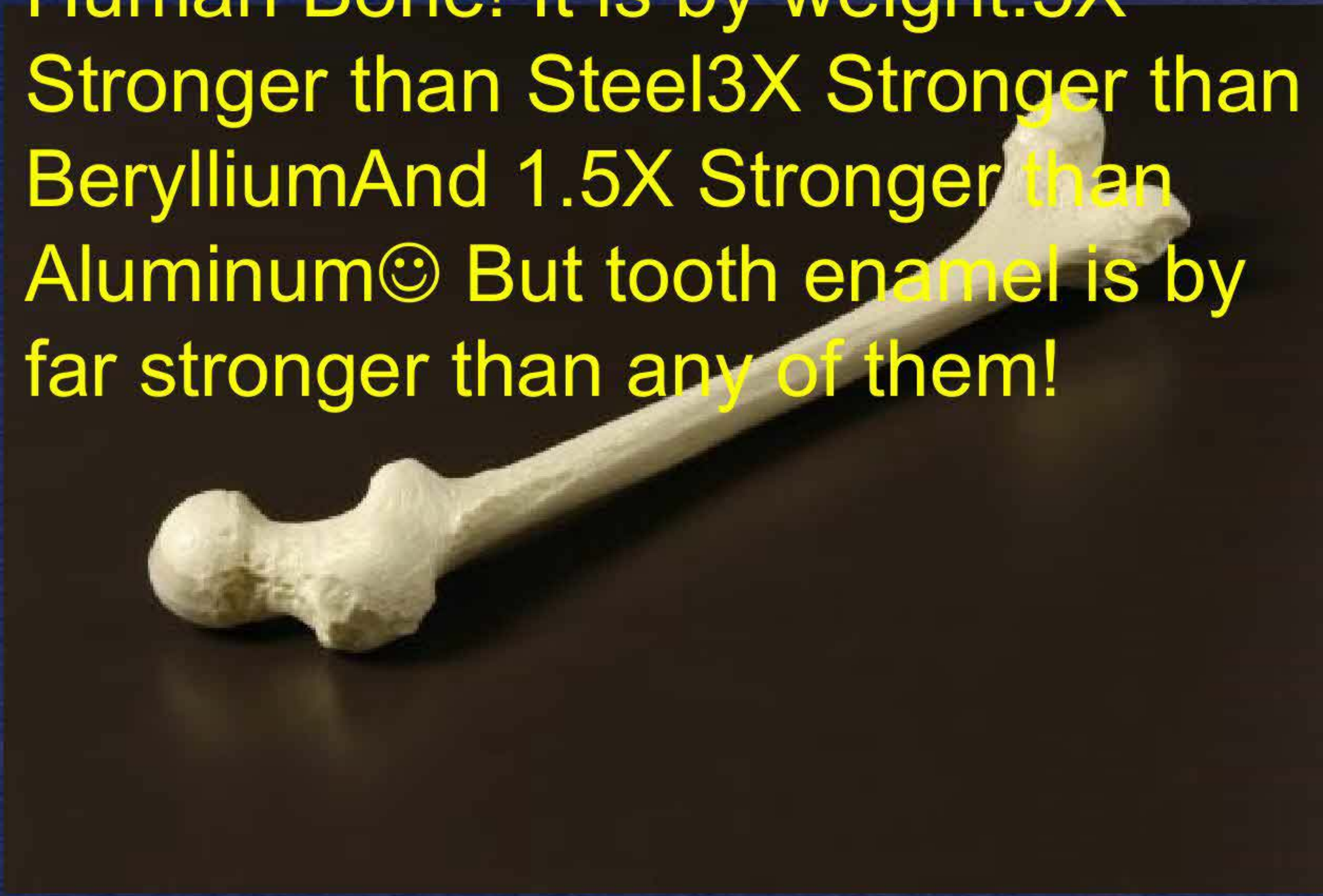
The Answer!

- Human Bone! It is by weight:5X Stronger than Steel3X Stronger than BerylliumAnd 1.5X Stronger than Aluminum☺ But tooth enamel is by far stronger than any of them!



INTERESTING FACTS!

- Magnesium is a lightweight, strong and malleable metal that forms an oxide coating and protects itself like aluminum

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INTERESTING FACTS!

- BUT!!! Once ignited, magnesium burns with an incredibly hot flame (4000oF; steel melts at 2500oF))that is not easily extinguished!The older VW Beetle bumpers were made from magnesium. They sometimes ignited in crashes!!!

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CHEMICAL HAZARDS

–Routes of Exposure:Inhalation of dust or fumes (acute & chronic)Requires massive amounts (acute)Breathing difficulty; cough, cyanosisDermalMild rashMitigation:Dust mask/respiratorGlov le/ and leather)

NTSB

CHEMICAL HAZARDS

- Oxygen CanistersMixture of sodium chlorate and barium peroxideIgnited by percussion capHIGHLY Exothermic reaction (releases oxygen and heat) >5
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mat TIO p
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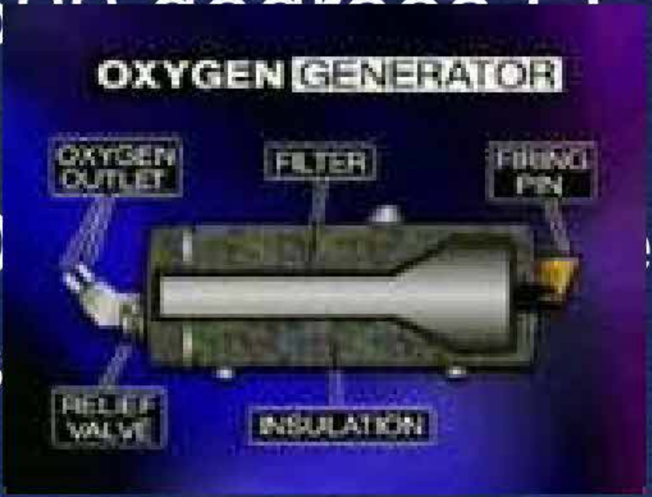
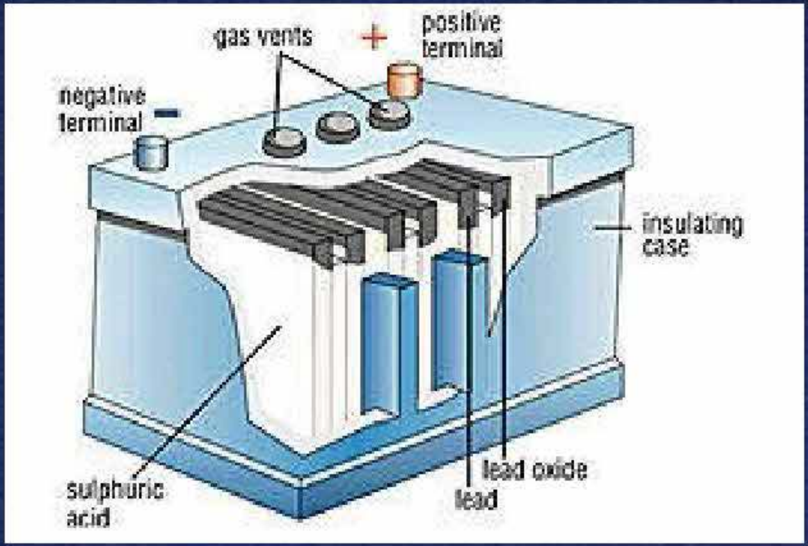


NTSB

CHEMICAL HAZARDS

- BatteriesThree major typesLead-acid (Lead Dioxide/Sulfate & Sulfuric Acid)



AIRCRAFT BATTERY

- Typically Lead-Acid (Pb-Sulfuric Acid)Sulfuric Acid is VERY concentrated and VERY corrosive

NTSB

CHEMICAL HAZARDS

- Primary hazard is concentrated sulfuric acid; may cause severe burnsSecondary hazard may be small amount of hydrogen & oxygen gas (explosive)Mitigation:Lots of water to remove sulfuric acidTyvek suitsLatex or Nitrile glovesVentilation for possible hydrogen and oxygen gases

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CHEMICAL HAZARDS

- Nickel-Cadmium (NiCd)Fire and explosion hazard present only when (over)chargingPresence of potentially toxic cadmium (mostly chronic toxicity

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CHEMICAL HAZARDS

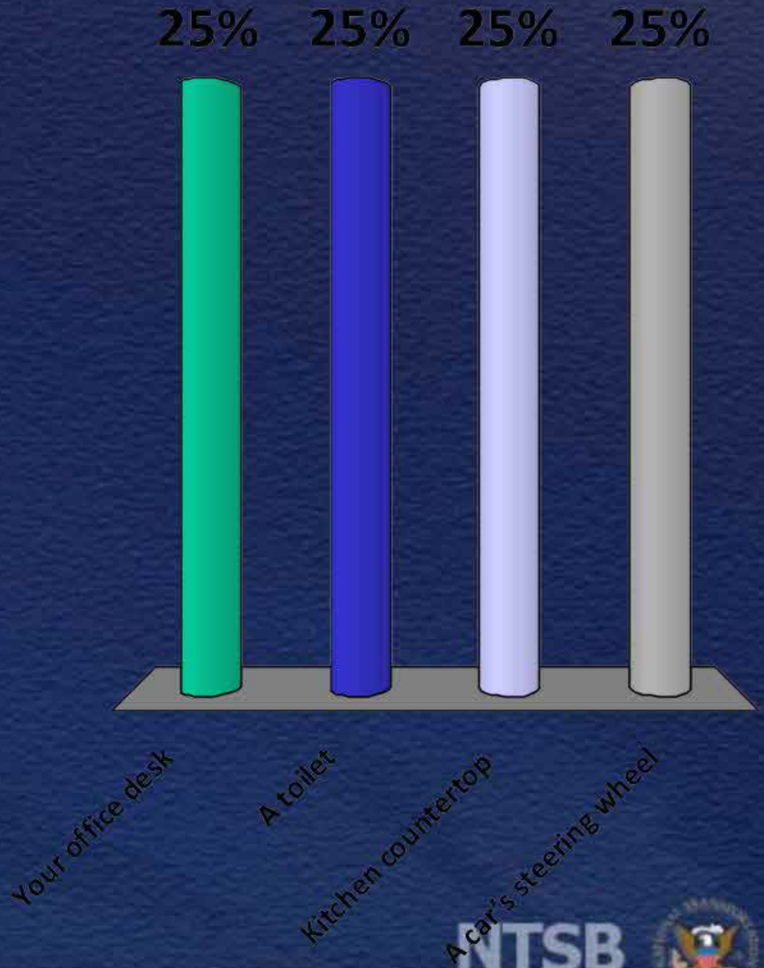
- Lithium and Lithium-ionLithium batterie metallic lithium; Very reactive with wate generates hydrogen gasExplosion hazardLithium-ion batteries use lithium compoundsHazard is in blocking a mer and having battery explodeMitigation (both):Have hazmat team secure and dispose

ON-SCENE

BIOLOGICALH
AZARDS

Which item contains the most bacteria?

A. Your office deskA toiletKitchen countertopA car's steering wheel



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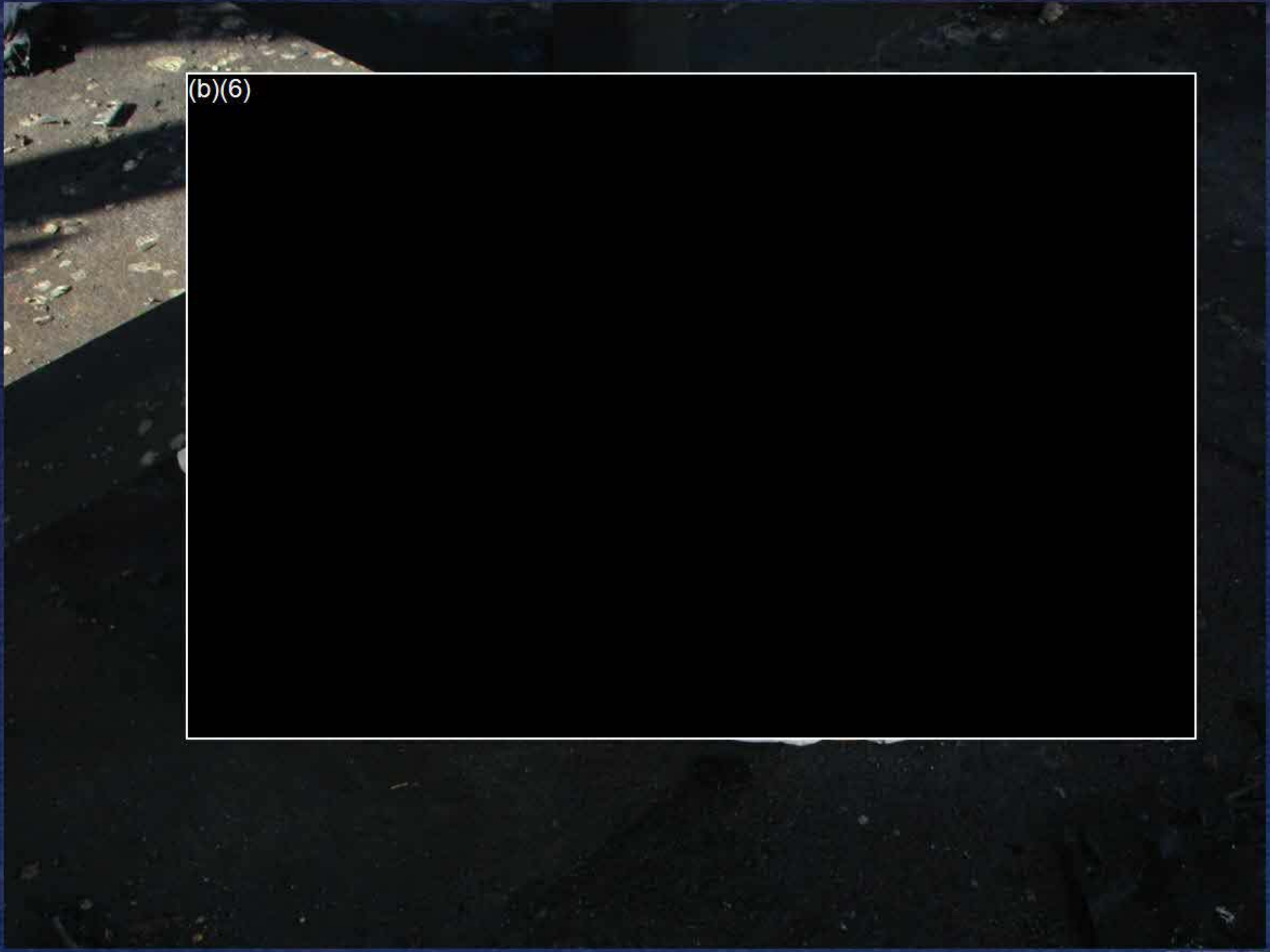
ANSWER!

- Your Office Desk…it actually contains 400 TIMES!!! More bacteria than a toilet!

Biohazard & Components



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[redacted]

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Biohazard & Remains

- Get in contact with local Coroners & Medical Examiners – DO NOT TOUCH!

(b)(6)

[redacted]

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TYPICAL DECONTAMINATION SITE

- Normally setup by local Emergency Responders

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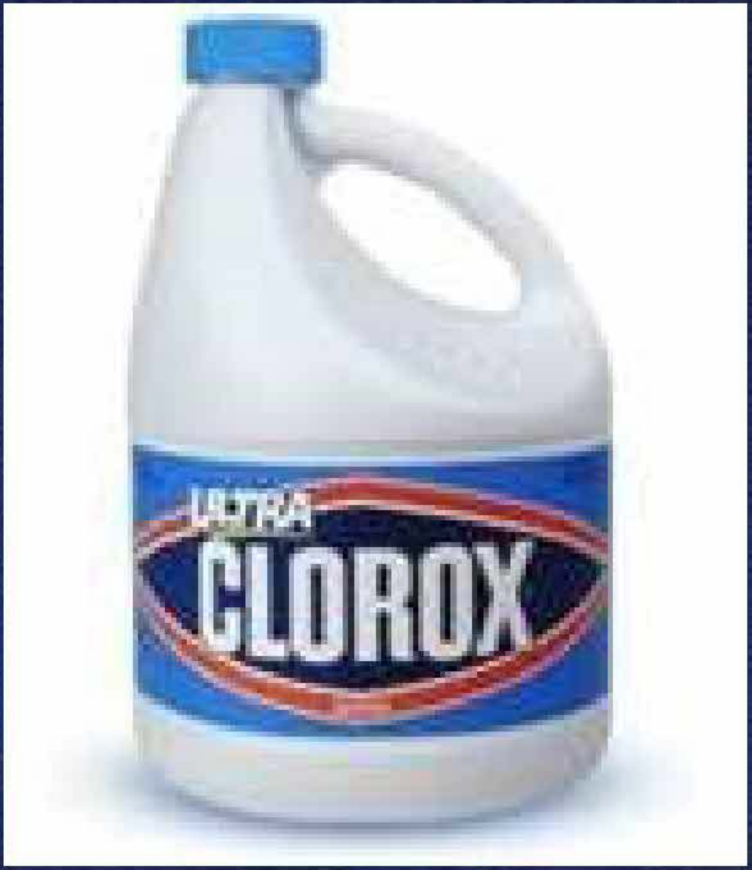
1:10 Clorox (hypochlorite):Water

- Topical for itemsDO NOT USE ON SKIN!!!



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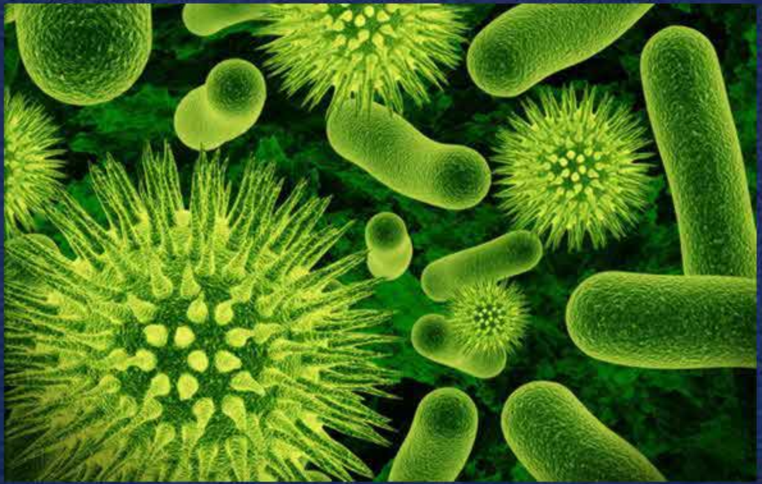
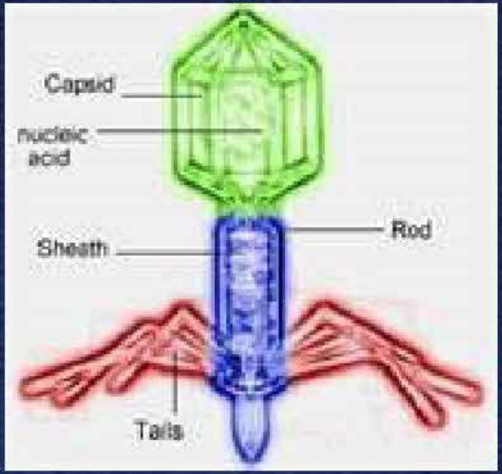
BIOLOGICAL HAZARDS

- E-ColiHepatitis StrainsHuman Immunodeficiency Virus (HIV)





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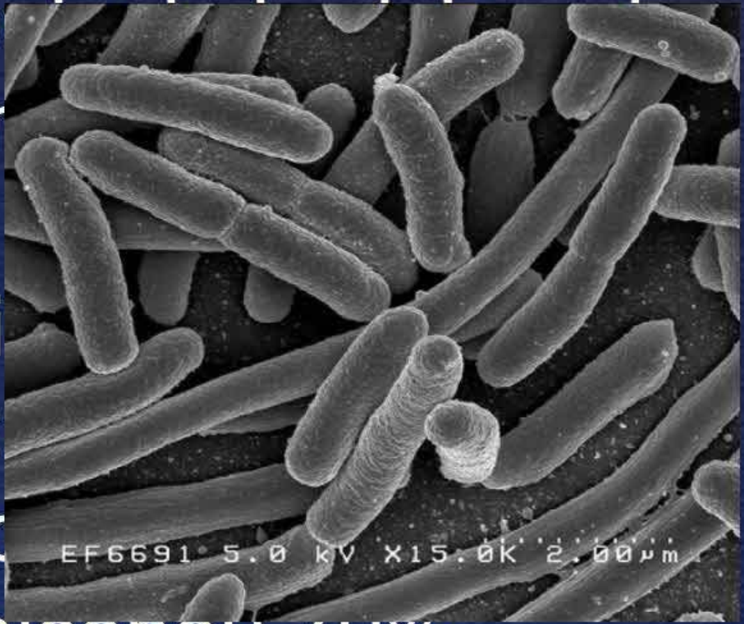
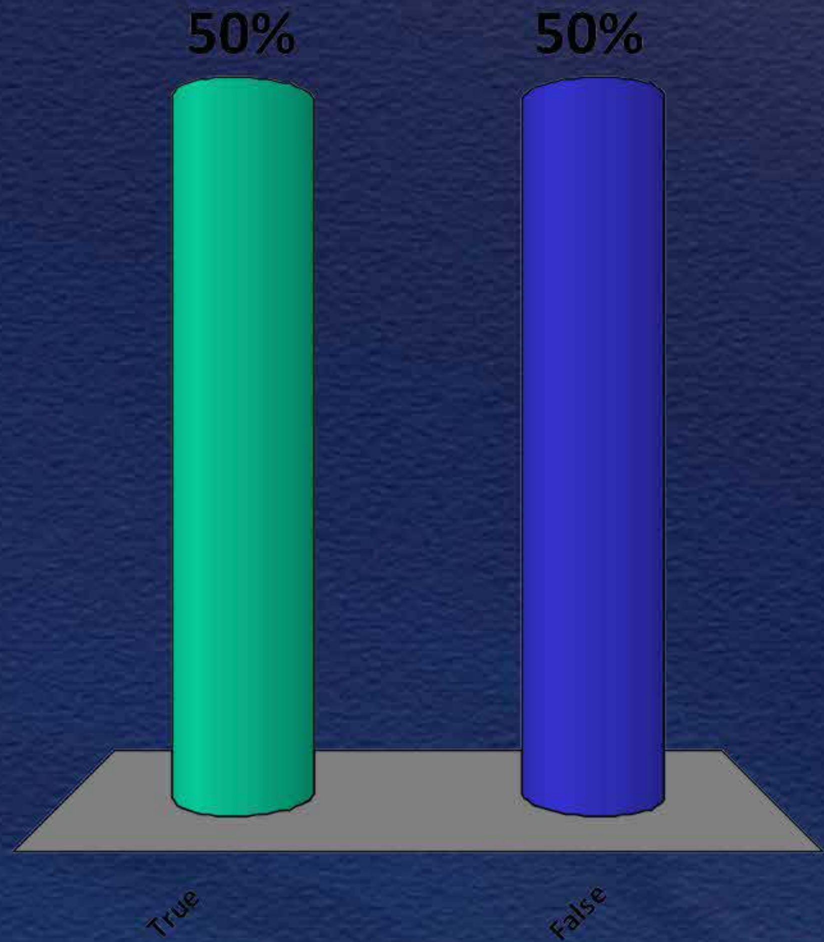
BIOLOGICAL HAZARDS

– Escherichia coli (E.coli)Found in intestines of warm-blooded animalsCan survive brief periods o
contaminationResistar
antibioticsRoute of
exposureIngestionDisi
orites (bleach:water 1:
(wood alcohol); ethanc
isopropanol (rubbing alcohol) 70% solutionsCidex (2% glutaraldehyde)



Wearing a headset for an hour increases the levels of bacteria in your ear.

A. TrueFalse



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Answer!

- TRUE!!!A one hou d, wearing a full headset will increase the bacteria level in your ears by 700 TIMES!!!

BIOLOGICAL HAZARDS

- HepatitisViralMeans injury to the liverThree common typesHepatitis A (HAV)Hepatitis B (HBV)Hepatitis C (HCV) →

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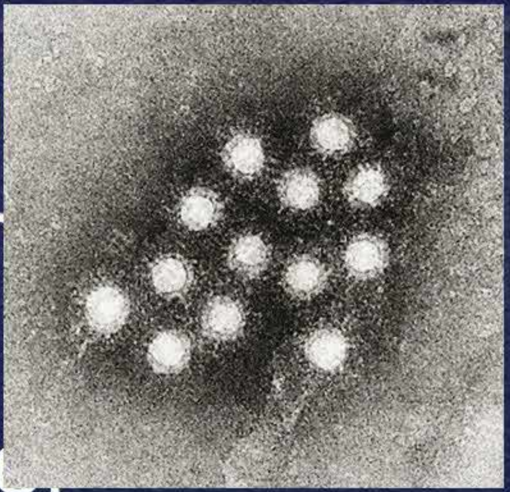
BIOLOGICAL HAZARDS

- Hepatitis (Continued)Hepati
(HAV)Route of exposure: or
contaminated food or water
sanitation)No permanent liv
damageCan be prevented by
vaccination and good hygiene habits



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BIOLOGICAL HAZARDS

- Hepatitis (Continued)Hepatitis B (HBV): over 2 billion people infected worldwideRoute of exposure: exposure to infectious blood or b fluidsCan live for one week in dr bloodMay cause permanent liver damage; cirrhosis and cancer (fatal)Can be prevented by vaccination

BIOLOGICAL HAZARDS

- Hepatitis (Continued)Hepatitis C (HCV): over 200 million people infected worldwideRoute of exposure: blood to blood contact; Virus can survive one week in dried blood!May cause permanent liver damage; cirrhosis and cancer (fatal)New drugs for treatment (VERY EXPENSIVE; $1000/day or more for 90 days or more): Merck Victrelis (66% cure rate)Ve Telaprevir (79% cure rate)J&J Simeprevi (combo 68-75%)Gilead Sofosbuvir (comb 75%)Gilead Ledipasvir + Sofosbuvir (Ha (95-98%)

BIOLOGICAL HAZARDS

- Hepatitis (Continued)Potentially infectious fluids:BloodSalivaS or vaginal secretionsSkin and tissueVomitusCerebrospinal f

(b)(6) [redacted]

BIOLOGICAL HAZARDS

- Decontamination:Hepatitis A & B:Hypochlorites (bleach:water 1:10)Methanol (wood alcohol); ethanol (grain alcohol); isopropanol (rubbing alcohol) 70% solutions in waterCidex (2% glutaraldehyde)Hepatitis C: 1:10 bleach:water MAY(?) be effective but no evidence

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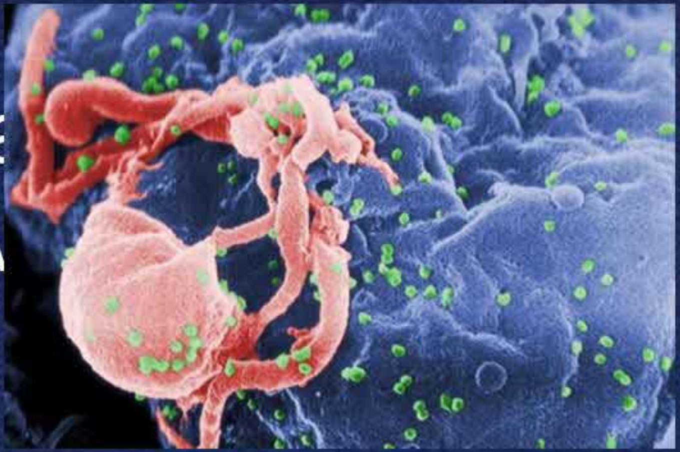
BIOLOGICAL HAZARDS

- Human Immunodeficiency Virus (HIV)Destroys the body's ability to fight infection and certain cancersCan lead to AIDSVirus is found in:BloodSalivaSemen or va secretionsSkin and tissue\



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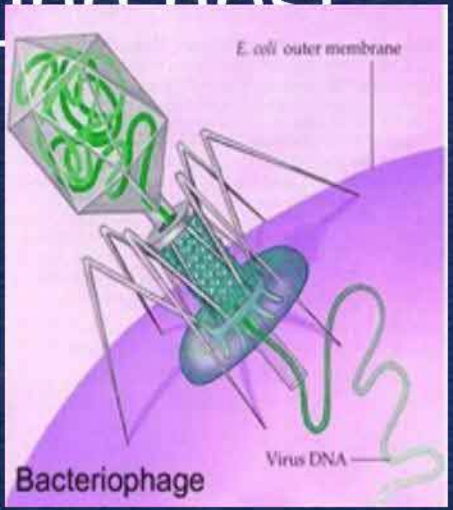
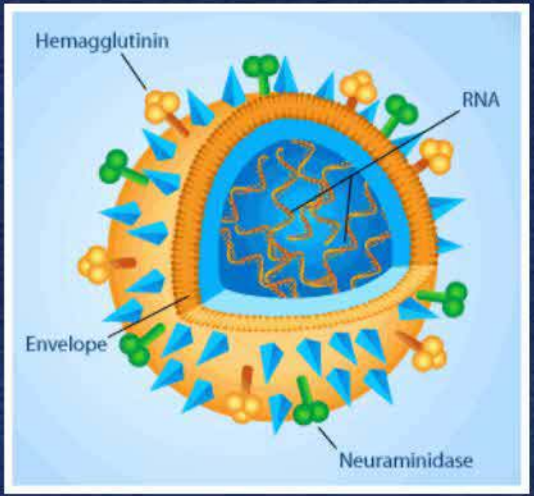
BIOLOGICAL HAZARDS

- Human Immunodeficiency Virus (HIV)Virus does not survive well outside of the body (seconds to minutes)No vaccine is availableTherefore HAZARD is VERY HIGH! But with precautions EXPOSURE would be low. Decontamination:Hypochlorites (bleach:water 1:10)Methanol (wood alcohol); ethanol (grain alcohol); isopropanol (rubbing alcohol) 70%

INTERSTING FACTS!

- Bacteria vs. VirusesA bacteria is a one-celled living organism; a virus is non-living piece of RNA or DNA covered by a protein coatBacteria can self-reproduce; a virus requires a living host





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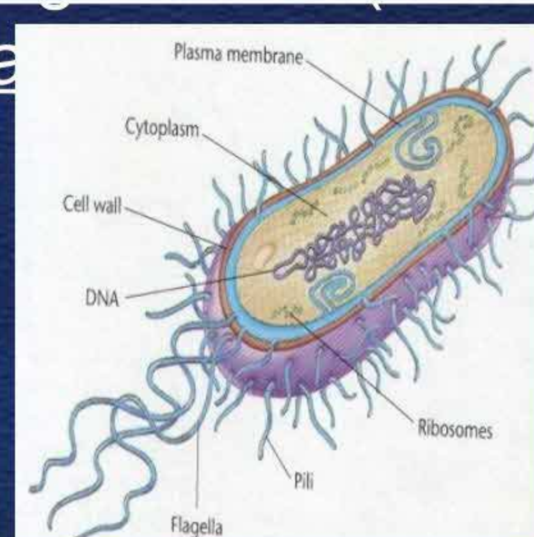
INTERESTING FACTS!

– Bacteria vs. Viruses99% of bacteria are beneficial; almost no viruses are considered beneficial-their sole mission is to create more viruses!!!Most bacteria can be killed with antibiotics; there are almost NO effective antiviral agents! Vaccines work by “tricking” the body into creating B-Cells (immune ... using pa ... lled”



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ON-SCENE

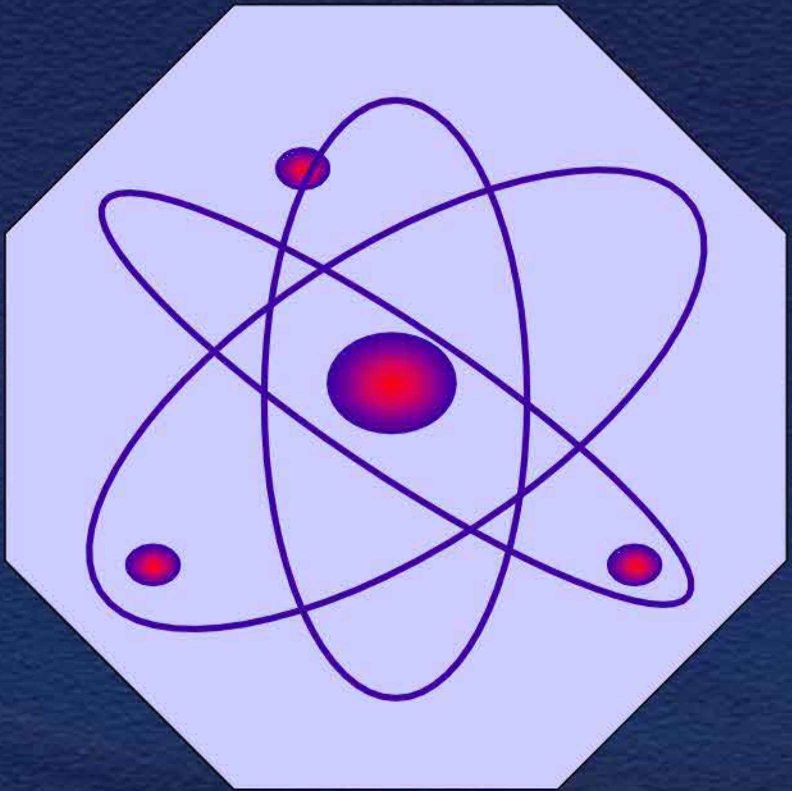
RADIOLOGICAL HAZARDS

RADIOLOGICAL HAZARDS

- You may see any of the following symbols

RESPONDER HAZARDS

- Radioactive hazards may be on site as part of the aircrafts systems or cargo



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RADIOLOGICAL HAZARDS

- There are five types of damaging radiation, but only three are of concernALPHA ParticleBETA ParticleGAMMA Ray

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ALPHA PARTICLE

- Also known as alpha decay or alpha emitterHelium Nucleus (low energy)2 Neutrons and 2 ProtonsVery ionizing but stopped by skin or sheet of paper (penetration factor=1)Common alpha decay processes:U238 (DUR)Am231 (Smoke Detectors)Po210 (anti-static wraps)

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BETA PARTICLE

- Also known as beta decay or beta emitterHigh Energy Electron (medium energy)Penetrates human tissue to ca. 1cm (½ inch)(penetration factor=100)Common beta decay processes:Sr90 (industrial testing for thickness)Tritium Oxide (watches; older signs)

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GAMMA RAY

- Also known as high energy X-RAYSHigh Energy PhotonExtremely penetrating – Very thick lead (penetration factor=10,000) (very high energy)Common gamma emitters:Tc99m (medical diagnostics; materials testing; gamma knife)

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MOST COMMON RADIOLOGICAL HAZARDS

- Depleted Uranium (U238); Main hazard is chemical poisoning by Uranium Oxide rather than radioactivity (U238 is very weak alpha emitter; DU is less radioactive than natural U!)Where foun
Counterweights (Cadmium
(800 lbs in B747)Containers
transfer of radioactivesInert
Reference System
devicesGyroscopic compassesMost

MOST COMMON RADIOLOGICAL HAZARDS

- Polonium: All isotopes radioactive; strong alpha emitter (Irene Curie died from radiation effects)Very volatile for a metalWhere found:Cargo a static devicesMost common exposure:InhalationIngestion

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MOST COMMON RADIOLOGICAL HAZARDS

- Tritium (3H) as gas (3HH) or Tritium Oxide (3HHO); Mild beta emitter Where found:Self-Luminous dials/numbersSelf-Luminous signsNot used very much anymoreMost common routes of exposure:IngestionInhalationDermalMitigation:Avoid contact; ventilation

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MOST COMMON RADIOLOGICAL HAZARDS

- Radium (Rd); strong alpha & beta, and gamma ray emitter; Extremely dangerous; replaces Calcium in the bonesEmits Radon (Rn) gas (strong alpha & beta, gamma ray emitter)Where found:Mostly older aircraft on instrument, clock dials and numerals RARELY LABELED!!! common routes of exposure:DermalInh (Radon gas)Mitigationnone al; ventilation for inhalation

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INTERSTING RADIATION FACTS!!!

- Smokers receive a radiation dose equivalent to about 300 chest x-rays annually due to the radioactive isotope Polonium-210 contained in tobacco smoke that comes from the ingredients of the fertilizers that are used in farming tobacco.Flight crews (pilots, flight attendants, etc.) are classified as radiation workers and are exposed to more radiation annually than nuclear plant workersCrew in an underway nuclear submarine are actually exposed to less radiation than the average person on land, due to reduced background radiation and the shielding effect of the water while being submerged.

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INTERESTING FACTS!

- People actually used these!!!

Thorium-Radium Face Cream

Radium Bread

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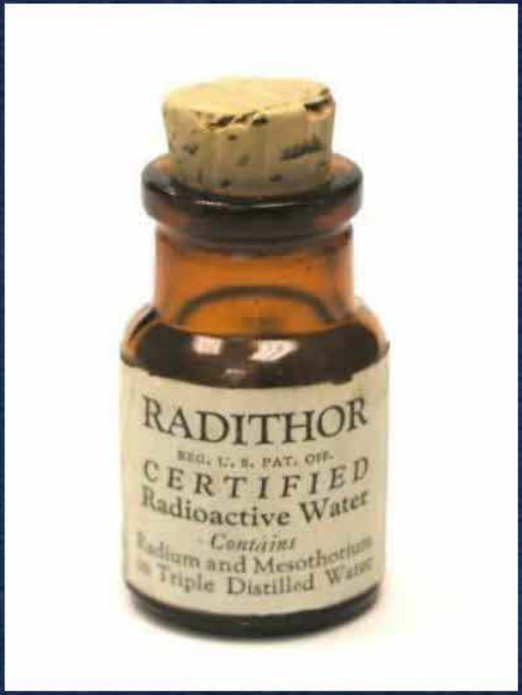
INTERESTING FACTS!

- Manufactured from 1918 to 1928 by the Bailey Radium Laboratories, Radithor was a well-known patent tonic that consisted of triple distilled water containing at a least one microcurie of Radium 226 and 228 isotopes. Said to cure stomach cancer, mental illness and restore sexual vigor and vitality, it was even advertised as ‘Perpetual Sunshine’ until it gained notoriety when Eben Byers, an American industrialist, drank a bottle a day for four year and consequently died in excruciating pain as cancer of the jaw caused his facial bones to disintegrate.



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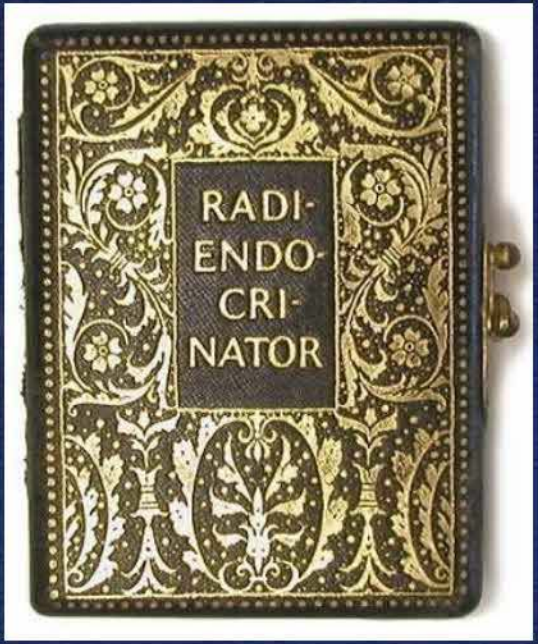
INTERESTING FACTS!

- The Radiendocrinator was intended to be placed over the endocrine glands to invigorate sexual virility and consisted of seven radium soaked pieces of paper, about the size and shape of a credit card, covered with a thin piece of clear plastic and two gold-wire screens. Men were advised to place the instrument under the scrotum at night like an ‘athletic strap’. The inventor of the Radiendocrinator (and Radithor), William J. Bailey, had so much faith in his products he claimed not only that he regularly used them, but that he had drunk more radium water than any living man - he died in 1949 of bladder cancer.



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INTERESTING FACTS!

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Who discovered Halley's Comet?

A. Sir Isaac NewtonJohannes KeplerSir Edmond HalleyNobody Knows

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Answer!

- Nobody Knows! It was first recorded in 240 BC and returns every 75 years or so. It will next appear in 2061. It was named after Edmond Halley because he was the one who used Kepler's Laws of Planetary Motion to predict it's orbit and period!

ON-SCENE

EXPLOSIVEHAZ
ARDS

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EXPLOSIVE HAZARDS

- Four explosive factors:Initiation of reactionRapidity of reactionRapid expansion of gasesEvolution of heat

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The Fire Triangle

- OxidizersLiquidshydrogen peroxide, nitric acid, perchloric acidGasesOxygen, fluorine, chlorineSolidsMetal peroxides, ammonium nitrate

- Fuels:Liquidsgasoline, acetone, ether, pentaneSolidsplastics, wood dust, fibers, metal particlesGasesacetylene, propane, carbon monoxide, hydrogen

Ignition sourcesSparks, flames, static electricity, heat

EXPLOSIVE HAZARDS

- Low Explosives: Burn at a rate of 1 -10 in./second; normally a mixture of compoundsTends to “deflagrate” (hot burning material heats the next layer of cold material and ignites it)e.g. gunpowder, flares, pyrotechnics, other illumination devices, ANFO

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EXPLOSIVE HAZARDS

- High Explosives: Burn at a rate of 1000-10,000 yds/second (36,000 – 360,000 in./second); normally a single compoundTends to "detonate" (which is supersonic and propagates through shock compression).

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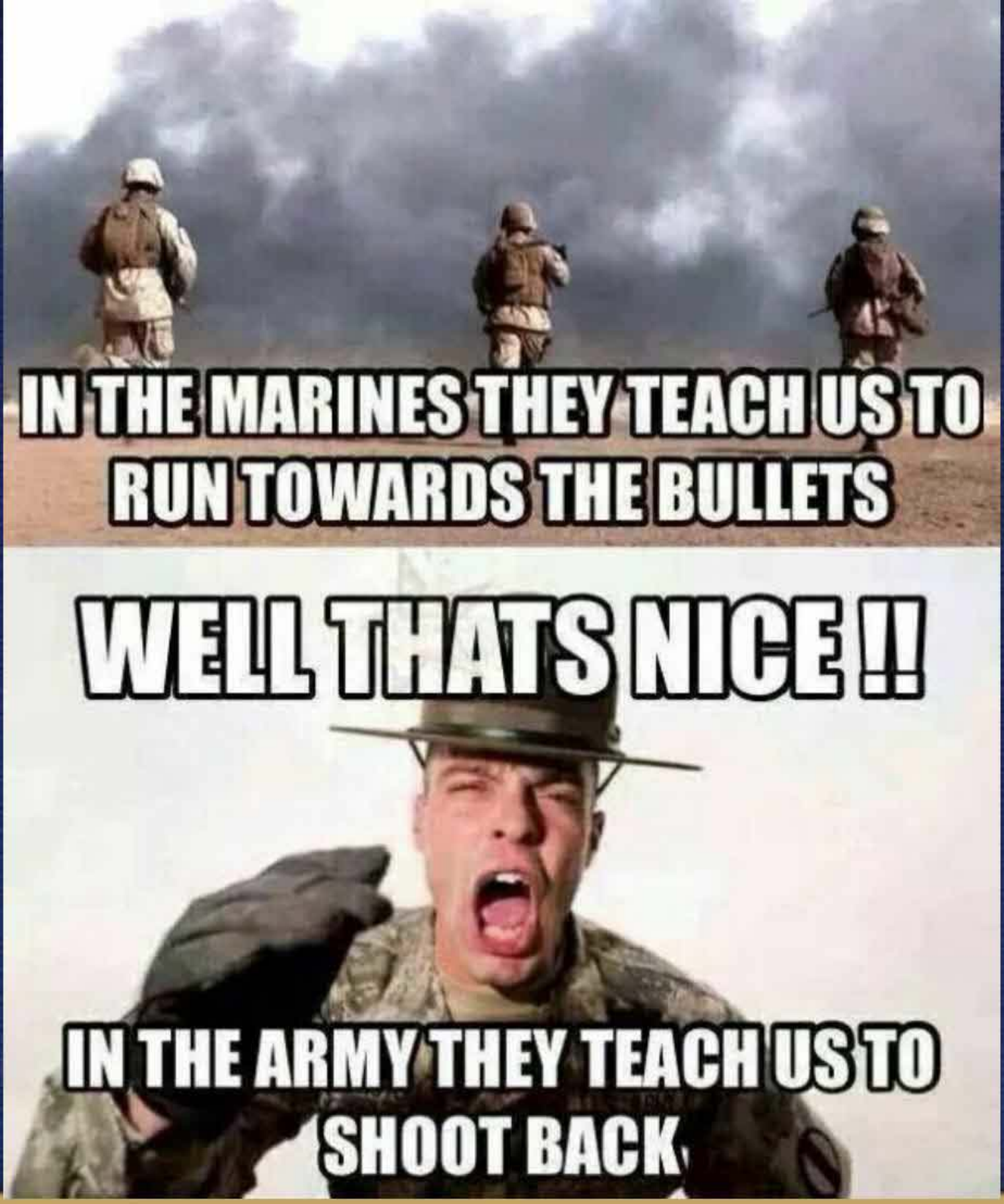
IN THE MARINES THEY TEACH US TO
RUN TOWARDS THE BULLETS
WELL THATS NICE !!
IN THE ARMY THEY TEACH US TO
SHOOT BACK

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EXPLOSIVE HAZARDS

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EXPLOSIVE HAZARDS

- Two types of High ExplosivesPrimary: extremely sensitive to shock, friction, heat; examples are mercury fulminate, lead azide, lead styphnateSecondary: generally insensitive to shock, friction, heat; may burn (deflagrate) when exposed to flame but may also detonate; examples are dynamite, TNT, RDX, PETN, HMX

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EXPLOSIVE HAZARDS

- Factors affecting whether an explosive will deflagrate or detonate: Chemical nature of compound(s) Degree of confinement Mixture with other inert ingredientsDynamite is nitroglycerin mixed with sawdust, diatomaceous earth, or silicaPlastics can be added to make explosive malleableAluminum can be added to increase total energy and blast effects

EXPLOSIVE HAZARDS

- Two main effects of conventional explosives:Concussive (shock): This is a result of a rapidly expanding volume of gases.e.g. ½ lb of TNT (trinitrotoluene) (about the volume of a baseball) on detonation will rapidly liberate almost a 55-gallon drum full of gases!

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EXPLOSIVE HAZARDS

- Two main effects of conventional explosives (con't):Thermochemical: Detonations give off heat which can also be very destructive.e.g. Detonation of approximately ¾ lb of PETN will generate 500 BTU of heat. This is like burning 3 gallons of Jet A all at once.

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MILITARY EXPLOSIVE HAZARDS

- Most accident scene explosives will be high explosives, and may have been exposed to heat, sun, electricity and other environmental factors that can greatly affect their stability!.

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MILITARY EXPLOSIVE HAZARDS

- Stability – several factors affect stability of an explosiveChemical Constitution; presence of nitrite (NO2), nitrate (NO3) or azide (N3) groups indicate thermal instability; fire in an accident can make them unstable.Storage Temperature: Generally highly stable at -10oC to 35oC (14-95oF). MOST explosives become dangerously UNSTABLE above 70oC (160oF)!!!

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MILITARY EXPLOSIVE HAZARDS (Con't)

- Exposure to the Sun: Many explosives contain nitrogen groups that rapidly decompose upon exposure to UV rays of the sun.Electrical Discharge: Spark sensitivity is common to explosives and can cause detonation. Grounding is mandatory.

Photographic Examples

- General Photos and,January 8, 2003; Charlotte, NCBeech 1900D crashed 37 seconds after takeoff21 S.O.B. – all fatalWhat to watch out for?What do you see that's good?What do you see that's bad?

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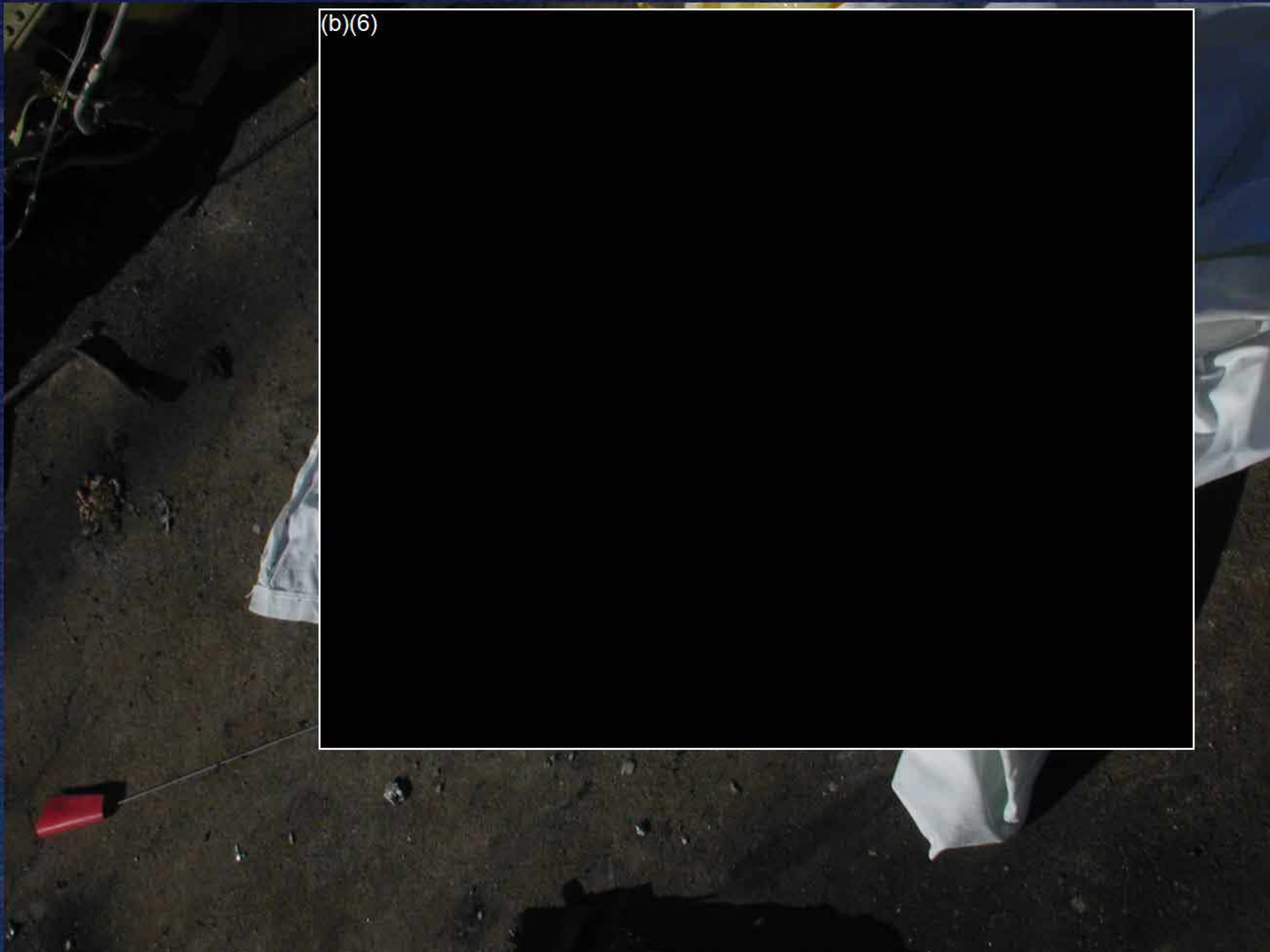
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Go Bag

- Purpose: To have materials and minimal equipment available to begin investigation and documentation of the wreckage.

- Every investigator is different and will have different needs and equipment.

-Equipment will also differ depending on which group you are working with. i.e. Powerplants Group will have different needs than Crew Operations Group.

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LANDS' END
NATIONAL TRANSPORTATION
E PLURIBUS UNUM
SAFETY BOARD

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Paul F. Schu
NATIONAL TRANSPORTATION SAFETY BOARD
"SHOOTER"


MedProtect Inc.
To aid in the prevention of
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AVIATION ACCIDENT INVESTIGATION
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(2) Pair High-Risk Powder-Free Latex Gloves
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(1) Pair Canvas Leather Palm Gloves
(1) Fog-Free Protective Goggles w/Indirect Vents
(2) Hypoallergenic Respirators
(1) Pair Latex Boot Protectors
(2) Surface Disinfectant Wipes
(4) Antimicrobial Hand Wipes, 1 Bttle Purell Hand Cleaner Gel
(1) Sweatband----------------------------------(New Item)
(2) Biohazard Waste Bags
(2) Rolls of Duct Tape, 2" X 60 yds (rolls per case of 10 kits)
Packs should never be reused. Contaminated Products should never be touched with bare hands. Please dispose of properly
Non-Sterile Lot#010919
S/M
LAR
XL
2XL
3XL
TAKE THE PRESERVATION OF YOUR HEALTH SERIOUSLY! WE DO!
MedProtect Packs should be used in any situation where protection from body fluids, contaminated matter, or potentially harmful substances is necessary.
TEAR HERE
"SEE INSIDE FOR INSTRUCTIONS"


NATIONAL TRANSPORTATION SAFETY BOARD
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NTSB
Center


LASER APERTURE

1
2
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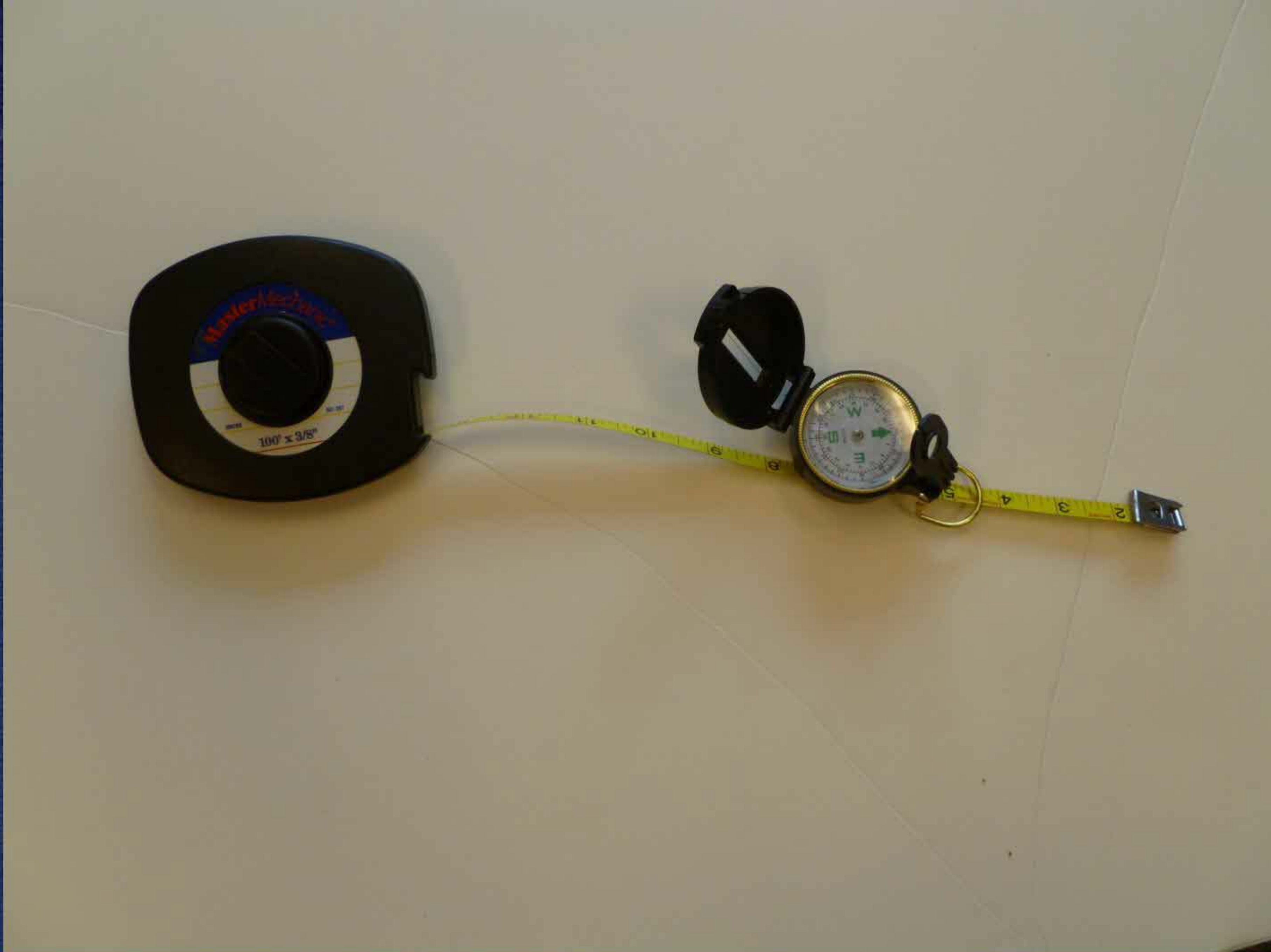
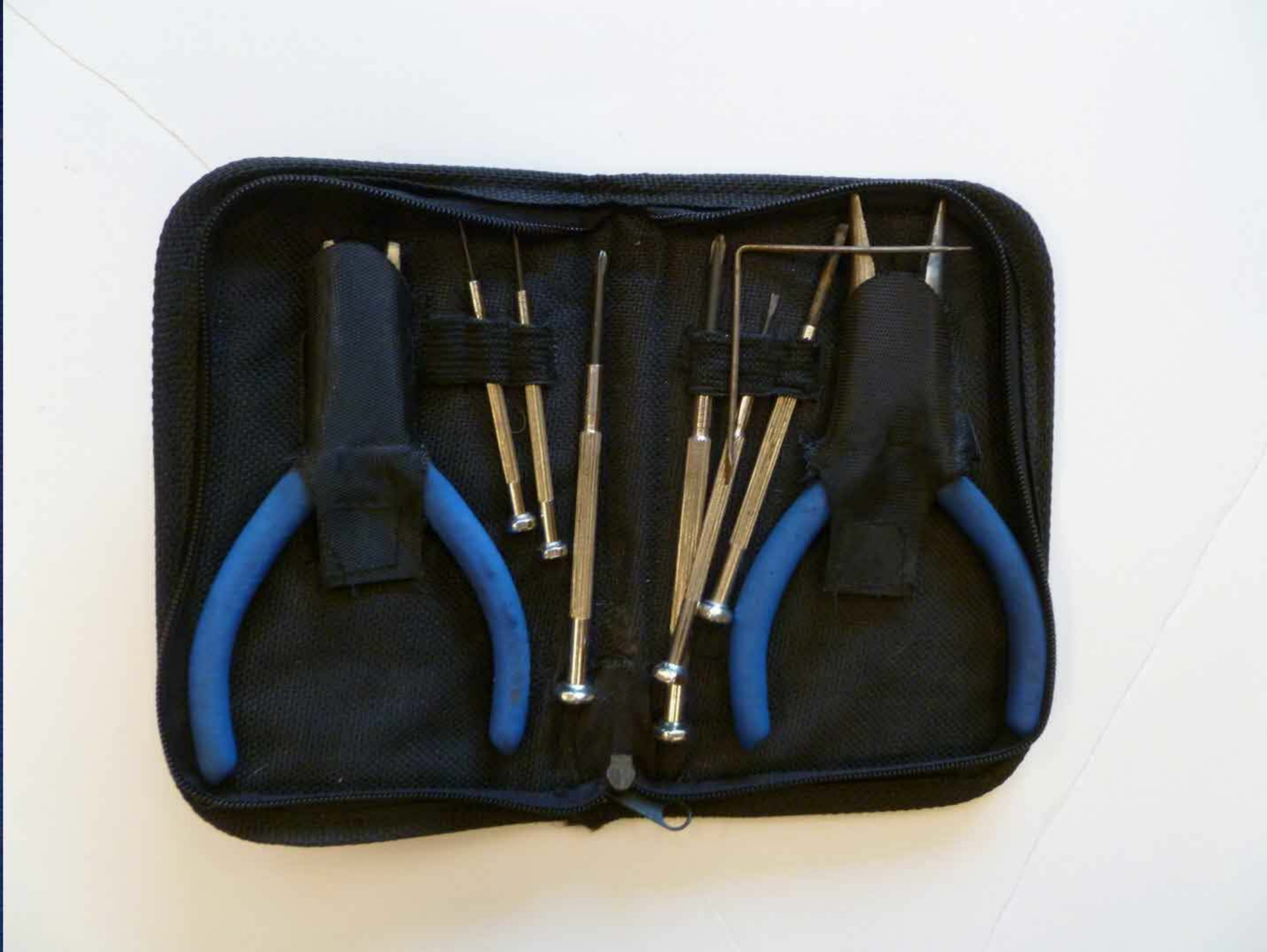

MasterMechanic
100' x 3/8"

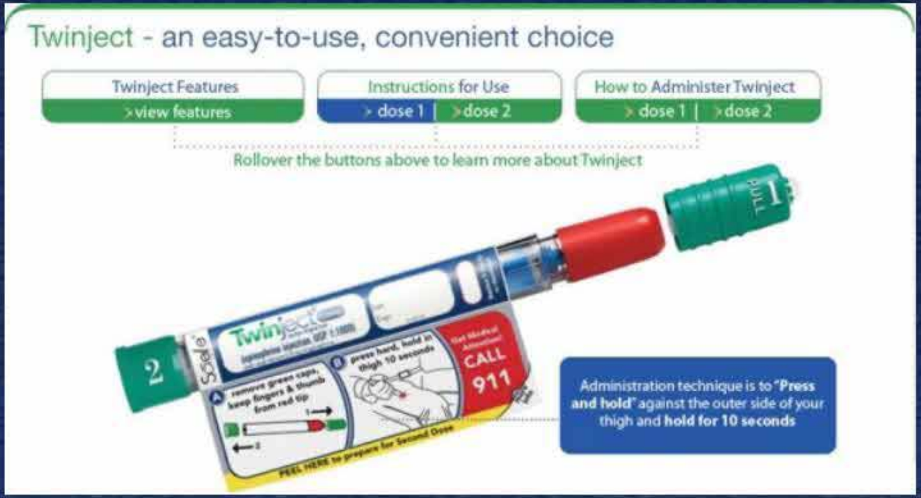



WISS


9
3
MARKS
OIL
FLAP
OPEN
AFT ↑
Helix

Site Safety Items

- AutoinjectorAtropine (for toxins e.g. pesticides) Epinephrine (for anaphylaxis; allergic reactions to stings, bites etc.)



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Site Safety Items

- First Aid KitBandages, scissors, antiseptic, burn cream

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Site Safety Items

- Hydrocortisone CreamFor rashes, stings, bites, inflammation

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Site Safety Items

- Hand Sanitizer: Topical for skin cleansing70% alcohol (ethanol)Very effective for bacteria

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Site Safety Items

- Disinfectant Wipes: effective for bacteria

Site Safety Items

- Sunscreen

NTSB

Site Safety Items

- Insect Repellent: “DEET”Eucalyptus Oil

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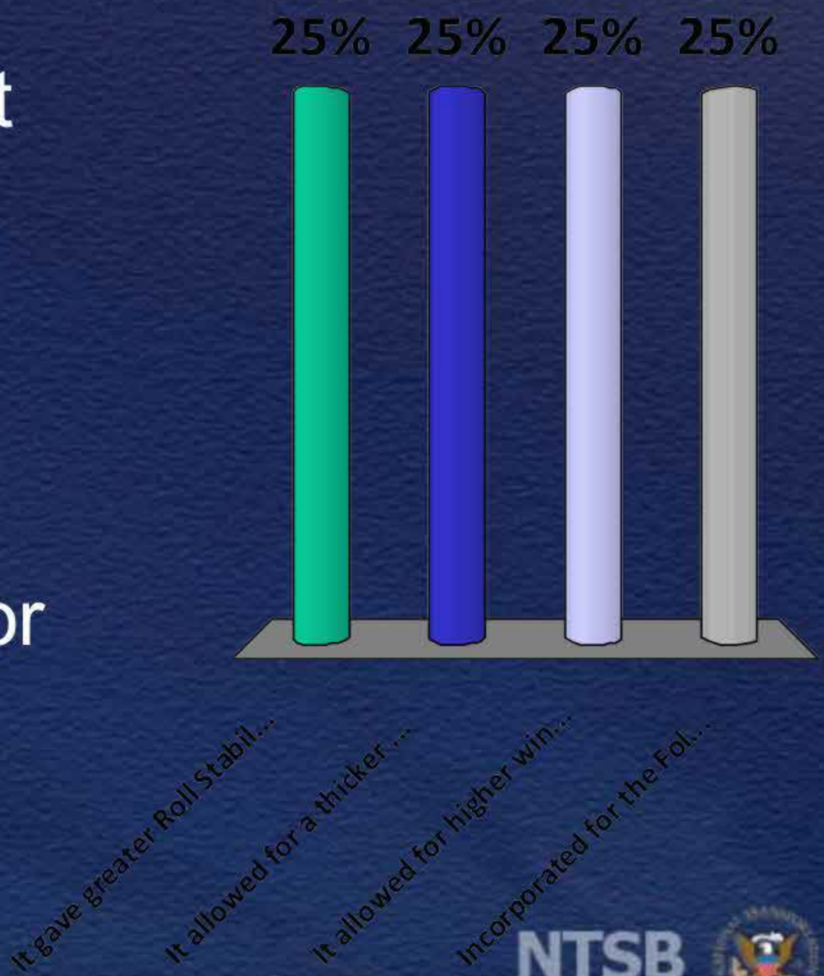
QUIZ!!!

- The McDonnell F4 Phantom 2 had several “unique” design features that included:A 12 degree dihedral wing panel about 2/3 of the way out A “dogtooth” leading edge on the wingA 23 ½ degree anhedral tailJ79 Afterburning Turbojets that were angled downwards from the fuselage centerlineWHY?

A 12 degree Dihedral wing panel about 2/3 of the way out

A. It gave greater Roll Stability to the Aircraft.It allowed for a thicker wing and more fuel.It allowed for higher wing loading and a more stable bombing platform.Incorporated for the Folding Wing Tip design.



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A 12 degree Dihedral wing panel about 2/3 of the way out

- ANSWER is A!It was originally designed to be flat; but it was found that a 5 degree dihedral was necessary for roll stability at high angles of attack; it was easier (avoided redesign of the central titanium section) to give dihedral outboard on the wings to give an average 5 degree dihedral overall.

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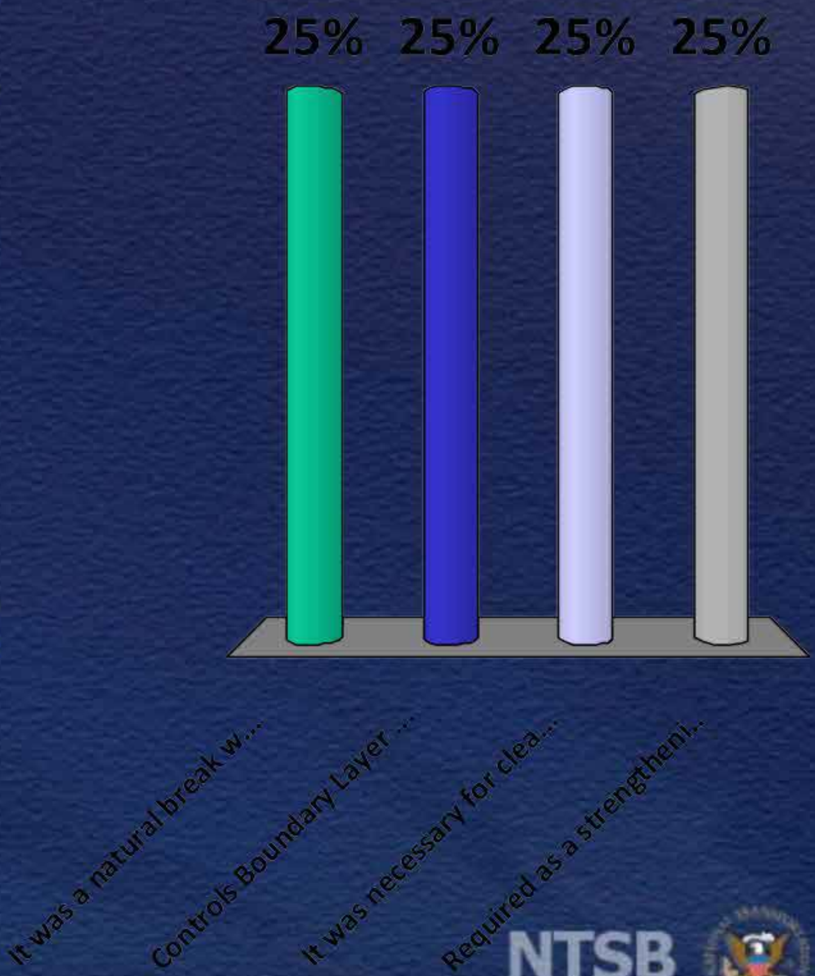
A "Dogtooth" leading edge on the wing

A. It was a natural break where the dihedral occurred.Controls Boundary Layer airflow by inducing a vortex over the wing and lowering stall speed.It was necessary for clearance because of the location of the wing hard points for munitions.Required as a strengthening feature at that point because of the dihedral.



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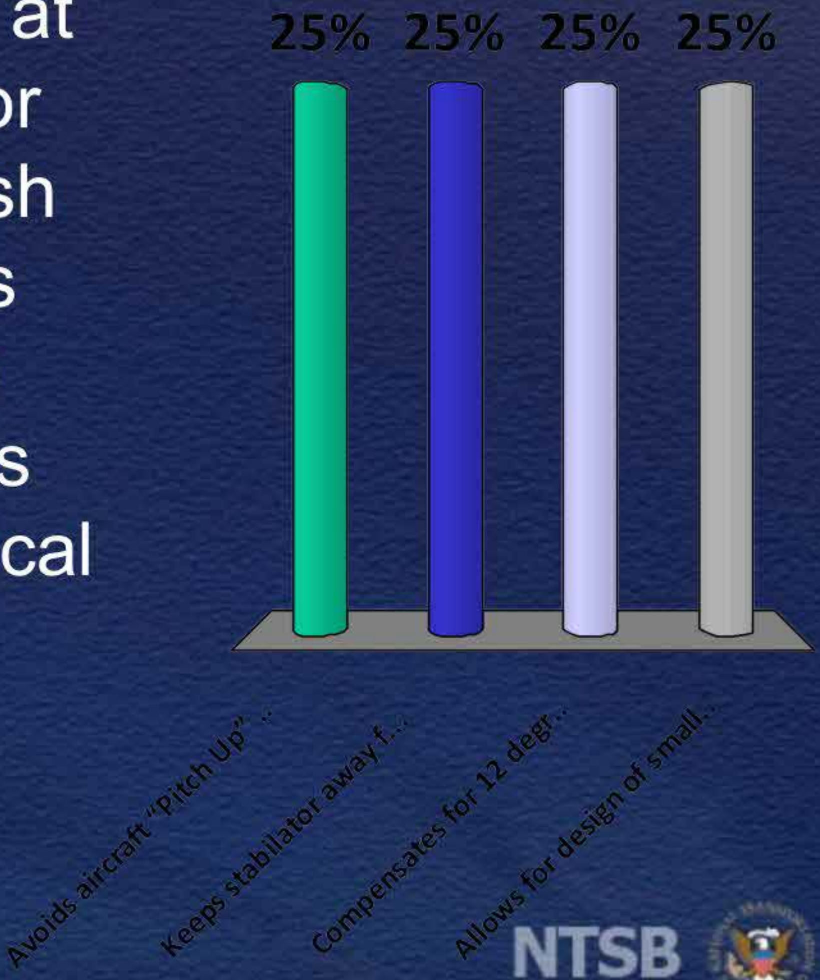
A “Dogtooth” leading edge on the wing

- Answer is B!It induces a vortex over the wing to control boundary layer airflow and reduces the stall speed. It also helps to avoid pitch up at high angles of attack.

A 23 ½ degree Anhedral tail

A. Avoids aircraft "Pitch Up" at high AOA.Keeps stabilator away from wing downwash at Mach 2+.Compensates for 12 degree dihedral on the outboard wings.Allows for design of smaller vertical stabilator/rudder to fit in Carrier Hangar Bays.



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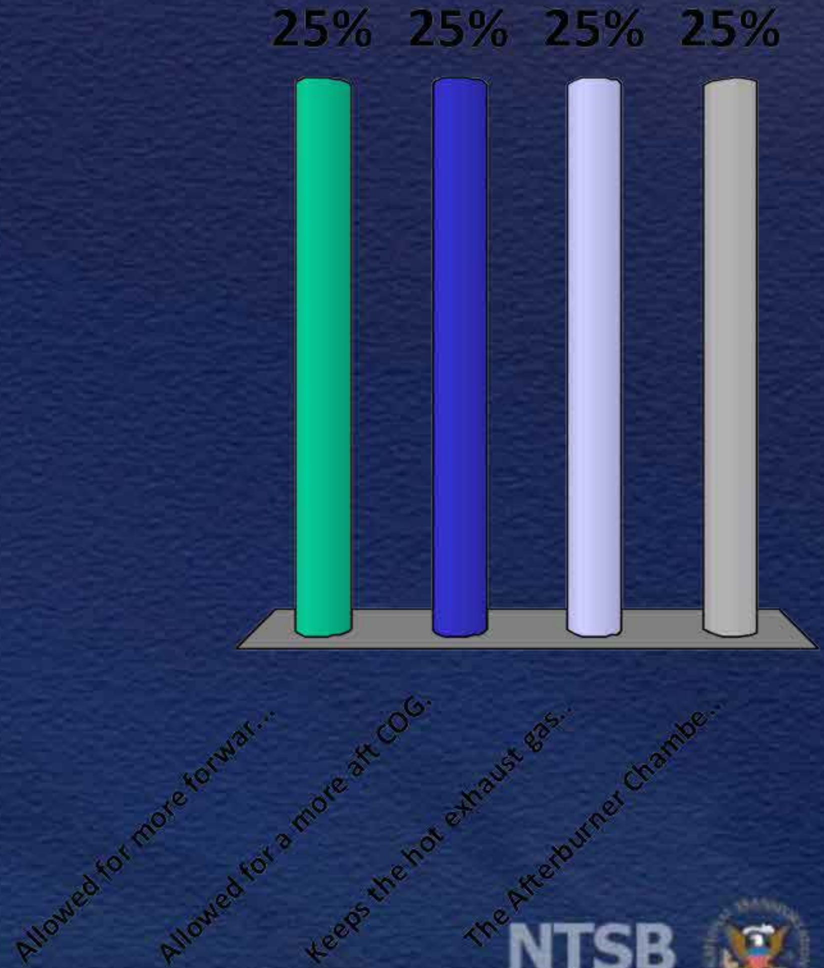
A 23 ½ degree Anhedral tail

- Answer is B!It kept the stabilator well away from the wing downwash (buffeting and pitch stability) at high speeds (Mach 2+).

J79 Afterburning Turbojets that were angled downwards from the fuselage centerline

A. Allowed for more forward COG.Allowed for a more aft COG.Keeps the hot exhaust gases from burning away the Anhedral Tail☺The Afterburner Chambers were larger than the engine at the rear and required more headspace in the bay.



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J79 Afterburning Turbojets that were angled downwards from the fuselage centerline

- Answer is C!It kept the hot exhaust gases away from the anhedral tail☺Postscript: All of these “features” were the result of poor design work☺

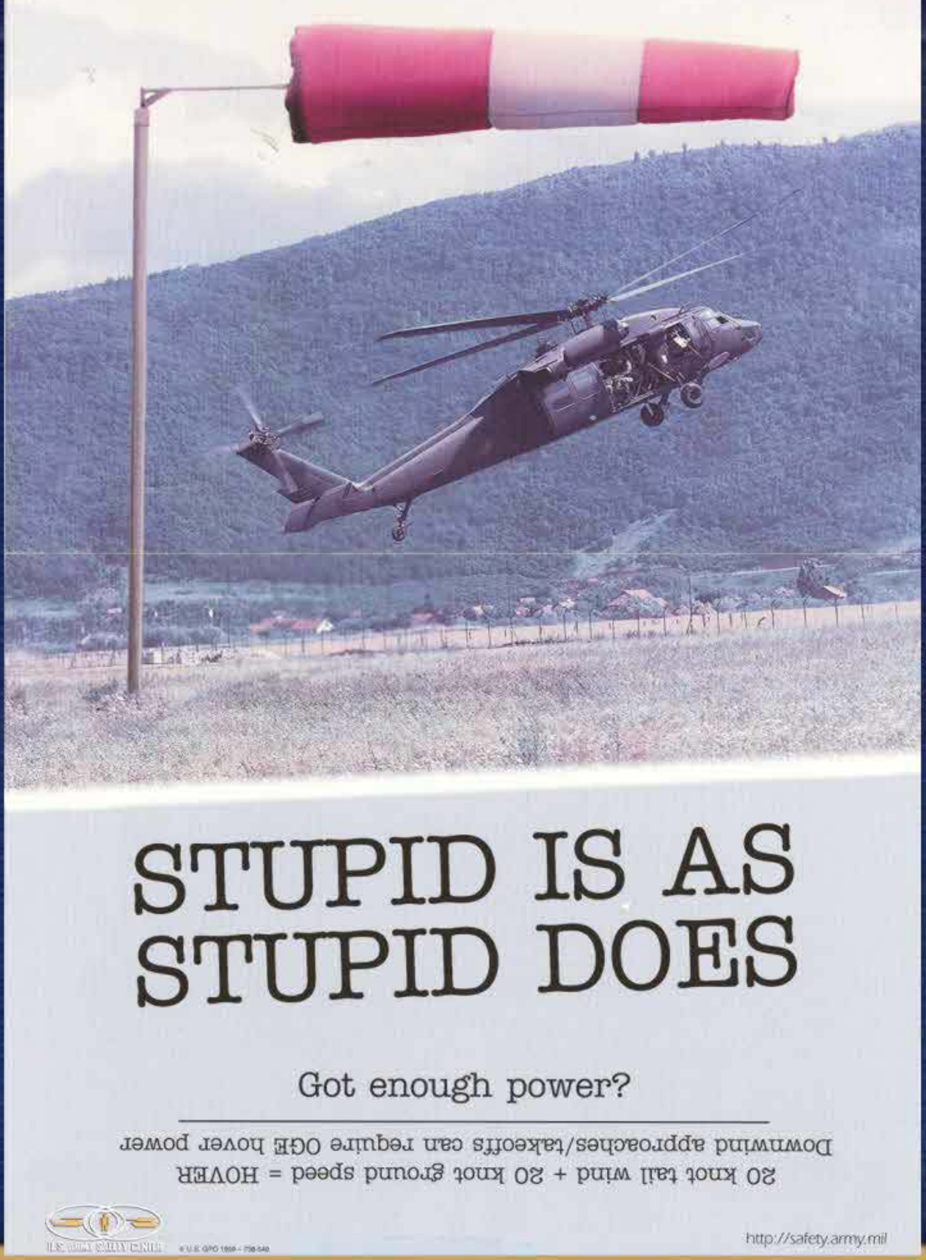
NTSB

THE MESSAGE!

- DO IT SAFELY….FIRST TIME!!!EVERY TIME!!!Dr. Paul F. Schuda (b)(6) [redacted]

(b)(6) [redacted] (b)(6) [redacted]

BECAUSE!!!



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National Transportation Safety Board

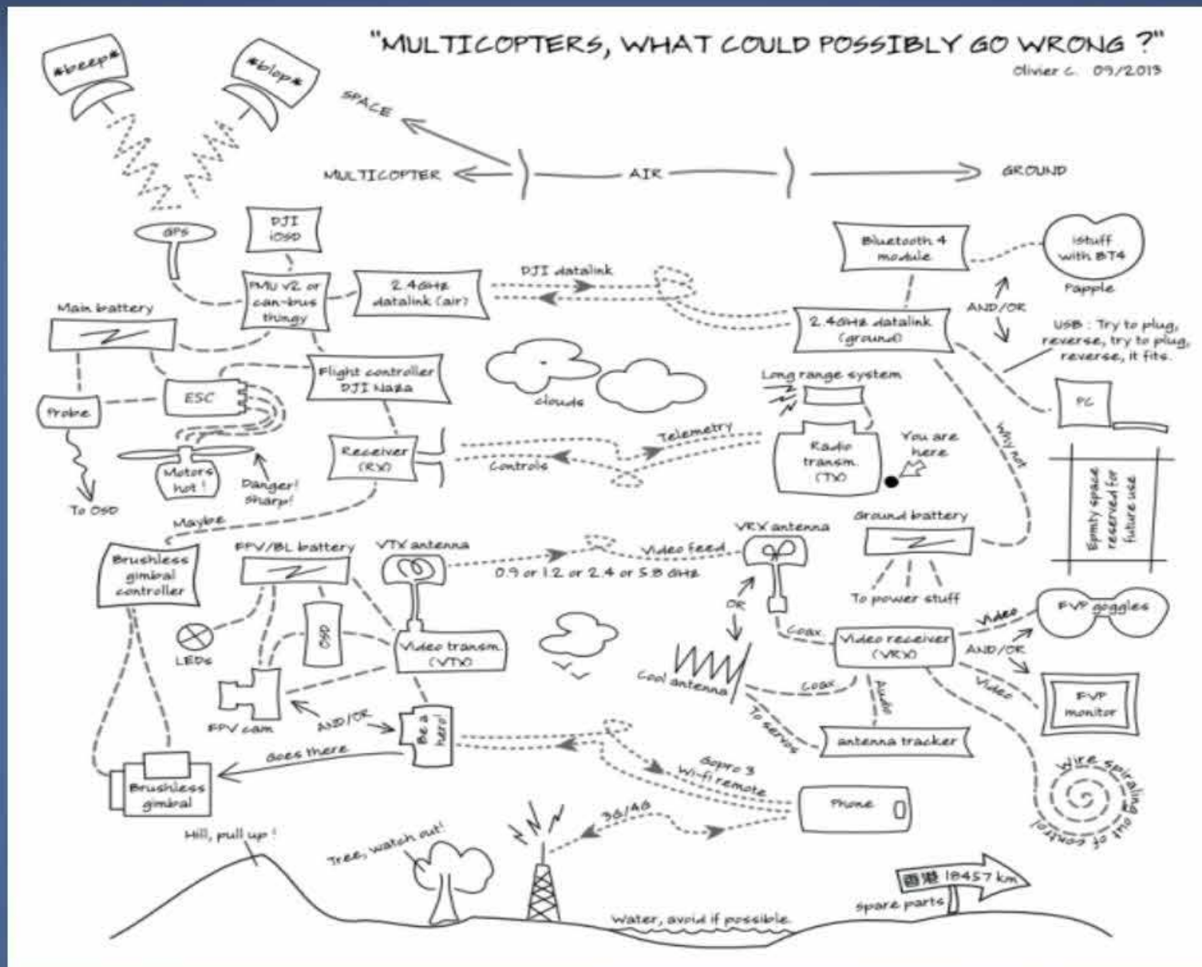
Unmanned Aircraft to Support Investigations

NTSB Training CenterDoE AS105Bill English UAS Program Lead

Objectives

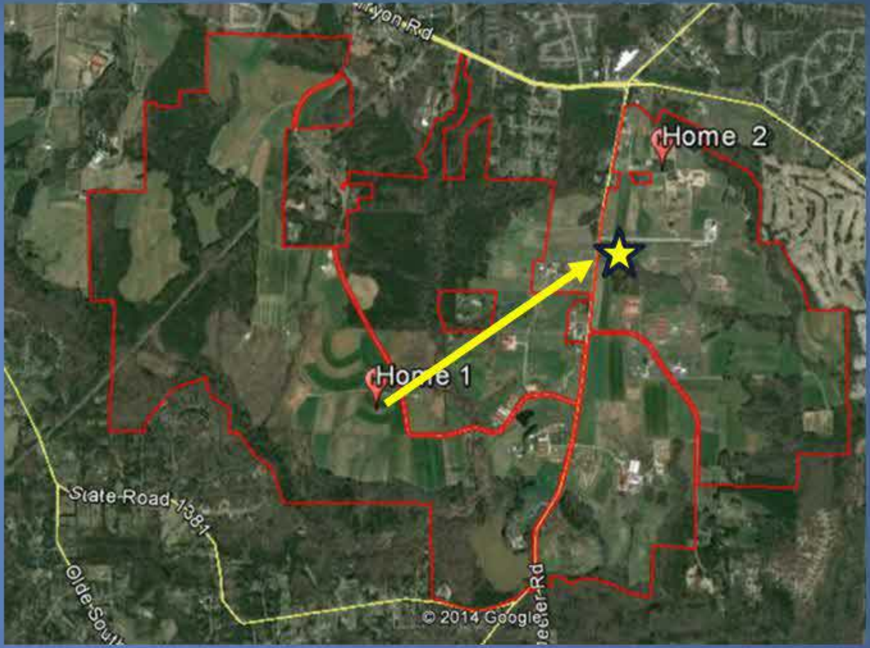
1. Investigations OF a UAS mishapUse of UAS to further the accident investigation missionAccident Site UAS imaging exercise

1. Investigating a UAS mishap



Case Study

- Scope of event Flight Control Malf – 830.5 notificationFly-away - through Class C and one mile lateralCrashed, but < 55lbs, no injury: not accidentNTSB -> IncidentFAA – requires report per COA, ATC airspace event



**49 CFR 830.5a(1): The operator of any civil aircraft…shall immediately…notify…of any of the following listed serious incidents: Flight control system malfunction or failure*

Assemble a Team of Experts

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Initial Information

- Flight to test Orthographic Mapping CameraHad been having vibration issuesRan up aircraftShortly after takeoff received battery warningAircraft rapidly climbedPilot could not reduce altitudeAircraft climbed to appx 5,000 feetCrashed about 1 mile northeast of launch

Initial Investigative Actions

- NTSB IncidentAlso operator internal, insurance/warranty claims, FAA evaluation of COA, etc.Preservation of wreckage/recordsWhat does that really mean?Participants – Explain Party SystemWho/how?Manufacturer non-USAnnex 13 provisiionsIf it was accident – would lau you think will be needed?

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Areas of Investigation

- Man/Machine/Environment From the ISASI UAS Investigations GuideHow will you examine these:

- Wreckage/On-sceneOrganizational InformationOperational FactorsEnvironmentAircraft PerformanceReconstruction of wreckageStructuralCollisionFirePowerplantSystemsMaintenanceSurvivalPathologySecurity/CyberSystem Design

Investigative Actions

- What else might you look for on-scene?Additional considerations for major/injury event - Press interestLocal government interest/requirementsLaw enforcement requirementsSupport for victim

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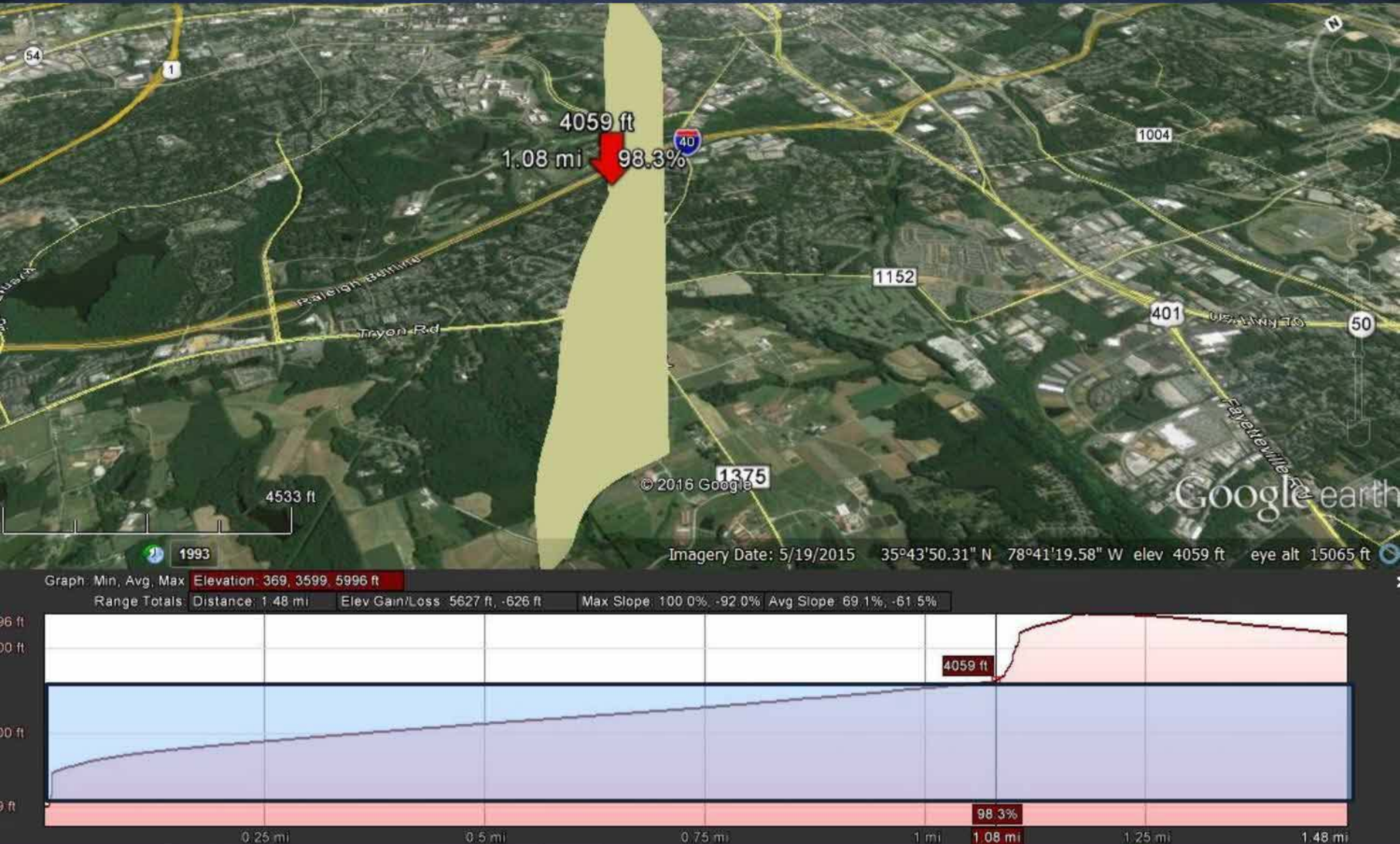
Build Sequence of Events

- To test vibration – crew held aircraftMotors run up, then auto-takeoff initiatedCaused flight controller to calculate hover powerHigh power draw reduced voltage to battery failsafe levelFalse hover power setting led to climbFailsafe landing cannot be interruptedPilot could not reduce powerObserver maintained visualTried emergency proceduresAircraft drifted to northeastCrashed when battery exhausted


4059 ft
1.08 mi
98.3%
40
1004
1152
401
50
Raleigh Beltline
Tryon Rd
1375
© 2016 Google
Google earth
4533 ft
1993
Imagery Date: 5/19/2015
35°43'50.31" N 78°41'19.58" W elev 4059 ft eye alt 15065 ft
Graph: Min, Avg, Max Elevation: 369, 3599, 5996 ft
Range Totals: Distance: 1.48 mi
Elev Gain/Loss: 5627 ft, -626 ft
Max Slope: 100.0%, -92.0%
Avg Slope: 69.1%, -61.5%
4059 ft
98.3%
0.25 mi
0.5 mi
0.75 mi
1 mi
1.08 mi
1.25 mi
1.48 mi

Build Sequence of Events

Initiation of Mission	History of issues with camera
Camera vibration test	Restrained runup
Takeoff	Pilot received warnings
Aircraft climbing	Non-responsive
Climbs above 400ft	Hazardous event
Pilot attempts to regain control	Emergency checklists
Aircraft lateral motion	Hazardous event
Changes in altitude/speed	Why?
Uncontrolled descent	Hazardous event

Investigative questions

- Ask why/how questions:History of vibration issue – mission deadlines?Restrained takeoff maneuverSpecified anywhere? Manual description?Ever encountered before?Analysis of maneuver?Gross error check in flight controller for false hover-power?User manual descriptions of failsafe autoland (not interruptible) vs. initiated autoland (interruptible)

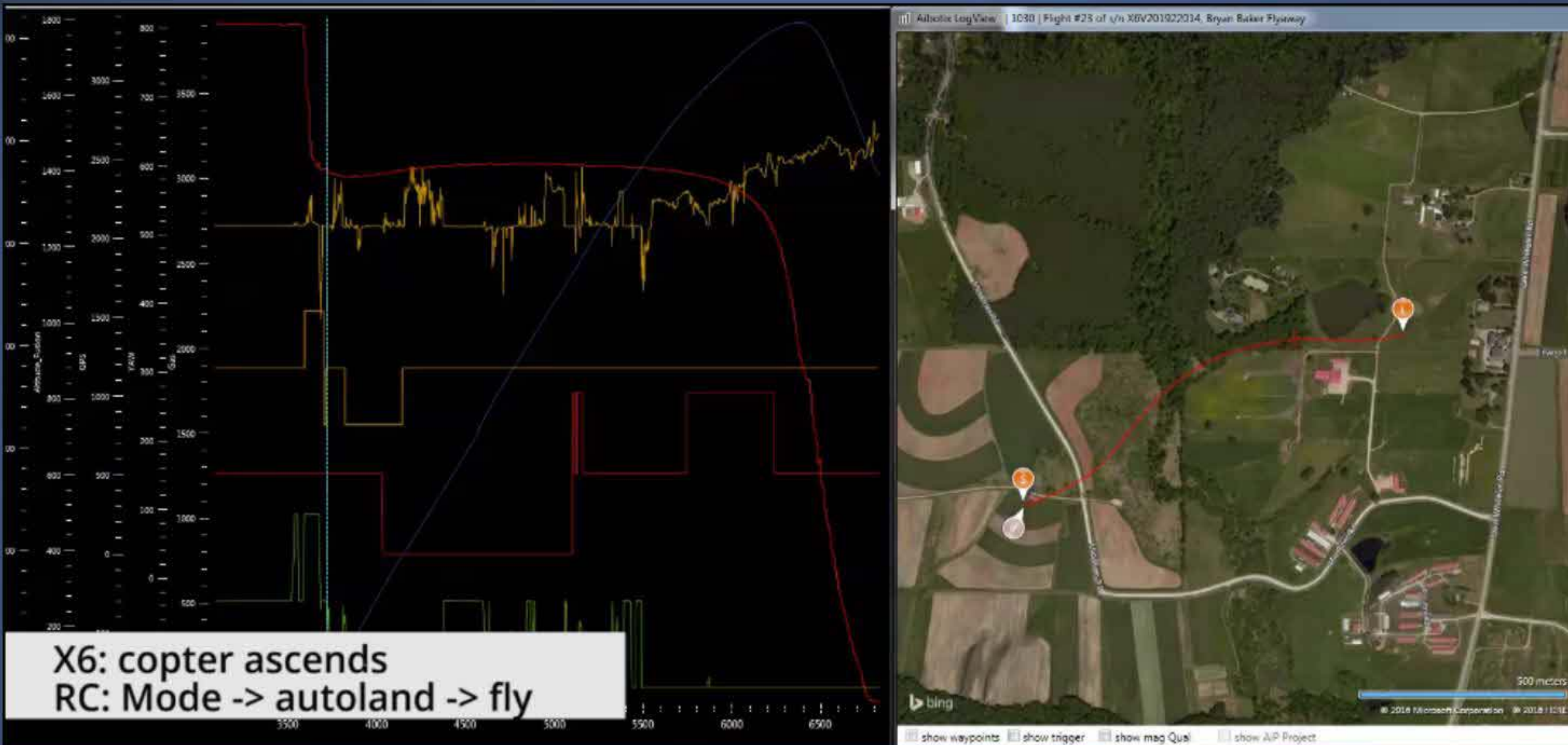
Manual Excerpts

- CAUTION Automatic descentTo prevent a crash due to low batteries, the Aibot X6 V2 will start an automatic descent depending on the actual altitude.Be aware that once started, this procedure cannot be interrupted.Controlling the position and heading is possible.3.4.8 Battery Failsafe…The Automatic Safety Landing works like the Auto Landing Mode.3.6.5 Abort Landing (Assist Mode)RC Flight Mode -> FLY

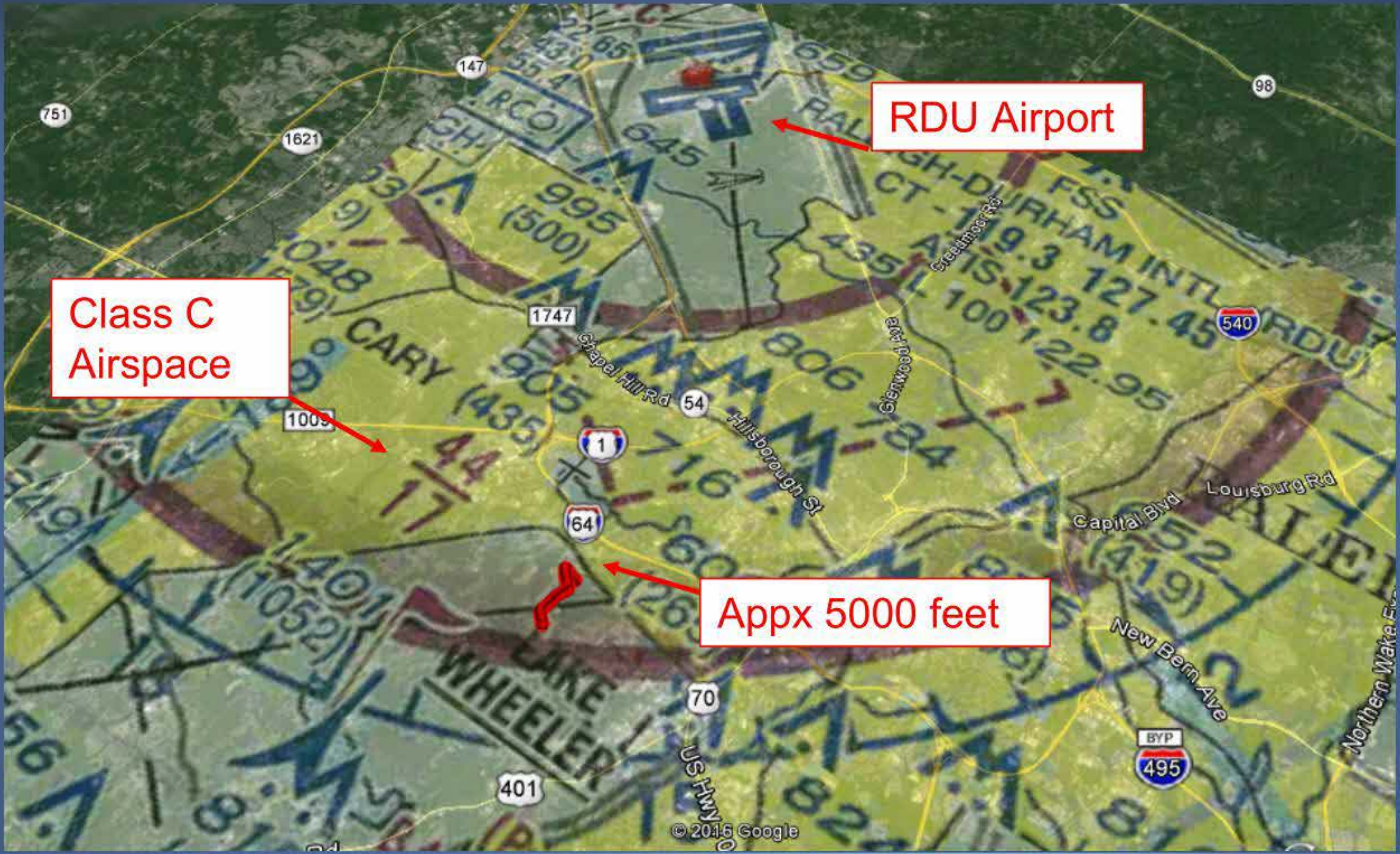
Initial Event

- SOP:Functional checks of the UAS and associated payload shall be accomplished before each flight.Flights that test hardware or software modifications will include a written description of what is being tested the aircrafts expected behavior, and additional communication, and safety measures.COA:A configuration control program must be in place for hardware and/or software changes made to the UAS to ensure continued airworthiness.User Manual:3.5.2 Pre-Flight CheckPayload - Fixed and configured

Build Sequence of Events



Build Sequence of Events



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A "simple" accident

- Where are likely spots for prevention?Pre-flight procedures?Evaluation of test procedure?Operator procedures for mission pressure?Training/practice on emergencies?Manual/documentation?Error check in flight controller?Failure modes analysis?Requirements for buffer zone sufficient?What else do you think?

Operator

- Who do you answer to?Do you really have operational control?What is your response plan?Notification/CommunicationsTechnical response team Secure appropriate documentation – operational, maintenance, legalLegal teamMedia RelationsEmployee/Victim supportResponsibilities to oversight authorityEven a good operator can have a mishapDo you have ability to deal with all of these?

Response Plan

Manufacturer

- Who do you answer to?Response/Support – (from a major airframer):Provide detailed technical knowledge and supportHardware/Software evaluationsRecords of precursor events?Design, Certification(?) MaintenanceManuals and Training guidanceYour suppliers/vendorsLegal – proprietary, export controls, securityDo you have ability to deal with all of these?What is your relation with the aviation authority?

Regulator

- FAAGives operator a lot of responsibility under 333 or PAO, but maintains some level of oversight (COA reporting etc.)Also is the airspace authority (usually)Military or other Gov'tWill conduct own investigationWill also be potential subject of Safety Investigation

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FAA Responsibilities

- “9 areas”: FAA facilities, contract facilities, airworthiness cert, airmen cert, adequacy of FARs, airports, security, medical, violationsMany parts of FAA will be involvedSafety investigation, Legal, ATOAs well as UAS specific offices

Other Requirements/Pressures

- Laws/policyWhat FAA regulations may applyState/Local – much more active than with conventional aviationHow Law Enforcement treat the case?International protocolsWill ICAO Annexes apply? What does home country of manufacturer consider?Political needsSecurity, Executive Branch, Congressional transportation and technology committees, local representatives, etc.

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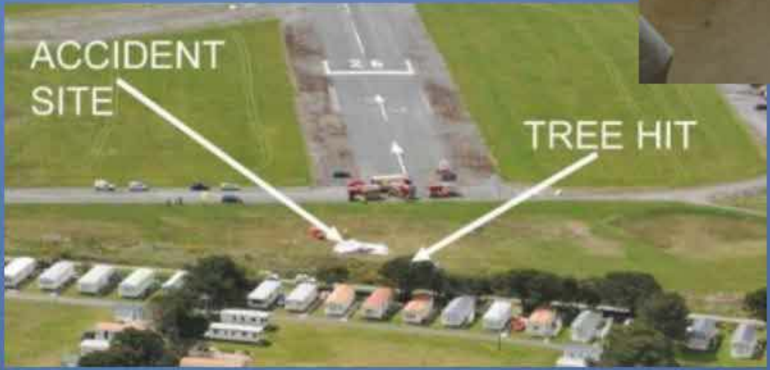
2. Use of UAS as investigative tool

- Aerial imagery - a powerful toolUAS have potential to expand the capabilities and use of aerial imageryCostRepeatabilityPOVPortability



Use of UAS as investigative tool

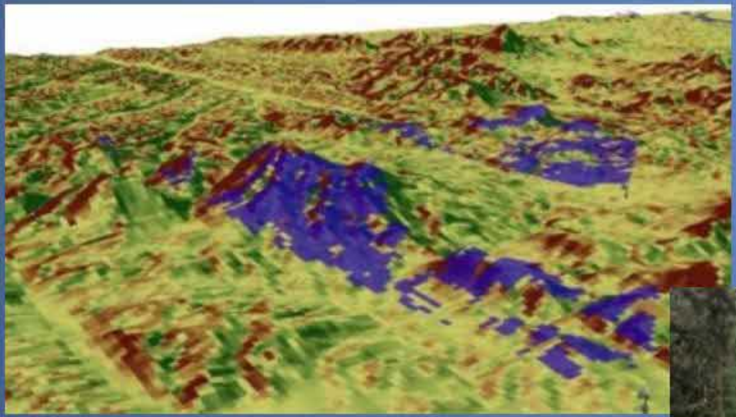
- Payloads and ProcessingUAS and converging technologiesOptical, IR, LIDAR etc.Photogrammet Change detectionImaging near real-timeRapid processingCloud or local

Use of UAS as investigative tool

- New applications:Cooperatio
  with First RespondersSite
  Safety
  MonitoringEnvironmental
  Hazard mitigationSite
  SecurityThings we haven't
  e t

Other sample applications

- Compatible with GIS



Components of UAS

- Payloads and SensorsThe reason the UAS existsEO – electro optical photographyGyro-stabilized, controllable gimbalOrtho-rectified for mappingIR – infrared photographyLaw enforcement, crop monitoringMulti/Hyper-spectral imagingLIDAR, SIGINT, Chem sniffers, etc. etc.

Platform Considerations

- Sensor size/weight/powerRangeAltitudeNavigationAutonomyFPV/Data streamCrew requirementsPortabilityEnvironmentalObservabilityReliabilityExpendibilitySafety

Other sample applications

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Regulations and Guidance

- FAA Reauthorization 112-95Section 333 FAA FAA v. PirkerFAR 107 – NPRM Certificate of Authorization (COA)Public Aircraft/Agency

FAA Regulations/Policy

- All UAS are “aircraft” (14 CFR 1.1)Numerous FARs cannot be met by a UASWere very few ways to operate a UAS (except hobbyist)Public Aircraft was almost exclusive until 2012, FAA “working on regulations”FAA Reauthorization required an avenue for sUAS commercial operation exemptions – “Section 333” of PL 112-95Operator requests exemption of certain FARs. Aircraft must be registered and carry an FAA N number.sUAS must remain within visual line of sight of the operator.Generally requires some type of pilot certificate.Summary approvals and Blanket COA (<200feet, away from airports), other safety mitigationsApproximately 5300 to date (more every day)May be appropriate for accident site

FAA Regulations/Policy

- 333 process is rough equivalent to type/airworthiness/pilot “cert”COA allows access to the NAS – operational regulationBoth put a great deal of responsibility on the operatorThere are no type-certified UAS, nor UAS pilot certificates (yet)COA is highly restrictive – can’t be near airports, crowds, infrastructure, etc. etc. “Blanket COA” <400 feetBut this gets commercial activity started. >5300 holdersThis is a potential method to use at some accident sites

FAA Hobbyist Policy

- RC aircraft have long been operated under Advisory Circular 91.572007 interp began limiting hobbyistsPirker case related to FAA enforcement of Careless and Reckless (eventually)Further interpretations, revisions to AC91.57, NOTAMs, “guidance” to prevent hobbyists from entering airspacesRegistration of hobbyist drone ownersSignificance for us:NOT permissible to initiate hobbyist flight over accidentMAY use “passer-by” imagery

Next FAA goal – Part 107

- small UAS rule – Not yet effective - NPRM in processUnder 55 lbs. - no minimum weightOperator must be FAA certified. Aeronautical Knowledge test. Recurrent test every two years.Aircraft must be registered and carry an FAA N number.sUAS must remain within visual line of sight of the operator.No “daisy-chaining” observersAirspeed not to exceed 87 knots. No higher than 500 feet.Daylight VMC only operations. Remain in defined area (box)

Next FAA goal – Part 107

- No operation over anyone not involved in the sUAS operation.No Class A. ATC permission for Class B, C, D and surface E. Operator would determine the airworthiness of the sUAS.Operator determines maintenance and preflight (Draft AC)COAs no longer requiredPublic COAs/Waivers possible to go outside provisionsMaybe mid 2016?

NTSB Program

- Developed SOP/FOM for site imagingGaining experience and developing proceduresObtained Public COA, SFRA waiver (for ops at Academy)Network with appropriate providersAssist Parties in developing capabilities

Other Applicable Regulations

- For NTSB – Federal acquisition regulations regarding aircraftEthics and Conflicts of InterestPrivacy and Data Security issuesState and Local regulationsNumerous locales have passed laws regardless of FAA authorityMaintain site safety/ICS coordinationPublic ReactionNot regulatory, but must account

NTSB use of UAS - tactical

- Can get ACOAs/eCOAs for near airportsBring in commercial operators “off the street” “End service contract” modelUse in-house equipment and staffUse Parties?Is that a commercial air service relation?Like Boeing’s pinger-locator?Appearances are very touchyFAA, political, media

Public COA - partners

- Best method for working close to airportsUntil we get Part 107?Will put commercial air service provider under Public Aircraft operationAlso needs to feed back into SoP:Criteria for operatorPAO declaration?Agreement with Airport

Providers and Parties

- Build list of appropriate providersAccident experience – not real estate or movie people (Ohio guy…)Assist Parties in developmentGetting 333s etc.Parties and providers assist developmentTechnology and techniquesFuture-proofs the capabilityWhat are next steps in go-forward?

UAS as investigative tool – Multi-Modal

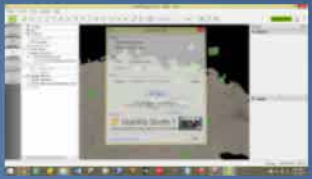
UAS as investigative tool - Repeatable

Not a Panacea

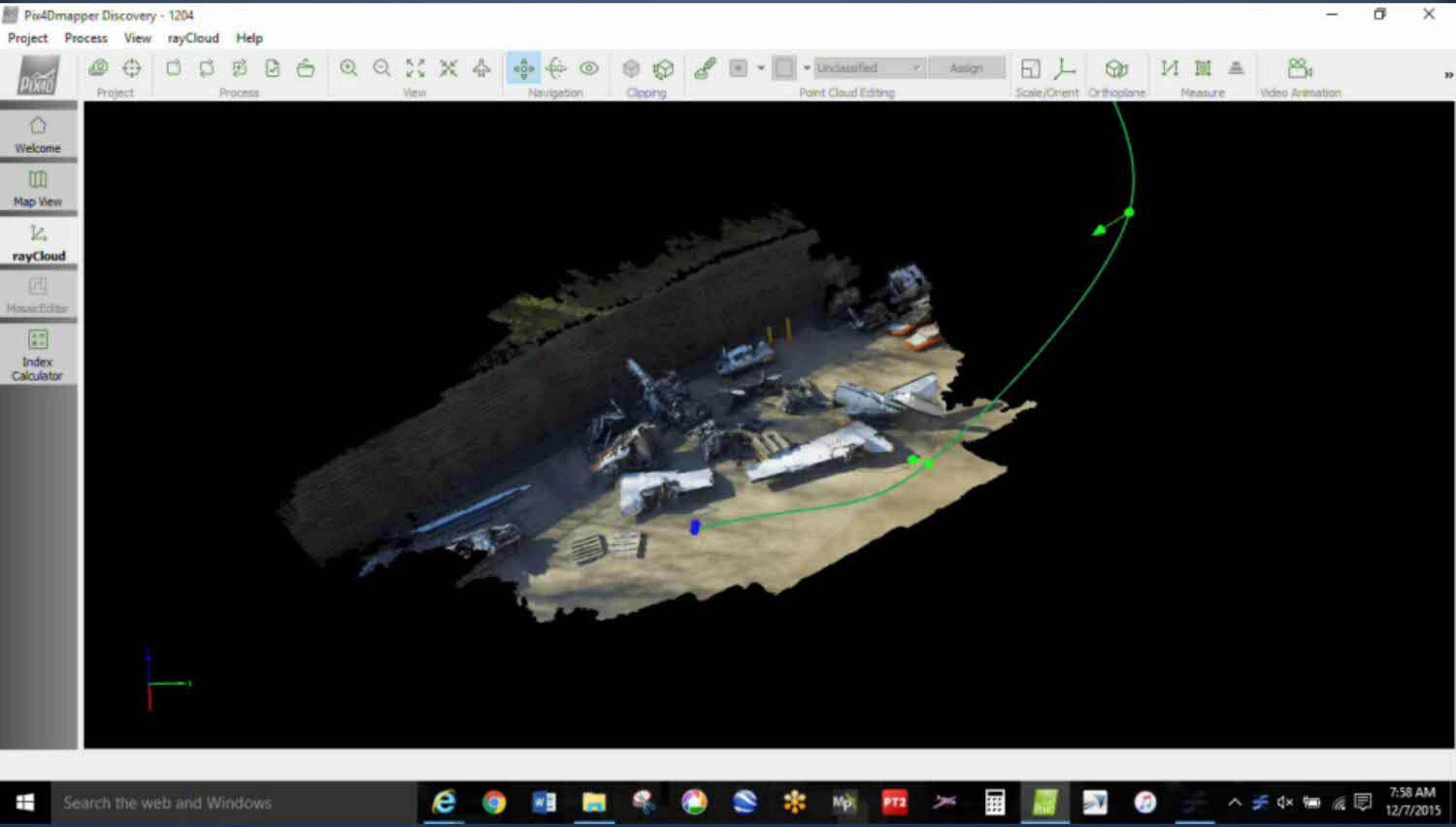
Drawbacks and other

- Not always the best toolMay be very difficult environment – weather, interference, bystanders, etc.Not always cheapestSometime Local PD helicopter comes in for freeTechnology and Future-proofingTodays tech is obsolete in 6 months

Use of UAS as investigative tool - Processing



Use of UAS as investigative tool - Processing



Drone photography

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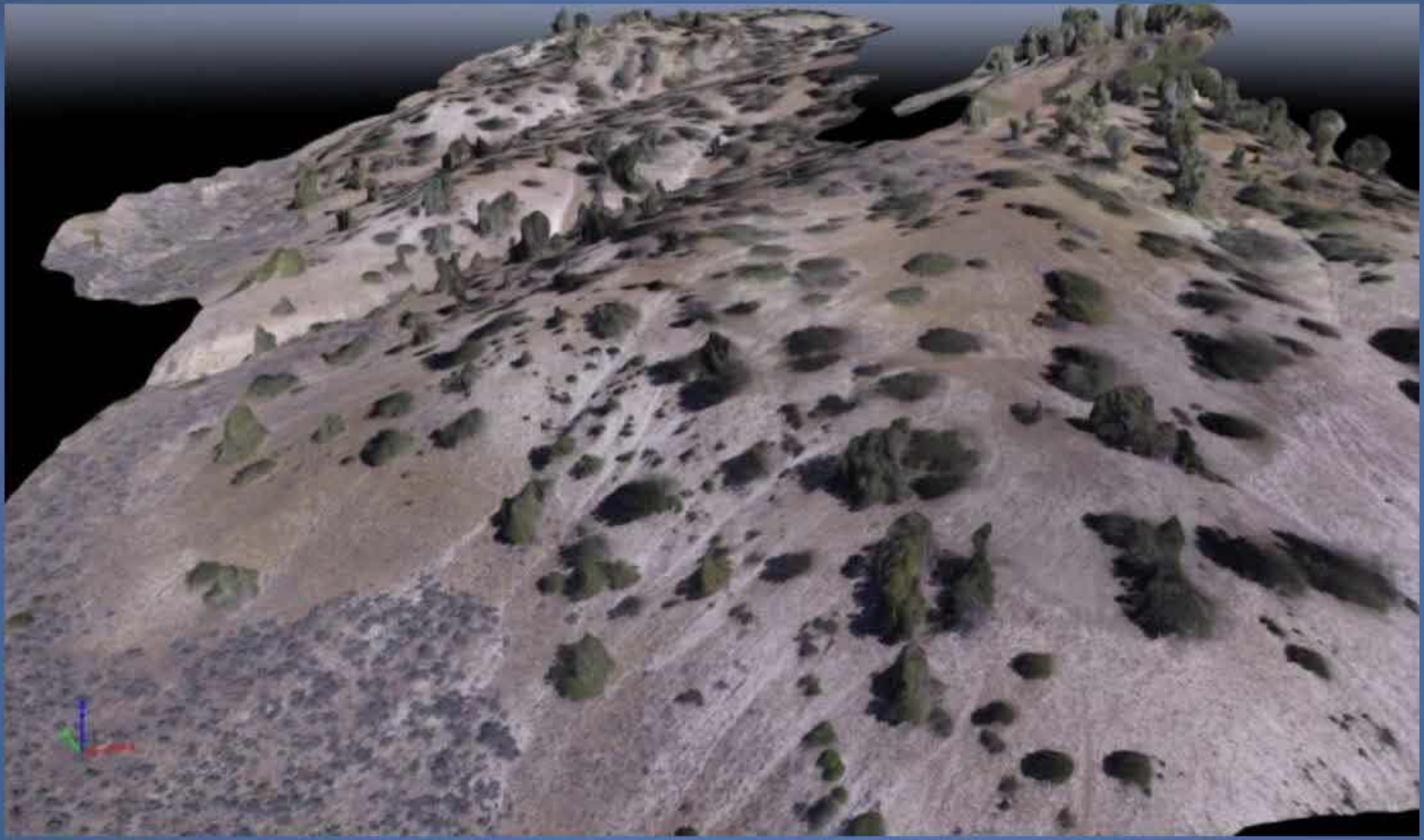
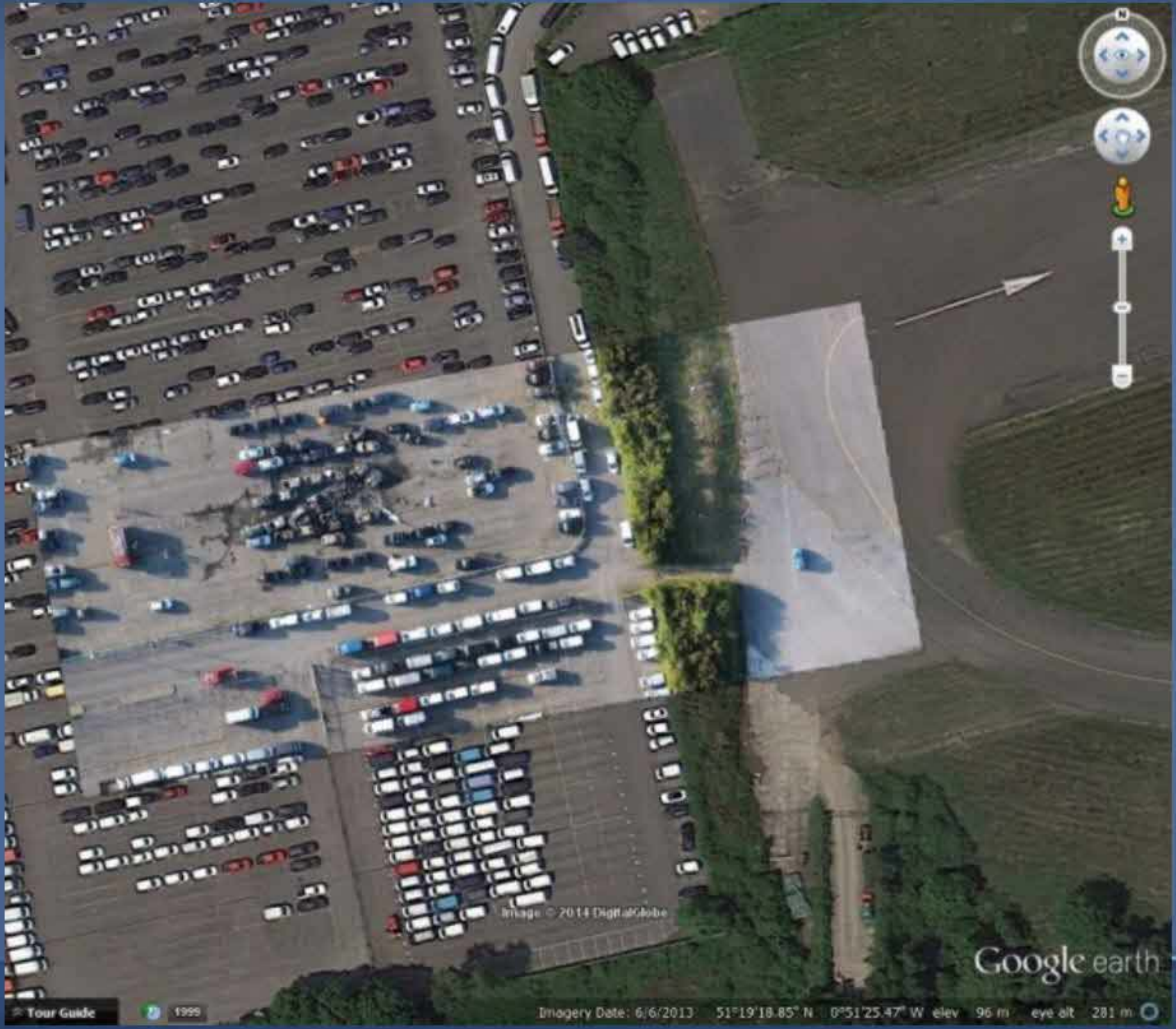
Drone photography

Drone photography

Drone photography



Drone photography



Drone photography

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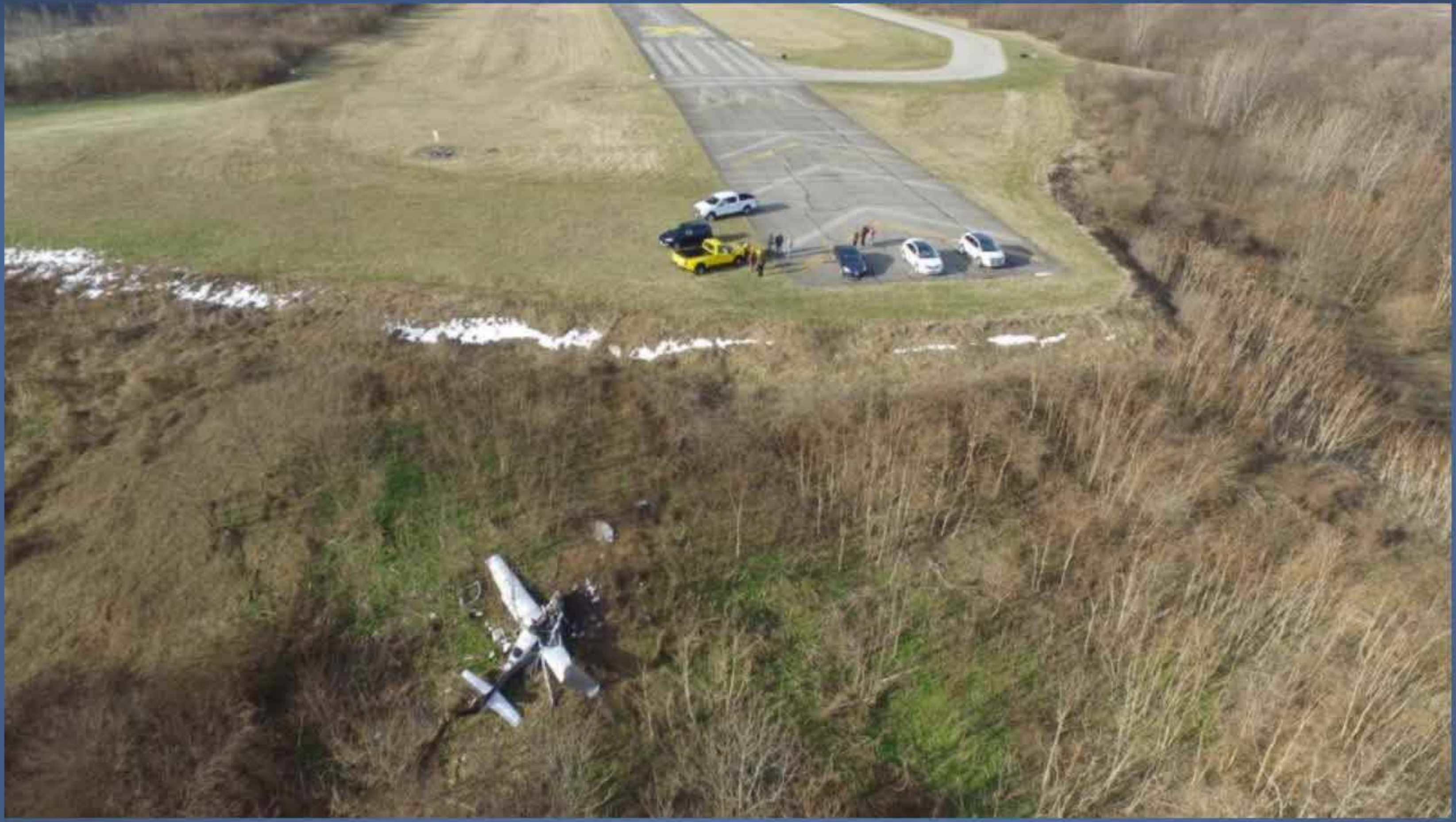

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On-Site Application - SOP/FOM/Checklist excerpts:

- Overall mission previewRight tool for the job?Coordinate with IICFlight crew/essential personnelTrained/restedPre-flight maintenanceBatteries, firmware/software, mapsAirspace evaluationDo we need an eCOA/ACOA?ATC coordinationAirport coordinationNOTAM/TFR
- Operating Area evalLaunch/recovery areaContingency locationsPhysical obstructionsRF/Mag interference sourcesWeather TerrainPublicAdvise OC/mediaProperty issue?First responderCoord with ICSAccident site specific hazardsHazmatConsider multiple observersWhat else can you think of?

3. Accident Site exercise – Let's go fly!!

National Transportation Safety Board

Any questions?

Family Assistance Operations

Max Green
Emergency Operations Coordinator
Transportation Disaster Assistance Division

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Situational Awareness

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Fundamental Concerns of Family Members

Notification of Involvement

"What happened?"

- Initial notification
- Immediate factual information

Access to Resources and Information

"How will I get information and resources?"

- Crisis counseling/disaster mental health
- Information regarding investigation
- Financial/logistical
- Legal rights

Victim Accounting

"Where is my loved one?"

- Search, rescue, hospitalization
- Search & recovery of fatalities
- Identification, death certification, and return of remains

Personal Effects

"Where are their belongings?"

- Recovery, processing and return of personal effects
- Associated and unassociated

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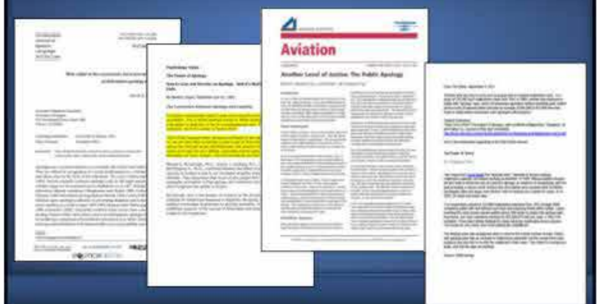
To Communicate Or Not to Communicate...



Family Assistance Could be...

- Accurate information
- Travel arrangements
- Hotel arrangements
- Food and beverages
- Financial assistance
- Someone to listen
- Someone to yell at
- Recovery/return of personal effects
- A presence
- Someone in charge
- Memorial
- Funeral assistance
- A secure location to grieve
- A shoulder to cry on
- Dispelling rumors
- A site visit
- Legal advice
- Spiritual care
- Mental health counseling
- Comfort dogs
- Child care
- Antemortem interviews
- Toiletries
- Locksmith
- Investigative updates
- Recovery/return of a loved one
- Words of encouragement from…?
- **Providing realistic expectations**
- Explanation of process
- …???

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Family Assistance Provides

- Information (factual)
- Consistency (routine)
- Realistic expectations
- A place and the people to get answers
- Safety and security (from public and media)
- Support in the grief process
- Reduction in stress and anxiety

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Family Assistance Might Not Provide…

- Closure
- All the answers
- Elimination of legal actions
- Support for all needs

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Effective Family Assistance…

- Builds rapport and credibility
- Provides realistic expectations
- Is flexible based on the event
- Requires interagency coordination/cooperation

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On-scene Information Flow

Organizational Meeting
- Designate parties and party coordinators
- Establish and organize groups

Progress Meetings
- Summarize findings
- Info for briefings

Family Briefings

Press Briefings

Fatality Management

- Investigate, recover and examine decedents in a dignified and respectful manner
- Accurately determine cause and manner of death
- Perform accurate and efficient identification of victims
- Provide for the rapid return of victims to their legal next of kin if possible
- Exchange factual and timely information with families in a compassionate manner

Medical Examiner/Coroner Responsibility

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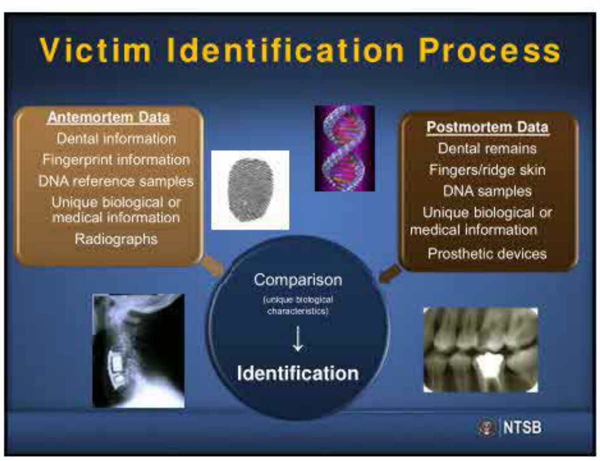

Family Member Concerns

- How is the search and recovery of my family member progressing?
- What is the condition of my family member's remains?
  - Whole body vs. other states of remains
- When can we see the remains?
- How will you identify my family member?
  - Methods (esp. DNA)
  - Length of time
- Why are you asking for dental, medical, and other types of records?
  - Antemortem data collection
- Who will make the final decisions about:
  - Receipt of information on the identification?
  - What happens to group/unidentified tissues?
  - The release and final disposition of remains?

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Personal Effects

Photographs Redacted

- Evidentiary
- Sentimental
- Financial

Photo courtesy of

Photograph Redacted

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Categories of Personal Effects

Associated with human remains
ME/C responsibility

Photograph Redacted

Associated with victim name
Air carrier responsibility*

Photograph Redacted

Photo courtesy of

Unassociated
Air carrier responsibility*
Catalog → family member review
Unclaimed → retain for 18 months

Photograph Redacted

*Air carrier responsibility assuming legislated accident.

Responsibilities **not specified** if accident does not meet criteria set forth in family assistance legislation.

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Operational Flow: Personal Effects

- On scene documentation
- Collection
- Cleaning/making safe to handle
- Cataloging
- Restoration
  - Decision driven by policy limits and claimant interest
- Return to owners/family members

Photograph Redacted

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Keys to Successful Planning for a Family Assistance Operation

- Identify response partners
- Plan and prepare
- Identify capabilities, limitations and gaps
- Involve senior management
- Define and agree upon mindset and intent
- Recognize family assistance is more than a checklist
- Understand the process prior to an accident

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Training and Exercises

- Include family assistance operations
- Workshops with partner agencies
  - Define roles/responsibilities
- Tabletop exercises
  - Test viability of plans
- Full-scale exercises
  - Play out a response
  - Logistics of family assistance operations
  - Movements, materials, etc.
- Schedule recurrent training
  - Practice, practice, practice...

Team Care and Self-care

- Self-care or wellness programs
- Employee support services (Employee Assistance Program)
- Peer Support Programs
- Allow access to external support systems

Self-Care is a priority and necessity - not a luxury - in the work that we do.

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NTSB Response Operations Center (ROC) NTSB Headquarters, Washington, DC 24/7/365

To report an incident/accident:
(844) 373-9922
or
(202) 314-6290

Duty Officers available 24/7/365

- Modal Divisions (Aviation, Highway, Marine, Pipeline, and Rail)
- **Transportation Disaster Assistance (TDA)**
- Public Affairs (PA / PAO)
- Government Affairs (GA / GAO)

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NTSB Training Center

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http://www.ntsb.gov/Training_Center/Pages/TrainingCenter.aspx

TDA Division Training Center Courses

TDA-301: Transportation Disaster Response – Family Assistance
September 26 – 28, 2016

TDA-403: Mass Fatality Incidents for Medicolegal Professionals
October 11 – 13, 2016

TDA-406: Accounting for Victims Following Transportation Mass Casualty Incidents: A course for Emergency Managers, Law Enforcement, Hospitals and the Medicolegal Community

NTSB


Max Green
Emergency Operations Coordinator
National Transportation Safety Board
Transportation Disaster Assistance Division
Office: [redacted]
Email: [redacted]
NTSB

National
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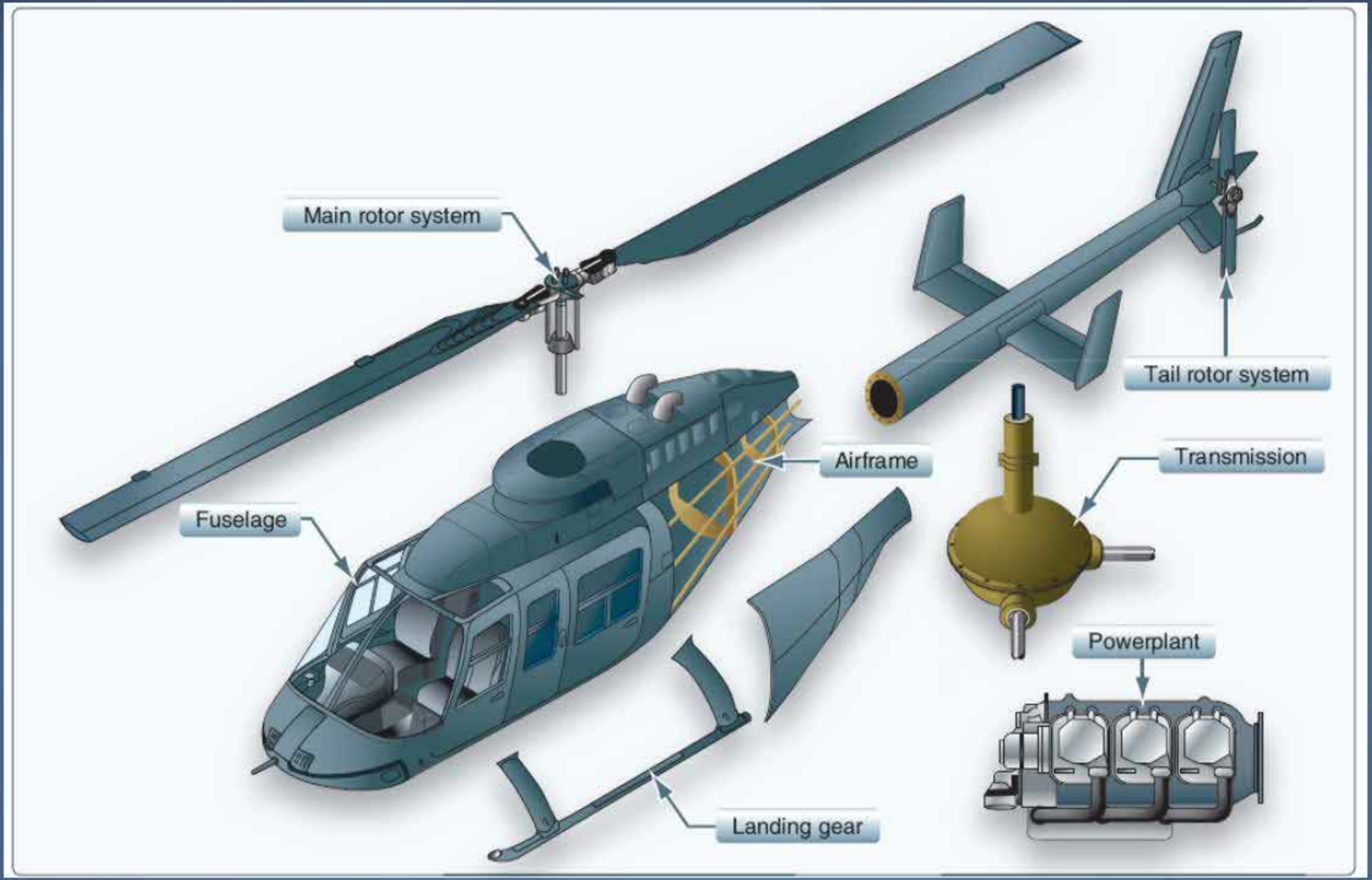
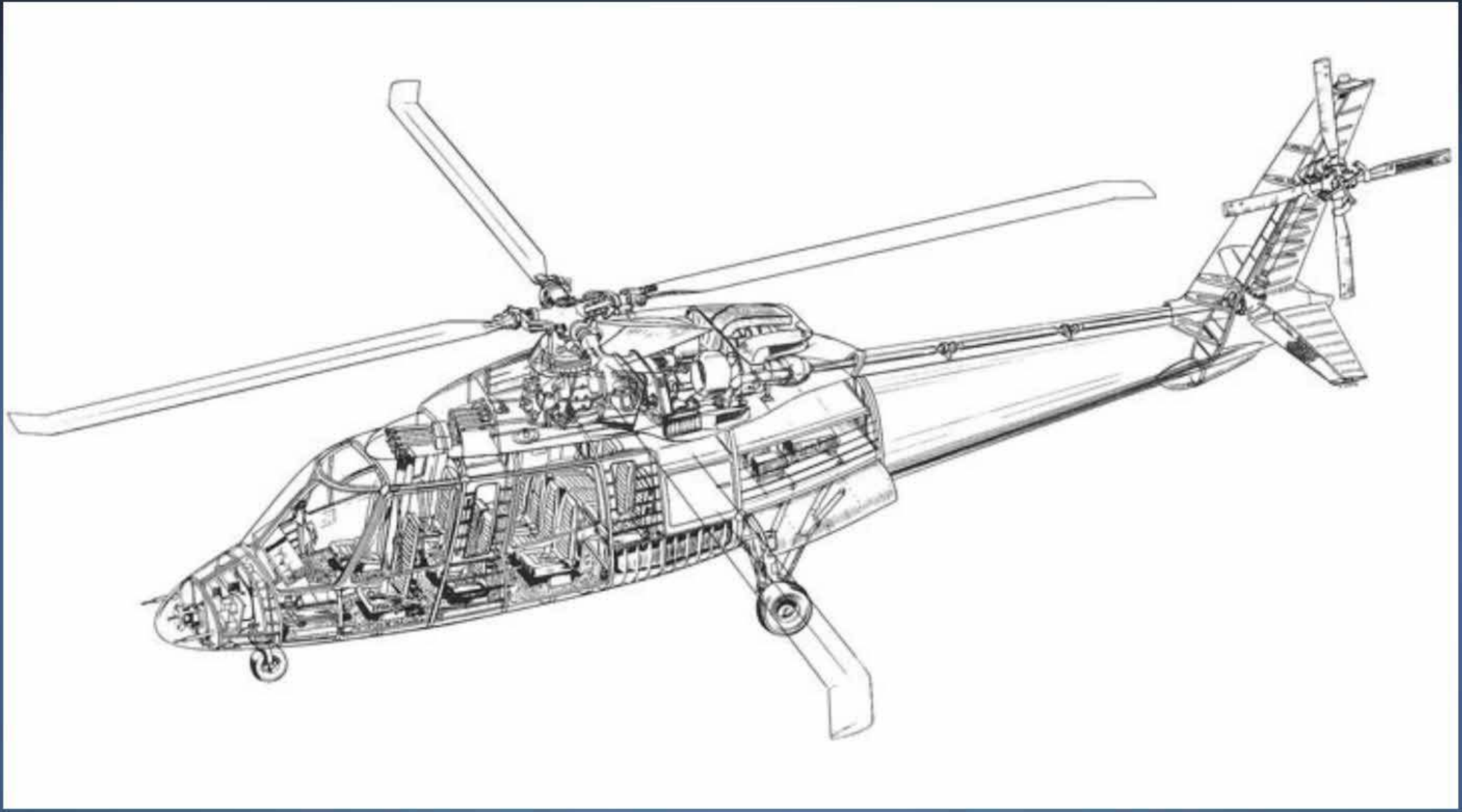
Helicopter Overview and Investigation Techniques

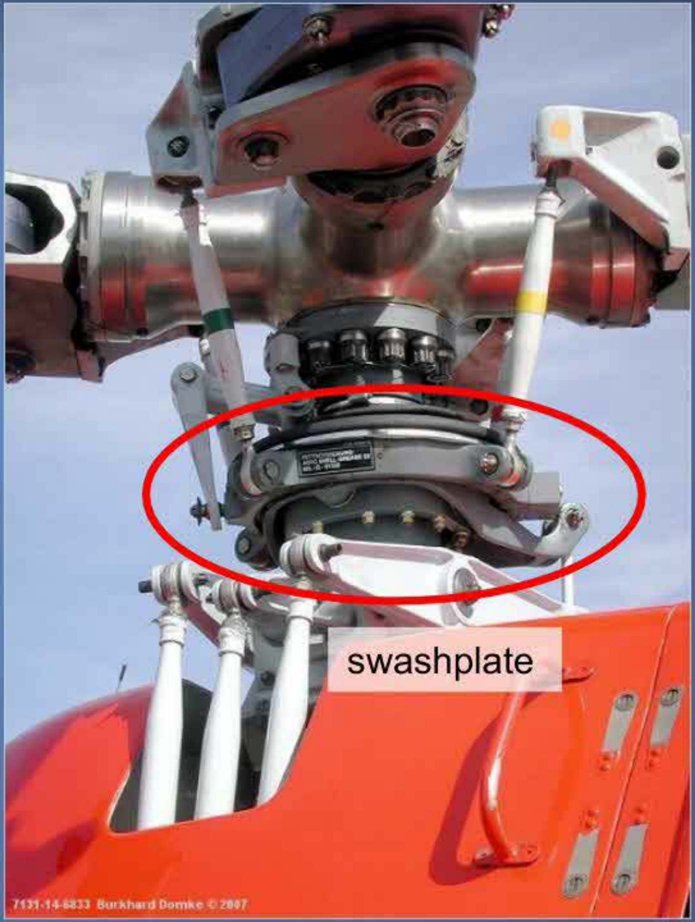
Chihoon “Chich” ShinAviation
Engineering (AS-40)

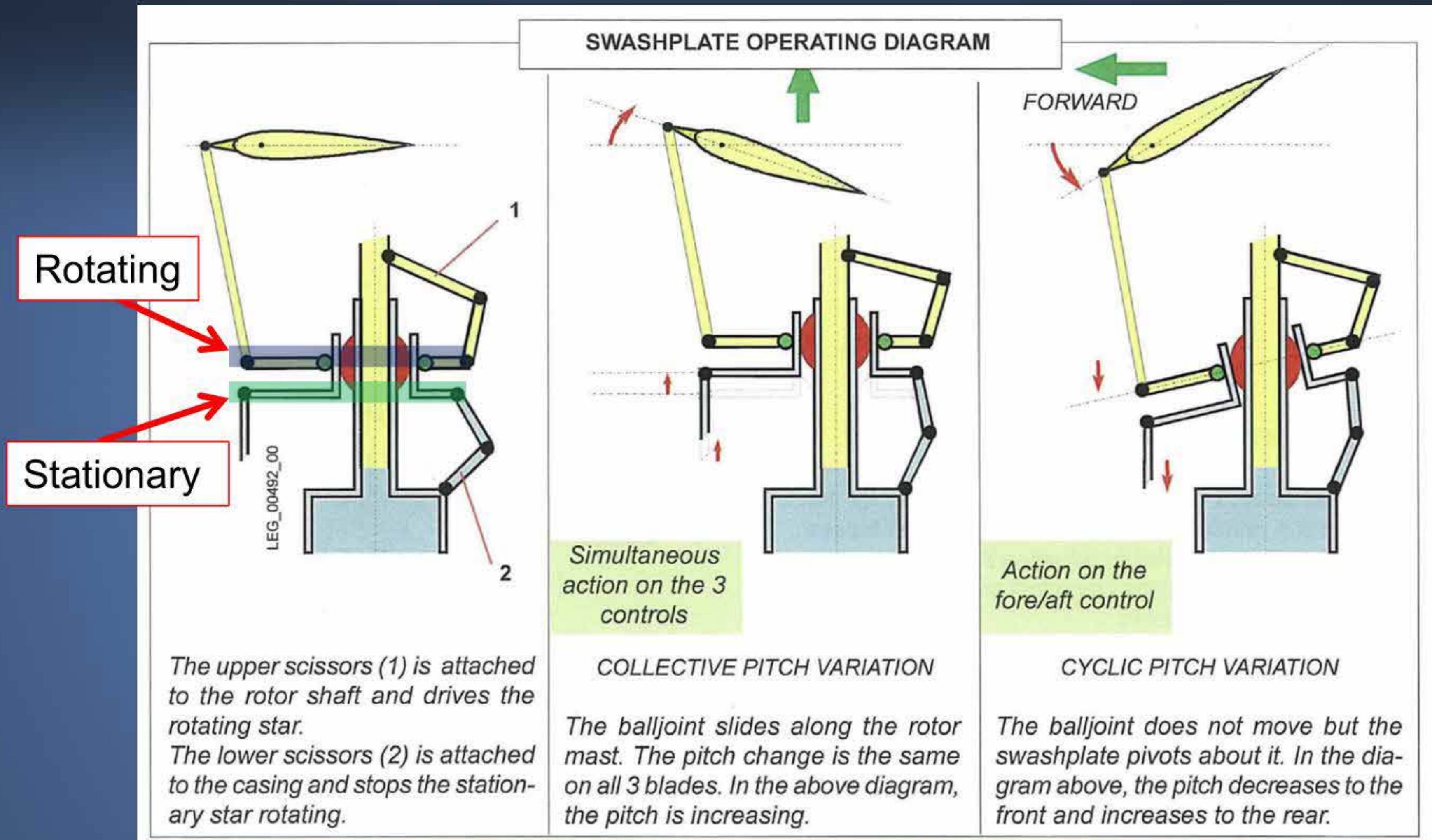
Basic Helicopter Systems





Helicopter Controls




SWASHPLATE OPERATING DIAGRAM
Rotating
Stationary
1
2
LEG_00492_00
FORWARD
Simultaneous action on the 3 controls
Action on the fore/aft control
The upper scissors (1) is attached to the rotor shaft and drives the rotating star.
The lower scissors (2) is attached to the casing and stops the stationary star rotating.
COLLECTIVE PITCH VARIATION
The balljoint slides along the rotor mast. The pitch change is the same on all 3 blades. In the above diagram, the pitch is increasing.
CYCLIC PITCH VARIATION
The balljoint does not move but the swashplate pivots about it. In the diagram above, the pitch decreases to the front and increases to the rear.

This is an animation of a
S-61 "Sea king" helicopter
Rotorhead assembly.

Enjoy the movie,

Karel Kinable

So what's different?

Example	Airplane	Helicopter
Look for signatures of engine power and rotational energy.	Propeller blades, engine(s), fuel	Rotor blades, engine(s), fuel
Look at structural integrity.	Wings, fuselage	Rotor blades, fuselage
Look for control continuity (cables, lines, linkages, surfaces).	Continuity to ailerons, rudder, elevators	Continuity of controls to swashplate, main and tail rotor
Look at actuators and subsystems.	Hydraulic, electric	Hydraulic, electric

The Usual Suspects

- Mechanical malfunctionMaintenance issuesComponent failuresPerformance and AerodynamicsLoss of tail rotor effectiveness (LTE)Weight and balanceOperational/training issuesWire strikesErroneous pilot actionsWeather factors

Main and tail rotor blades

- Look for impact marks and ground scars.Look for evidence of rotational energy (power):High rotational energySignificant distortion, fracturing, or shattering of blade.Spar fractures opposite the direction of normal rotation.Low rotational energyFlapwise (chord) bendingMinimal damage and distortion to leading edge and spar.May generally look “intact”.Look for evidence of bird strikes.Where are the blade tips and weight packages?If low rotational energy, was drive available or deliberately removed?

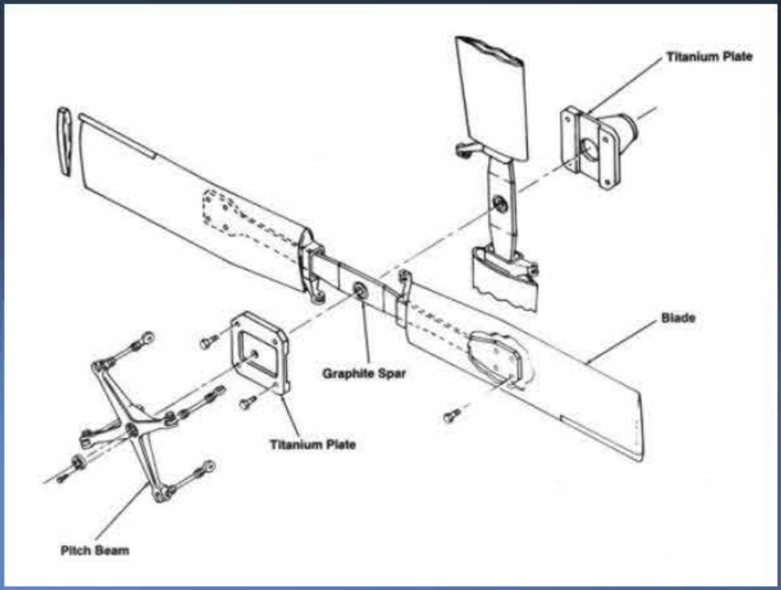
High rotational energy

Low rotational energy

Low rotational energy

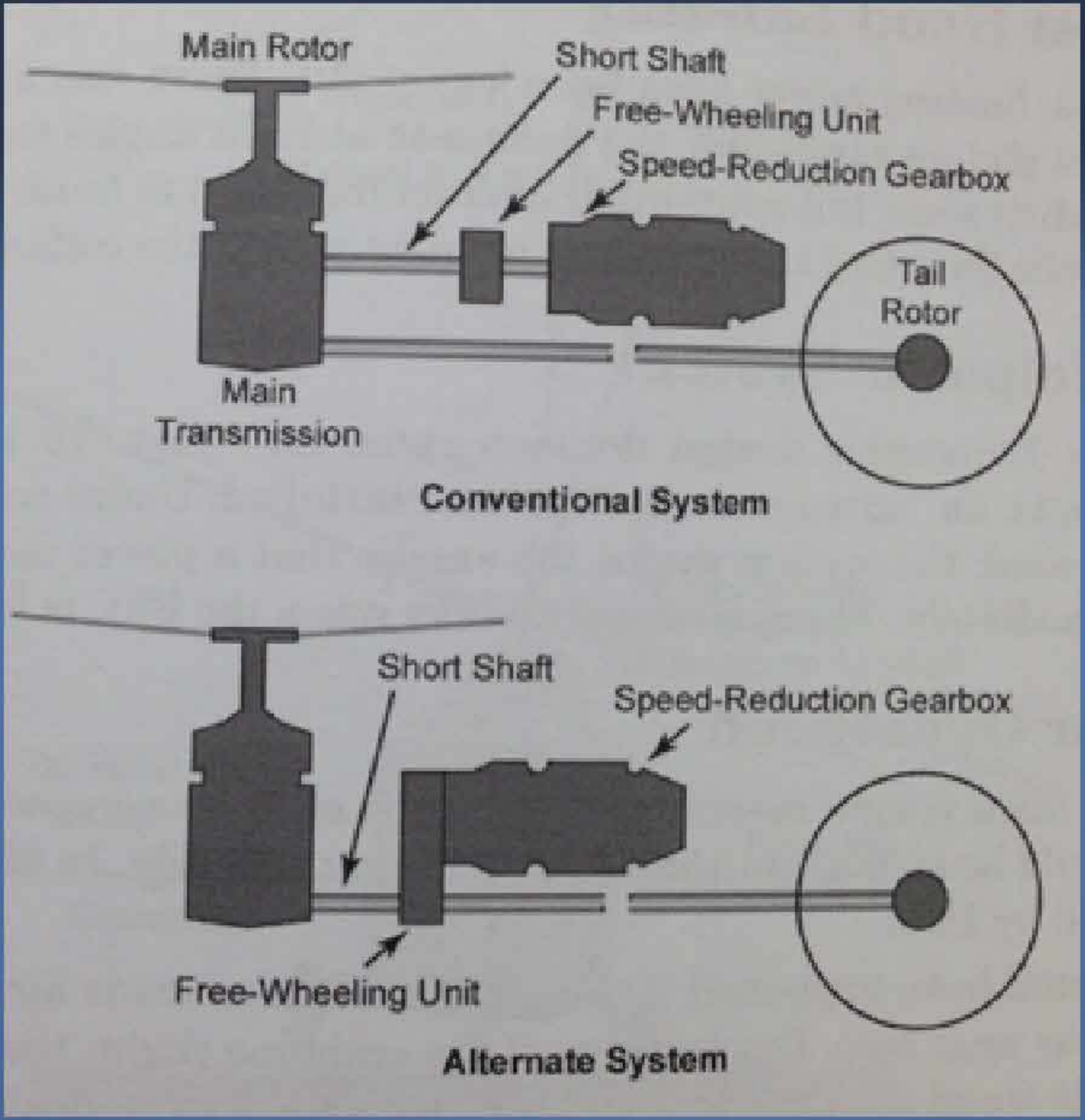
In-Flight Blade Separation

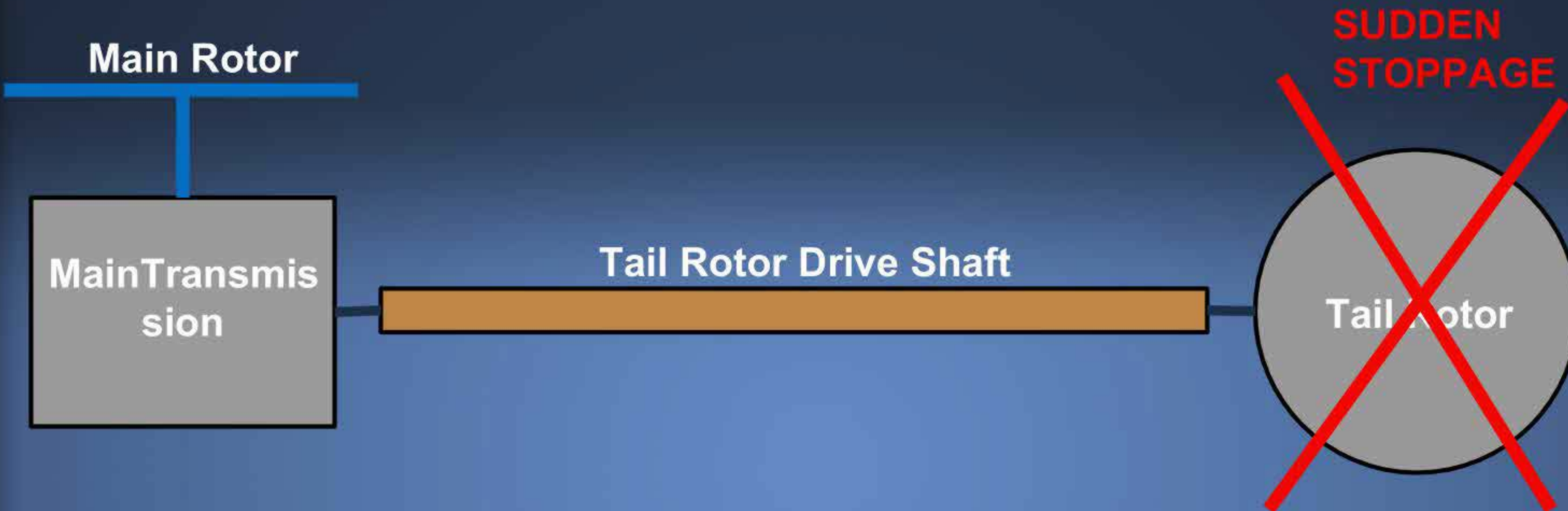
Imbalances

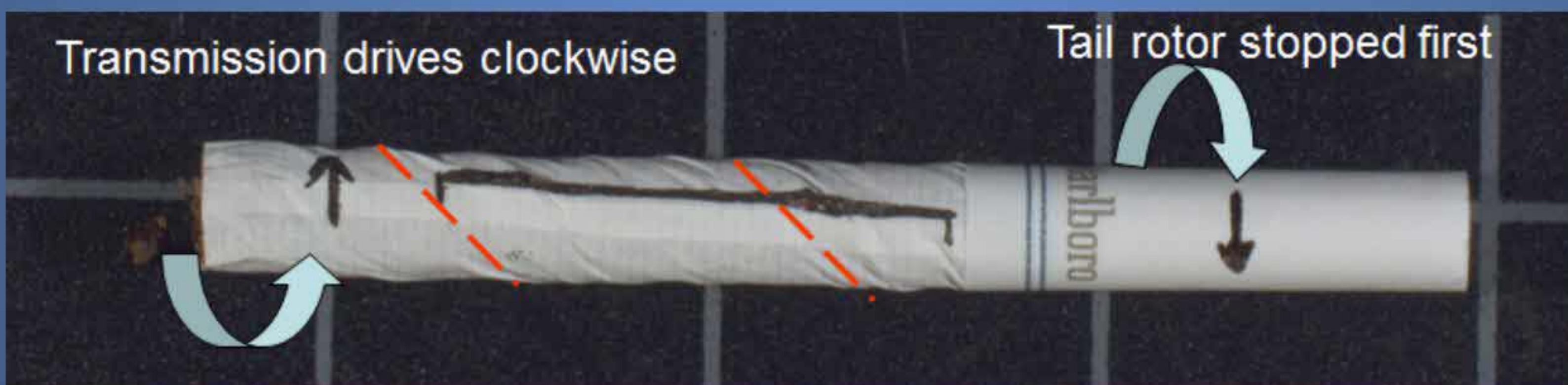

Titanium Plate
Blade
Graphite Spar
Titanium Plate
Pitch Beam

Drive shafts

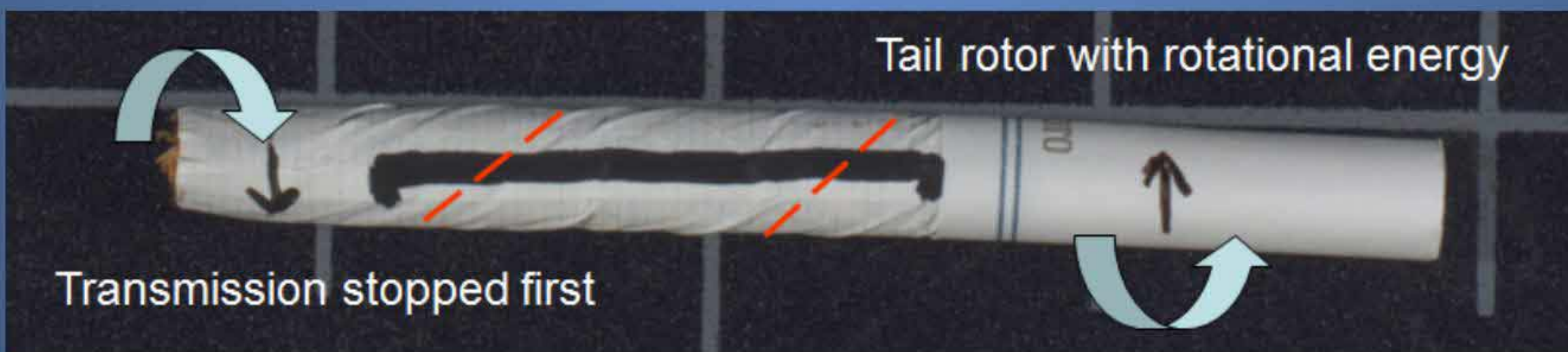
- Look for evidence of:Rotational energy (was power available?)Continuity of driveImbalanceDirection of twists and smearing (if any)Twisting of drive shafts usually occur when the drive shaft has rotational energy and one end encounters resistance ("sudden stoppage").


Main Rotor
Short Shaft
Free-Wheeling Unit
Speed-Reduction Gearbox
Tail
Rotor
Main
Transmission
Conventional System
Short Shaft
Speed-Reduction Gearbox
Free-Wheeling Unit
Alternate System





(in this example, drive shaft is spinning clockwise when aft-looking-forward)(smoking is not encouraged)



(in this example, drive shaft is spinning clockwise when aft-looking-forward)(smoking is not encouraged)


forward

Powerplant

- Was the engine producing power at the time of the accident?Things to checkObstructions to engine inletFuel contamination (fuel sample if possible)Fuel/oil delivery to engineForeign object debris ingestion (soft or hard body FOD)Internal failure of engine componentBlade sheddingThermal damage/melting of blades

Soft body FOD damage

Hard body FOD damage

undamaged

Partially melted blades

Blade shedding (overspeed)

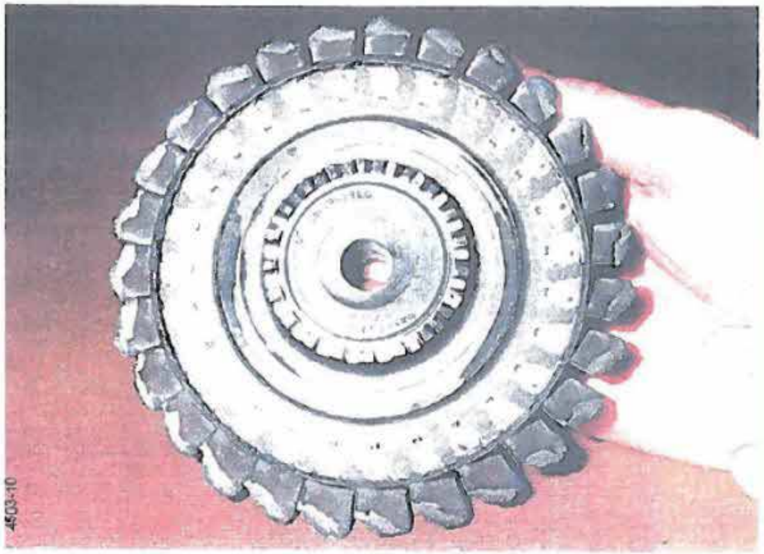
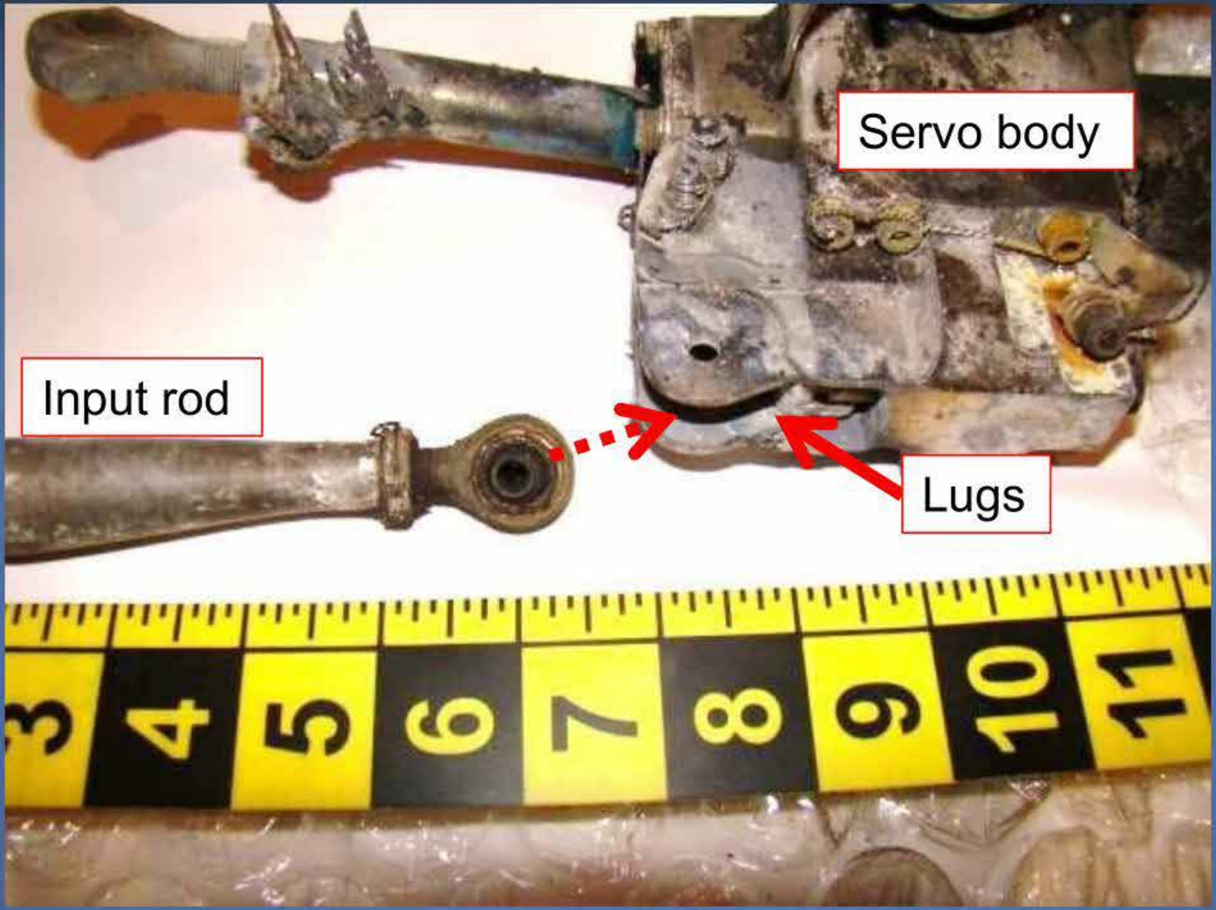


Figure 70

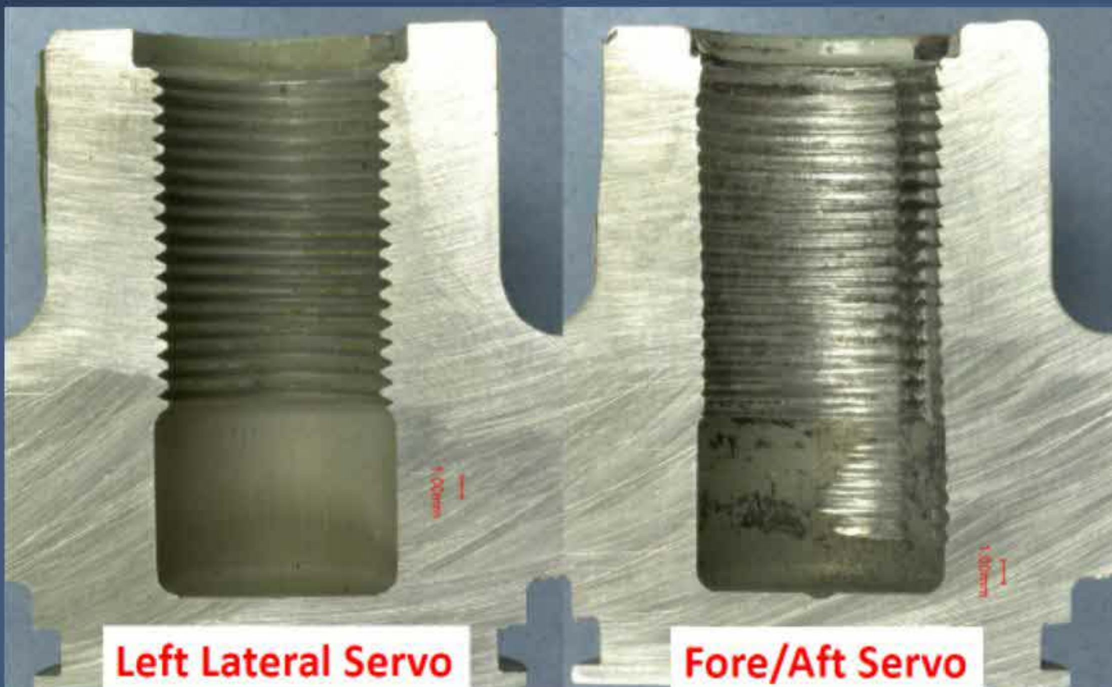
Flight Controls

- Check linkages for continuityCheck integrity of connections between linkagesFreedom of movement (evidence of restrictions?)Hydraulic and electric actuatorsElectric: once power lost, actuators typically “lock up” in position when power was lost.Hydraulic: if system is compromised, actuators can move after system depressurization.Look for witness marks which can indicate actuator position at impact.Check hydraulic pumps and lines for integrity

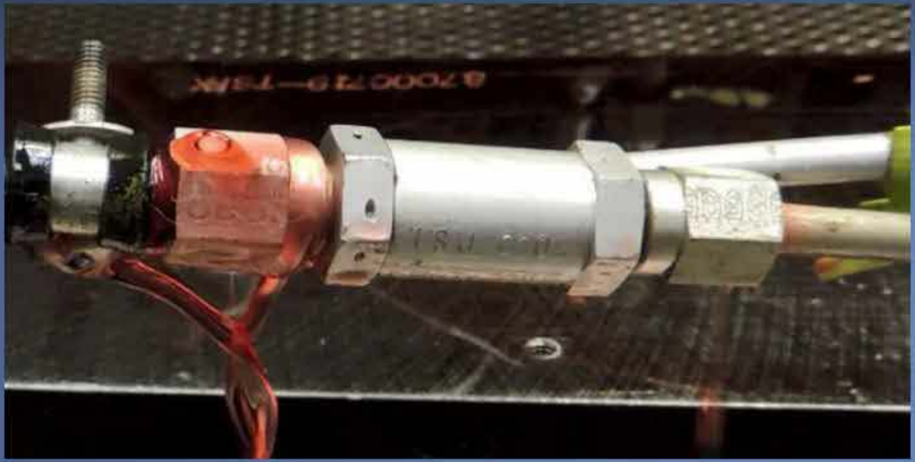
Rod end disconnect example

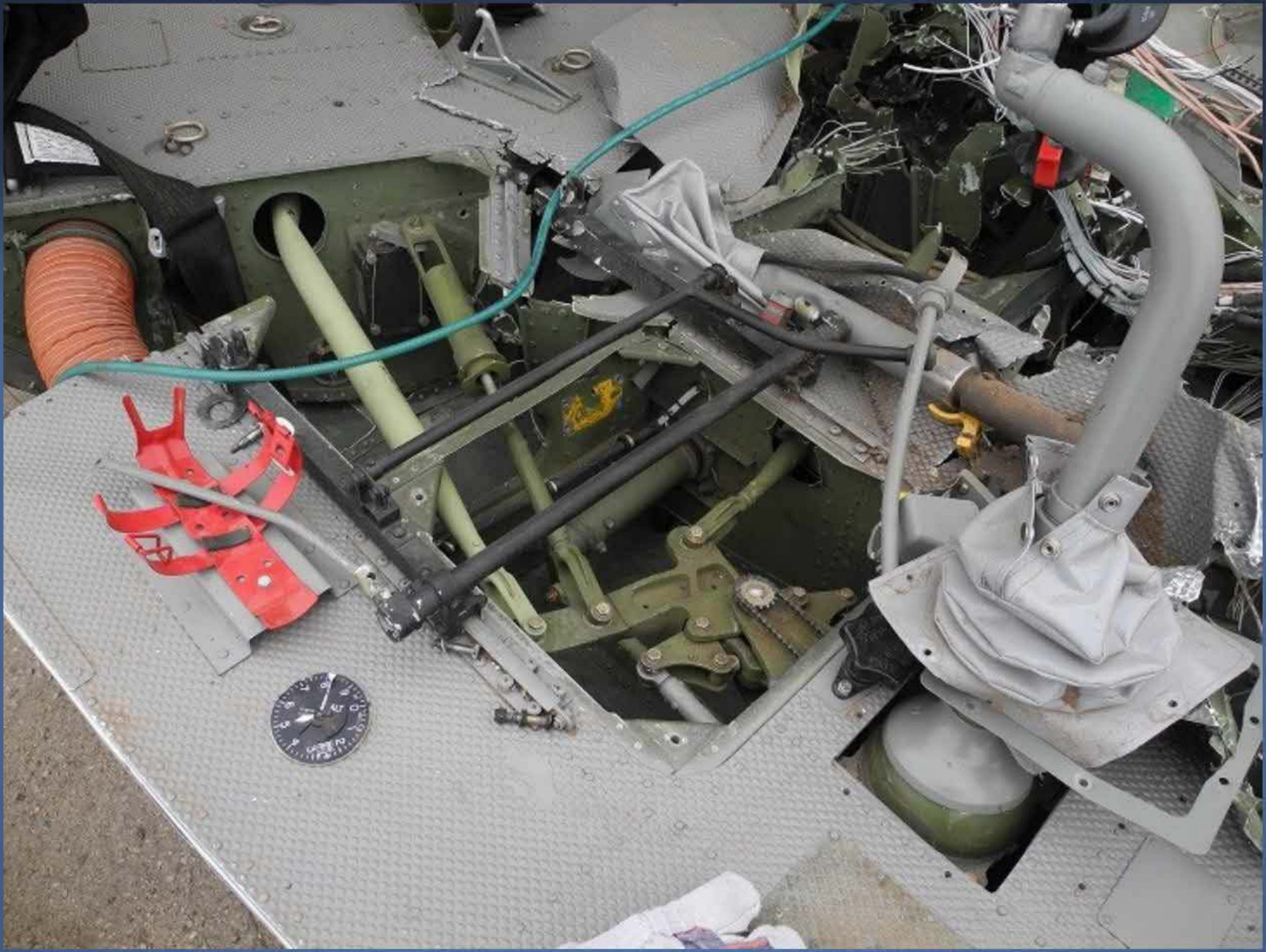


Rod end thread wear example



Hydraulic fluid leakage





Airframe/Structures

- Structural separation in flight?Blade strike?Hard landing?Look for ground scars.Look at debris pattern.


Loss of Tail Rotor Effectiveness (LTE)

- Not a mechanical malfunctionAerodynamic/performance-relatedAsking for more tail rotor anti-torque than tail rotor can produce.Factors that could induce LTE include relative/changing winds, gross weight, airspeed, and tail rotor design.

Helicopter Accident Case Study

Case Study

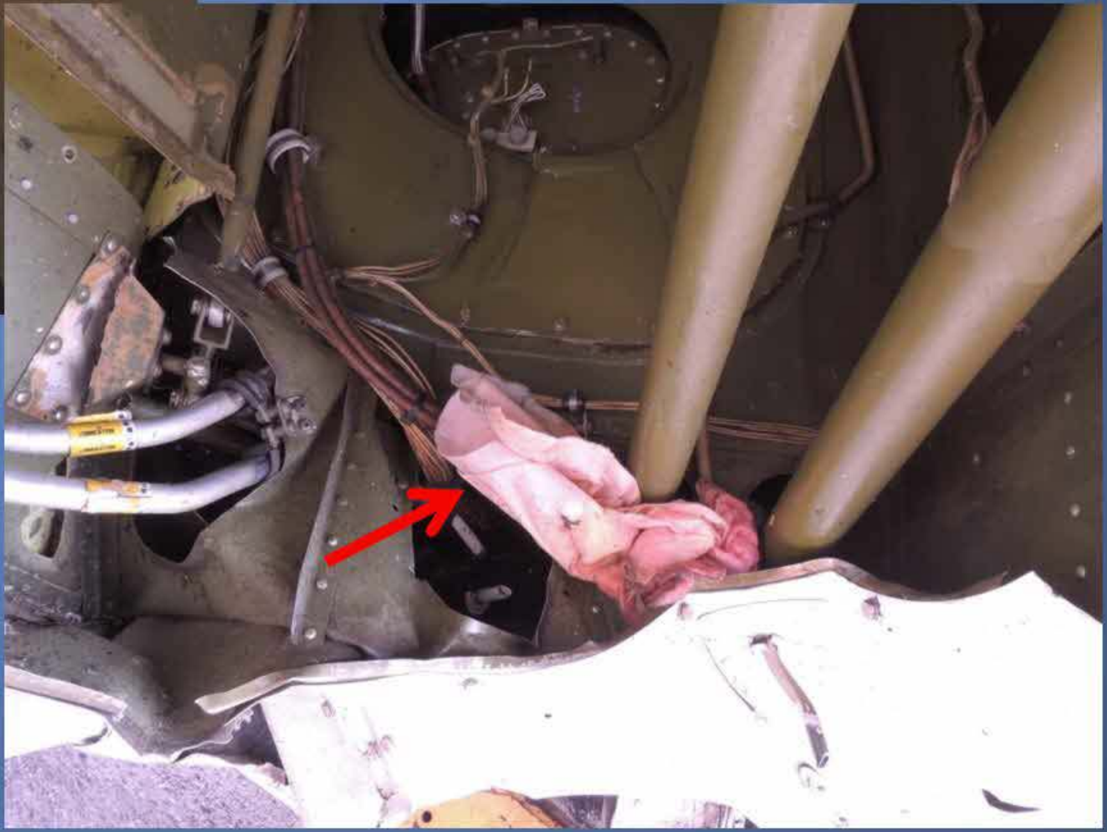
- Bell UH-1H helicopterOne Honeywell (Lycoming) T53-L-13B engineNear Dove Creek, COJuly 16, 2013Injuries: 1 fatalNTSB Case No. CEN13FA415

Background

- On July 16, 2013, about 0955 MDT, a Bell UH-1H helicopter was substantially damaged after a loss of control and ground impact.Part 133 Class B rotorcraft external load operation (basket load via long line).Ground witnesses stated pilot overshot intended drop site and the basket load impacted the ground, followed immediately by the 150 ft long line. At the same time, helicopter entered a right bank, followed by a steep left bank until ground impact.

Wreckage Examination

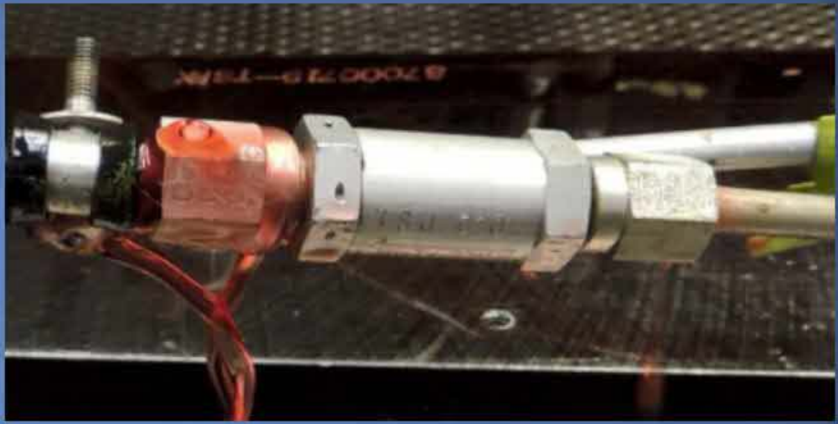
- All major components accounted for on scene.Evidence of engine providing power at the time of the accident.Hydraulic check valve in the area of undistorted aft belly compartment structure could be rotated by hand. Several rags soaks with hydraulic fluid found in the same compartment.Bulb filament analysis revealed hydraulic pressure annunciator and auxiliary master caution lights exhibited evidence of stretching. Remainder of annunciator bulbs did not appear stretched.



NTSB

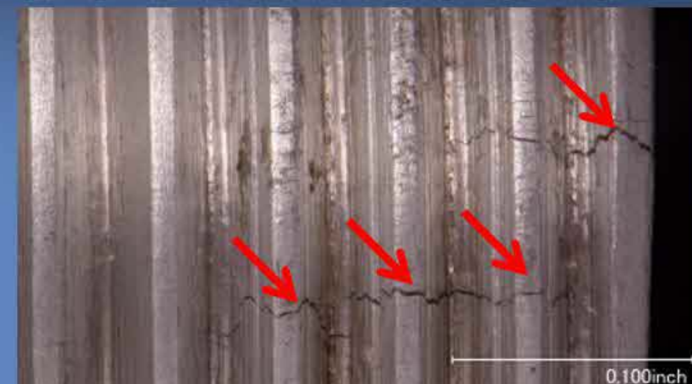
Lab Examination

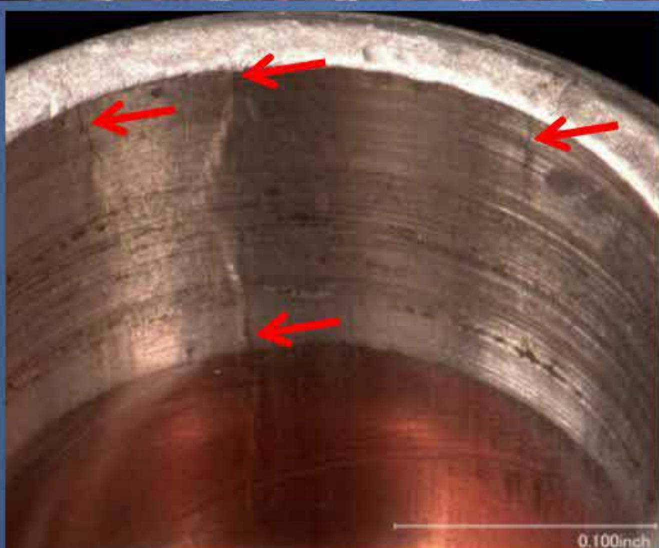
- Bench testing of check valve revealed a severe hydraulic leak.Bunched teflon [tape] found on outlet threads of check valve.Stress corrosion cracks found on both inlet and outlet ends of check valve.



inlet

outlet





Maintenance History

- Mechanic stated that hydraulic leaks had been a long term challenge with the accident helicopter.Mechanic and accident pilot aware of a slow, weeping hydraulic leak in the aft belly of fuselage, but did not foresee the leak causing a significant issue.Replacement components for the area of the leak, including hydraulic lines and a check valve, were due to arrive within days of the accident.Utilized teflon tape in an attempt to help the check valve fittings “grab” more effectively.

"Test Flight"

- Unbeknownst to NTSB and FAA, the operator performed a long line hydraulics off "test flight" at a higher altitude to simulate accident helicopter conditions. The operator stated that due to the high forces on the collective, the flying pilot would have a tendency to brace themselves on the cyclic to pull up on the collective stick.

Operations Culture

- The operator described the operating environment at the survey site as "tense".Operator terminated a pilot after reports that said pilot was flying aggressively at the survey site.Survey personnel expressed dissatisfaction to the accident pilot regarding the termination of the previous pilot.

Operations Culture

- Survey personnel were “timing” the accident pilot and informing the operator that the accident pilot was taking “50% longer” than the terminated pilot in performing the same operations.Accident pilot had expressed concern about losing the survey contract. Mechanic stated feeling pressure to ensure flights were completed.

Resultant Safety Actions

- TC holder working with FAA on flight manual change regarding the potential for over-controlling helicopter at low airspeeds after a loss of hydraulic pressure. TC holder working to develop a STC for a low hydraulic fluid level warning system.

Probable Cause

- Pilot-induced oscillations caused by the loss of hydraulic assist of the flight controls due to an excessive loss of hydraulic fluid during a critical phase of flight, which resulted in ground impact. Contributing to the accident was an inadequate analysis of the hydraulic fluid leak by the pilot and mechanic.

National Transportation Safety Board

NTSB National Transportation Safety Board

Office of Aviation Safety

Department of Energy Basic Accident Investigation Environmental Factors - Weather

Donald Eick ("Ike")

NTSB Senior Meteorologist

Background & Experience

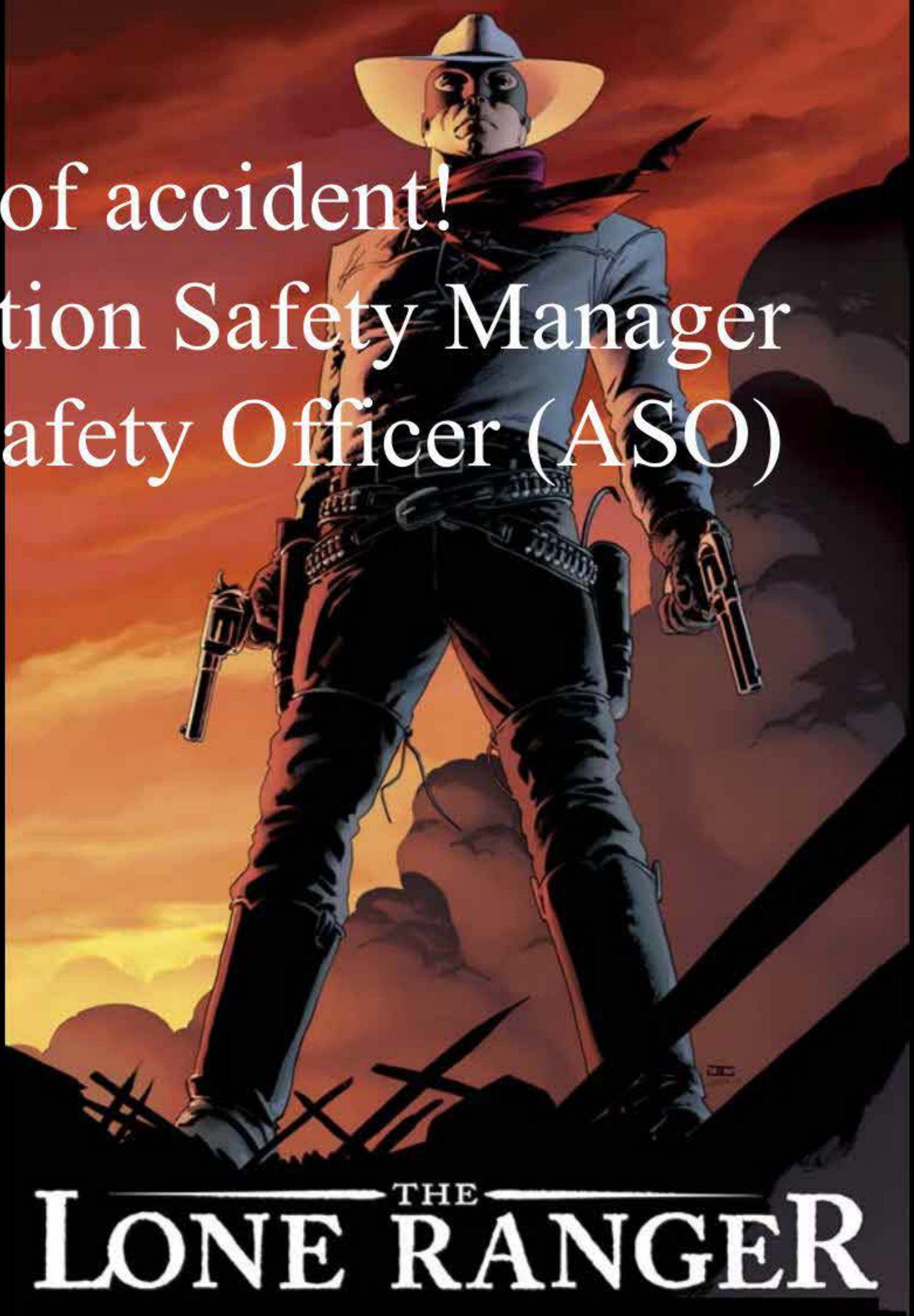

NATIONAL TRANSPORTATION SAFETY BOARD
Accident Investigations:
A Meteorological Perspective

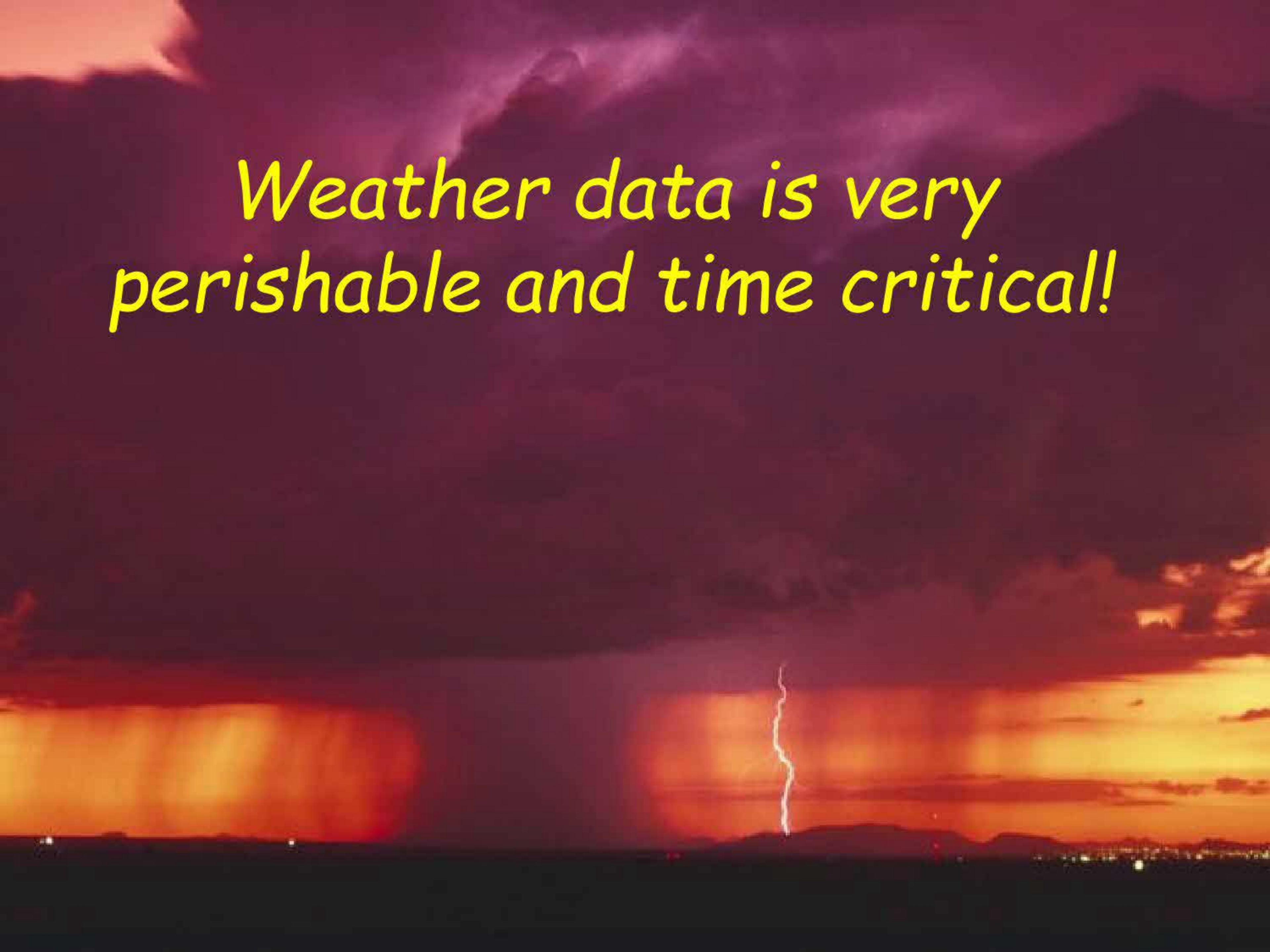
Accident Notification

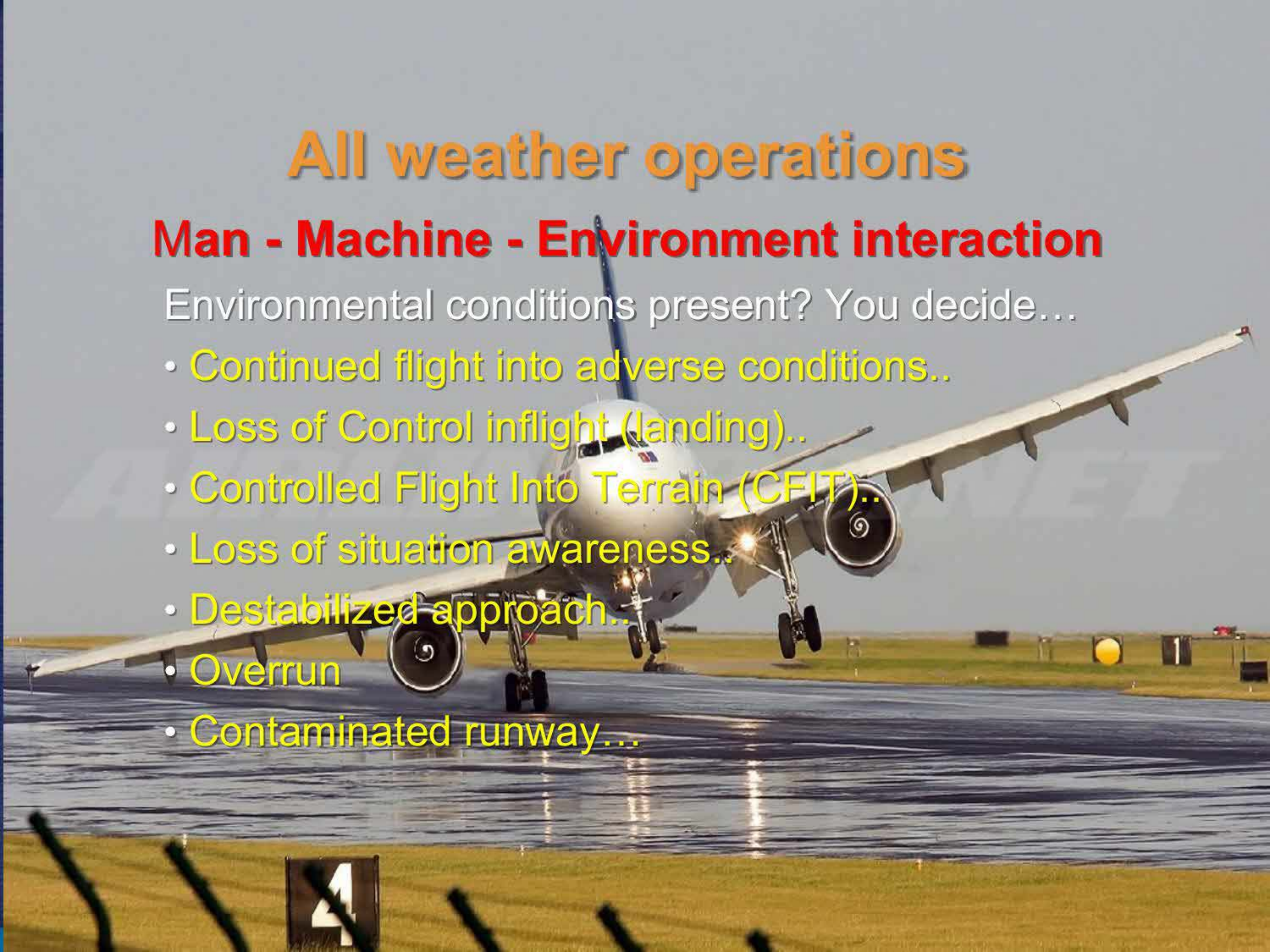
Call comes in about midnight reporting a DOE helicopter down, location outside of "Auchtermucky" around 2130, fatal, cause and details unknown! Get your bag ready, your being launched!

NTSB

- Notification of accident!
  - –DOE Aviation Safety Manager
  - –Aviation Safety Officer (ASO)




Weather data is very
perishable and time critical!


All weather operations
Man - Machine - Environment interaction
Environmental conditions present? You decide…
• Continued flight into adverse conditions..
• Loss of Control inflight (landing)..
• Controlled Flight Into Terrain (CFIT)..
• Loss of situation awareness..
• Destabilized approach..
• Overrun
• Contaminated runway…

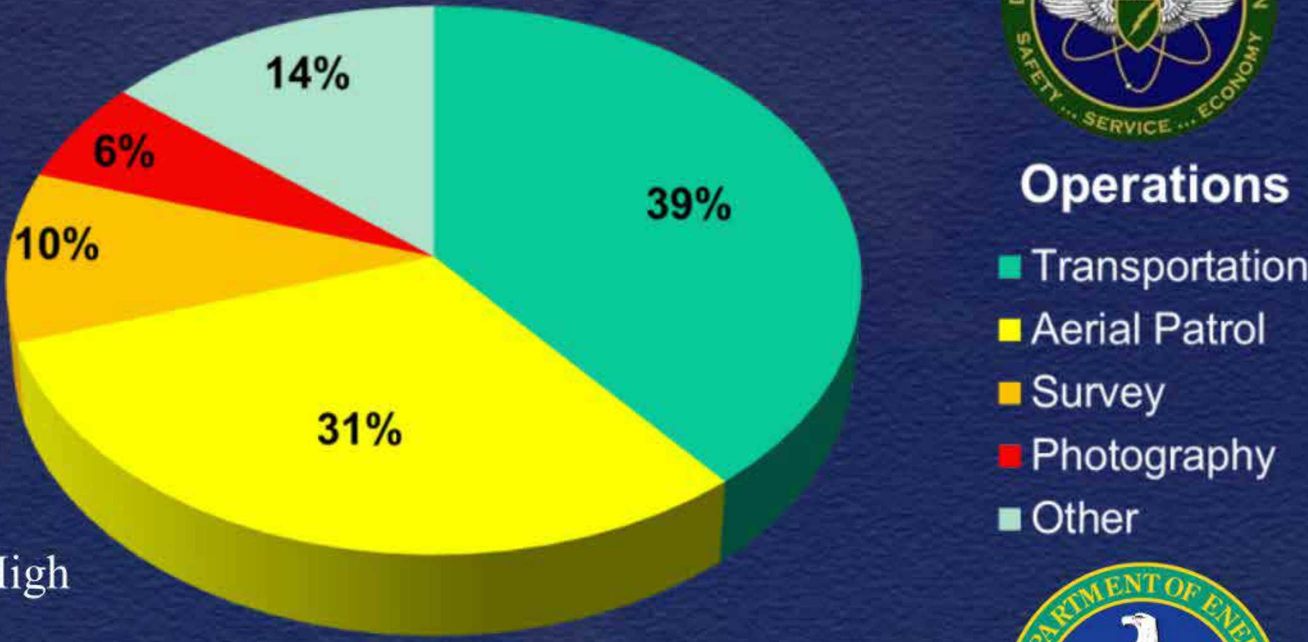
Weather Related Accidents

Environmental factors listed as a leading cause or factor in the majority of all accidents

Primary Topics

- Weather impacts to DOE Operations
- Elements of a weather study
  - How to get data
  - What weather information is needed
  - Where to get the data
  - Who to interview/statements
- Weather hazards and related accidents

Department of Energy Flight Operations



B-737-300	(2)	High
DC-9-33	(1)	
B200/350	(5)	Mid
Bell 206/407	(7)	
Bell 412	(2)	Low Altitude
BK117	(2)	
TOTAL	19	

NTSB

Meteorological Hazards

- Low-altitude operations
  - Adverse winds
  - VFR into IMC; fog, brownout
  - Loss of control in IMC
    - spatial disorientation
  - Thunderstorms; gust fronts, haboobs & microbursts
  - Winter Wx conditions – whiteout, icing
- Mid-altitude operations
  - In-flight icing
  - Inadvertent entry into adverse weather (TSTMS)
- High-altitude operations
  - Turbulence; CAT, CIT, mountain wave
  - High-altitude Ice Crystal Icing
  - Volcanic ash

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Adverse Winds

- Crosswind
- Tailwind
- Windshifts (45°)
- High gusting winds
- Gust fronts
- Low-level wind shear (LLWS)
- Helicopters – no wind
  - Transitional lift
  - Loss Tail-rotor Effectiveness (LTE)

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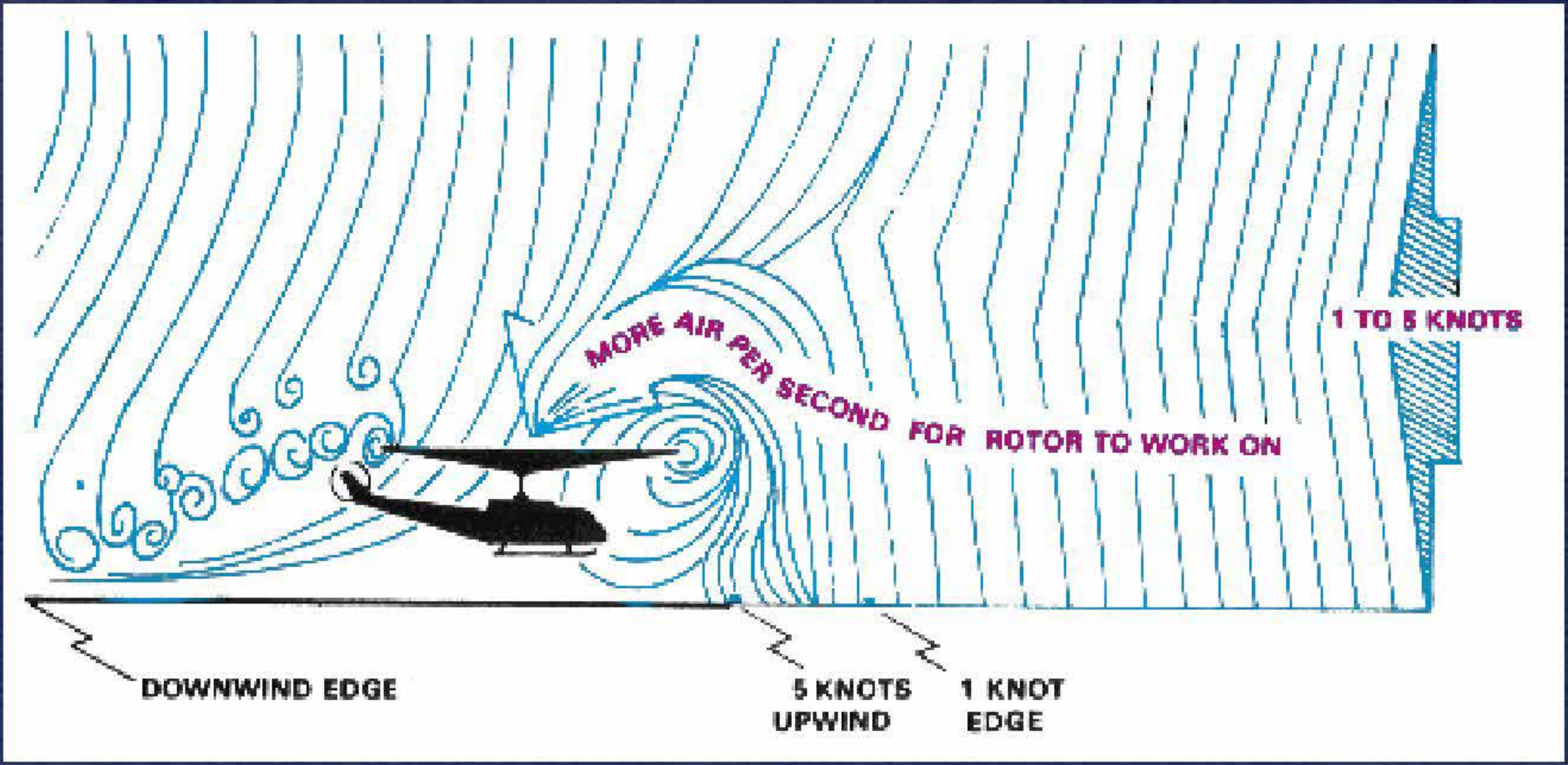
Adverse Winds Example

- Fiji Helicopter

Transitional Lift

Light winds 1-5 KT – reduce helicopter performance

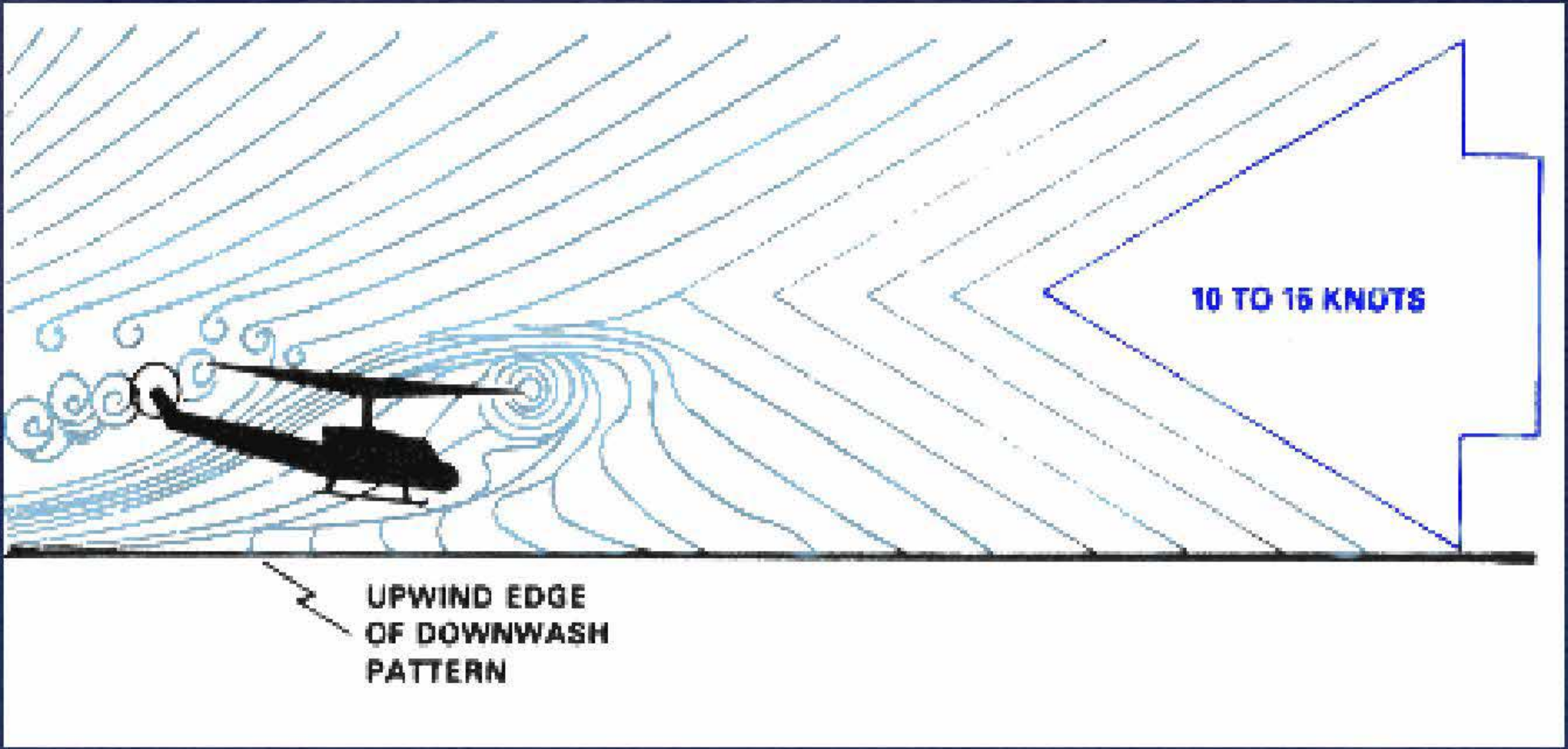
Carlson Helicopter S-61, Weaverville, CA



- Efficiency of the hovering rotor system is improved with each knot of wind.

Transitional Lift

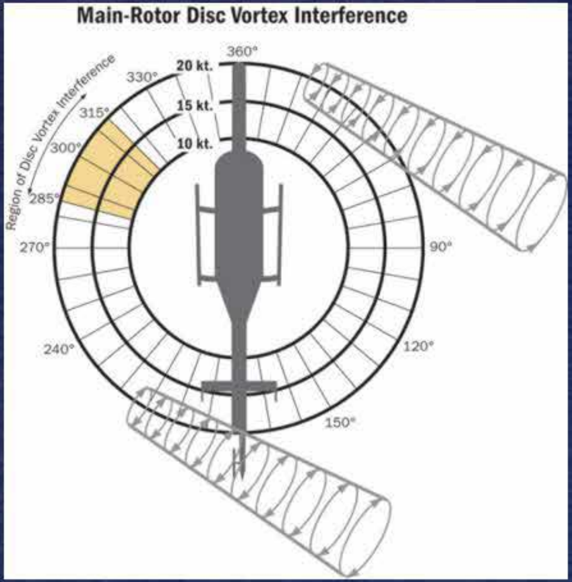
Winds 10 – 15 KT   less power required



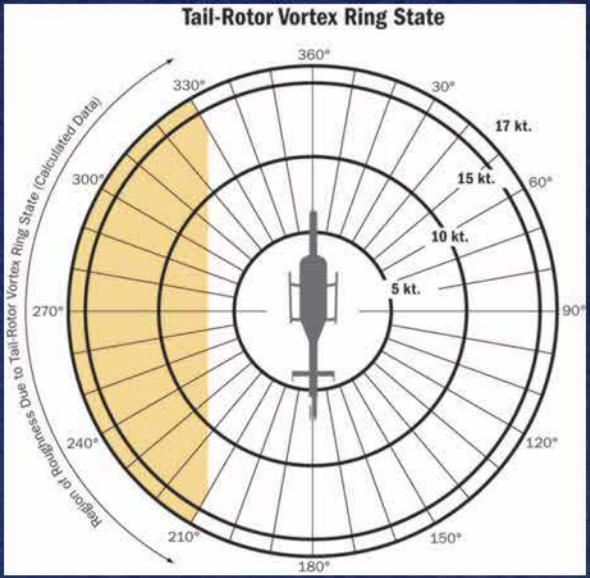
The leading edge downwash pattern is being overrun and is well back under the helicopter.

Critical Wind Directions

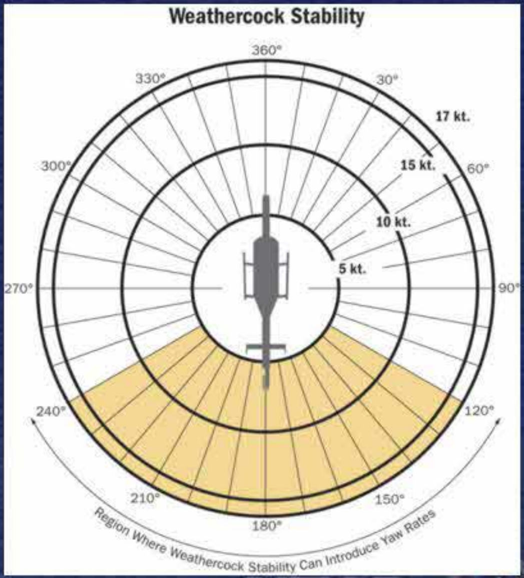
- Wind direction critical to helicopters approach, landing, or at hover:
  - Loss of tail-rotor effectiveness (LTE)
  - Vortex ring state
  - Weathercock stability



285°-315°



210°-330°



120°-240°

Mount Hood USAF UH-60
May 30, 2002
1351 local (2051Z)

- 10,700 feet
- Wind shift
- Loss of rotor RPM
- Uncontrolled right yaw
- Crew survives
- Damage $3,750,385.29

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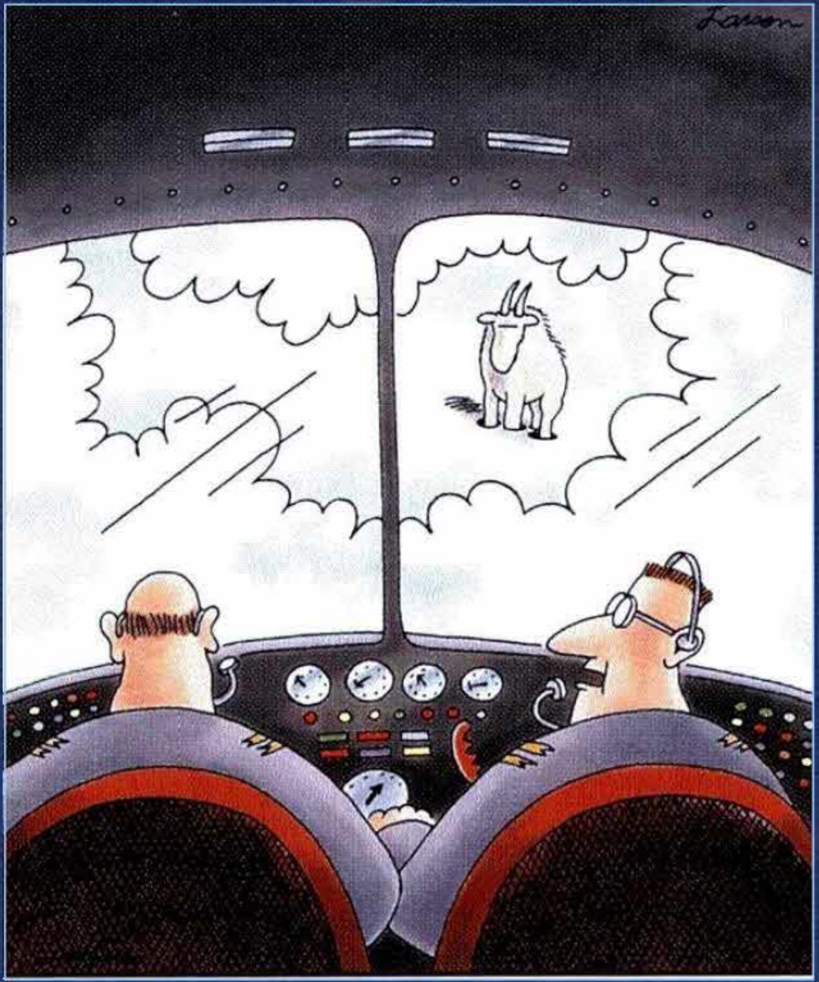
Low Ceilings & Visibility

- Not a violent or dynamic weather event
- Common fatal weather related accident cause:
  - VFR into IMC conditions
  - Spatial Disorientation
  - CFIT
- Flight crew not adhering to standard instrument approach procedures

THE FOG

Last comment on CVR:



Say… what's a mountain goat doing way up here in a cloud bank?


What was the worst aircraft
accident in history?

Fog and Runway Incursions

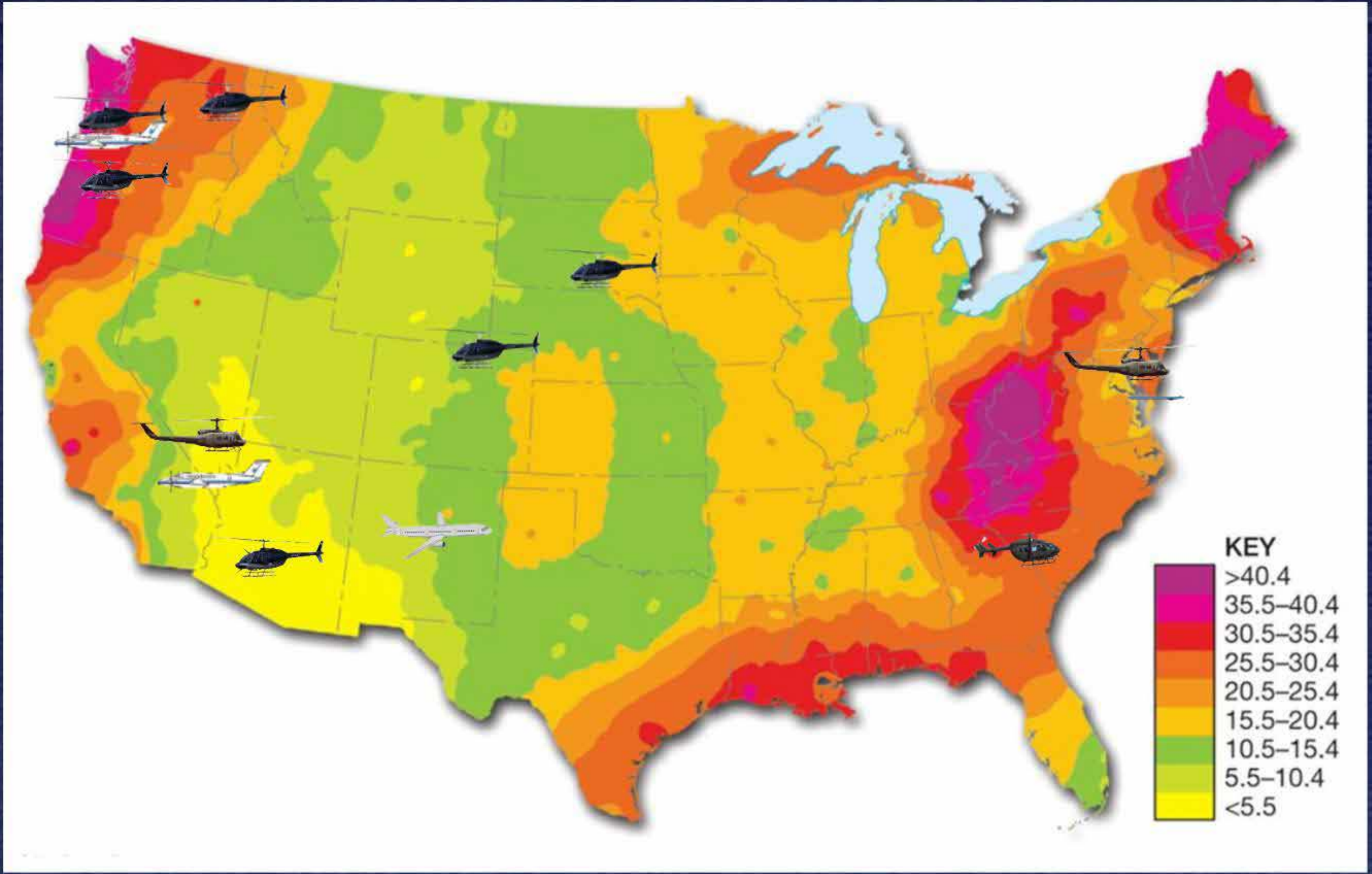
WX M1/4SM FG VV001

Tenerife, Canary Islands
Pan Am and KLM B747's
March 27, 1977

Worst aviation accident in history - 583 fatalities
61 survivors from Pan Am

NTSB

Average number of days per year with dense fog



Dense Fog – visibility less than 1/4SM

Love Ceilings & Visibility

- All aircraft impacted
- Helicopter operations most susceptible to encountering unforecast & local restricted visibility conditions
- Loss of control in IMC events almost always fatal

DOE Flight Department Safety Manager

- DOE Bell 406 returning from survey work coming into for landing hit by gust of wind, and began to spin uncontrollable, and impacted terrain.
- Thunderstorm in vicinity
- Substantial damage & minor injuries
- NTSB limited investigation (telephone)
- Boss wants to know what happened and now!

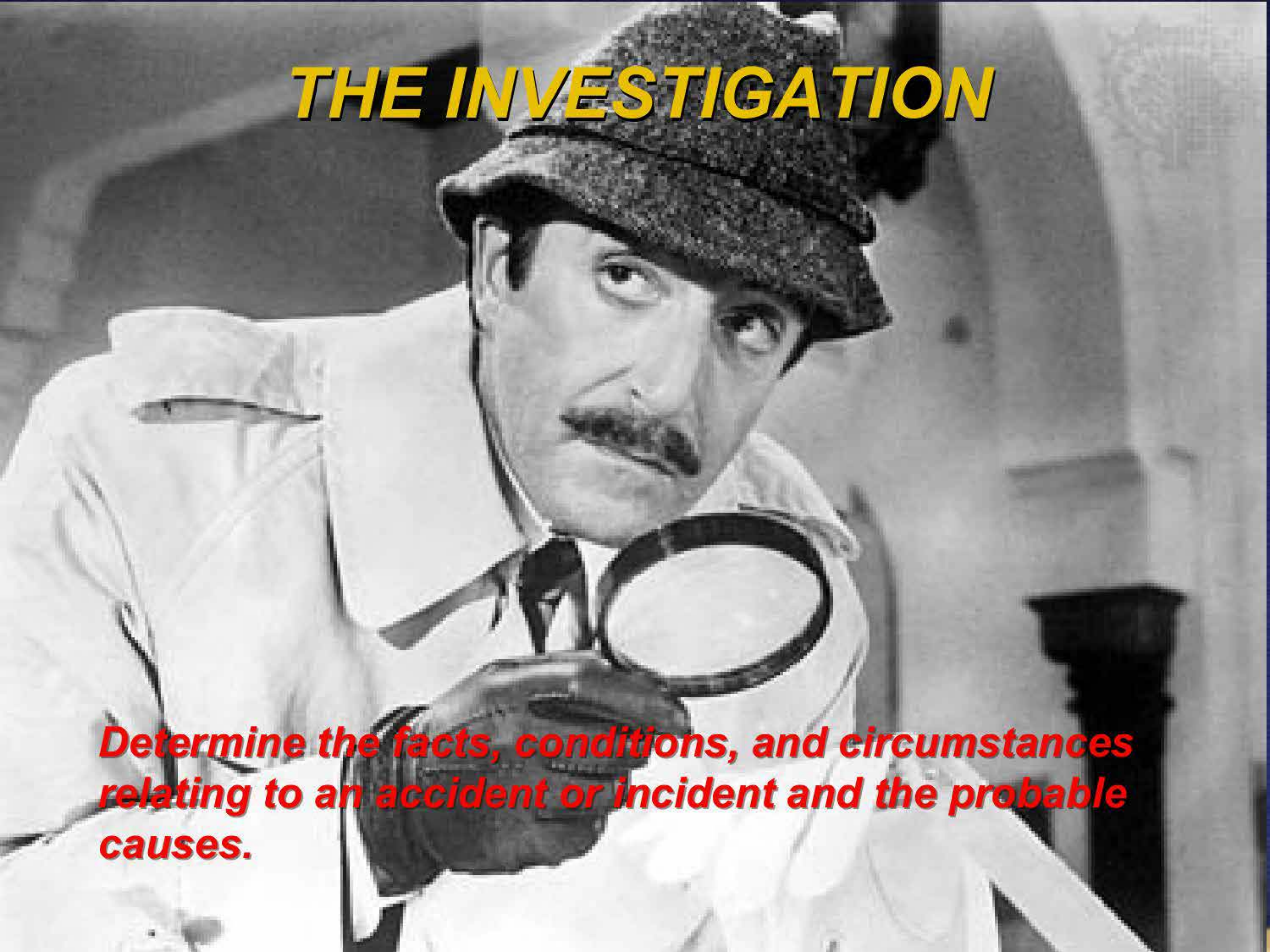
NTSB

CEN12LA258 – Amarillo, TX
Bell 406B, N2068X
April 26, 2012 @ 1645 CDT

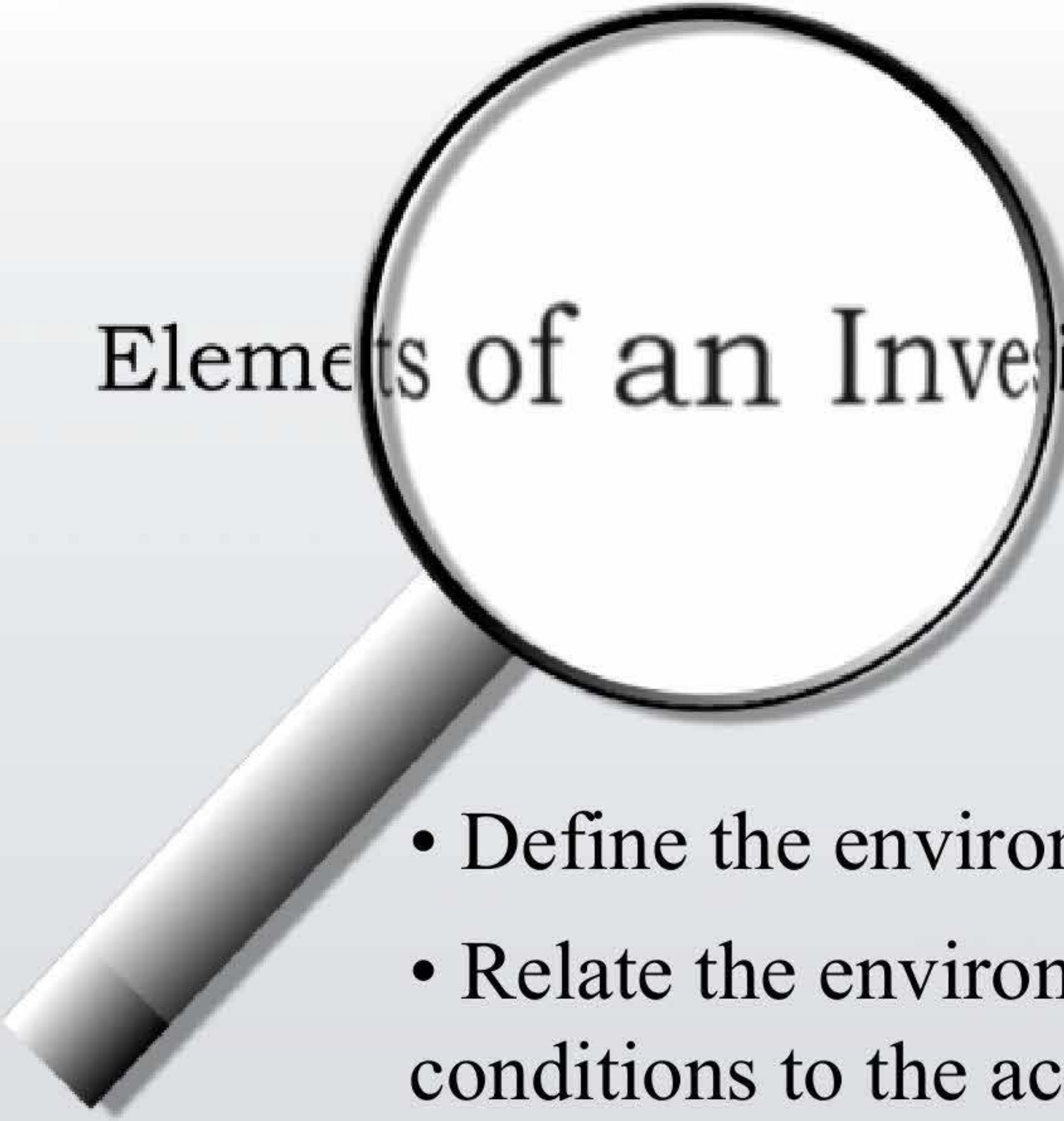
- Part 91 aerial observation
- Day VMC prevailed
- Pilot: commercial/CFI helicopter 1,105 hours
- Wx briefing: ForeFlight, MyRadar, Aero Weather
- Pilot aware of thunderstorms & lightning close to the airport, trying to beat storm in (heading 150°)
- Caught in wind gust, lifted helicopter & uncommanded turn, spinning to the right, impacting ground
- Helicopter destroyed, 2 shaken but uninjured
- What happened?

NTSB

THE INVESTIGATION



Determine the facts, conditions, and circumstances relating to an accident or incident and the probable causes.



Elements of an Investigation

- Define the environment
- Relate the environmental conditions to the accident
- Evaluate weather products and services

Common Elements of a Weather Study

- Synoptic conditions
- Observations
- Upper air data
- Satellite imagery
- Radar imagery
- Lightning data
- NWS advisories and forecast
- Weather briefing documents
- Witness statements & interviews
- Astronomical data

Weather Elements

- **Synoptic Conditions:**
  - NWS Surface Analysis Chart
    - Define the major pressure systems and boundaries influencing the area, wind, and weather
  - NWS Weather Depiction Charts
    - Extent of IFR / MVFR / VFR areas
  - Regional Radar Mosaic images
  - NWS Constant Pressure Charts
    - Upper air features and support, such as jet stream
  - NWS Prognostic Charts
    - Forecast conditions
  - Convective Outlook
    - Thunderstorm extent and severity

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Aviation Weather Services

AVIATION WEATHER SERVICES

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Advisory Circular,
AC 00-45G,
Change 1

Photo courtesy of Aaron A. Gilstad

Published July 29, 2010

AC 00-45G

- Basic reference guide how to read and interpret all NWS weather products
- Listed as required knowledge in FAA Airmen test guides

http://www.faa.gov/regulations_policies/

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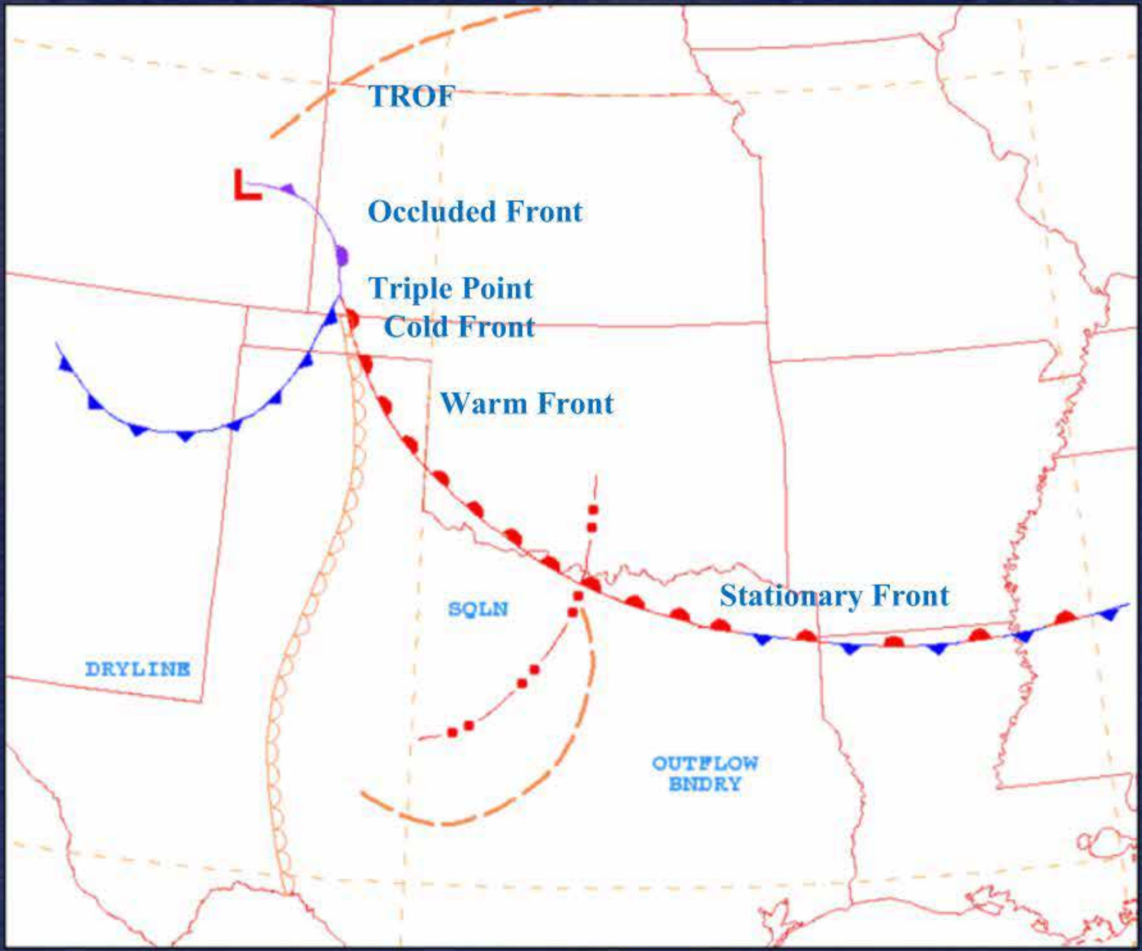
Surface Analysis

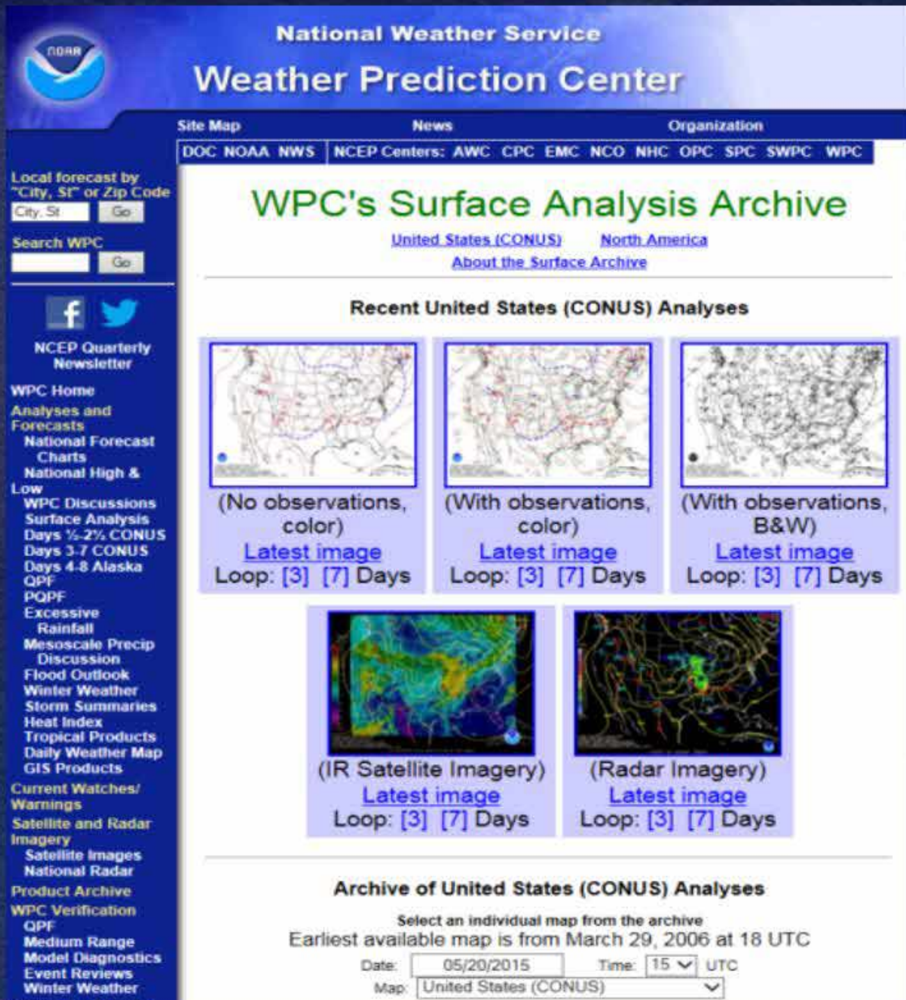


Key features:

- Pressure systems
- Fronts
  - Occluded
  - Cold
  - Warm
  - Stationary
- Boundaries
  - Trough “trof”
  - Dryline
  - Squall line
  - Outflow

Boundaries are locations providing forceful lifting of the airmass and support wind shifts, clouds, and weather

Synoptic Conditions: Archive Surface Analysis from Weather Prediction Center (WPC)



Data from 2005

Map options:

- United States (CONUS)
- Fronts/Analysis only
- Analysis/Satellite Composite
- Analysis/Radar
- High resolution map

http://www.wpc.ncep.noaa.gov/archives/web_pages/sfc/sfc_archive.php

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National Center for Environmental Information (NCEI) Weather Chart Archive

NOAA NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Home Climate Information Data Access Customer Support About NCDC

Search NCDC

NOMADS > SRRS Charts

NOMADS Support | About SRRS | Chart Terms

Chart Type Selection

The Service Records Retention System (SRRS) is an archive and access system for selected National Weather Service (NWS) operational products maintained at the National Climatic Data Center.

NOTE: This system provides National Weather Service charts that are archived at the National Climatic Data Center. Additional charts from earlier years are available for offline ordering.

North American Analysis
North American Forecast
Northern Hemisphere Analysis
Northern Hemisphere Forecast
Ocean Analysis
Ocean Forecast
Southern Hemisphere Analysis
Tropical Analysis
US Radar Summary

Continue

Define chart terms (opens in new window)

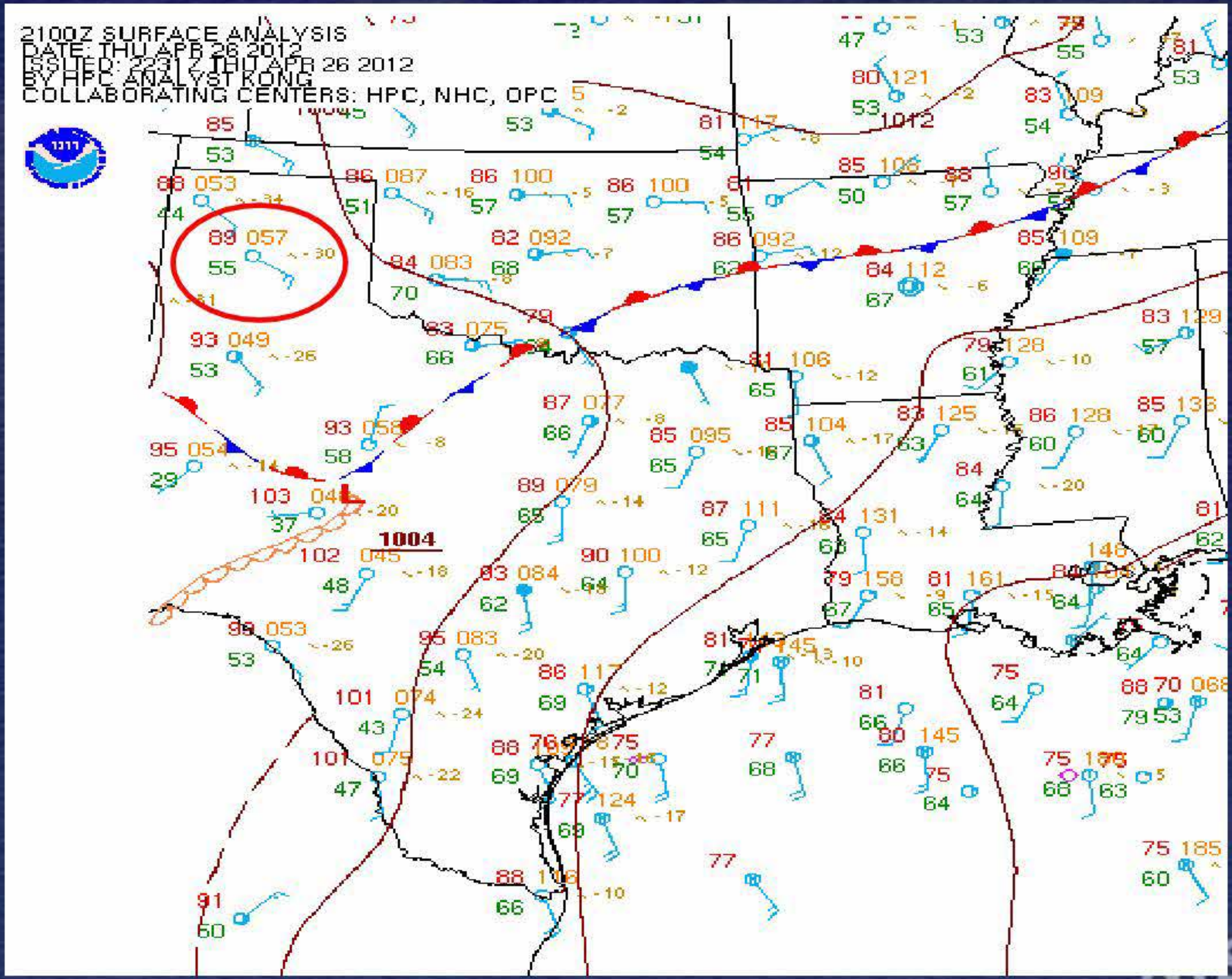
Access to:

- Surface Analysis Chart
- Weather Depiction Chart
- Radar Summary Chart
- Constant Pressure Charts

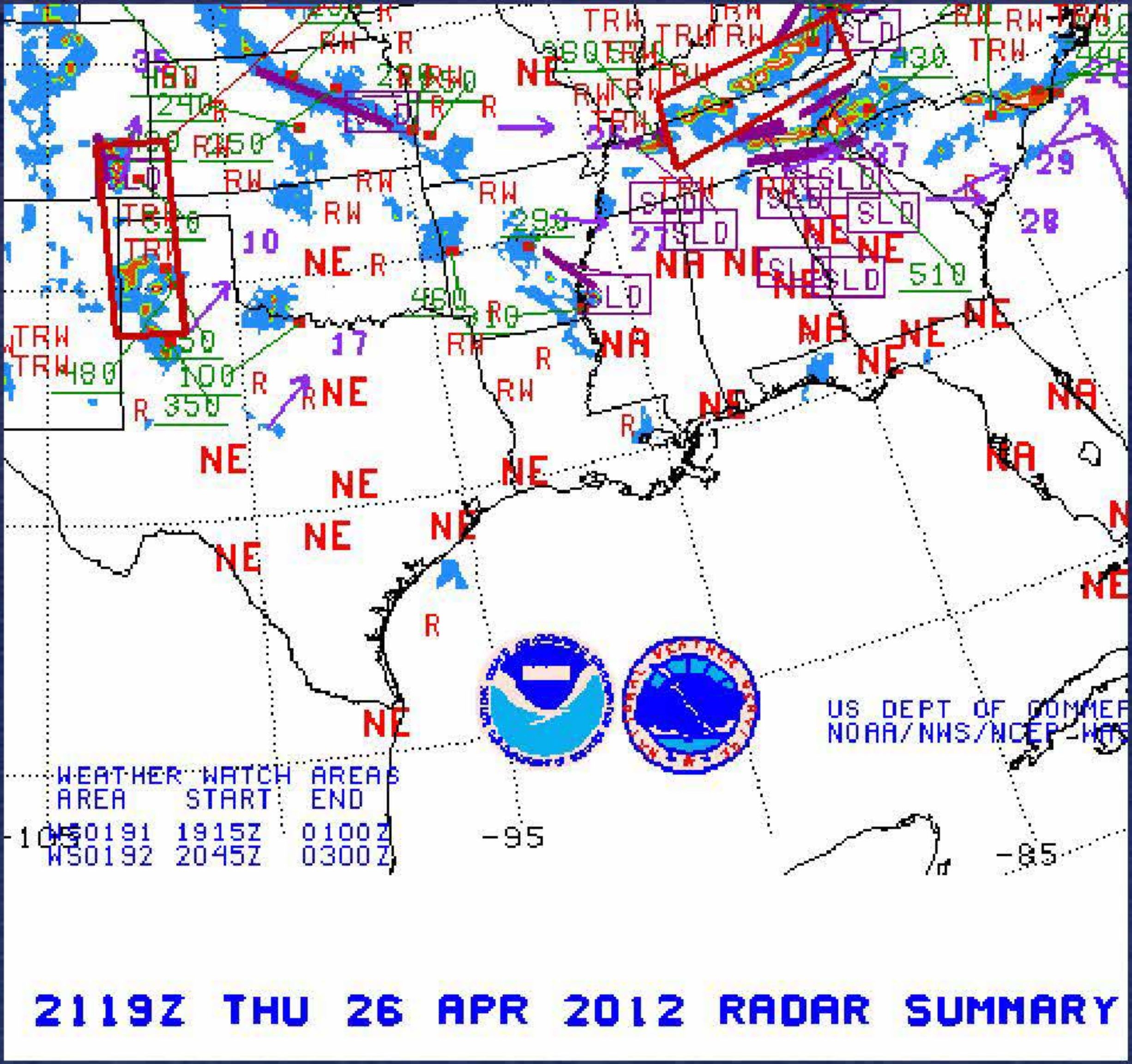
Formerly known as National Climatic Data Center (NCDC)

http://nomads.ncdc.noaa.gov/ncep/NCEP

United States Analysis Charts -
Surface south-central Analysis



NWS Radar Summary Chart



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Radar Coded Message (RCM) Plot – Radar Summary

Plymouth State Weather Center

Make Your Own...

Archived Radar Control Message (RCM) Data Maps

Radar Control Message (RCM) summaries are composites of high resolution NEXRAD reflectivity data that have been mapped to 10-km gridded resolution. This process loses some detail, but it still provides much finer resolution than corresponding Manually Digitized Radar (MDR) report-based maps. RCM reports also are provided every
red to the hourly frequency of MDR reports.

Contiguous US
New Hampshire
New England
Northeast
Mid-Atlantic
Southeast
Midwest
Southern Plains
Northwest
Southwest

center location(and zoom factor), type, date/time, county option, and size for the map.

Type:	Date/Time:	County Outlines:	Map Size:
Radar Summary	2012 Apr 26 2145 Z	No counties	640x480

----------OR----------

Center Location: KAMA **Zoom Factor:** No Zoom

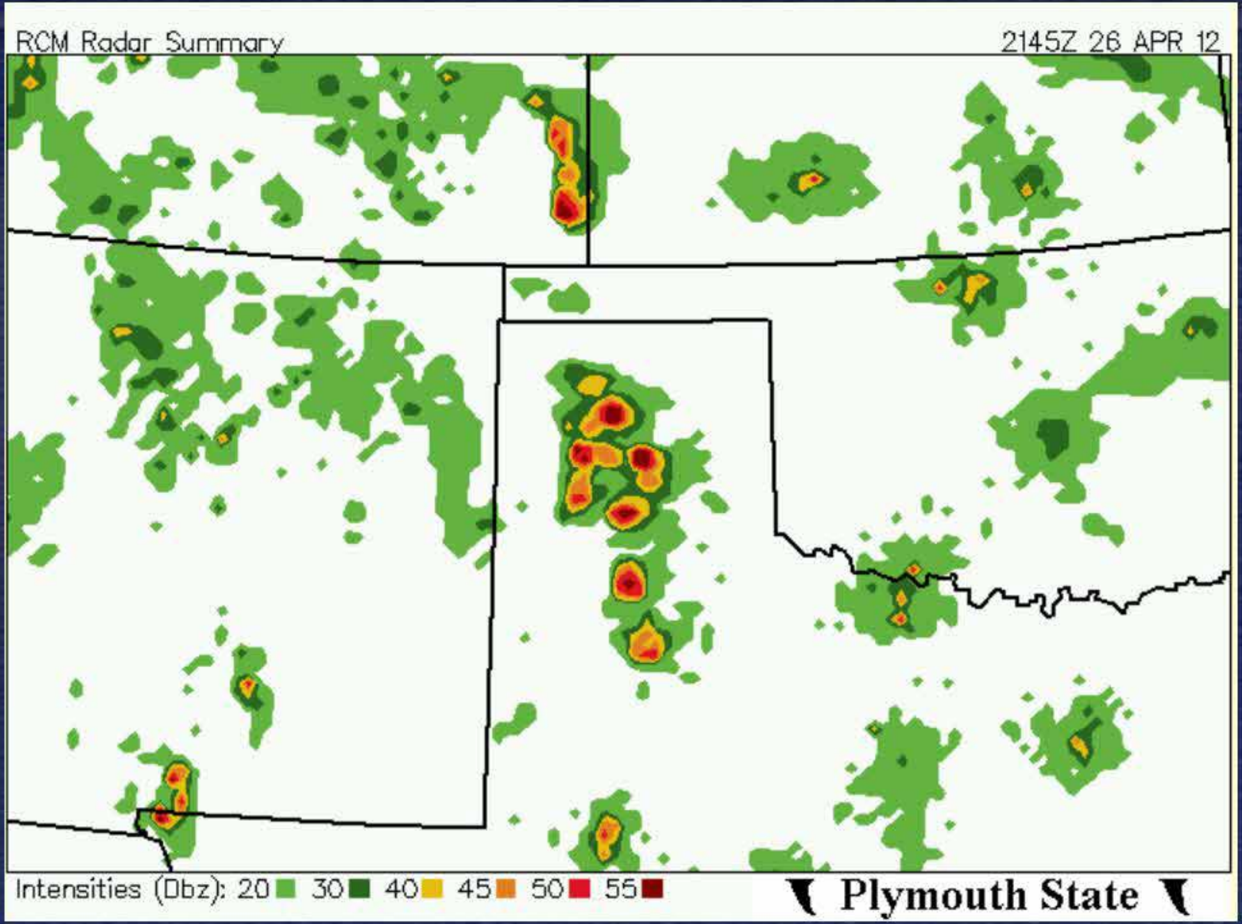
Click Here to Make the Map | Reset

- NWS discontinued making Radar Summary Charts in 2013
- RCM image provides a quick radar image

http://vortex.plymouth.edu/rcm-u.html

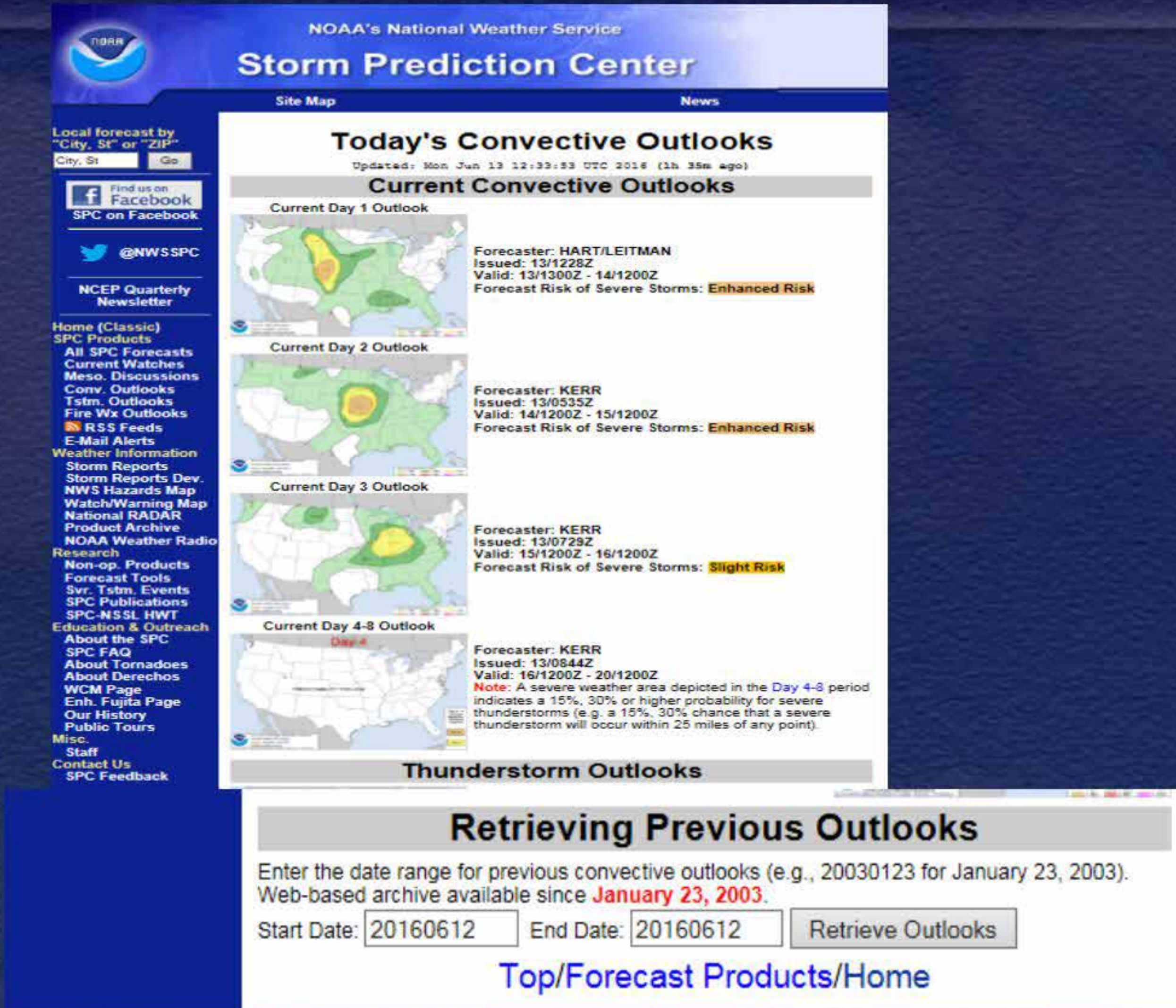
NTSB

Plymouth State RCM Radar Display



- Several large organized areas of echoes depicted, further radar data will be required to determine potential impacts…

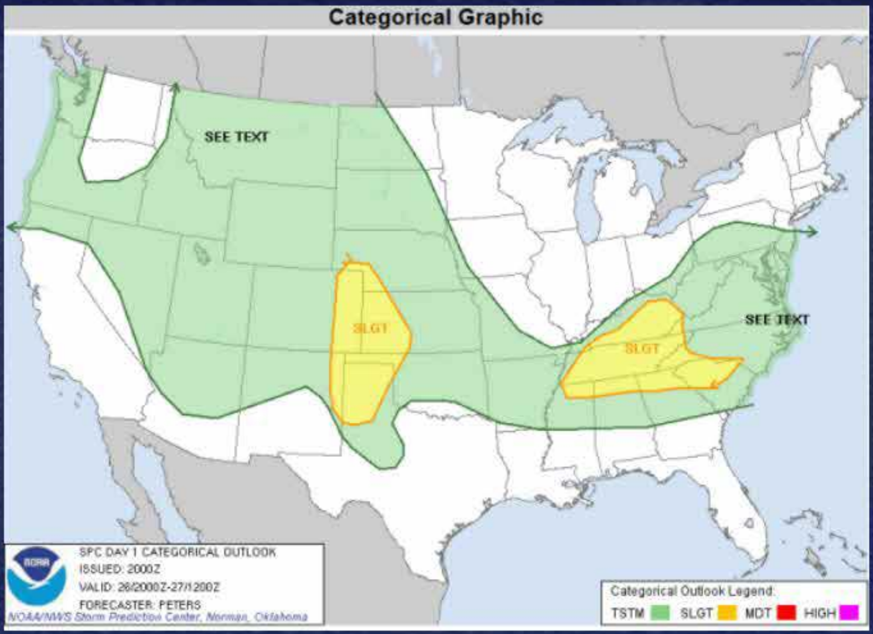
Convective Activity



http://www.spc.noaa.gov/products/outlook/

NTSB

Convective Outlook (AC)



SPC AC 262000

DAY 1 CONVECTIVE OUTLOOK
NWS STORM PREDICTION CENTER NORMAN OK
0300 PM CDT THU APR 26 2012

VALID 262000Z - 271200Z

...THERE IS A SLGT RISK OF SVR TSTMS ACROSS PARTS OF THE CENTRAL AND SRN HIGH PLAINS...

...THERE IS A SLGT RISK OF SVR TSTMS ACROSS KY/TN TO SC AND SRN NC...

...SRN/CENTRAL HIGH PLAINS THIS AFTERNOON TROUGH TONIGHT...
A COMPACT SHORTWAVE TROUGH OVER SRN CA THIS MORNING WILL EJECT ENEWD TO THE FOUR CORNERS THIS EVENING AND SE CO-NRN TX PANHANDLE BY 27/12Z...IN RESPONSE TO THE INLAND MOVEMENT OF A LARGER-SCALE TROUGH OVER THE PAC NW. LEE CYCLOGENESIS WILL OCCUR ACROSS THE HIGH PLAINS OF E/SE CO LATER TODAY INTO TONIGHT IN ADVANCE OF THE MIDLEVEL TROUGH. THE LEE CYCLOGENESIS WILL INDUCE STRENGTHENING SELY LOW-LEVEL FLOW AND NWWD ADVECTION OF THE 55-65 F BOUNDARY LAYER DEWPOINTS NOW OBSERVED ACROSS WRN OK/ERN TX PANHANDLE... BENEATH A VERY WARM ELEVATED MIXED LAYER. GIVEN THE PRESENCE OF THE STRONG CAP...RELATIVELY LATE ARRIVAL OF THE SHORTWAVE TROUGH... AND A SUBSTANTIAL PLUME OF MID/HIGH-LEVEL MOISTURE/CLOUDS...THE MORE PROBABLE AREA FOR DAYTIME STORM INITIATION WILL BE ON THE HIGH PLAINS FROM NE NM INTO SE CO. HERE...AFTERNOON TEMPERATURES OF 80-85 F WILL BE SUFFICIENT TO REMOVE CONVECTIVE INHIBITION...AND STORM DEVELOPMENT IS EXPECTED ALONG THE SHARPENING LEE TROUGH.

THE INITIAL STORMS WILL LIKELY BE HIGH-BASED SUPERCELLS CAPABLE OF PRODUCING LARGE HAIL/DAMAGING WINDS GIVEN SOMEWHAT LIMITED BOUNDARY LAYER MOISTURE THIS AFTERNOON...WHILE THE LOWER PLAINS REMAIN CAPPED. TONIGHT...FOCUSED ASCENT IN ADVANCE OF THE MIDLEVEL TROUGH WILL HELP ERODE THE CAP...AS A WARM FRONT MOVES NWD ACROSS THE TX PANHANDLE/WRN OK AND RICHER MOISTURE SURGES NWWD. LOW-LEVEL SHEAR WILL LIKEWISE INCREASE...RESULTING IN AN ENVIRONMENT THAT IS MORE FAVORABLE FOR A COUPLE OF NOCTURNAL TORNADIC SUPERCELLS FROM EXTREME SE CO INTO SW KS. THE SRN EXTENT OF THE OVERNIGHT SEVERE THREAT BECOMES MORE QUESTIONABLE DUE TO STRONGER CAPPING.

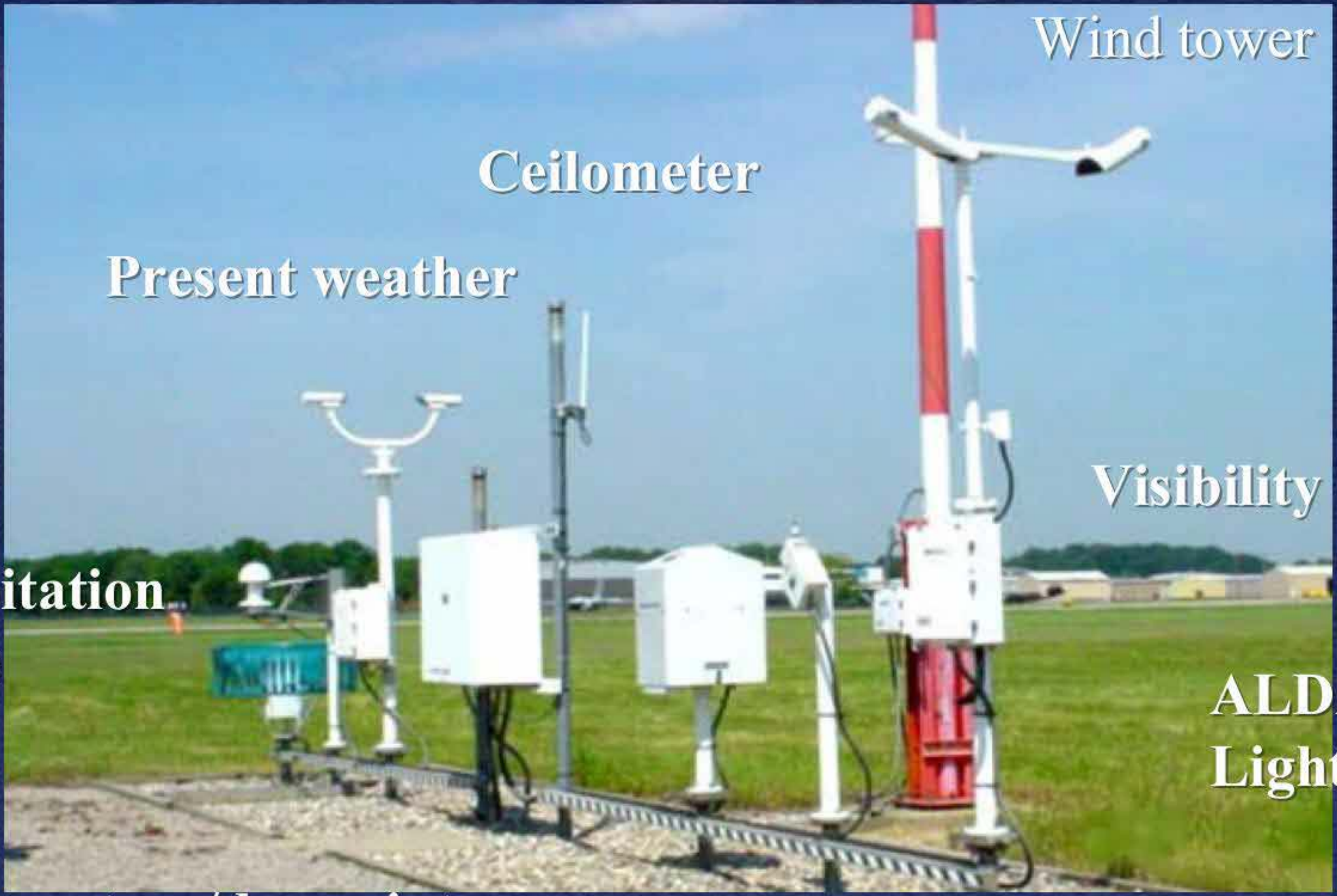
Elements of a Weather Study

- Synoptic conditions
- **Observations**
  - **Automated Surface Observation System (ASOS)**
    - Federally installed & maintained systems - NWS
    - NWS synoptic stations
    - Major airports – full sensor array
    - Almost always augmented by observers – 0600-2200 local
    - High resolution data: 5-min & 1-min data
  - **Automated Weather Observation System (AWOS)**
    - Federal/State funded - FAA
    - Secondary airports
    - Airports with instrument approach procedures
    - Varying sensors – levels 1, 2, 3
    - Typically unaugmented "AUTO"
    - Observations every 20-min long line (wx circuits)

NTSB

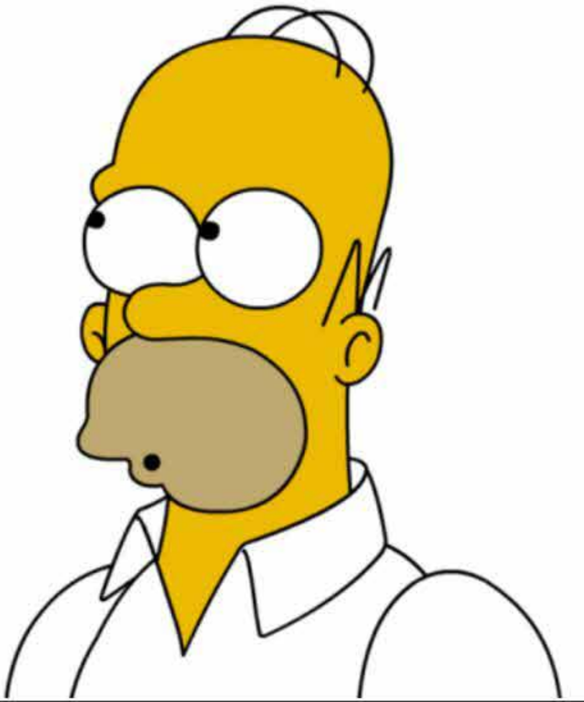
Automated Surface Observation System (ASOS) – Federal NWS
Automated Weather Observation System (AWOS) – Non-Federal

- Typical location near touchdown zone of primary runway



CAN YOU READ THIS FAST WITH UNDERSTANDING?

METAR KAMA 262153Z 12019G25KT 10SM TS FEW090 SCT110 28/14 A2984 RMK AO2 PK WND 11027/2134 TSB47 SLP054 T02780144



Meteorological Aerodrome Reports (METARs) and Specials (SPECI)

TYPE STATION DATE/TIME WIND VISIBILITY WEATHER CLOUDS

METAR KAMA 262153Z 12019G25KT 10SM TS FEW090 SCT110 28/14 A2984 RMK AO2 PK WND 11027/2134 TSB47 SLP054 T02780144

TEMPERATURE/ DEWPOINT **ALTIMETER QNH** **RMK SUPPLEMENTAL INFORMATION**

ASOS

See Decode Sheet in Reference Notes

NTSB

KEY TO DECODE AN ASOS (METAR) OBSERVATION

```
METAR KABC 121755Z AUTO 21016G24KT 180V240 1SM R11/P6000FT -RA BR BKN015 OVC025 06/04 A2990
RMK AO2 PK WND 20032/25 WSHFT 1715 VIS 3/4V1 1/2 VIS 3/4 RWY11 RAB07 CIG 013V017 CIG 017 RWY11 PRESFR
SLP125 P0003 60009 T00640036 10066 21012 58033 TSNO $
```

TYPE OF REPORT	METAR: hourly (scheduled) report; SPECI: special (unscheduled) report.	METAR
STATION IDENTIFIER	Four alphabetic characters; ICAO location identifier.	KABC
DATE/TIME	All dates and times in UTC using a 24-hour clock; two-digit date and four-digit time; always appended with Z to indicate UTC.	121755Z
REPORT MODIFIER	Fully automated report, no human intervention; removed when observer signed-on.	AUTO
WIND DIRECTION AND SPEED	Direction in tens of degrees from true north (first three digits); next two digits: speed in whole knots; as needed Gusts (character) followed by maximum observed speed; always appended with KT to indicate knots; 00000KT for calm; if direction varies by 60° or more a Variable wind direction group is reported.	21016G24KT 180V240
VISIBILITY	Prevailing visibility in statute miles and fractions (space between whole miles and fractions); always appended with SM to indicate statute miles; values <1/4 reported as M1/4.	1SM
RUNWAY VISUAL RANGE	10-minute RVR value in hundreds of feet; reported if prevailing visibility is ≤ one mile or RVR ≤ 6000 feet; always appended with FT to indicate feet; value prefixed with M or P to indicate value is lower or higher than the reportable RVR value .	R11/P6000FT
WEATHER PHENOMENA	RA: liquid precipitation that does not freeze; SN: frozen precipitation other than hail; UP: precipitation of unknown type; intensity prefixed to precipitation: light (-), moderate (no sign), heavy (+); FG: fog; FZFG: freezing fog (temperature below 0°C); BR: mist; HZ: haze; SQ: squall; maximum of three groups reported; augmented by observer: FC (funnel cloud/tornado/waterspout); TS (thunderstorm); GR (hail); GS (small hail; <1/4 inch); FZRA (intensity; freezing rain); VA (volcanic ash).	-RA BR
SKY CONDITION	Cloud amount and height: CLR (no clouds detected below 12000 feet); FEW (few); SCT (scattered); BKN (broken); OVC (overcast); followed by 3-digit height in hundreds of feet; or vertical visibility (VV) followed by height for indefinite ceiling.	BKN015 OVC025
TEMPERATURE/DEW POINT	Each is reported in whole degrees Celsius using two digits; values are separated by a solidus; sub-zero values are prefixed with an M (minus).	06/04
ALTIMETER	Altimeter always prefixed with an A indicating inches of mercury; reported using four digits: tens, units, tenths, and hundredths.	A2990

REMARKS IDENTIFIER: RMK	RMK
TORNADIC ACTIVITY: Augmented; report should include TORNADO, FUNNEL CLOUD, or WATERSPOUT, time begin/end, location, movement; e.g., `TORNADO B25 N MOV E.`	
TYPE OF AUTOMATED STATION: AO2; automated station with precipitation discriminator.	AO2
PEAK WIND: PK WND dddff(f)/(hh)mm; direction in tens of degrees, speed in whole knots, and time.	PK WND 20032/25
WIND SHIFT: WSHFT (hh)mm	WSHFT 1715
TOWER OR SURFACE VISIBILITY: TWR VIS vvvvv: visibility reported by tower personnel, e.g., `TWR VIS 2`; SFC VIS vvvvv: visibility reported by ASOS, e.g., `SFC VIS 2`.	
VARIABLE PREVAILING VISIBILITY: VIS $v_nv_nv_nv_nVv_xv_xv_xv_x$; reported if prevailing visibility is < 3 miles and variable.	VIS 3/4V1 1/2
VISIBILITY AT SECOND LOCATION: VIS vvvvv [LOC]; reported if different than the reported prevailing visibility in body of report.	VIS 3/4 RWY11
LIGHTNING: [FREQ] LTG [LOC]; when detected the frequency and location is reported, e.g., `FRQ LTG NE.`	
BEGINNING AND ENDING OF PRECIPITATION AND THUNDERSTORMS: w'w'B(hh)mmE(hh)mm; TSB(hh)mmE(hh)mm	RAB07
VIRGA: Augmented; precipitation not reaching the ground, e.g., VIRGA.	
VARIABLE CEILING HEIGHT: CIG $h_nh_nh_nVh_xh_xh_x$; reported if ceiling in body of report is < 3000 feet and variable.	CIG 013V017
CEILING HEIGHT AT SECOND LOCATION: CIG hhh [LOC]; Ceiling height reported if secondary ceilometer site is different than the ceiling height in the body of the report.	CIG 017 RWY11
PRESSURE RISING OR FALLING RAPIDLY: PRESRR or PRESFR; pressure rising or falling rapidly at time of observation.	PRESFR
SEA-LEVEL PRESSURE: SLPppp; tens, units, and tenths of SLP in hPa.	SLP125
HOURLY PRECIPITATION AMOUNT: Prrrr; in .01 inches since last METAR; a trace is P0000.	P0003
3- AND 6-HOUR PRECIPITATION AMOUNT: 6RRRR; precipitation amount in .01 inches for past 6 hours reported in 00, 06, 12, and 18 UTC observations and for past 3 hours in 03, 09, 15, and 21 UTC observations; a trace is 60000.	60009
24-HOUR PRECIPITATION AMOUNT: $7R_{24}R_{24}R_{24}R_{24}$; precipitation amount in .01 inches for past 24 hours reported in 12 UTC observation, e.g., 70015.	
HOURLY TEMPERATURE AND DEW POINT: $Ts_nT_aT_aT_as_nT'_aT'_aT'_a$; tenth of degree Celsius; s_n: 1 if temperature below 0°C and 0 if temperature 0°C or higher.	T00640036
6-HOUR MAXIMUM TEMPERATURE: $1s_nT_xT_xT_x$; tenth of degree Celsius; 00, 06, 12, 18 UTC; s_n: 1 if temperature below 0°C and 0 if temperature 0°C or higher.	10066
6-HOUR MINIMUM TEMPERATURE: $2s_nT_nT_nT_n$; tenth of degree Celsius; 00, 06, 12, 18 UTC; s_n: 1 if temperature below 0°C and 0 if temperature 0°C or higher.	21012
24-HOUR MAXIMUM AND MINIMUM TEMPERATURE: $4s_nT_xT_xT_xs_nT_nT_nT_n$; tenth of degree Celsius; reported at midnight local standard time; 1 if temperature below 0°C and 0 if temperature 0°C or higher, e.g., 400461006.	
PRESSURE TENDENCY: 5appp; the character (a) and change in pressure (ppp; tenths of hPa) the past 3 hours.	58033
SENSOR STATUS INDICATORS: RVRNO: RVR missing; PWINO: precipitation identifier information not available; PNO: precipitation amount not available; FZRANO: freezing rain information not available; TSNO: thunderstorm information not available; VISNO [LOC]: visibility at secondary location not available, e.g., VISNO RWY06; CHINO [LOC]: (cloud-height-indicator) sky condition at secondary location not available, e.g., CHINO RWY06.	TSNO
MAINTENANCE CHECK INDICATOR: Maintenance needed on the system.	$
If an element or phenomena does not occur, is missing, or cannot be observed, the corresponding group and space are omitted (body and/or remarks) from that particular report, except for Sea-Level Pressure (SLPppp). SLPNO shall be reported in a METAR when the SLP is not available.	

U.S. **DEPARTMENT OF COMMERCE** - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION - National Weather Service - Observing Systems Branch, 1325 East-West Highway, Silver Spring, Maryland 20910 METAR/TA2/2-8-96

How to obtain METARs

- Multiple sources for observations:
  - OGIMET International data base
    http://www.ogimet.com/metars.phtml.en
  - Plymouth State Weather Center
    http://vortex.plymouth.edu/myo/sfc/statlog-a.html
  - University of Wyoming 30-day International data base
    http://weather.uwyo.edu/surface/meteorogram/
  - NWS AWC last 36 hours & graphic
    http://aviationweather.gov/adds/metars/
  - NCAR 5-day archive
    http://www.rap.ucar.edu/weather/surface/
  - NCDC Official NWS database
    http://cdo.ncdc.noaa.gov/qclcd/QCLCD?prior=N

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OGIMET – METAR/TAFs

FREE

OGIMET

Metar/Speci/Taf reports selection query

ICAO INDEXES	TYPE	SORT ORDER	NIL REPORTS	FORMAT
	ALL	Newest the first	NIL reports included	HTML

TIME INTERVAL	Year	Month	Day	Hour
BEGIN:	2012	March	20	12
END:	2012	March	21	12

Send Clean

Station

Date/Time

You have to set:

1. The **ICAO indexes** from desired stations, with a comma or space separing indexes. If you don't know the index, you can visit this page
2. The type of report you want to get
   - **ALL** It will show METAR, SPECI and TAF reports
   - **SA** METAR y SPECI.
   - **SP** only SPECI.
   - **FC** Only short TAF reports (validity 9 Hours).
   - **FT** Only large TAF reports (18 or 24 Hours).
3. Order of displayed results. You can select cronological or reverse order
4. You also can decide about to get "NIL" void reports
5. Output format
   - **HTML** Rich HTML output format
   - **TXT** Single plain TXT mode
6. Begin and end of time interval query. Time is UTC

http://www.ogimet.com/metars.phtml.en

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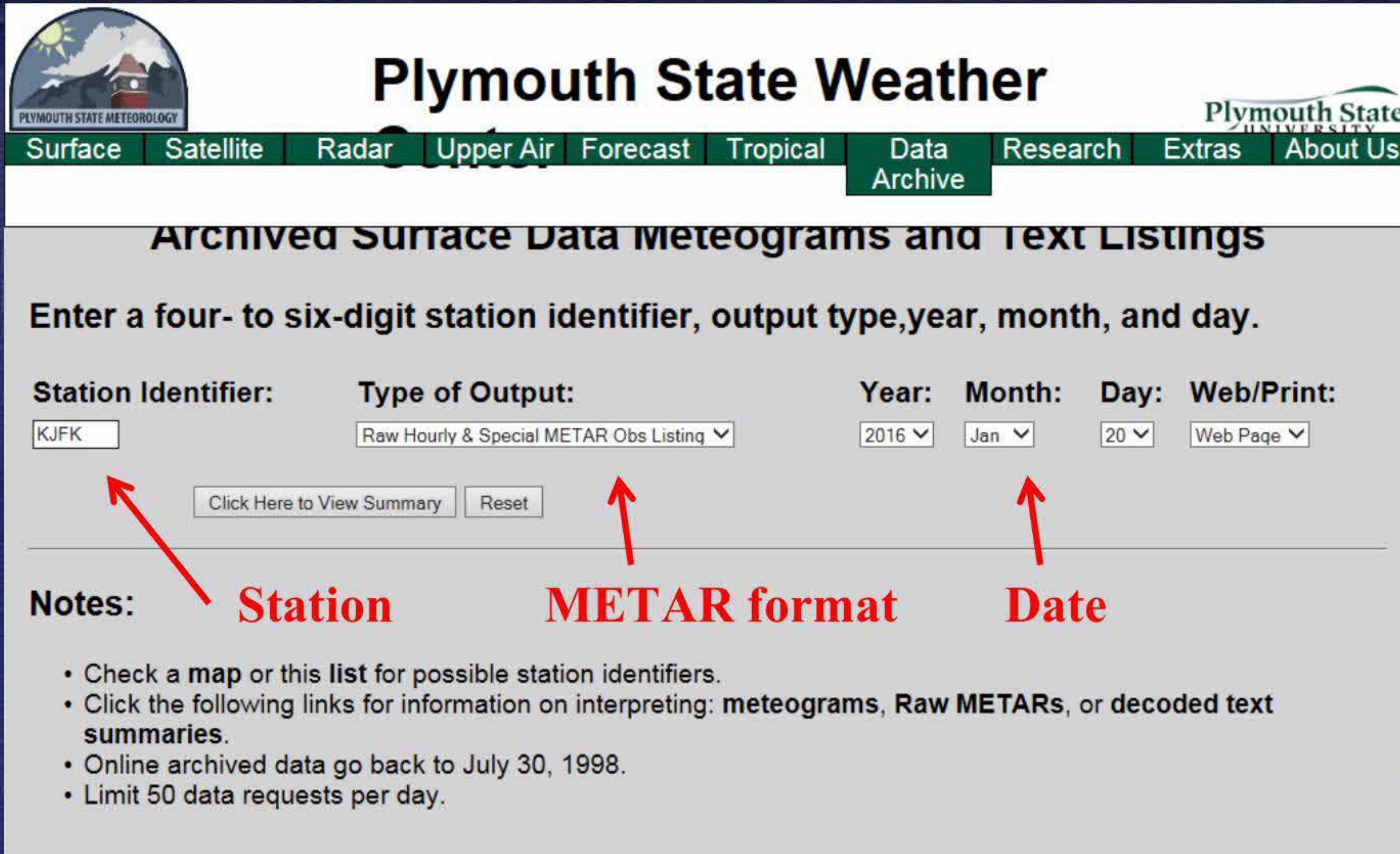
Plymouth State – METAR Archive



http://vortex.plymouth.edu/myo/sfc/statlog-a.html

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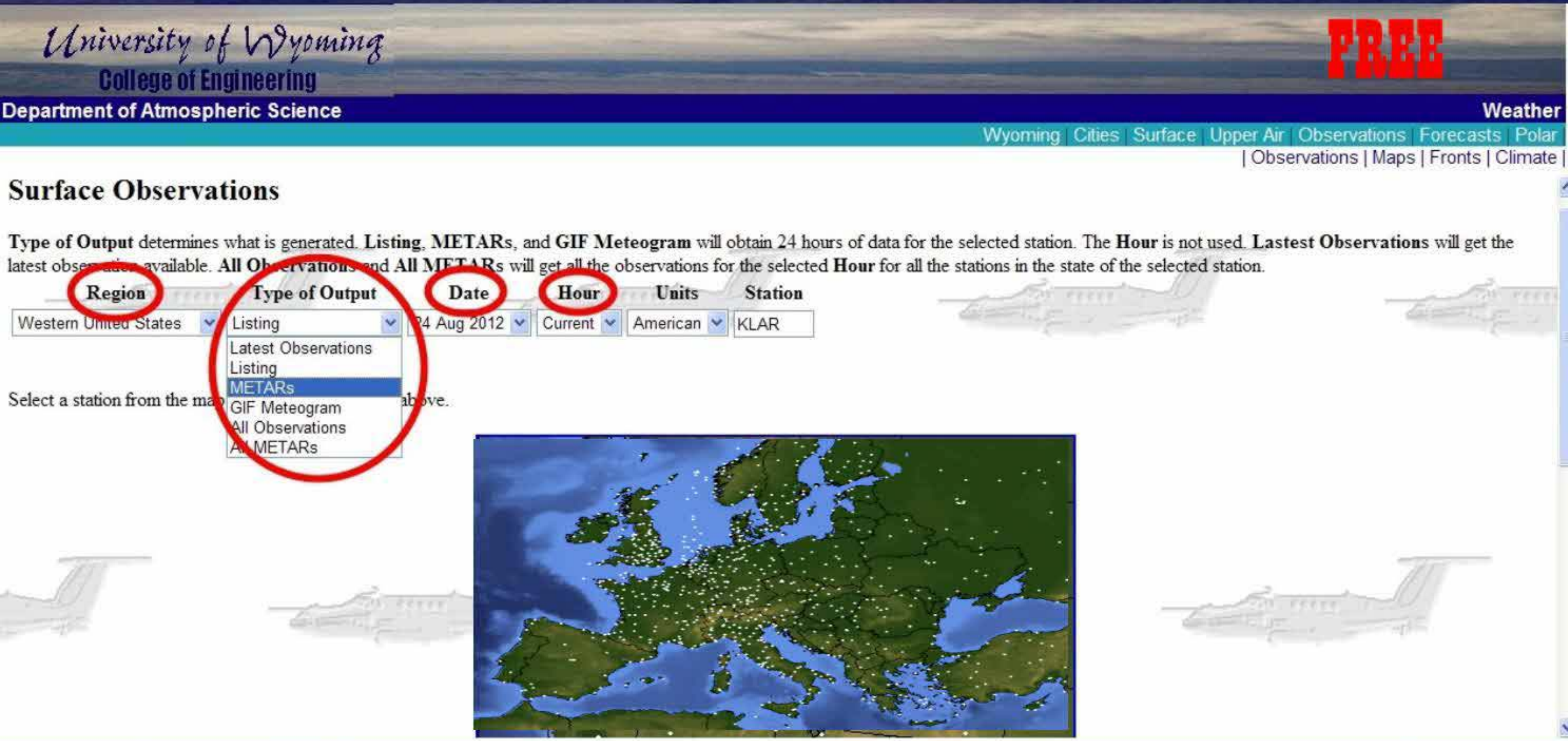
University of Wyoming - METARs

Choose "Region" of the world, select Type of Output as "METARs, then select ending date/time for period of interest. 30 day archive.



http://weather.uwyo.edu/surface/meteogram/

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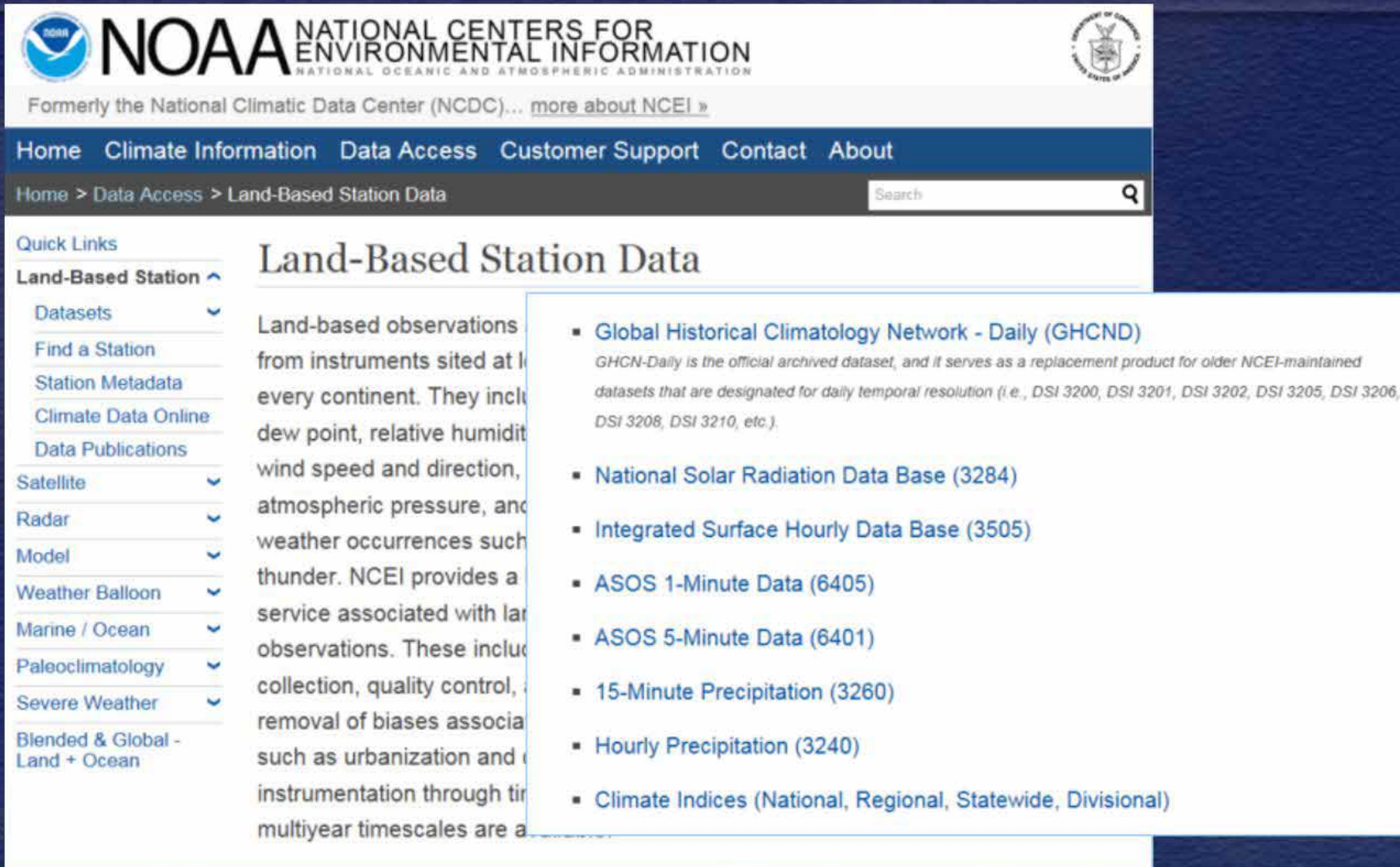
Observations

- Departure conditions
- METAR KAMA 261953Z 12009KT 10SM CLR 31/11 A2991 RMK AO2 SLP074 T03110111
- METAR KAMA 262053Z 12016G24KT 10SM CLR 32/13 A2986 RMK AO2 PRESFR SLP057 T03170128 58030
- Accident 2145Z
- METAR KAMA 262153Z 12019G25KT 10SM TS FEW090 SCT110 28/14 A2984 RMK AO2 PK WND 11027/2134 TSB47 SLP054 T02780144=
- METAR KAMA 262253Z 29029G40KT 1 1/2SM R04/6000VP6000FT +TSRA SCT036 SCT060 BKN070 17/14 A2990 RMK AO2 PK WND 29040/2252 RAB2154E13B40 SLP088 LTGICCG OVHD P0010 T01670139=

- Falling pressure, stronger pressure gradient & winds
- Wind direction ~30° left of nose
- High based thunderstorm – microburst conditions or gust front possibly involved?

NWS Observations & Forecasts



http://www.ncdc.noaa.gov/data-access/land-based-station-data

High Resolution Data 5-minute ASOS Observations Includes Station Pressure, RH%, Density Alt., magnetic wind

- 15:25:31 5-MIN KAMA 262125Z 11019G24KT 10SM CLR 29/13 A2982 3710 35 6200 110/19G24 RMK AO2 PRESFR
- 15:30:31 5-MIN KAMA 262130Z 11020G26KT 10SM CLR 29/12 A2981 3710 35 6200 110/20G26 RMK AO2 PK WND 09026/2127 PRESFR
- 15:35:31 5-MIN KAMA 262135Z 11021G27KT 10SM CLR 29/13 A2982 3700 36 6100 100/21G27 RMK AO2 PK WND 11027/2134
- 15:40:31 5-MIN KAMA 262140Z 10020G27KT 10SM CLR 29/13 A2982 3700 38 6100 100/20G27 RMK AO2 PK WND 11027/2134
- 15:45:31 5-MIN KAMA 262145Z 12020G26KT 10SM FEW090 28/14 A2983 3690 40 6100 110/20G26 RMK AO2 PK WND 11027/2134
- 15:50:31 5-MIN KAMA 262150Z 11019G25KT 10SM TS FEW090 SCT110 28/14 A2983 3690 42 6000 100/19G25 RMK AO2 PK WND 11027/2134 TSB47
- 15:55:31 5-MIN KAMA 262155Z 13017G25KT 10SM -TSRA FEW100 SCT110 27/15 A2984 3680 46 5900 120/17G25 RMK AO2 RAB54 P0000
- 16:00:31 5-MIN KAMA 262200Z 15013G23KT 10SM -TSRA SCT095 BKN110 27/14 A2982 3700 45 6000 140/13G23 RMK AO2 RAB2154 P0000

- Note wind 100°-120° at 20-27 KT

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Limitations of Automated Systems

- Only determine wx conditions directly over sensors, not over approach & departure routes
- Not all wx types identifiable, especially freezing precip
- Several different types of AWOS systems and service levels – some don't report weather type
- Not all AWOS's in NWS/FAA weather data bases for dissemination – available locally only

Observation Site Locations

Federal Aviation Administration

FAA Home ▸ Air Traffic

- Air Traffic 101
- Air Traffic Plans and Publications
- Environmental Reviews
- Flight Information
- International Aviation
- National Airspace System
- Separation Standards
- Technology

Surface Weather Observation Stations

ASOS/AWOS

Print

Share

State [Select a state or territory] Go

Weather station airport ID [ ] Go

example: KVNY for Van Nuys, CA

Top Tasks

- Check airport status & delays
- Become an air traffic controller
- View the Air Traffic Controller Workforce Plan

- AWOS A:
- AWOS A/V:
- AWOS I:
- AWOS II:
- AWOS III:
- AWOS IIIP:
- AWOS IIIT:
- AWOS IIIP/T:
- ASOS:
- AWSS:
- AWOS IV:
- Misc.:

https://www.faa.gov/air_traffic/weather/asos/

AWOS Systems – varying sensors

- Varying service levels of AWOS

Type	Wind	Visibility	Temp Dew Pt	Altimeter	Density Altimeter	Cloud Ceiling	Precipitation	Thunderstorm Lighting	Rainfall Accumulation	Runway Surface	Freezing Rain	Remarks
AWOS-A				✓								
AWOS-A/V		✓		✓								
AWOS-2	✓	✓	✓	✓	✓							
AWOS-3	✓	✓	✓	✓	✓	✓						
AWOS-3P	✓	✓	✓	✓	✓	✓	✓					
AWOS-3T	✓	✓	✓	✓	✓	✓		✓				
AWOS-3P/T	✓	✓	✓	✓	✓	✓	✓	✓				
AWOS-4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

Not all systems are alike!

NTSB

Elements of a Weather Study

- Synoptic conditions
- Observations
- **Upper air data**
  - **RAOB "balloon" reports**
  - **AMDAR/TAMDAR aircraft data**
  - **Numerical Model data**

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Upper Air data

- Worldwide over 900 sites, with ~100 NWS sites.
- Rawinsondes launched at 0000Z & 1200Z
- Observed information on:
  - Structure of the atmosphere
  - Temperature & moisture profile
  - Freezing level data
  - Cloud bases & tops
  - Precipitation type
  - Stability indices
  - Wind profile

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North America Upper Air Sites

NTSB

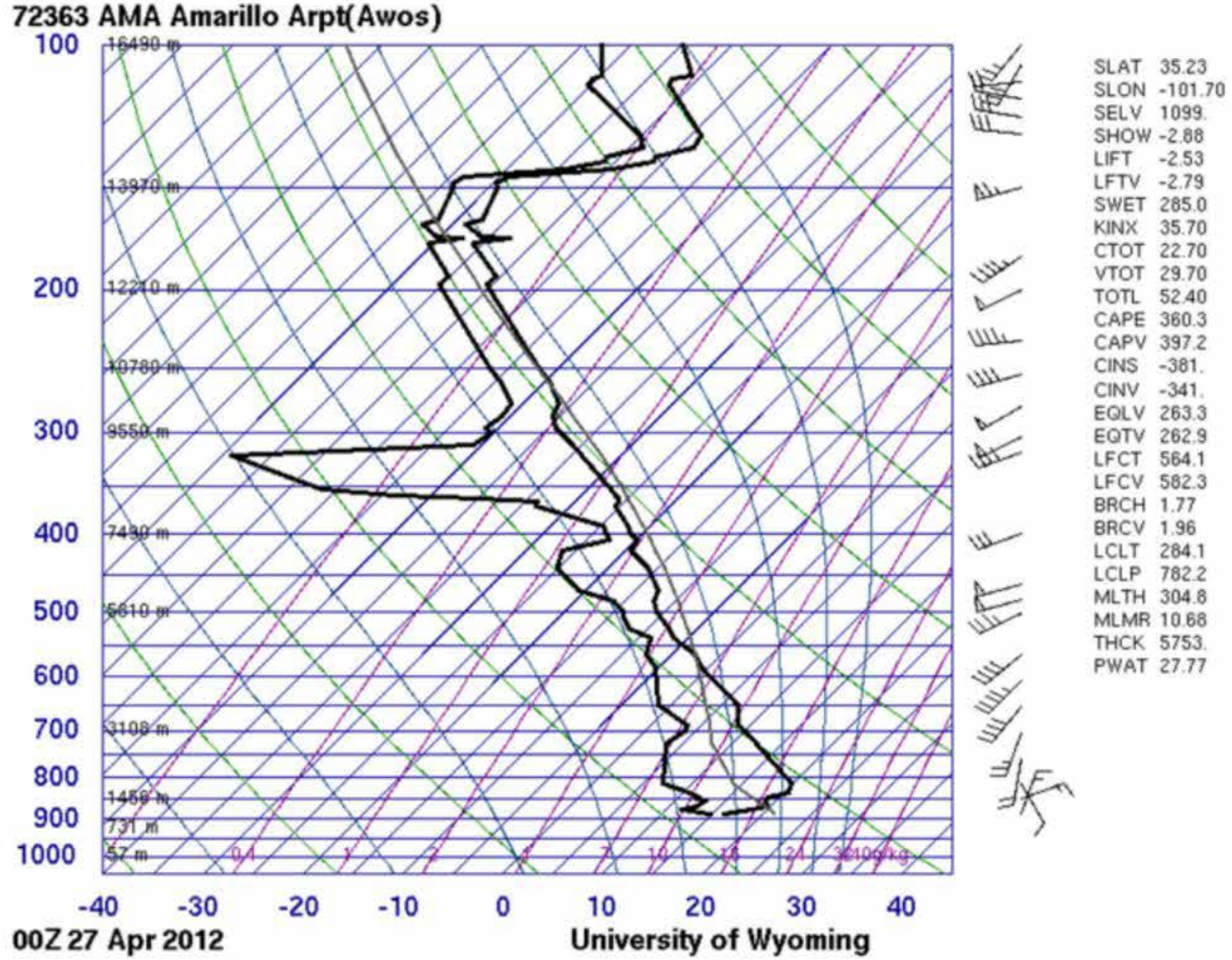
Upper Air Data - Soundings

University of Wyoming
College of Engineering
Department of Atmospheric Scie

Region | Type of plot
North America | Text: List

Click on the image to request a sounding

Skew-T plot
RAW Data



Description of the sounding indices.

Station Number: 72672

http://weather.uwyo.edu/upperair/sounding.html

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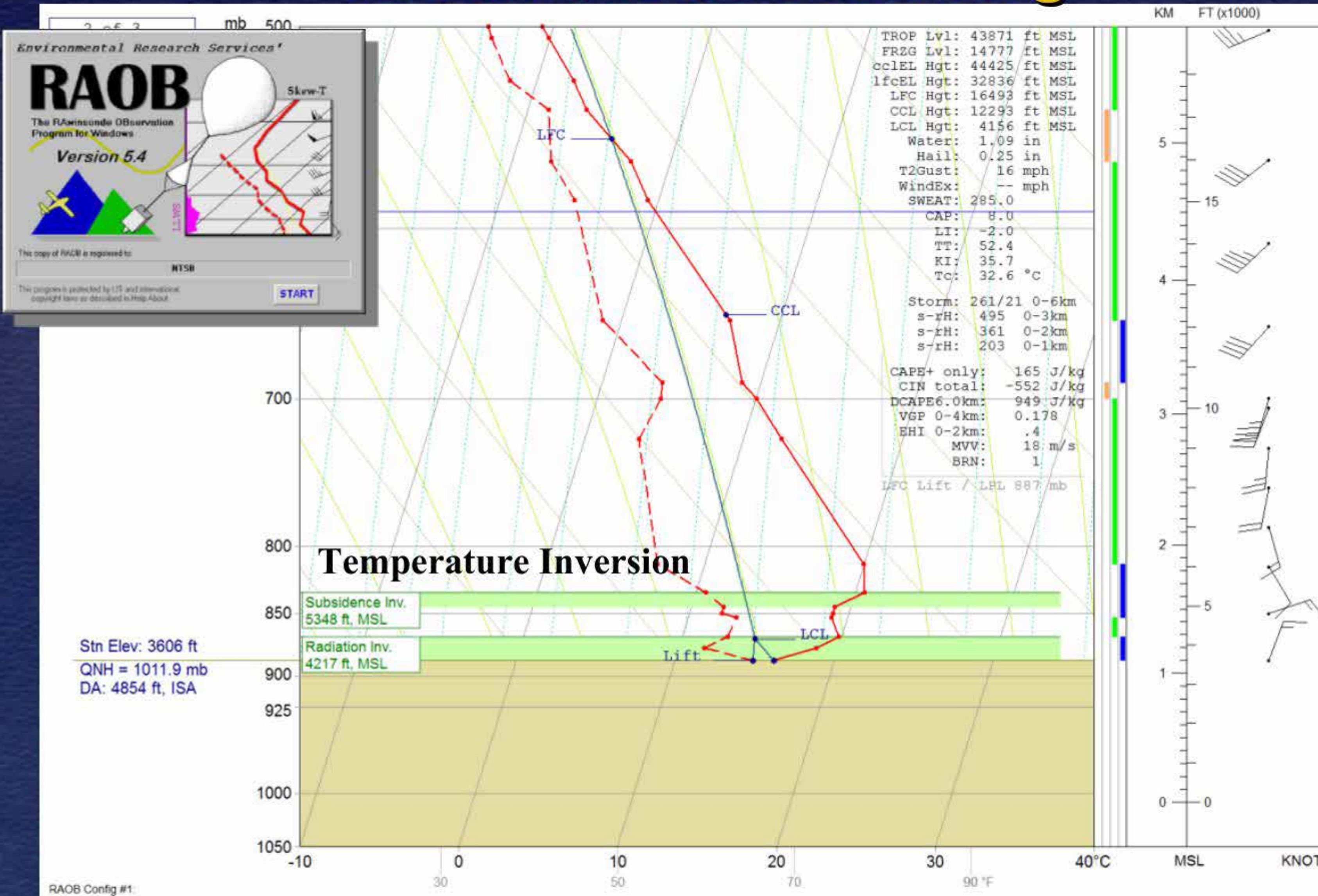
KAMA 0000Z sounding



http://www.raob.com/

Height (ft-AGL)	Pres (mb)	T (C)	Td (C)	RH (%)	DD/FF (deg/kts)	CAT (AF)	LLWS	Icing - Type (S-F clouds)	Wave/x—W—Turb nm fpm max
0	887	16.2	14.9	92	20/14				
319	877	18.6	11.6	64					
611	868	19.8	12.8	64					
1104	853	19.0	13.0	68		L-M	LIGHT		
1204	850	19.0	12.0	64	70/17				
1371	845	19.0	12.0	64					
1742	834	20.6	10.6	53		L-M	LIGHT		
2465	813	20.0	7.0	43	150/9				
3394	786				165/14	L-M			
4394	759				190/22				
5394	732				185/23				3.45 1296 MD-SV
5626	726	12.4	3.4	54		L-M			
6394	706				200/27	L-M			
6627	700	10.0	4.0	66	195/35				
7019	690	8.8	3.8	71		L-M			

Observed data:
- Pressure
- Height
- Temp/Dew T
- Relative Humidity
- Wind data

Analytical data:
- Turbulence (CAT)
- LLWS
- Icing
- MTN Wave


Requirements for thunderstorms:
1. Moisture
2. Instability
3. Lifting source
NASA

Parameter	Weak	Moderate	Strong
200 mb Wind Speed (kt)	51		
500 mb Wind Speed (kt)		39	
700 mb Wind Speed (kt)		35	
700 mb Dewpoint Depression (C)		6.0	
850 mb Wind Speed (kt)	17		
850 mb Dewpoint (C)		12.0	
700 - 500 mb lapse rate (C/km)	-7.7		
Boyden Index			101.6
BRN - Bulk Richardson No.	1		
BRN Shear (m^2/s^2)			207.4
CAP Strength	8.0		
CAPE 0-3 km, AGL	0		
CAPE Total	-387		
Craven SigSvr Parameter (mixed-layer lift)	6		
CT - Cross Totals		22.7	
DCAPE 6.0 km, AGL		949	
Delta Theta-e (ePT)	8.3		
EHI - Energy Helicity Index	0.4		
GOES HMI (Hybrid Microburst Index)	6		
Hail (inches)		0.25	
HI - Humidity Index			16.4
JI - Jefferson Index			32
K Index			35.7
KO Index			-4.7
LFC-LCL height (m)	3760		
LFC - Level of Free Convection (mb)	553		
LI - Lifted Index	-2.0		
MDPI - Microburst Day Potential Index	0.4		
NCAPE (Normalized CAPE)	0.03		
S Index			46.4
SCP - Supercell Composite Parameter			12.3
Severity - Thunderstorm Severiry Index			0.9
SHIP - Significant Hail Parameter	0.3		
SI - Showalter Index		-2.8	
srH - storm-relative Helicity (0-3 km)			495
STP - Significant Tornado Parameter	0.1		
Surface Dewpoint (C)		14.9	
SWEAT Index	285.0		
T2 Gust (kt)	14		
TI - Thompson Index			38
TQ Index		14	
TT - Total Totals		52.4	
VGP - Vorticity Generation Parameter		0.178	
VT - Vertical Totals			29.7
Waterspout Index			
WBZ - WetBulb Zero Hgt (ft,AGL)		9905	
Windex (kt)			
WMSI - Wet Microburst Severity Index	1		
Weighted Category Totals:	21	13	12

RPM = 26%

Stability of the Atmosphere

- Lifted Index (LI)
- K-Index
- Total Totals
- CAPE
- WINDEX

Event occurs:

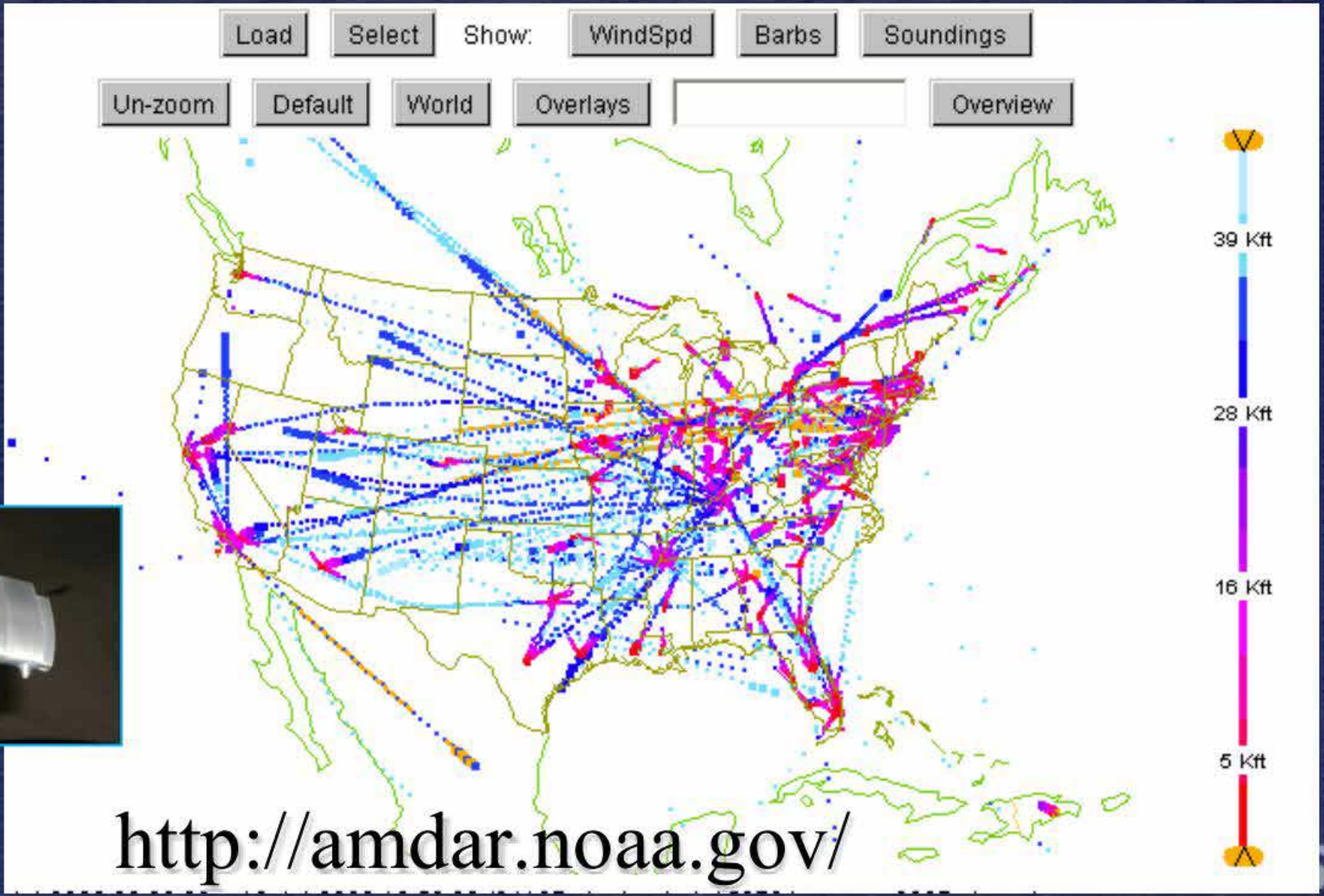
- **In between observations times**
- **Remote location**
- **Helicopter event far from reporting sites**

Options:

- **Aircraft observations**
- **Model data**

Aircraft Sounding Data

- Aircraft Communication Addressing and Reporting System (ACARS)
- Meteorological Data Collection and Reporting System (MDCRS)
- Aircraft Meteorological Data And Reporting (AMDAR)



http://amdar.noaa.gov/

NOAA/ARL Model Sounding

enter latitude/longitude in decimal format

Good source for foreign accident investigation where data is sparse and other remote locations, and for in between sounding launches

http://ready.arl.noaa.gov/READYamet.php

NTSB

Archive Model Data

ARL
Air Resources Laboratory
Conducting research and development in the fields of air quality, atmospheric dispersion, climate, and boundary layer

ARL Home > READY > Archived Meteorology > READY Program Options Menu

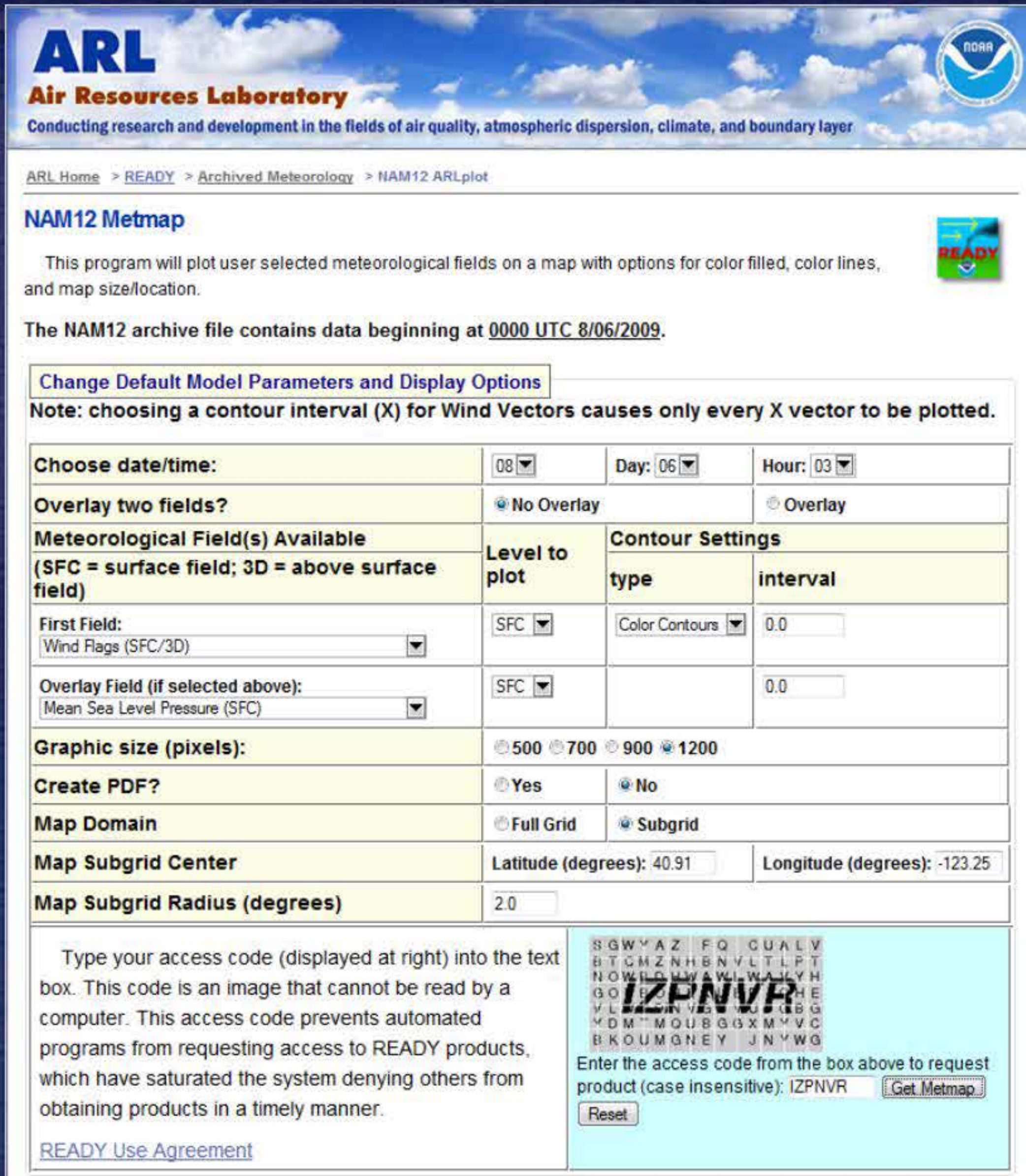
READY Program Options Menu

READY PRODUCTS FOR LOCATION: 40.91 -123.25

DISPLAY PROGRAM What is UTC, GMT, Z time?	METEOROLOGICAL DATA Information on archived datasets	
METEOROGRAM	-----------Choose An Archived Dataset-----------	Go
WINDGRAM	-----------Choose An Archived Dataset-----------	Go
WINDROSE	NAM (12km, 3 hourly, U.S.)	Go
SOUNDING	-----------Choose An Archived Dataset-----------	Go
STABILITY TIME-SERIES	-----------Choose An Archived Dataset-----------	Go
2D MAP (NCAR GRAPHICS)	NAM (12km, 3 hourly, U.S.)	Go
2D MAP (PSPLOT)	-----------Choose An Archived Dataset-----------	Go

Select display and model data

Archive Model Data



ARL
Air Resources Laboratory
Conducting research and development in the fields of air quality, atmospheric dispersion, climate, and boundary layer

ARL Home > READY > Archived Meteorology > NAM12 ARLplot

NAM12 Metmap

This program will plot user selected meteorological fields on a map with options for color filled, color lines, and map size/location.

The NAM12 archive file contains data beginning at 0000 UTC 8/06/2009.

Change Default Model Parameters and Display Options

Note: choosing a contour interval (X) for Wind Vectors causes only every X vector to be plotted.

Choose date/time:	08	Day: 06	Hour: 03
Overlay two fields?	No Overlay		Overlay
Meteorological Field(s) Available (SFC = surface field; 3D = above surface field)	Level to plot	Contour Settings type	interval
First Field: Wind Flags (SFC/3D)	SFC	Color Contours	0.0
Overlay Field (if selected above): Mean Sea Level Pressure (SFC)	SFC		0.0
Graphic size (pixels):	500 700 900 1200		
Create PDF?	Yes	No	
Map Domain	Full Grid	Subgrid	
Map Subgrid Center	Latitude (degrees): 40.91		Longitude (degrees): -123.25
Map Subgrid Radius (degrees)	2.0		

Type your access code (displayed at right) into the text box. This code is an image that cannot be read by a computer. This access code prevents automated programs from requesting access to READY products, which have saturated the system denying others from obtaining products in a timely manner.

READY Use Agreement

IZPNVR

Enter the access code from the box above to request product (case insensitive): IZPNVR Get Metmap

Reset

North American Mesoscale (NAM) numerical model 12KM, 3 hourly data for the U.S.

or

Global Data Assimilation System (GDAS) for 1° gridded data

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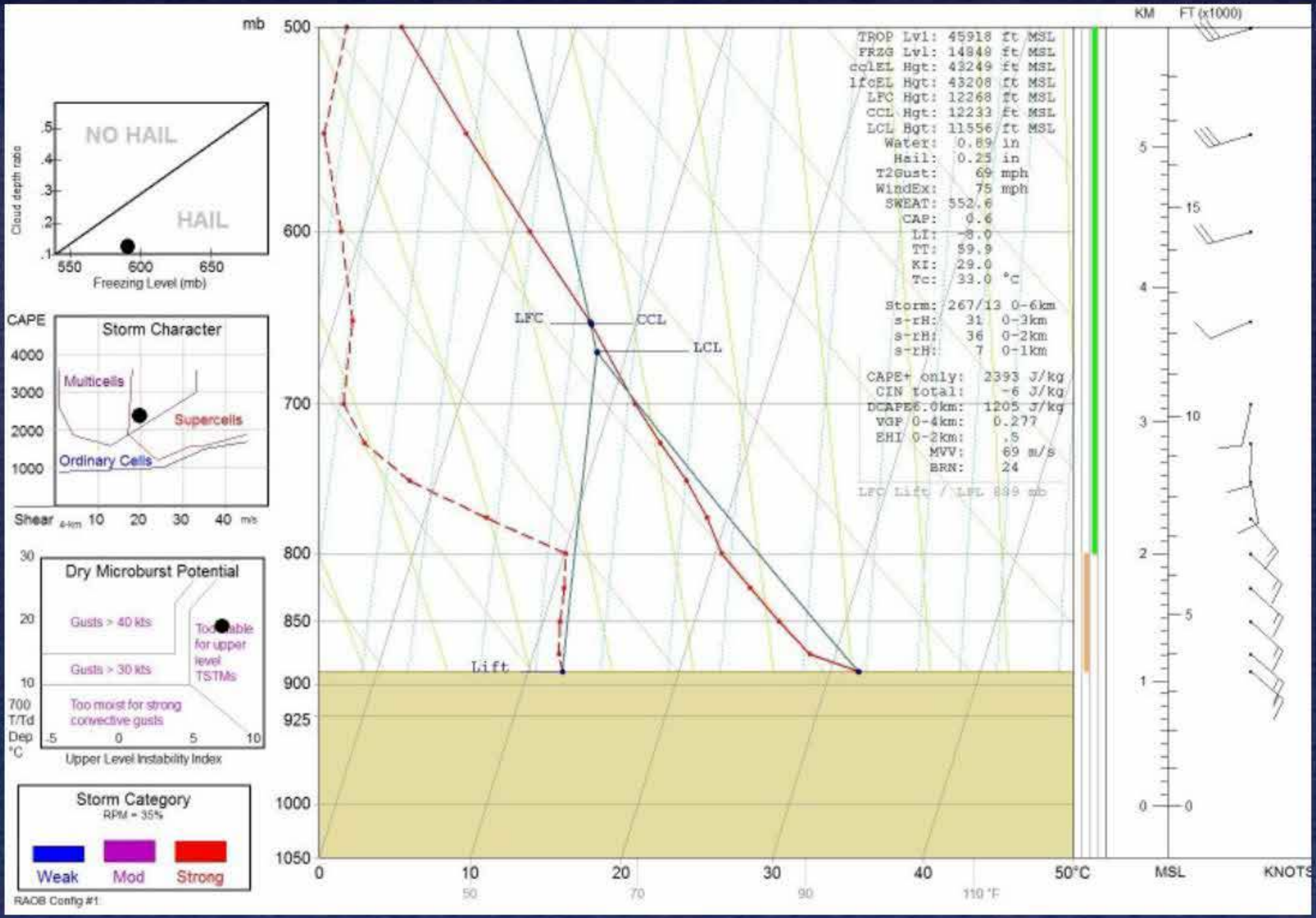
North American Mesoscale (NAM) numerical model for 2100Z over KAMA



Unstable atmosphere (LI -8) with moderate-strong likelihood of strong to severe multicellular to supercell type TSTMS due to increased shear

NTSB

Elements of a Weather Study

- Synoptic conditions
- Observations
- Upper air data
- **Satellite imagery**
  - **Infrared** – cloud tops temperatures (CTT)
  - **Water vapor** – jet stream, troughs, turbulence signature - moisture channel darkening
  - **Visible** – high resolution imagery (1 KM)

Geostationary Operational Environmental Satellites (GOES)

Alternate source for Satellite Imagery
Short term archive – 5 days

The National Center for Atmospheric Research
Operated by the University Corporation for Atmospheric Research

NCAR RAP Real-Time Weather Data

FREE

Home / RAP : Weather Home | Satellite | Radar | Surface | Upper-Air | Forecast

Images from GOES-12 and GOES-10 satellites:

- Visible
- Infrared (Color)
- Infrared (B/W)
- Water Vapor*
- Shortwave IR*

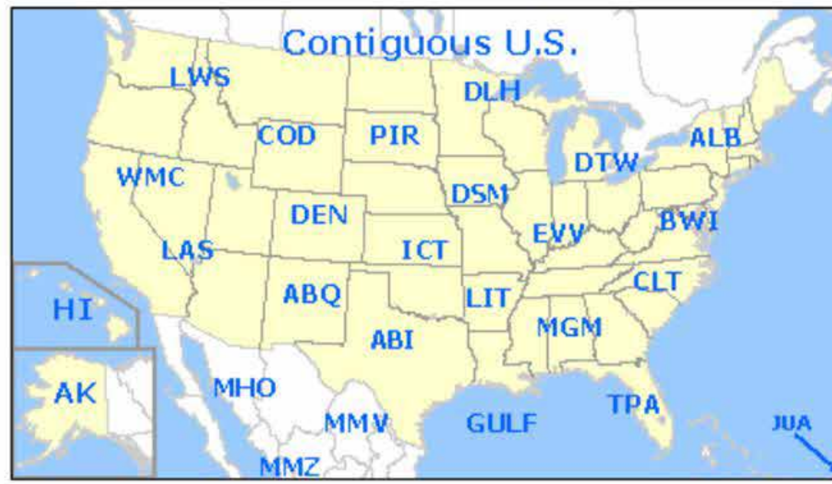
*Contiguous U.S. images only

Multi-Spectral:

- Channels 2-4*
- s/w IR reflectance*
- Icing Product*

End date: 23 Apr 2007
End time: 2000 UTC
Loop duration: Single image

Small size | Large size



http://www.rap.ucar.edu/weather/satellite/

NTSB

NOAA GEOSTATIONARY SATELLITE SERVER

GOES Home | Imagery at a Glance

GLOBAL
- Full Disk

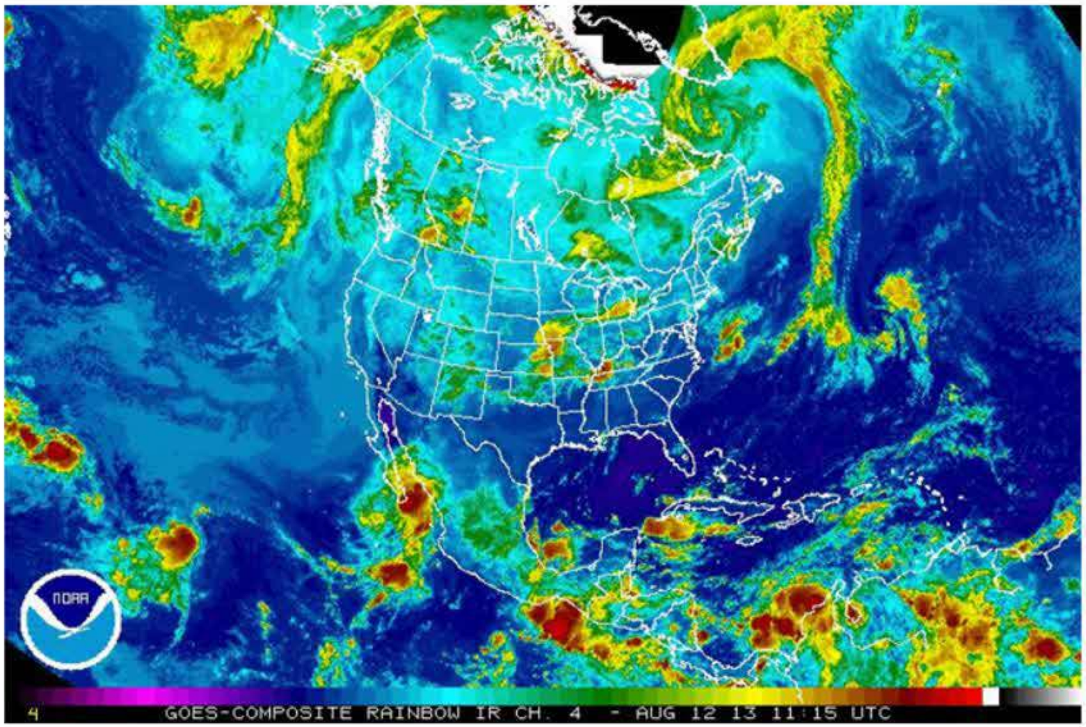
HEMISPHERIC
- GOES-East
- GOES-West
- Meteosat-10 (MSG)
- MTSAT
- East / West Composites

REGIONAL
- Northwest
- West Central
- Southwest
- Northern Plains
- Central Plains
- South Central
- Great Lakes
- Midwest
- Southeast
- Northeast
- Mid-Atlantic

STATE WFO SITES
- Eastern
- Southern
- Central
- Western
- Alaska
- Hawaii

SPECIAL IMAGE SETS
- Tropical Floaters
- Special Hazard Floaters
- Tropical Atlantic (Wide)
- Tropical East Pacific (Wide)
- Tropical West Pacific (Wide)
- GOES East Archives
- GOES West Archives

MISCELLANEOUS
- Previous Web Site



Continental US (NHEM) Sector Infrared

GOES-West	GOES-East	Meteosat-10 (MSG)	Meteosat-7	MTSAT
Global [IR | VIS]	Global [IR | VIS]	Global [IR | VIS]	Global [IR | VIS]	Global [IR | VIS]
Hemispheric	Hemispheric	Hemispheric		Hemispheric

http://www.goes.noaa.gov/

Note: Most of the previous version of the GOES Geostationary Server web site continues to exist and in time will be integrated into the new look and feel. » Previous web site

FREE

3 week archive available from NOAA

NTSB

Obtaining archive satellite images

NOAA OFFICE OF SATELLITE AND PRODUCT OPERATIONS
NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE

ORGANIZATION | SERVICES | PRODUCTS | OPERATIONS

Satellite Imagery Products

Archive | Composite | FAQ | Geographical Information Systems (GIS) | Geostationary Satellite Server | Land Sectors
Ocean Sectors | Current Image Overview | Hazard Specific Imagery | Fire/Smoke | Tropical Systems | Volcanic Ash

Archived Satellite Imagery

CLASS

Detailed Product Information

Local Archive
21 Day GOES Archive - GOES East | GOES West

Additional Archives
Comprehensive Large Array-data Stewardship System (CLASS)
NCDC GOES Archive
NGDC GOES Archive
University of Wisconsin (SSEC)

Historical Imagery
Operational Significant Event Imagery (OSEI)
Saved Tropical Imagery:
Hurricanes of 2005
Hurricane Sandy (October, 2012)
Super Typhoon Haiyan (November, 2013)

21 day archive

http://www.ospo.noaa.gov/Products/imagery/index.html

NOAA GEOSTATIONARY SATELLITE SERVER

GLOBAL
- Full Disk

HEMISPHERIC
- GOES-East
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- Northwest
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- Midwest
- Southeast
- Northeast
- Mid-Atlantic

STATE WFO SITES
- Eastern
- Southern
- Central
- Western
- Alaska
- Hawaii

GOES East Image Search

Choose the sector, channel, day and time you want to view. Only the last 21 days of images are online.

WHAT SECTOR?
- GOES EAST CONUS
- GOES EAST HURRICANE SECTOR

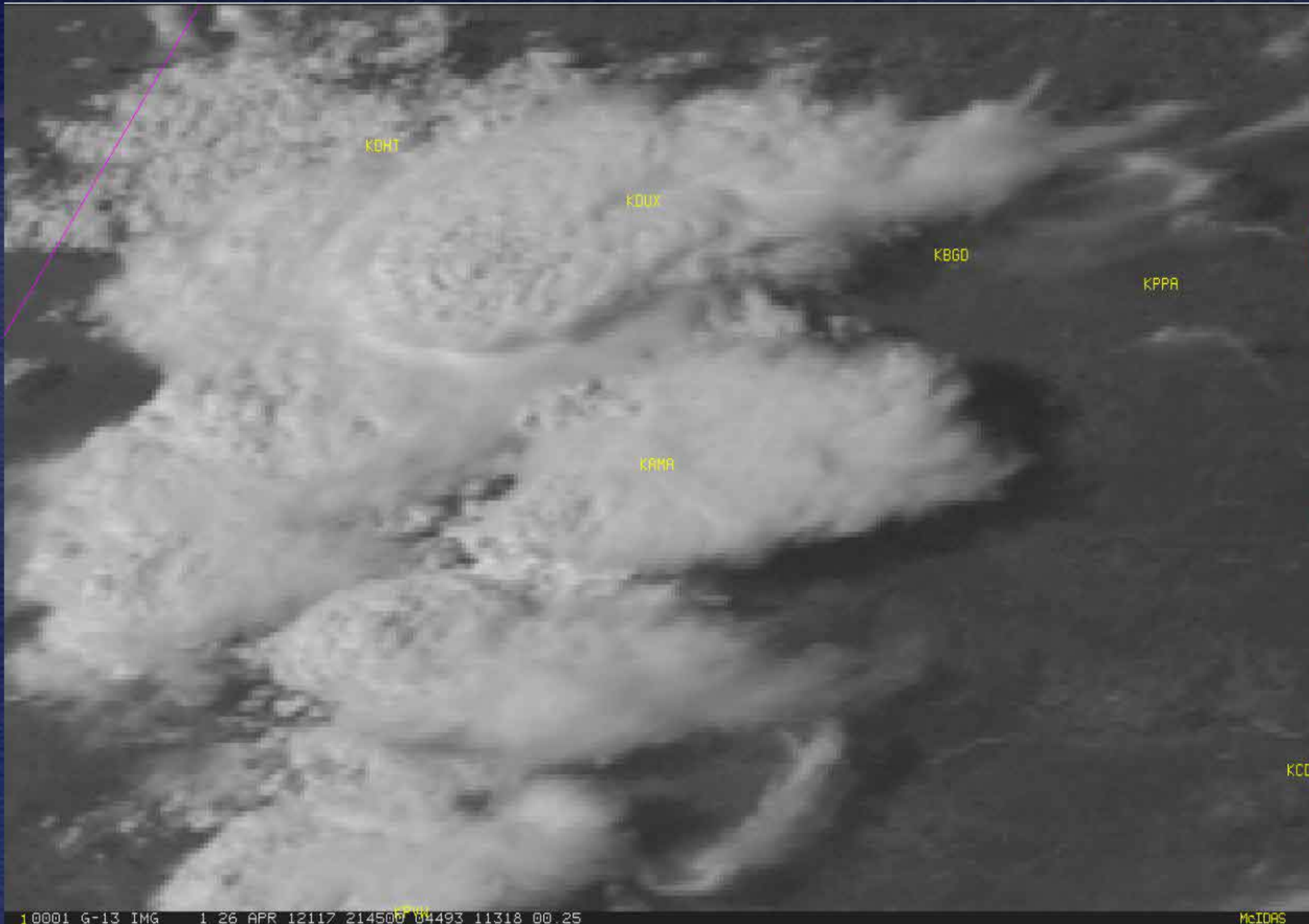
WHAT CHANNEL?
- INFRARED
- VISIBLE
- WATER VAPOR

WHAT DAY?
- SUNDAY
- MONDAY
- TUESDAY
- WEDNESDAY
- THURSDAY
- FRIDAY
- SATURDAY

WHAT WEEK?
- THIS WEEK
- LAST WEEK
- 2ND WEEK AGO
- 3RD WEEK AGO

WHAT TIME?
(scroll to see more times available)
- 0015Z
- 0045Z
- 0115Z
- 0145Z
- 0215Z

Submit Choice | Reset



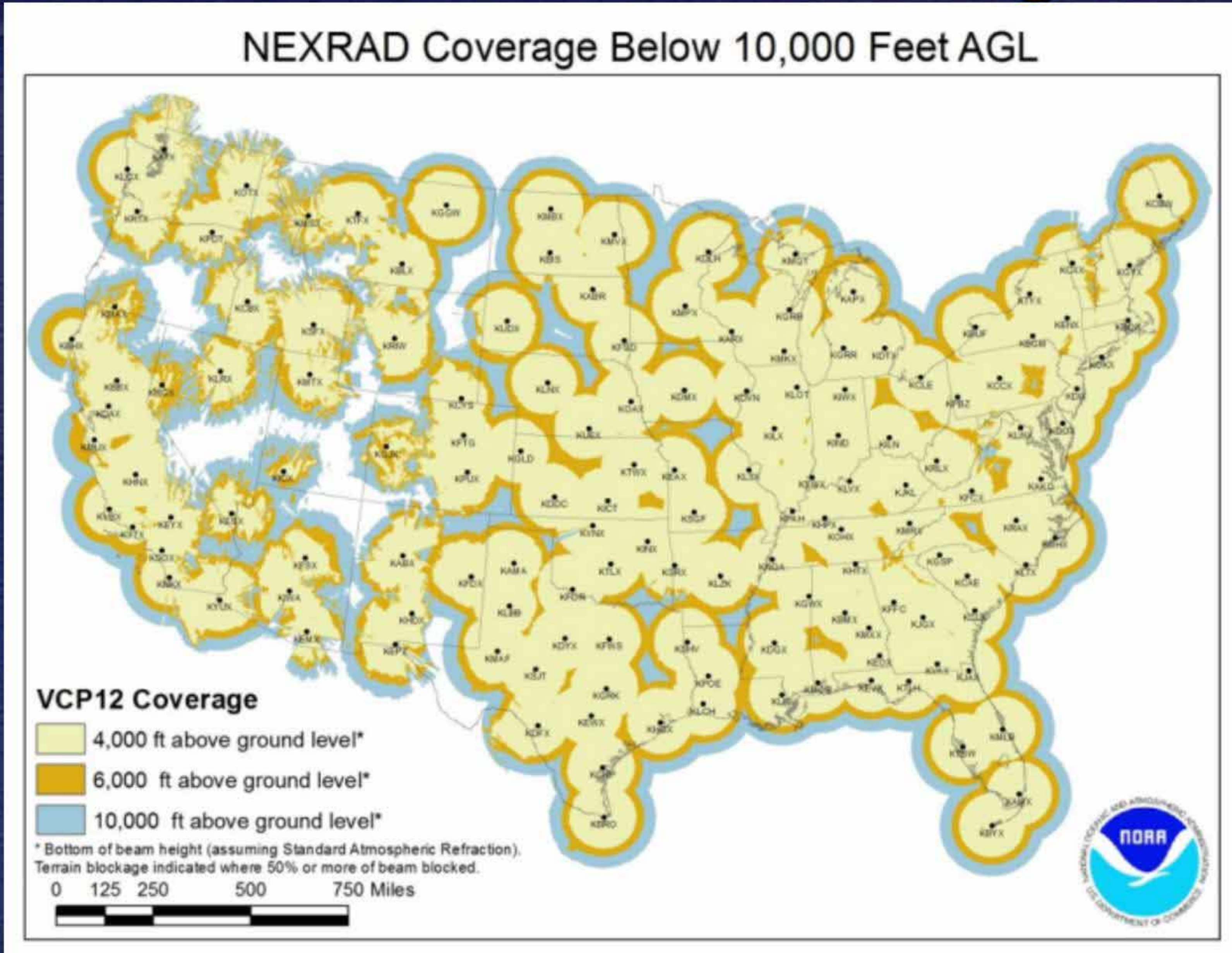
GOES-13 Imagery 2145Z on April 26, 2012
CCT 212° K (-61° C) KAMA sounding tops 41,500 ft

NTSB

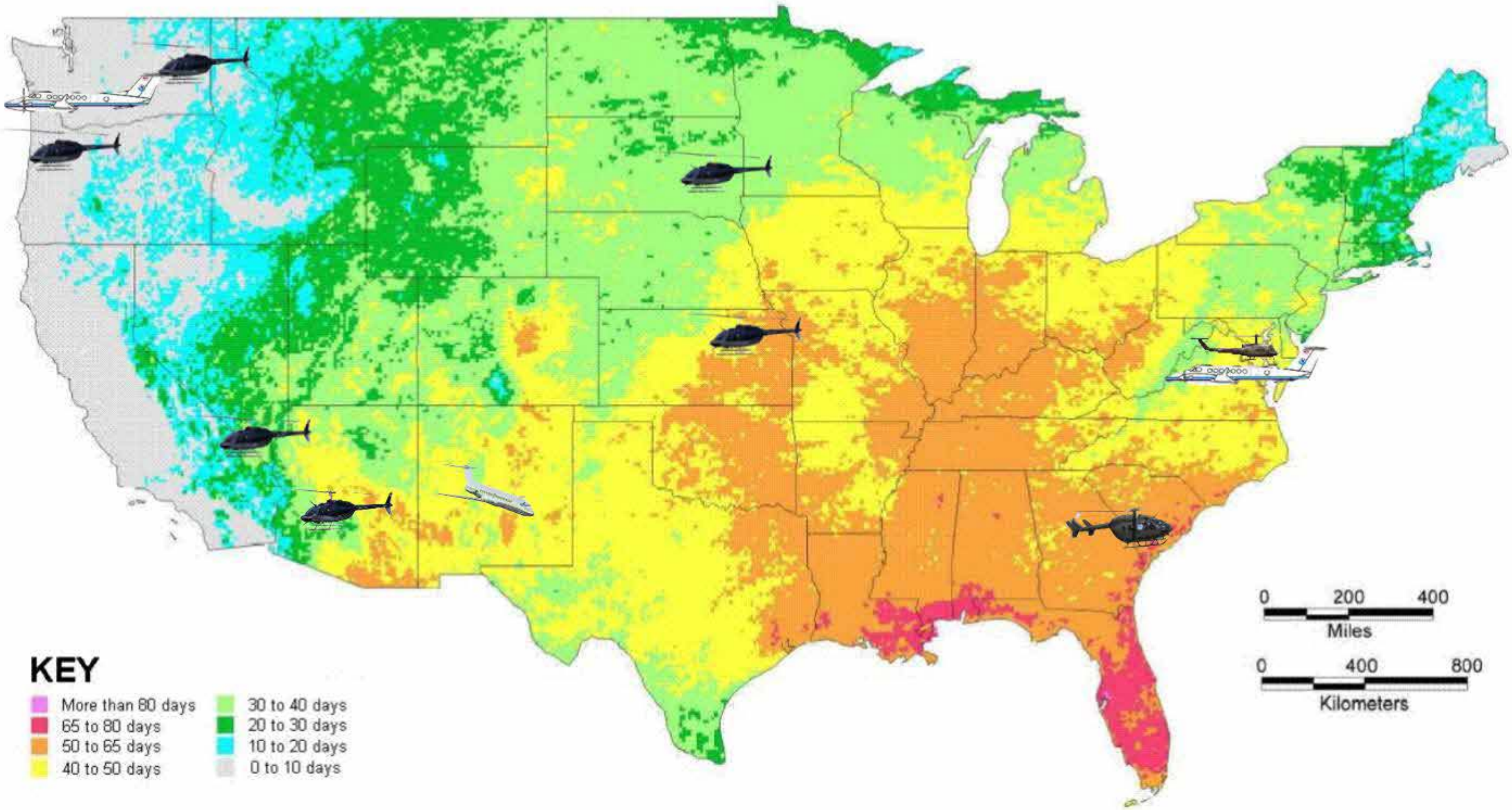
Elements of a Weather Study

- Synoptic conditions
  - Surface Analysis
  - Radar Summary
  - Convective Outlook
- Observations
- Upper air data
  - Stability indices
- Satellite imagery
  - Overshooting cloud tops
  - Enhanced V-shape
- **Radar imagery - WSR-88D "Nexrad"**

WSR-88D Radar Coverage



Average Number of Thunderstorm Days per Year



NTSB

Weather Surveillance Radar 1988 Doppler (WSR-88D) Data

- Primary products:
  - Base Reflectivity
  - Radial Velocity
  - Spectrum Width
- Update rates 4 ½ -10 min
- Composite Reflectivity
- Echo tops
- Vertical Azimuth Display (VAD) Wind Profiles (VWP)

Obtaining Archive Radar Data

NCAR

The National Center for Atmospheric Research
Operated by the University Corporation for Atmospheric Research

RAP Real-Time Weather Data

Home / RAP : Weather Home | Satellite | Radar | Surface | Upper-Air | Forecast

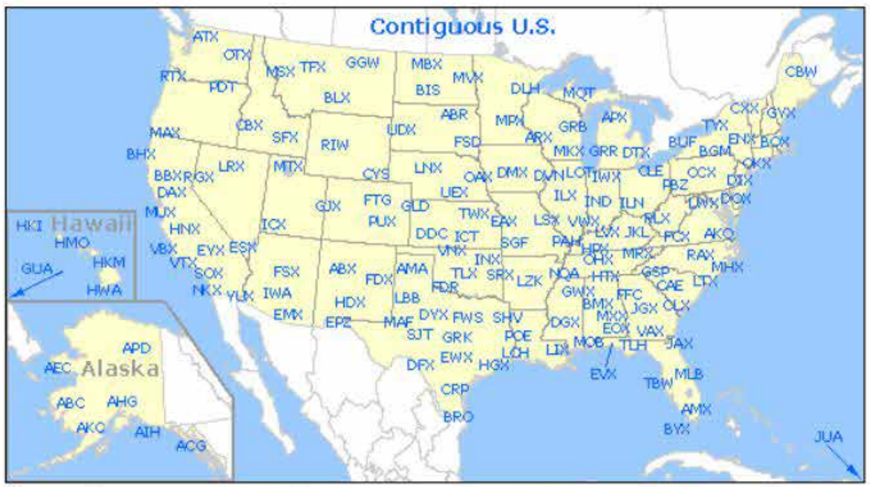
NEXRAD images from WSR-88D radars

FREE

Product:
- 0.5° Reflectivity
- 0.5° Velocity
- Regional reflectivity*
- Lightning**

Background:
- black
- gray-shaded terrain
- color-shaded terrain

End date: Today
End time: Most recent
Loop duration: Single image



*Regional images are only available for Contiguous U.S. and the choice of background color does not apply.
**Lightning data plots are only available to .ucar.edu addresses.

http://www.rap.ucar.edu/weather/radar/

- National Weather Service national mosaic

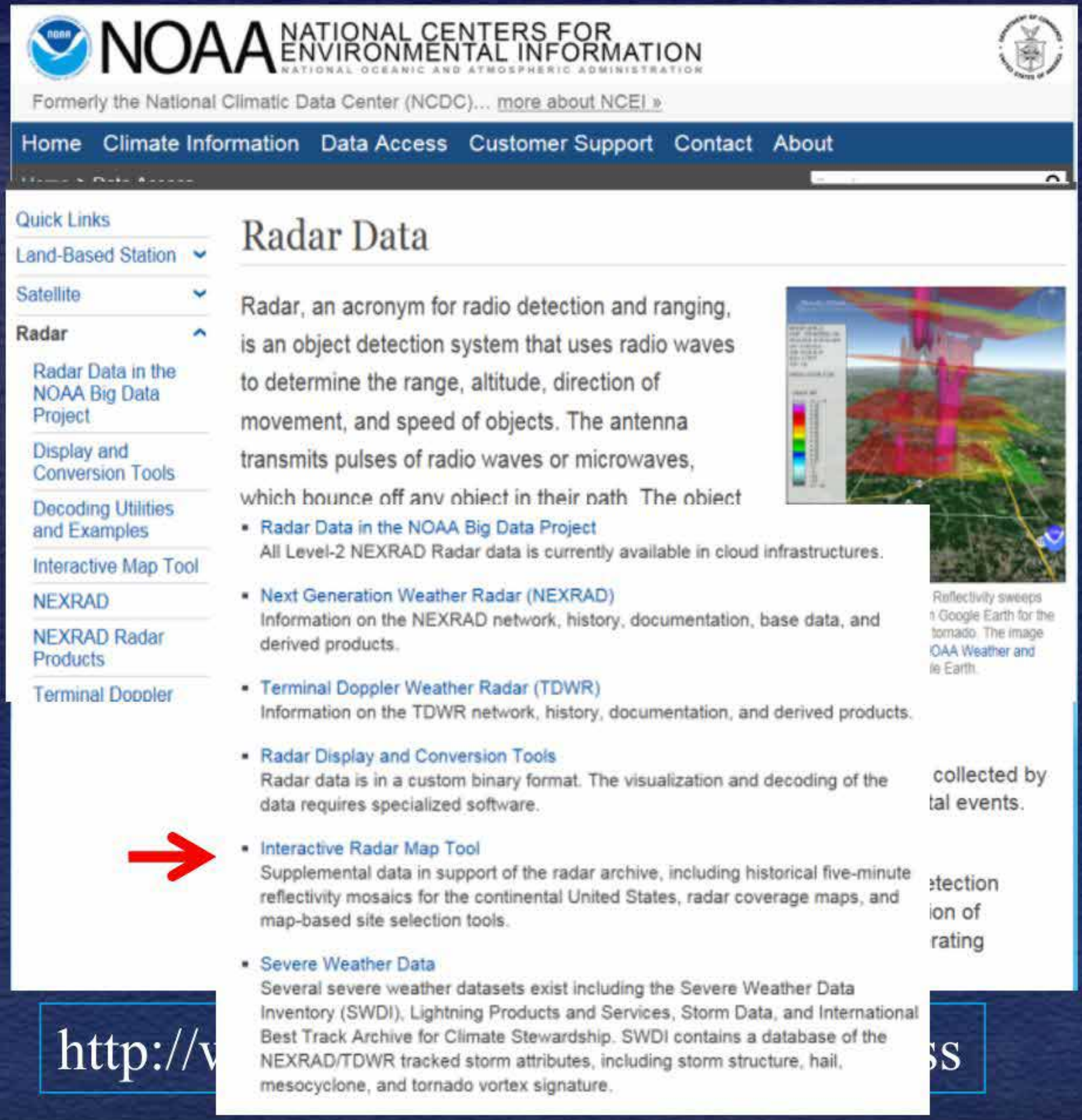
- National Weather Service Radars by State Go

NCAR - RAP
Research
Applications
Program

5-day archive

NTSB

NWS Archive Radar Data



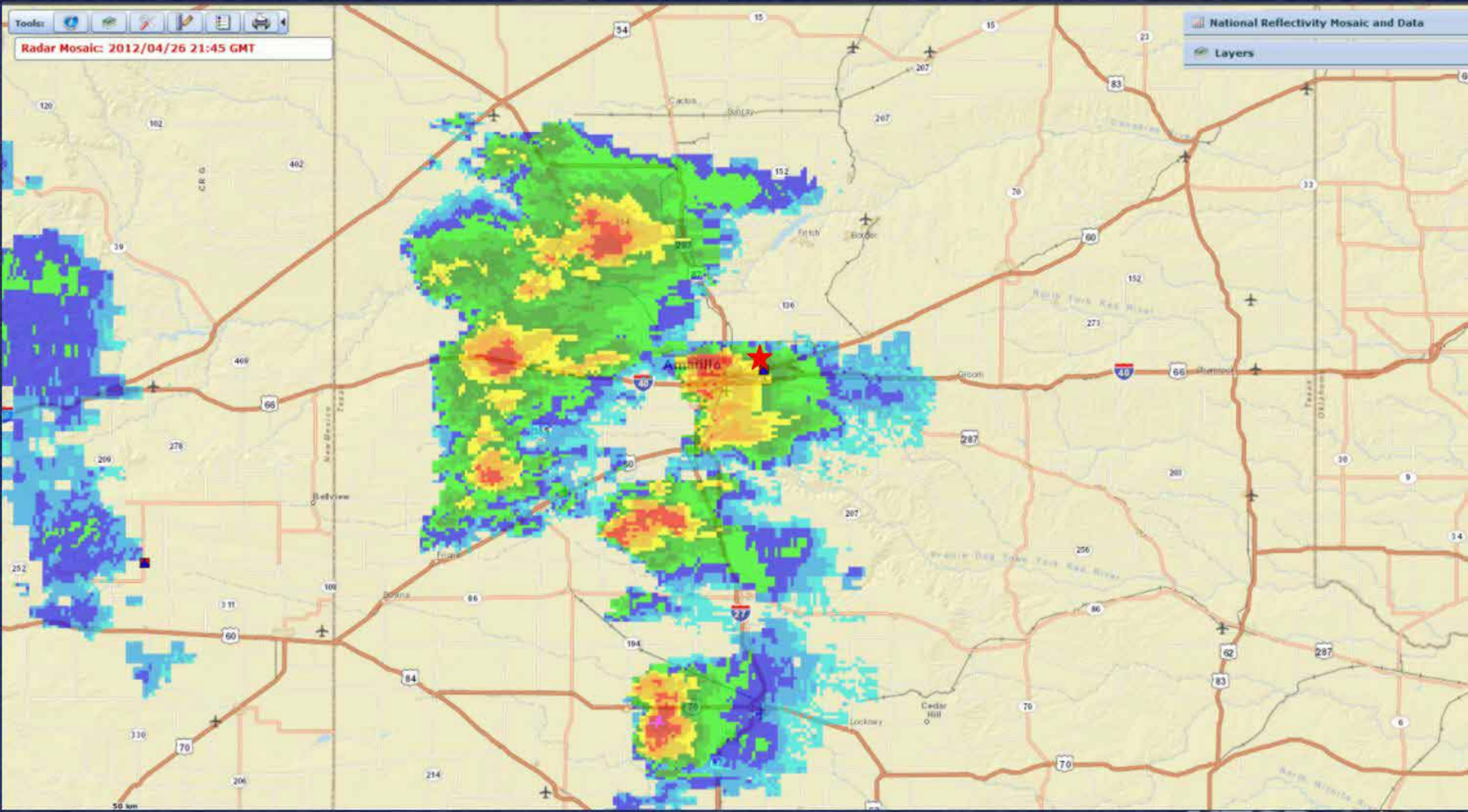
http://v ... ss

NTSB

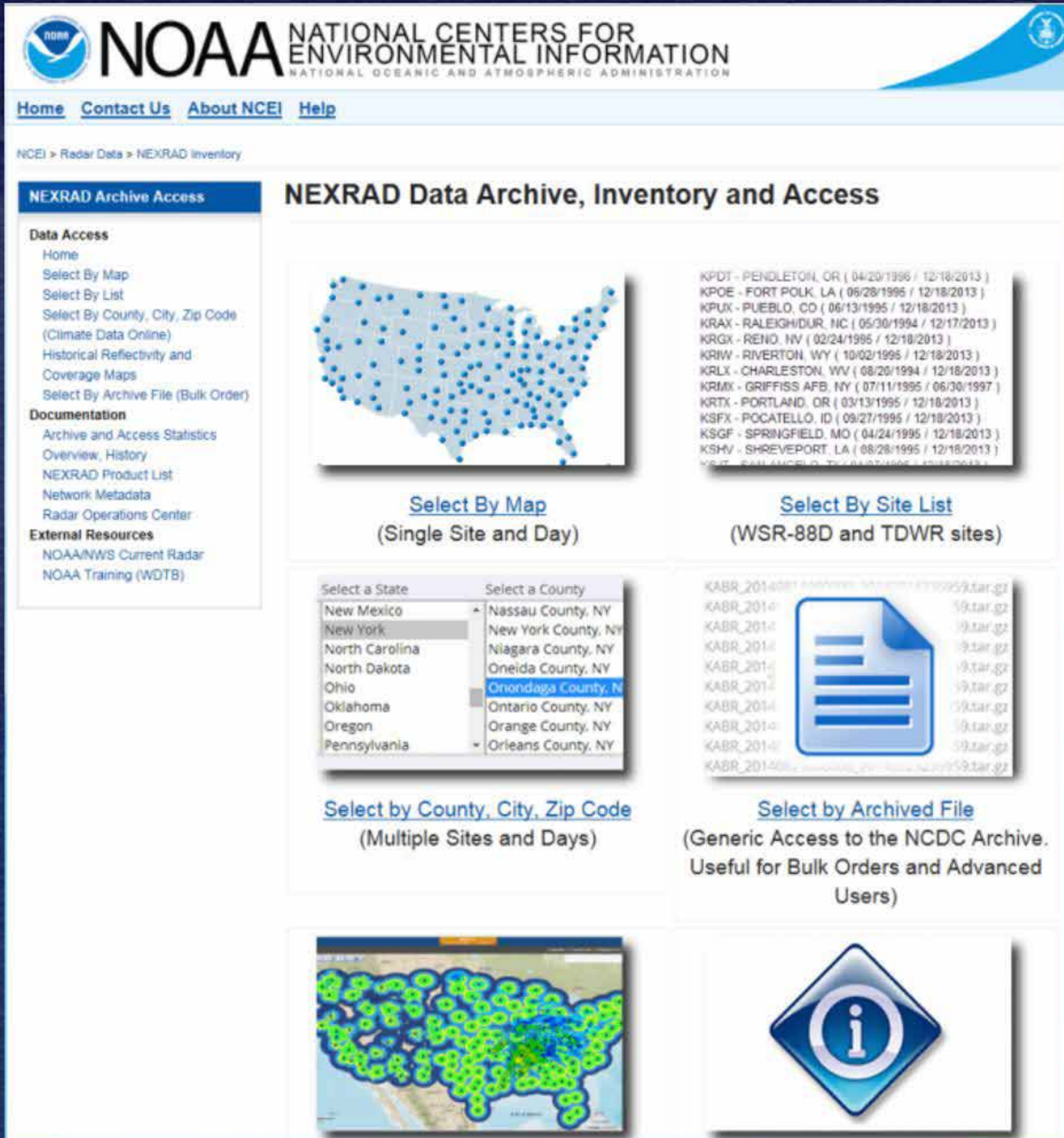
NWS National Radar Composite Archive

NTSB

NWS National Composite Reflectivity Archive Data at 2145Z April 26, 2012



NTSB



http://www.ncdc.noaa.gov/nexradinv/

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NOAA NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Home Contact Us About NCEI Help

NCEI > Radar Data > NEXRAD Inventory

NEXRAD Archive Access

Data Access
- Home
- Select By Map
- Select By List
- Select By County, City, Zip Code (Climate Data Online)
- Historical Reflectivity and Coverage Maps
- Select By Archive File (Bulk Order)

Documentation
- Archive and Access Statistics
- Overview, History
- NEXRAD Product List
- Network Metadata
- Radar Operations Center

External Resources
- NOAA/NWS Current Radar
- NOAA Training (WDTB)

NEXRAD Inventory: Choose Day and Product

KAMA - AMARILLO, TX

(Site Metadata)

Period of Record:

Level-II: 03/17/1994 to 06/13/2016

Level-III: 01/14/1994 to 06/10/2016

Examine Inventory:

Choose Date: 04 26 2012 (GMT)

Choose Product:

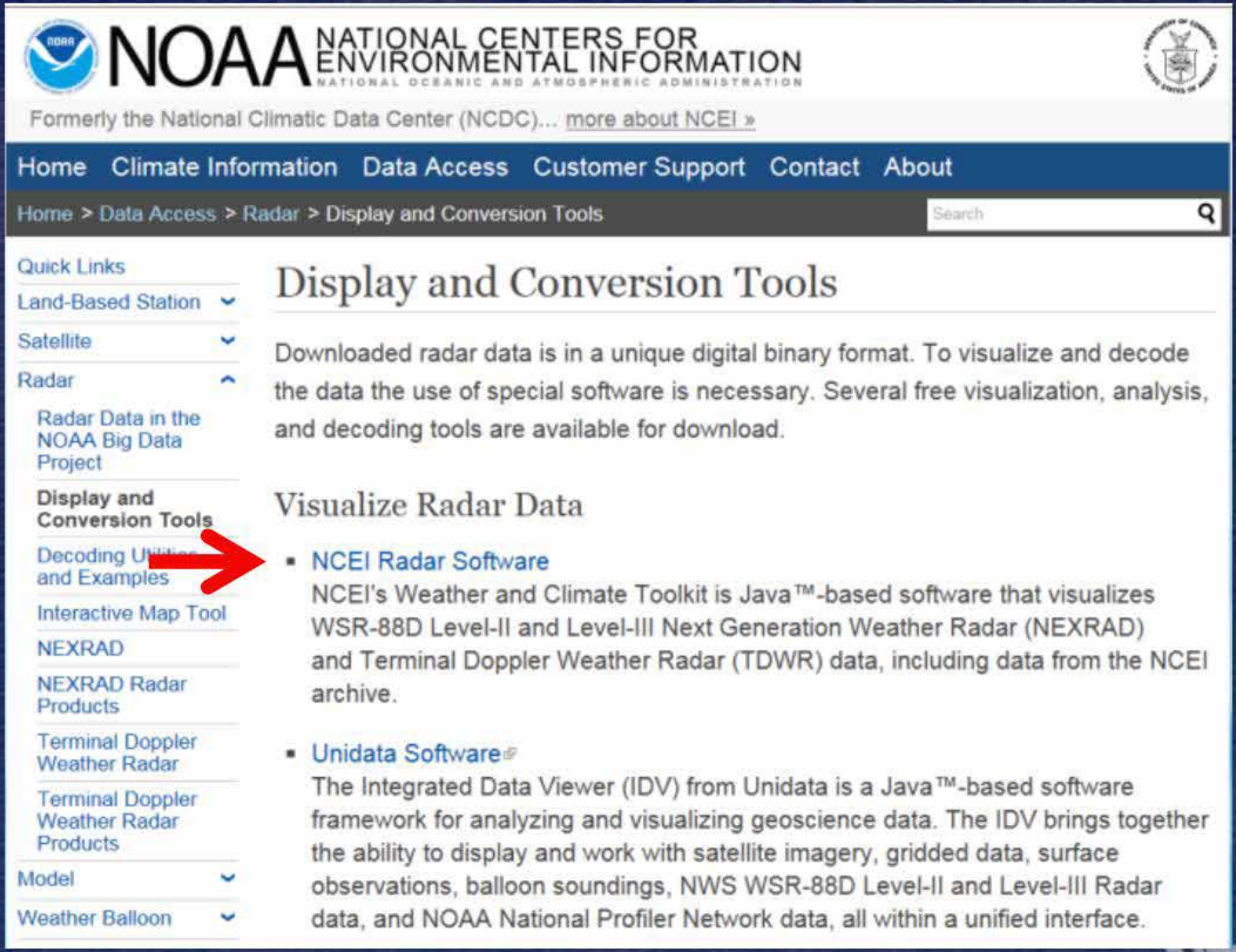
Level-II (Base Data)
Level-III (Products) (ALL)
L3 [N0R] - Short Range Base Reflectivity (16 Level / 230 KM) (~ 0.5 Deg)
L3 [N1R] - Short Range Base Reflectivity (16 Level / 230 KM) (~ 1.5 Deg)
L3 [N2R] - Short Range Base Reflectivity (16 Level / 230 KM) (~ 2.4 Deg)
L3 [N3R] - Short Range Base Reflectivity (16 Level / 230 KM) (~ 3.4 Deg)
L3 [N0Q] - Long Range Base Reflectivity (256 Level / 460 KM) (~ 0.5 Deg)
L3 [NAQ] - Long Range Base Reflectivity (256 Level / 460 KM) (~ 0.9 Deg)

Product Filter: Clear

Create Graph

Hold 'Shift' or 'Control' to select multiple Level-III Products

NWS Weather and Climate Toolkit Allows user to display raw WSR-88D data



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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

DOC > NOAA > NESDIS > NCEI   Search Field: Search NCEI

NOAA's Weather and Climate Toolkit

Quick Links
Weather and Climate Toolkit Home

Data Access:
- Station
- Radar
- Satellite
- Model
- Severe Weather

Toolkit
Download/Installation
Find Data
Image Gallery
Java Requirements
Export Formats
Batch Processing
Credits
API / Source Code

Documentation
User Guide/Tutorials
FAQ
Presentations

Introduction

NOAA's Weather and Climate Toolkit (WCT) is free, platform independent software distributed from NOAA's National Centers for Environmental Information (NCEI). The WCT allows the visualization and data export of weather and climate data, including Radar, Satellite and Model data. The WCT also provides access to weather/climate web services provided from NCEI and other organizations.

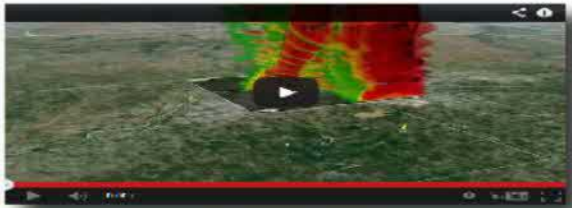
The WCT provides tools for background maps, animations and basic filtering. The export of images and movies is provided in multiple formats. The data export feature supports conversion of data to a variety of common formats including GeoJSON, KMZ, Shapefile, Well-Known Text, GeoTIFF, ESRI Grid and Gridded NetCDF. These data export features promote the interoperability of weather and climate information with various scientific communities and common software packages such as ArcGIS, Google Earth, MatLAB, QGIS, R and many more. Advanced data export support for Google Earth enables the 2-D and 3D export of rendered data and isosurfaces.

Download / Launch

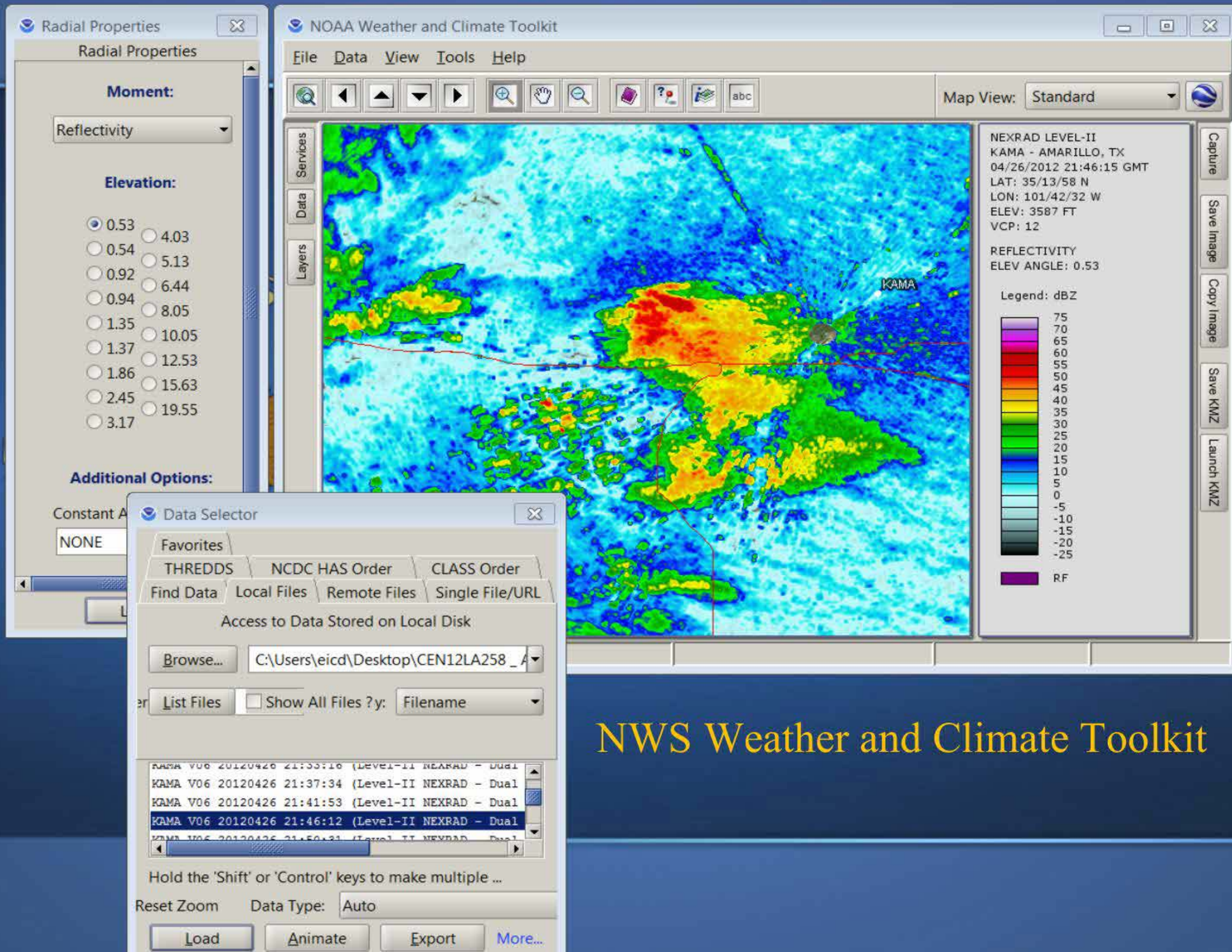
Current data types supported:

- CF-compliant Gridded NetCDF
- Generic CF-compliant Irregularly-Spaced/Curvilinear Gridded NetCDF/HDF
- GRIB1, GRIB2, GINI, GEMPAK, HDF (CF-compliant) and more gridded formats
- GOES Satellite AREA Files
- NEXRAD Radar Data (Level-II and Level-III)
- U.S. Drought Monitor Service (from the National Drought Mitigation Center (NDMC))
- OPeNDAP support for Gridded Datasets

New Features / FAQ / Tutorials

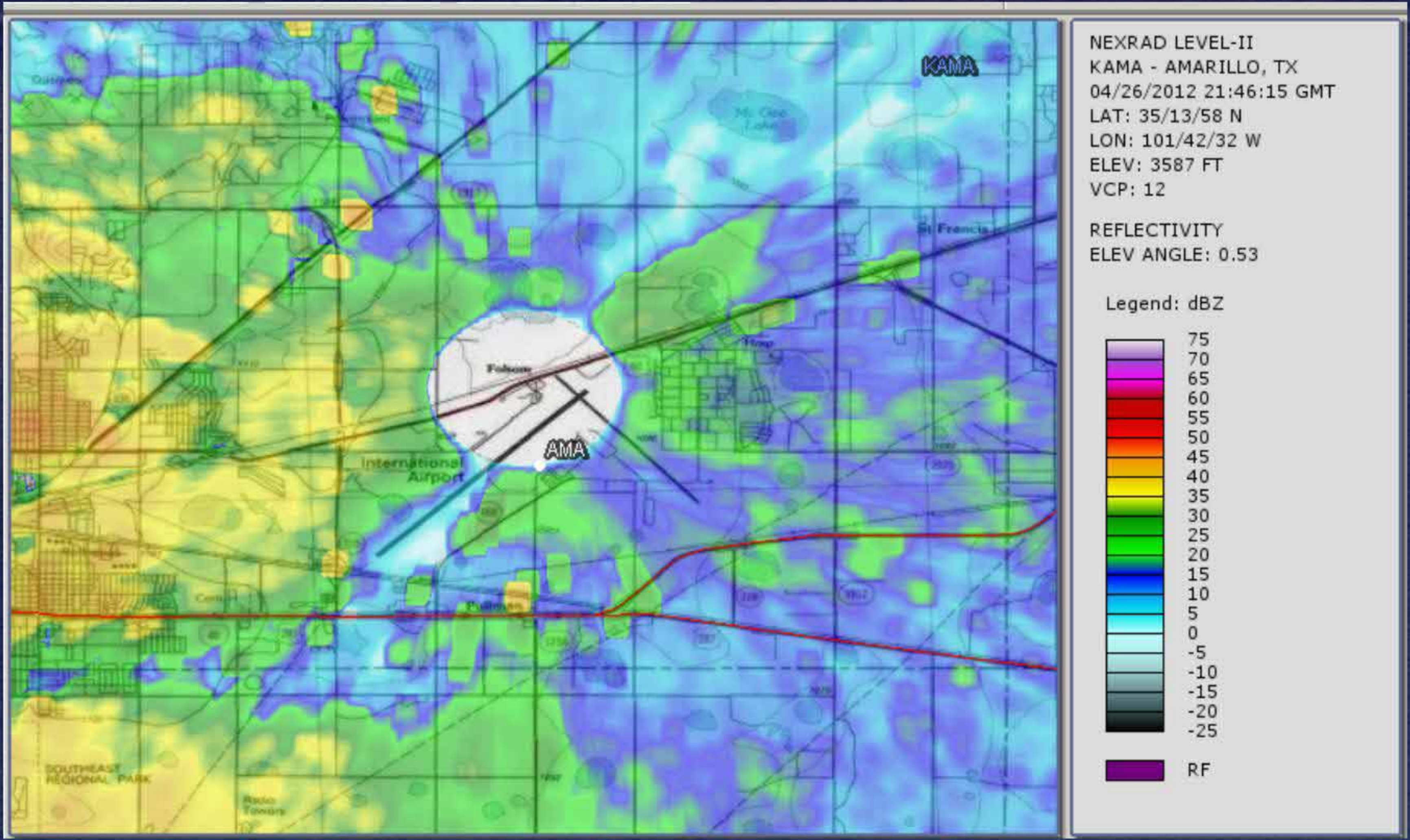


NOAA's Climate.gov created an article and video introduction to the Weather and Climate Toolkit. If you are a first time user, please check out this video for more information on the Toolkit's capabilities.



NWS Weather and Climate Toolkit

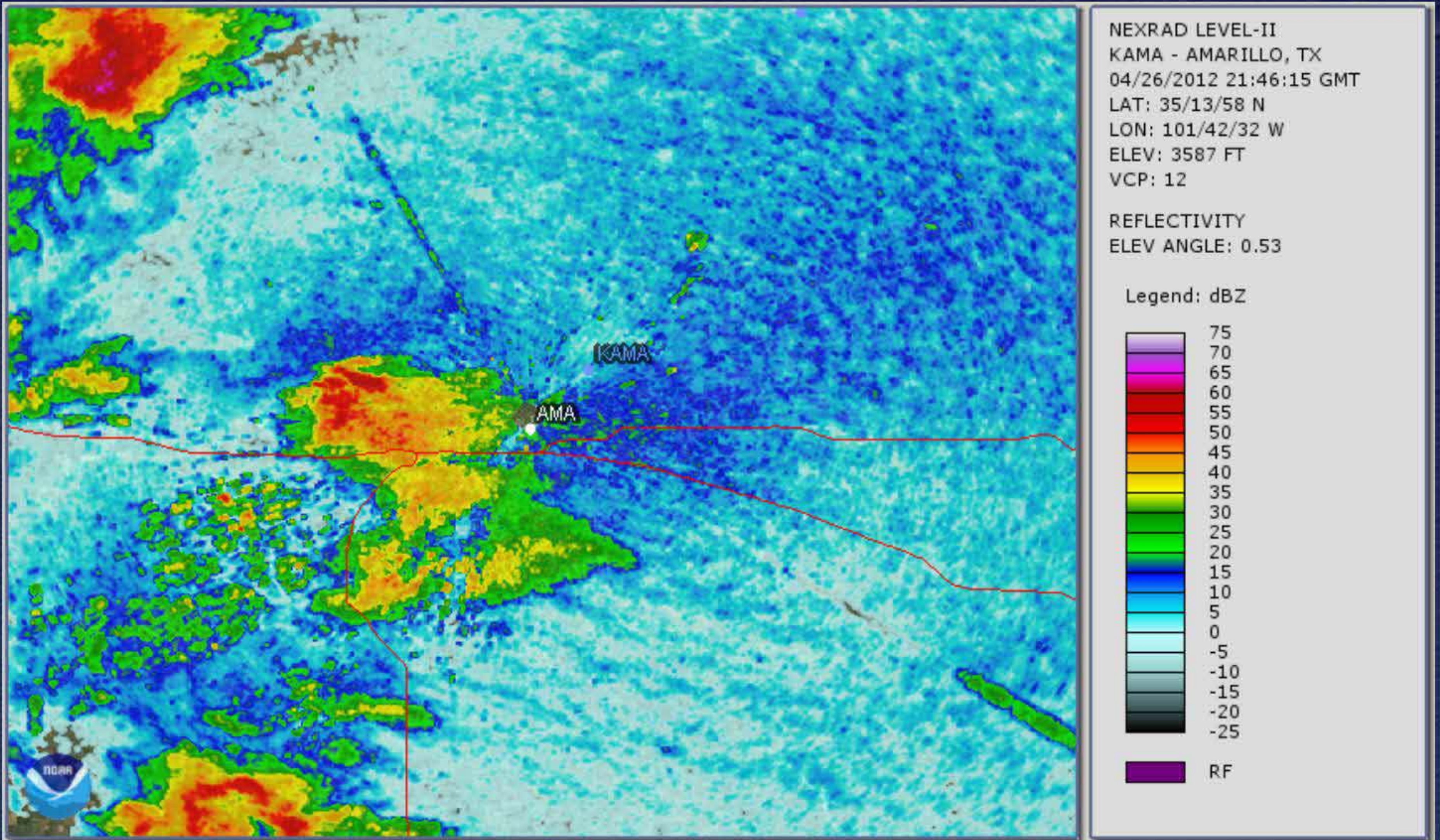
KAMA WSR-88D 0.5° base reflectivity image at 2146Z



50% transparency applied to show airport

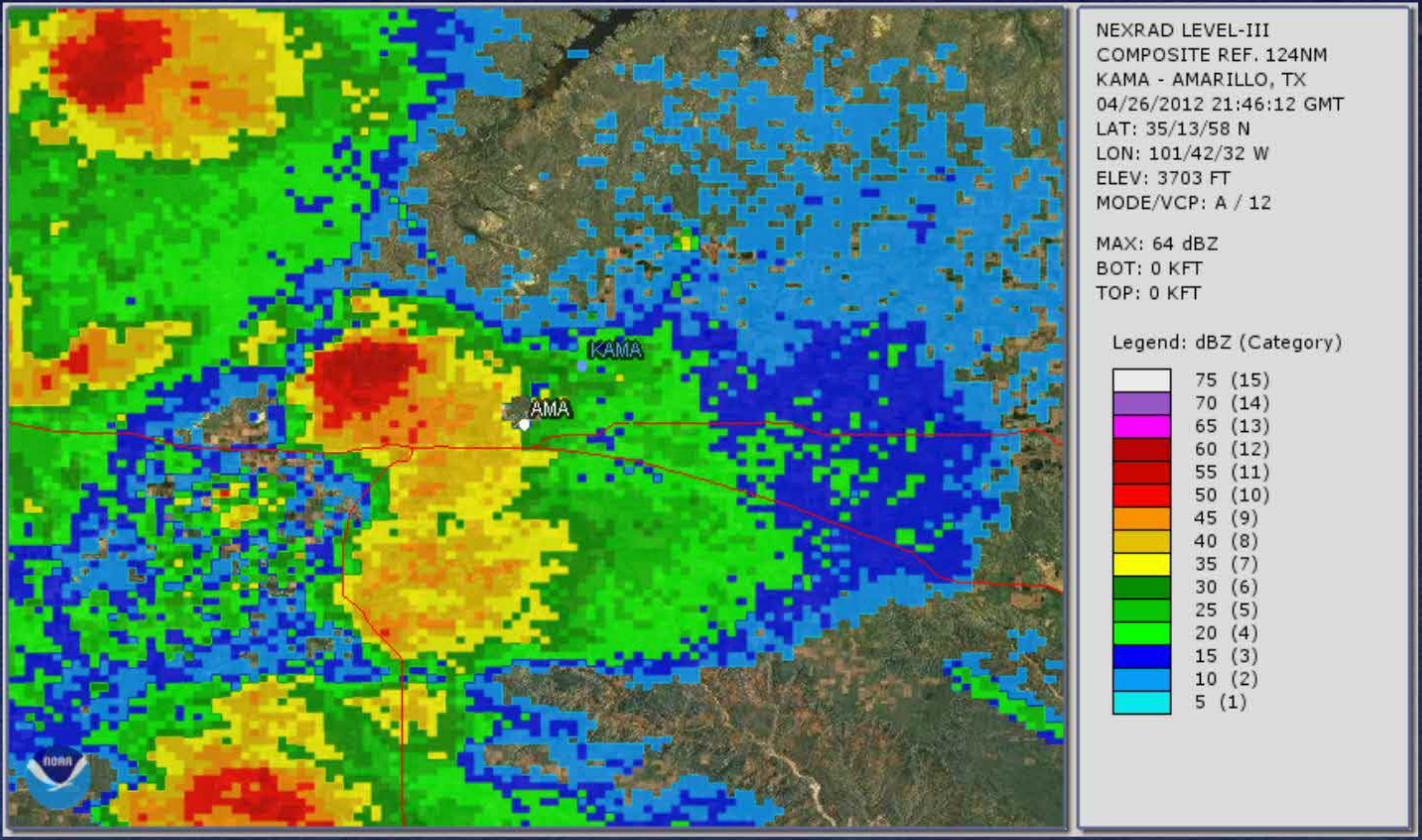
NTSB

KAMA WSR-88D 0.5° Base Reflectivity image at 2146Z



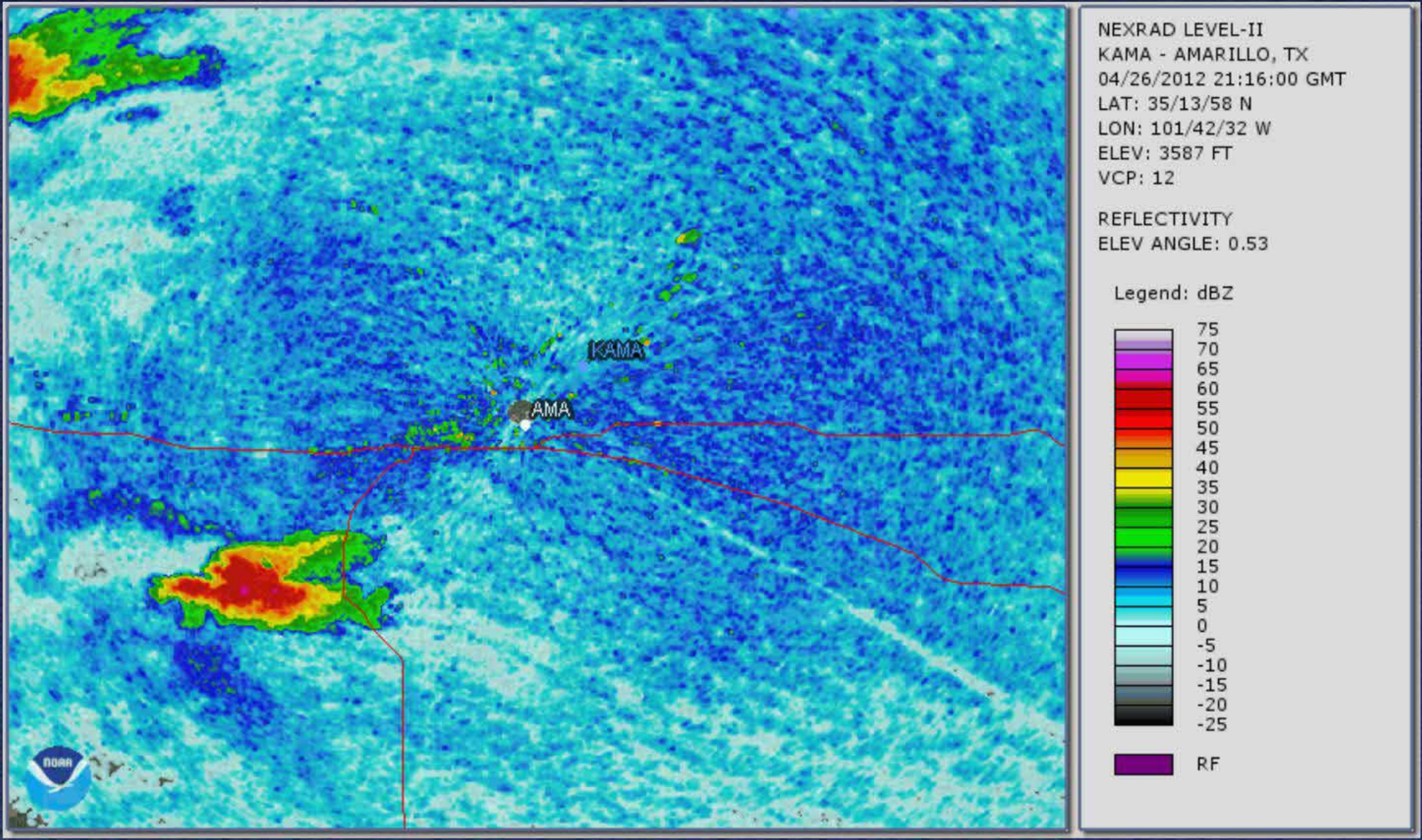
NTSB

KAMA Composite Reflectivity image at 2146Z



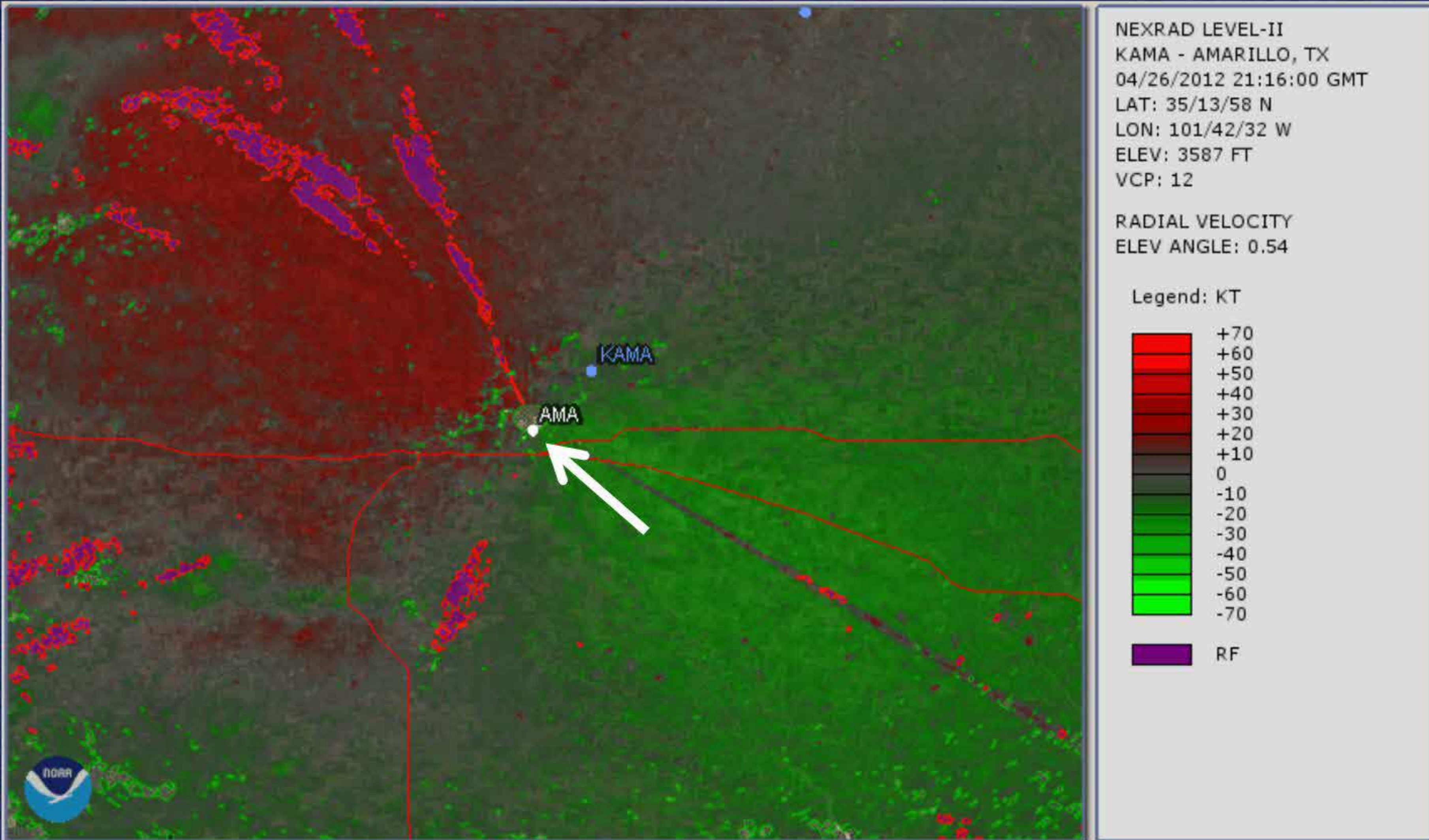
NTSB

KAMA WSR-88D Animation



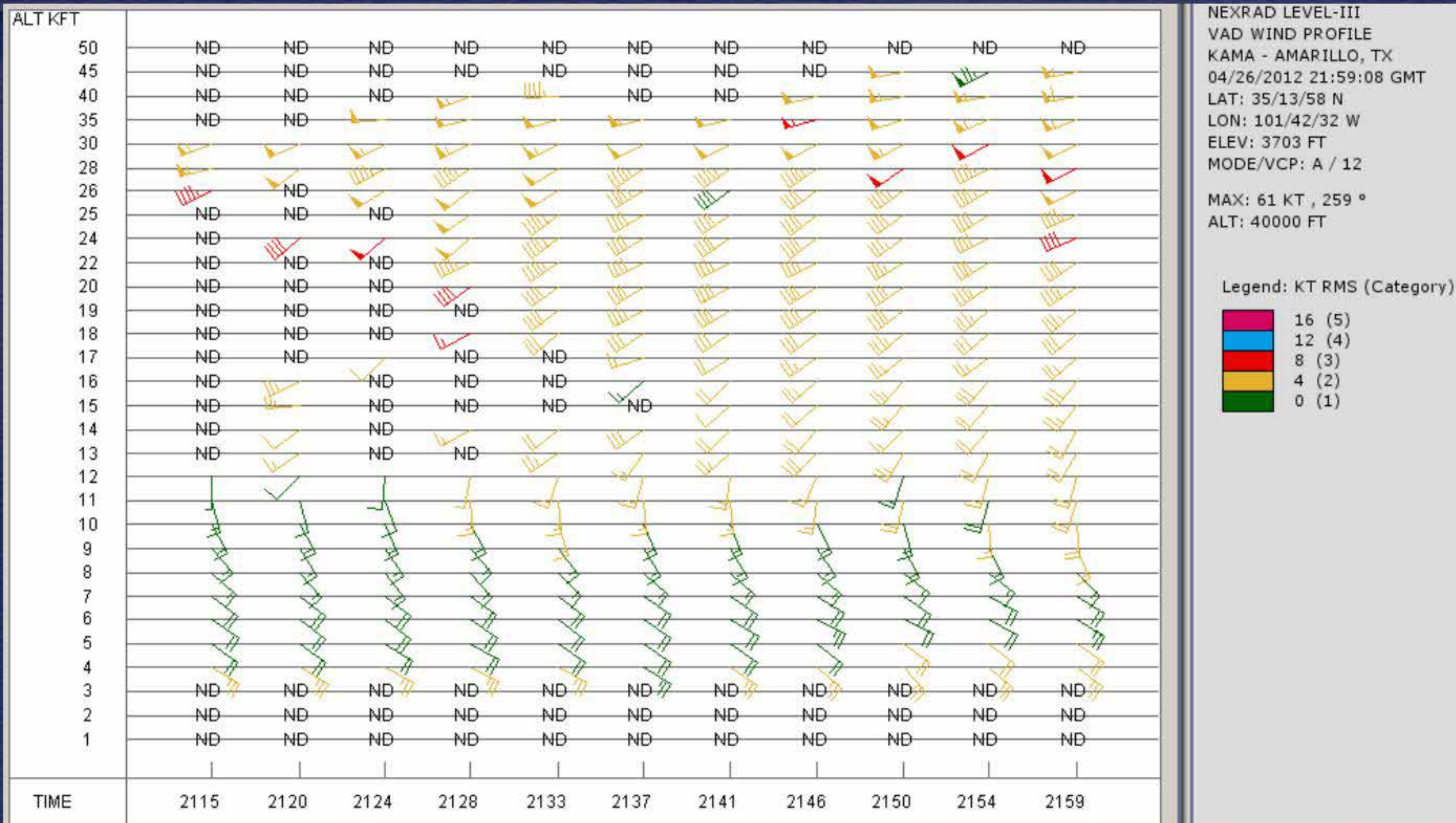
NTSB

KAMA WSR-88D Radial Velocity Imagery



NTSB

WSR-88D VAD Wind Profile



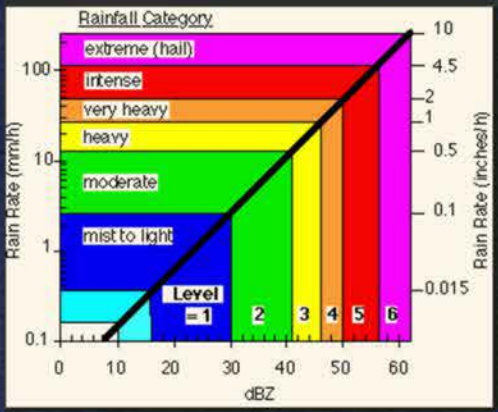
No echoes below 3,000 ft

4,000 ft wind from 120° 25-30KT

NTSB

VIP/dBZ Conversion Chart

NWS VIP	WSR-88D LVL	PRECIP MODE dBZ	RAINFALL
0	0 1 2	<5 5 to 9 10 to 14	
1 VERY LIGHT	3 4 5	15 to 19 20 to 24 25 to 29	.02 /hr
2 LIGHT TO MODERATE	6 7	30 to 34 35 to 39	.09/hr
3 STRONG	8	40 to 44	.48/hr
4 VERY STRONG	9	45 to 49	2.50/hr
5 INTENSE	10	50 to 54	5.70/hr
6 EXTREME	11 12 13 14 15	55 to 59 60 to 64 65 to 69 70 to 74 ≥ 75	12.0/hr

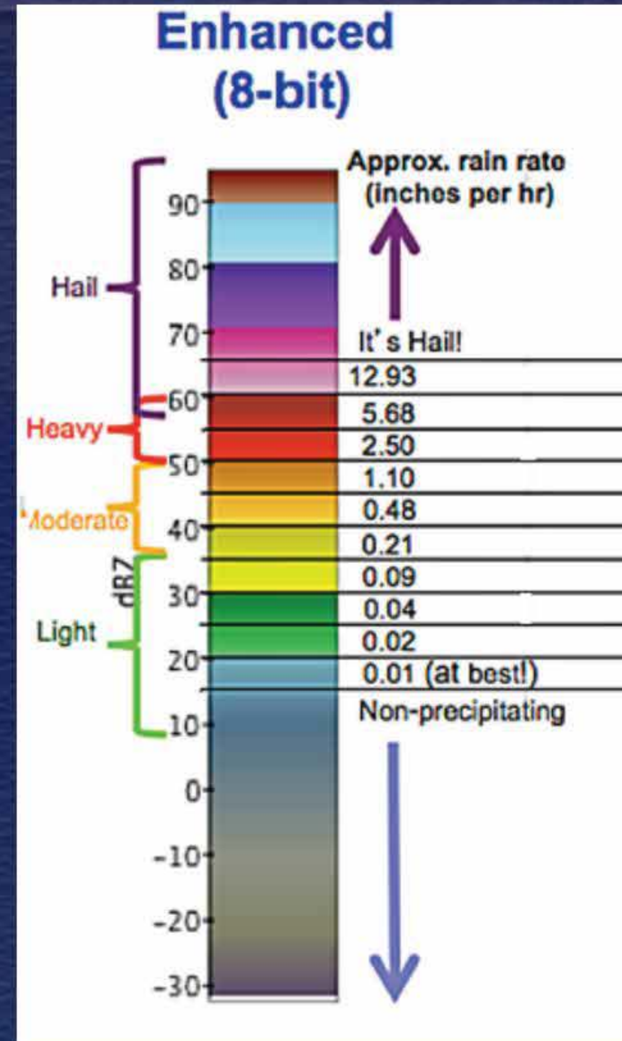


* VIP levels used in old Radar Summary Chart

Radar dBZ reflectivity scale and rainfall rates

dBZ versus Rainrate

dBZ	R (mm/h)	Rate (in/hr)	Intensity
5	0.07	< 0.01	Hardly Noticeable
10	0.15	< 0.01	Light Mist
15	0.3	0.01	Mist
20	0.6	0.02	Very Light
25	1.3	0.05	Light
30	2.7	0.1	Light to Moderate
35	5.6	0.22	Moderate Rain
40	11.53	0.45	Moderate Rain
45	23.7	0.92	Moderate to Heavy
50	48.6	1.90	Heavy
55	100	4	Very Heavy / Small Hail
60	205	8	Extreme / Moderate Hail
65	421	16.6	Extreme / Large Hail



NTSB

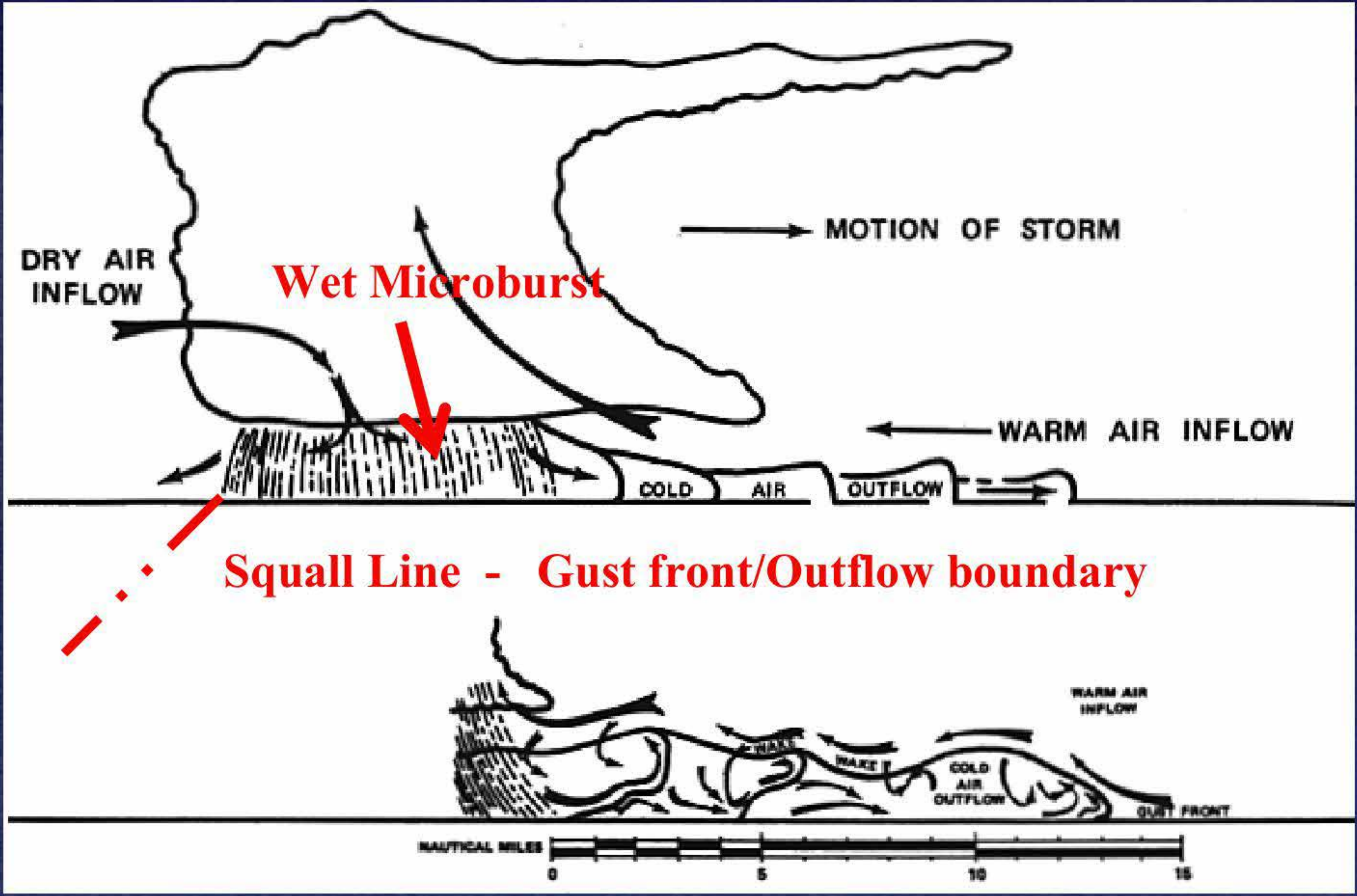
Updated AC 00-24C Thunderstorms

- Ground based weather radar
  - Echo Intensity (Reflectivity) -dBZ
  - WSR-88D clear air & precip modes
  - Base & composite reflectivity images
  - Flight planning
  - Weather in-cockpit displays
    - Not real time – time lag
- Airborne avoidance radar
  - 20 NM avoidance
  - Attenuation
- Do's & Don'ts rules on thunderstorms

Thunderstorm Hazards

- Tornadoes
  - Supercells
- Turbulence
- Windshear
  - Gust Front
  - Microbursts
- Icing
- Hail
- Low ceilings & visibilities
- Altimeter errors
- Lightning
- Engine water ingestion

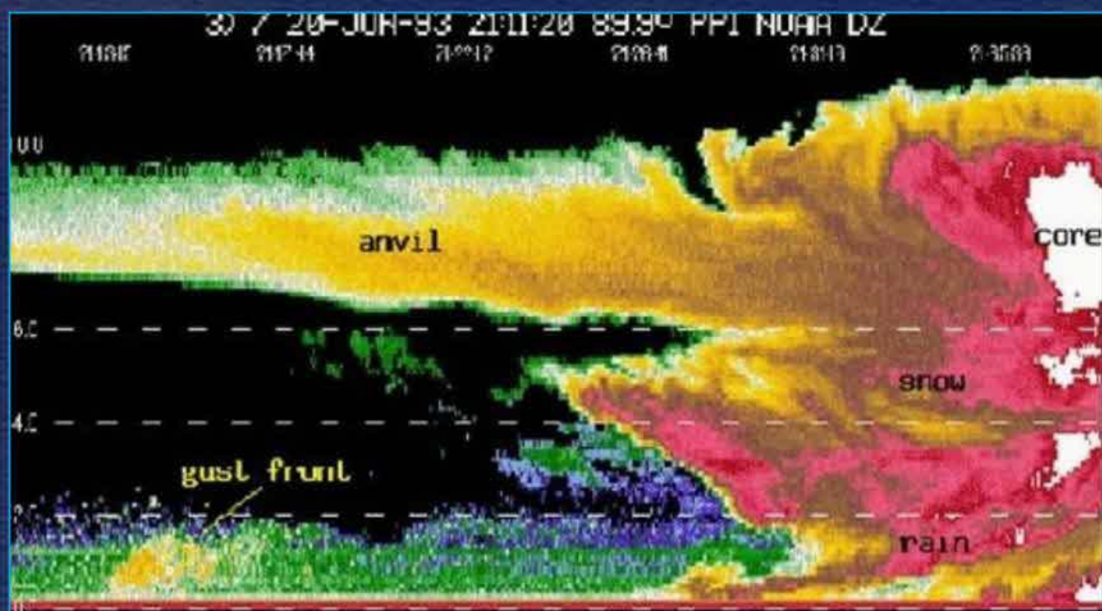
* Updated 2013: AC 00-24C - Thunderstorms


MOTION OF STORM
DRY AIR INFLOW
Wet Microburst
WARM AIR INFLOW
COLD AIR OUTFLOW
Squall Line - Gust front/Outflow boundary
WARM AIR INFLOW
WAKE
COLD AIR OUTFLOW
NAUTICAL MILES
0
5
10
15

NTSB

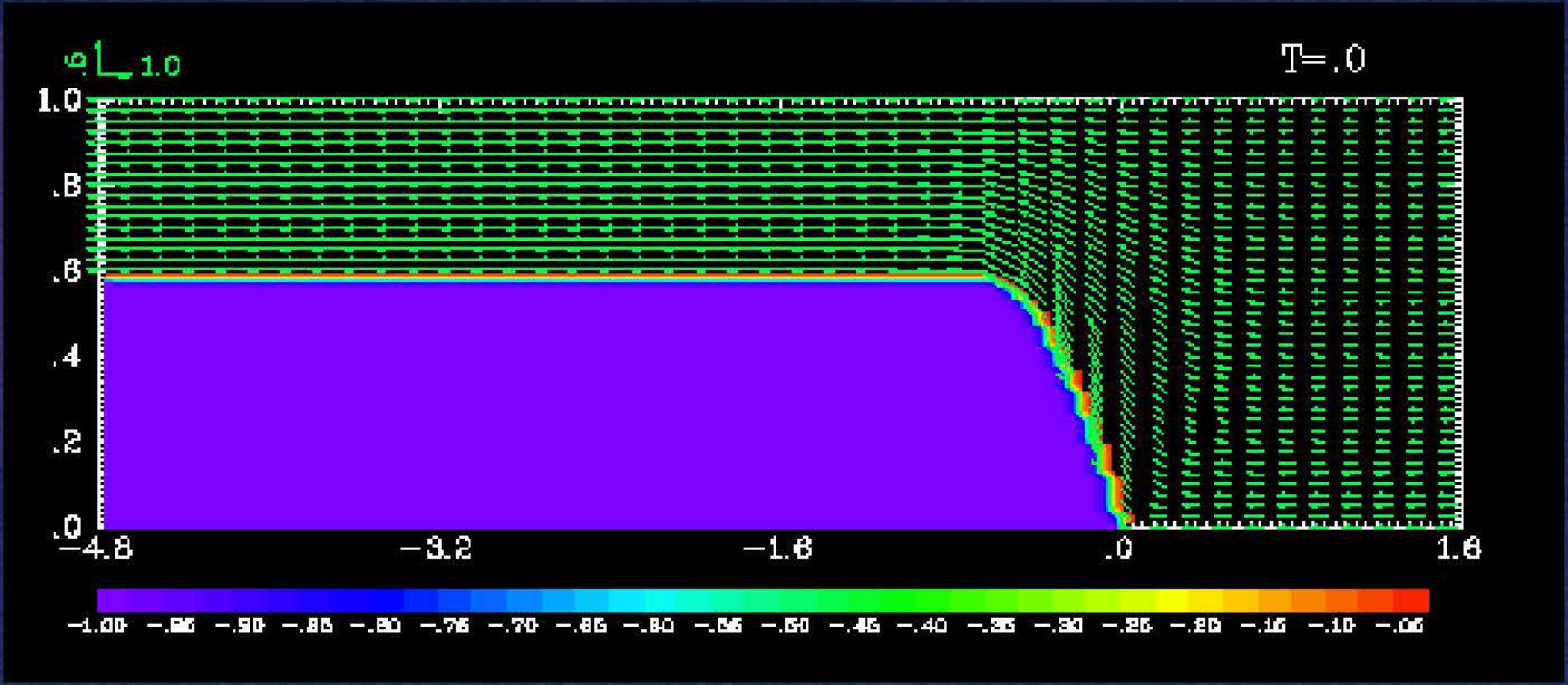
Thunderstorm Avoidance Rules:

(1) Don't land or takeoff in the face of an approaching thunderstorm. A sudden gust front of low-level turbulence could cause loss of control.

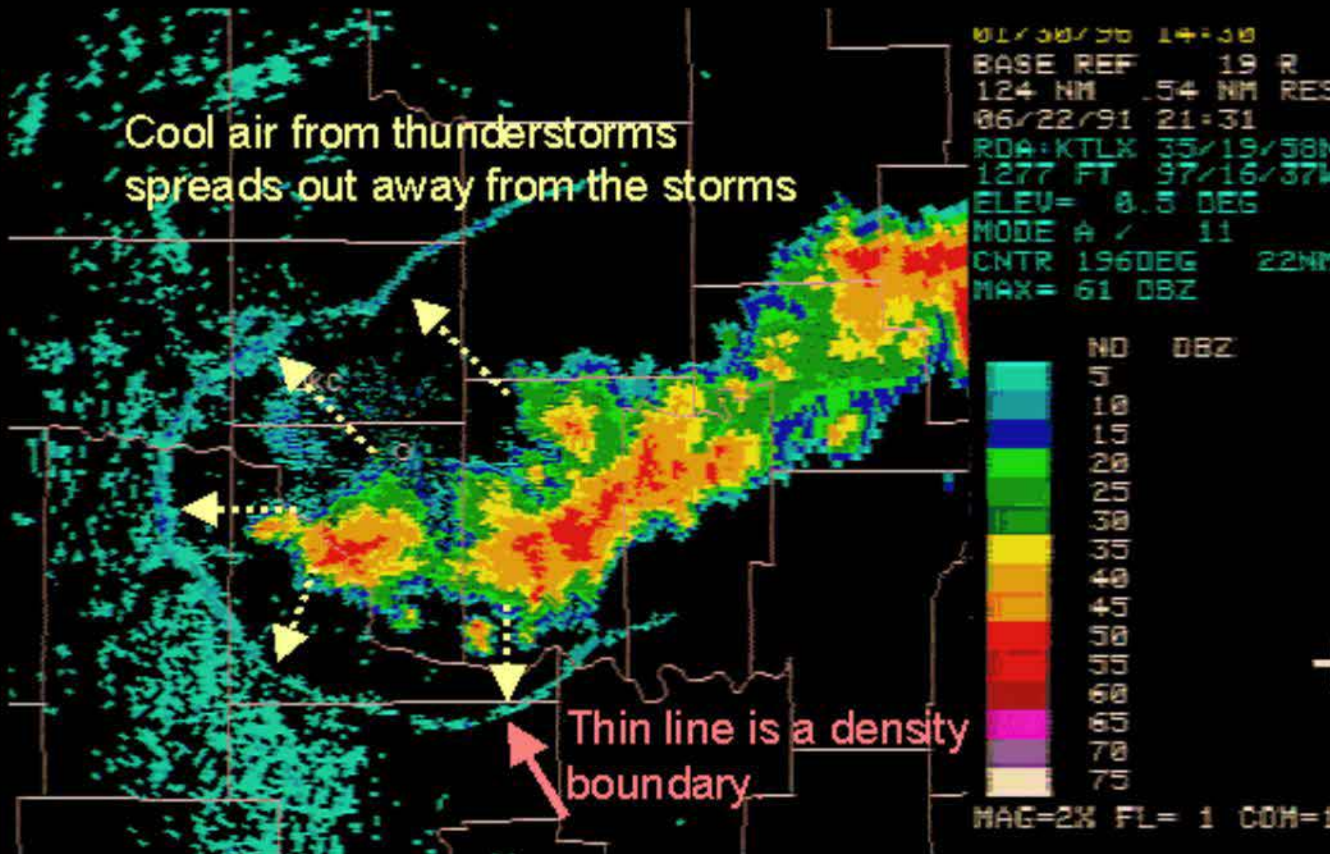

3D 7 20-JUN-93 21:11:20 89.9° PPI NOAA DZ
anvil
core
snow
gust front
rain

NTSB

Gust Front Hazard – takeoff & landing



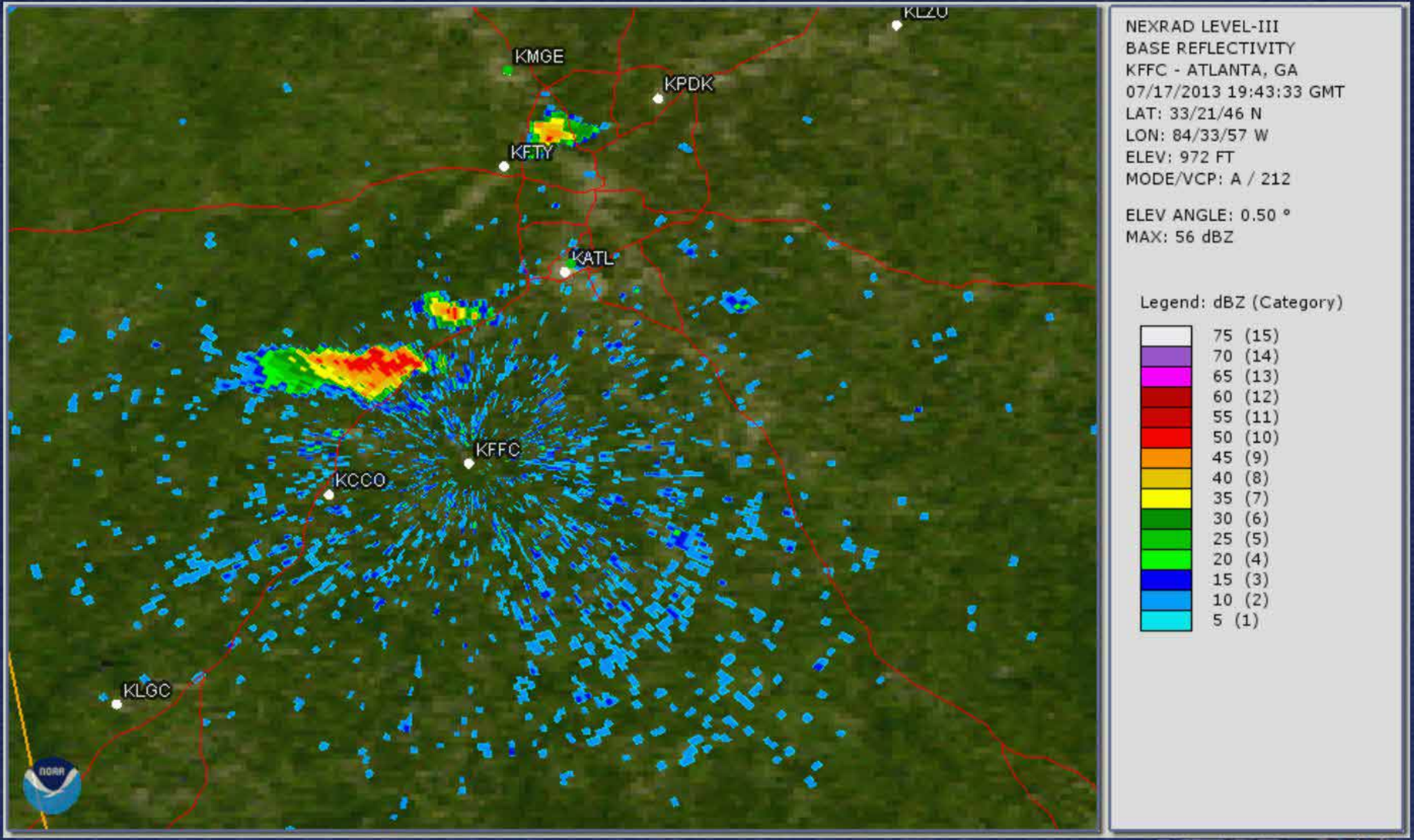
Outflow Boundary Example



Cool air from the thunderstorms spreads out in all directions away from the storms. These boundaries (separating the cool air from warmer ambient air) can act as focusing mechanisms for additional activity.

Warning – not identifiable in all radar displays, WSR-88D base

Atlanta, GA - Outflow boundary example
July 17,2013



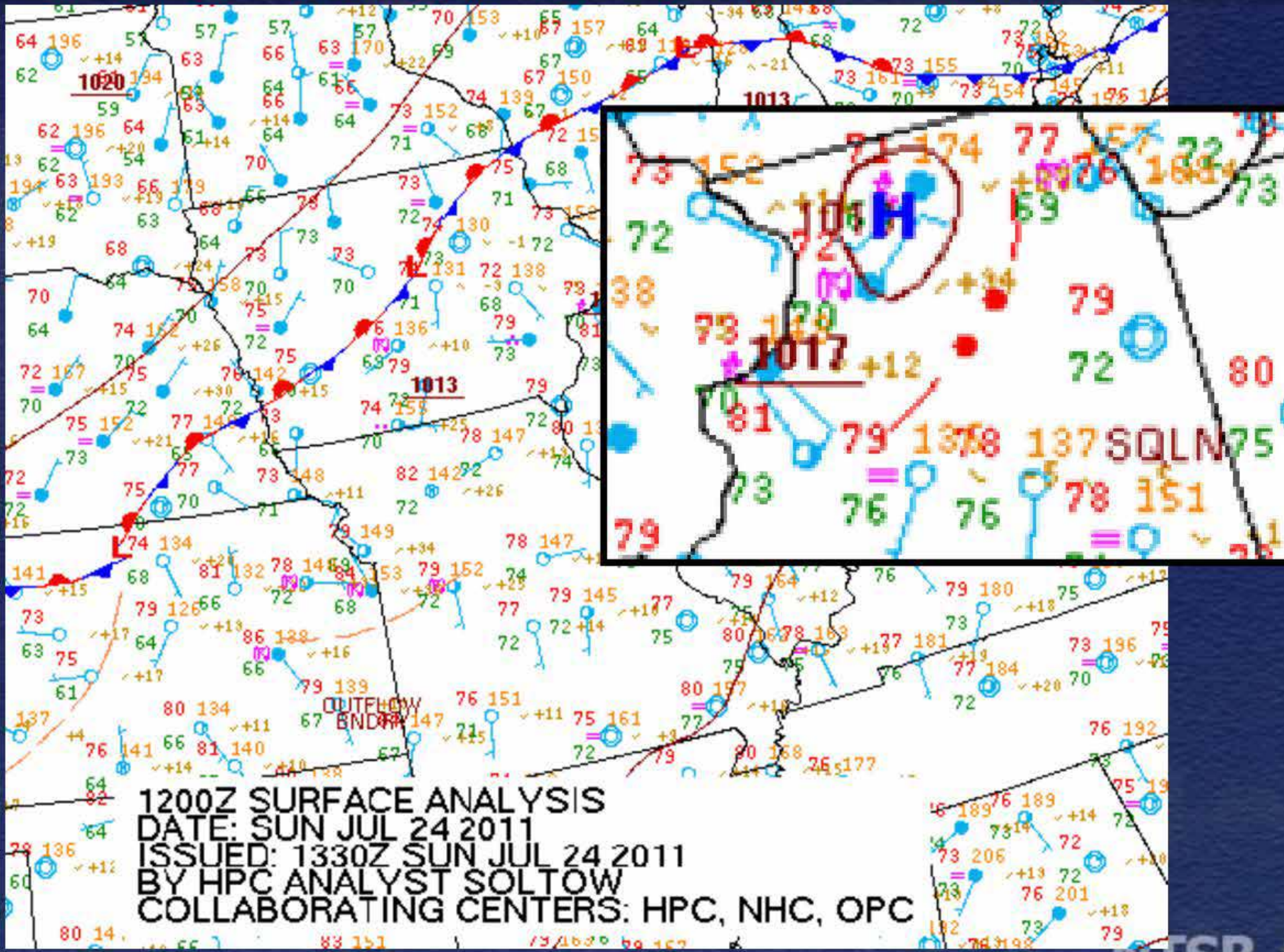
NTSB

CEN11FA500 - Rantoul, IL
Piper Malibu PA-46, N46TW
July 24, 2011

- Part 91 personal IFR flight
- Pilot – 1850 hr
- Rantoul (KTIP) to Sarasota (KSRQ)
- Pilot obtained internet weather briefing & filed IFR flight plan
- In hurry to beat the weather front moving through area
- Fatal family of 3

NTSB

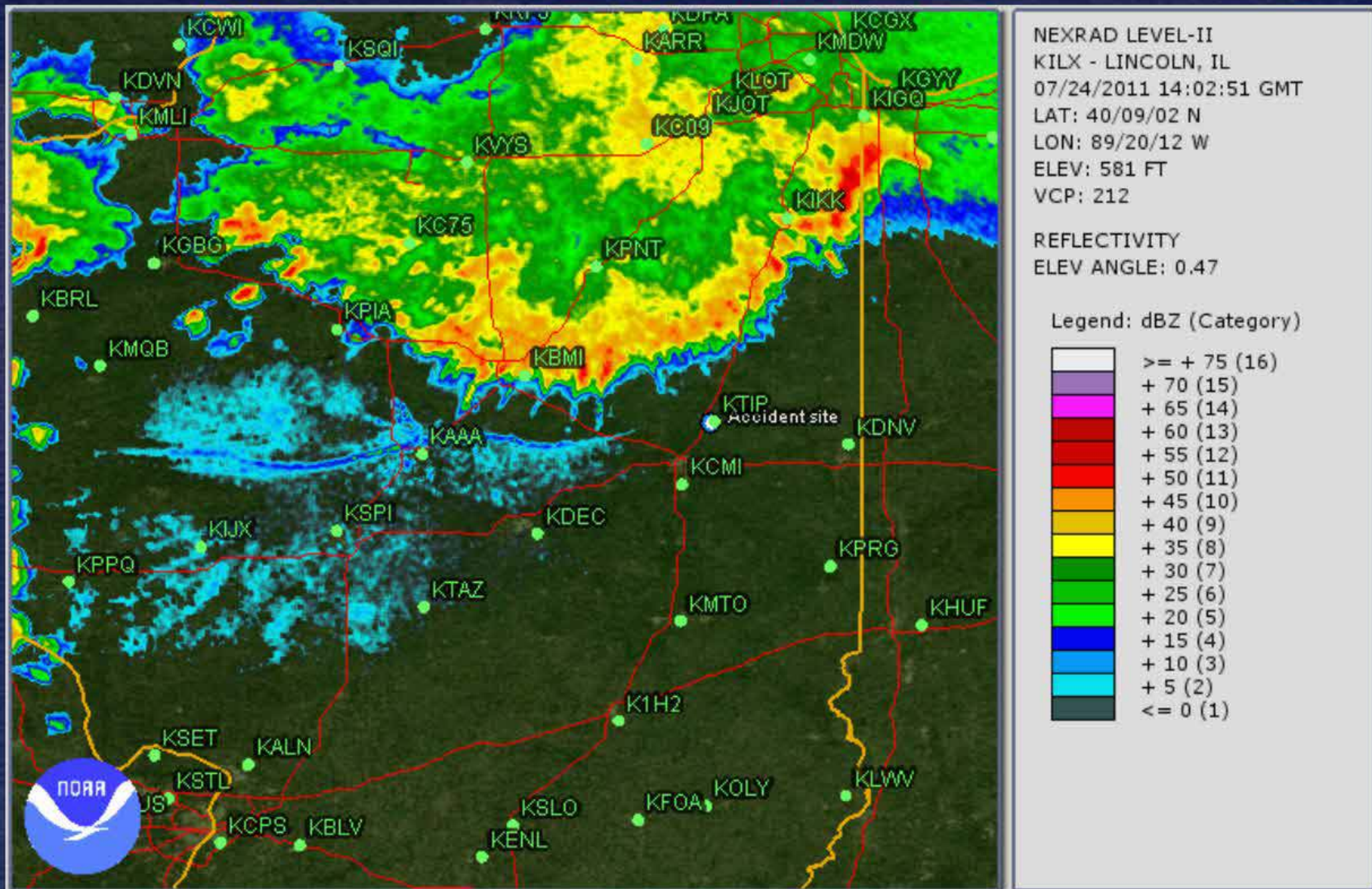
Surface Analysis



CEN11FA500 - Rantoul, IL

Photo’s taken by passenger on board accident airplane

CEN11FA500 - Rantoul, IL



1,163 lightning strikes within 30NM and 15-min of accident

NTSB

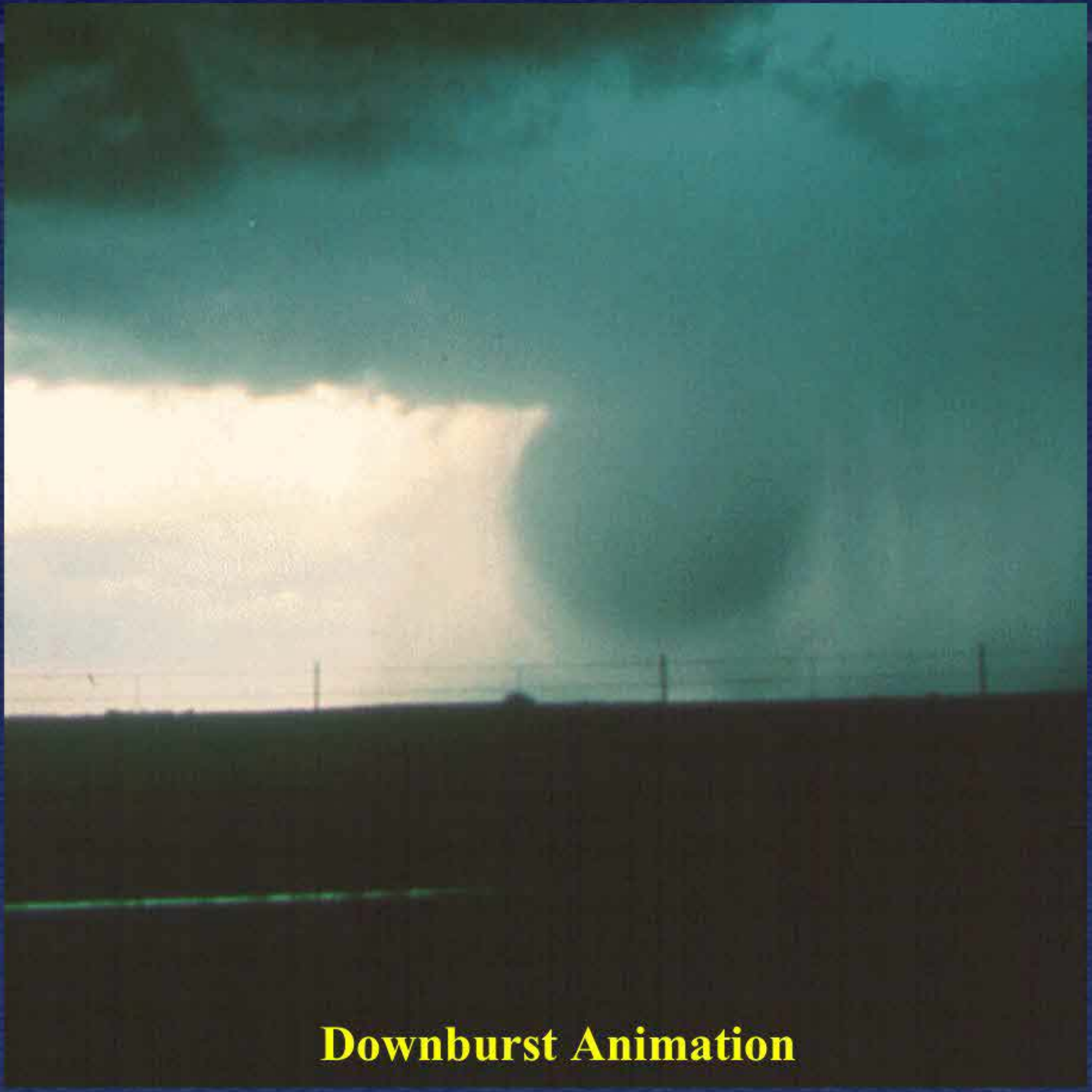
CEN11FA500 - Rantoul, IL

NTSB

Probable Cause ***– the pilot did not maintain airplane control during takeoff with approaching thunderstorms.*** ***Contributing factor*** ***was the pilot's decision to depart into adverse weather conditions.***

Microbursts

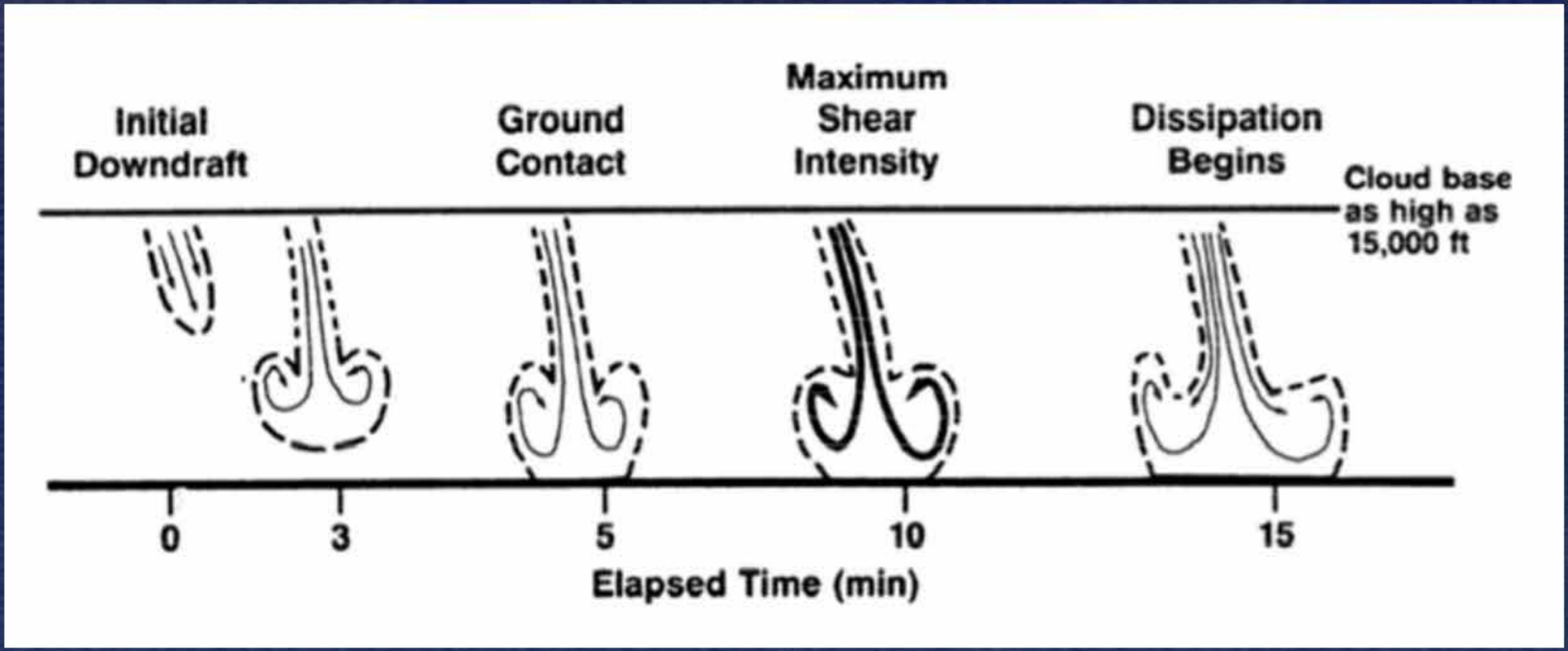
The Microburst



NTSB

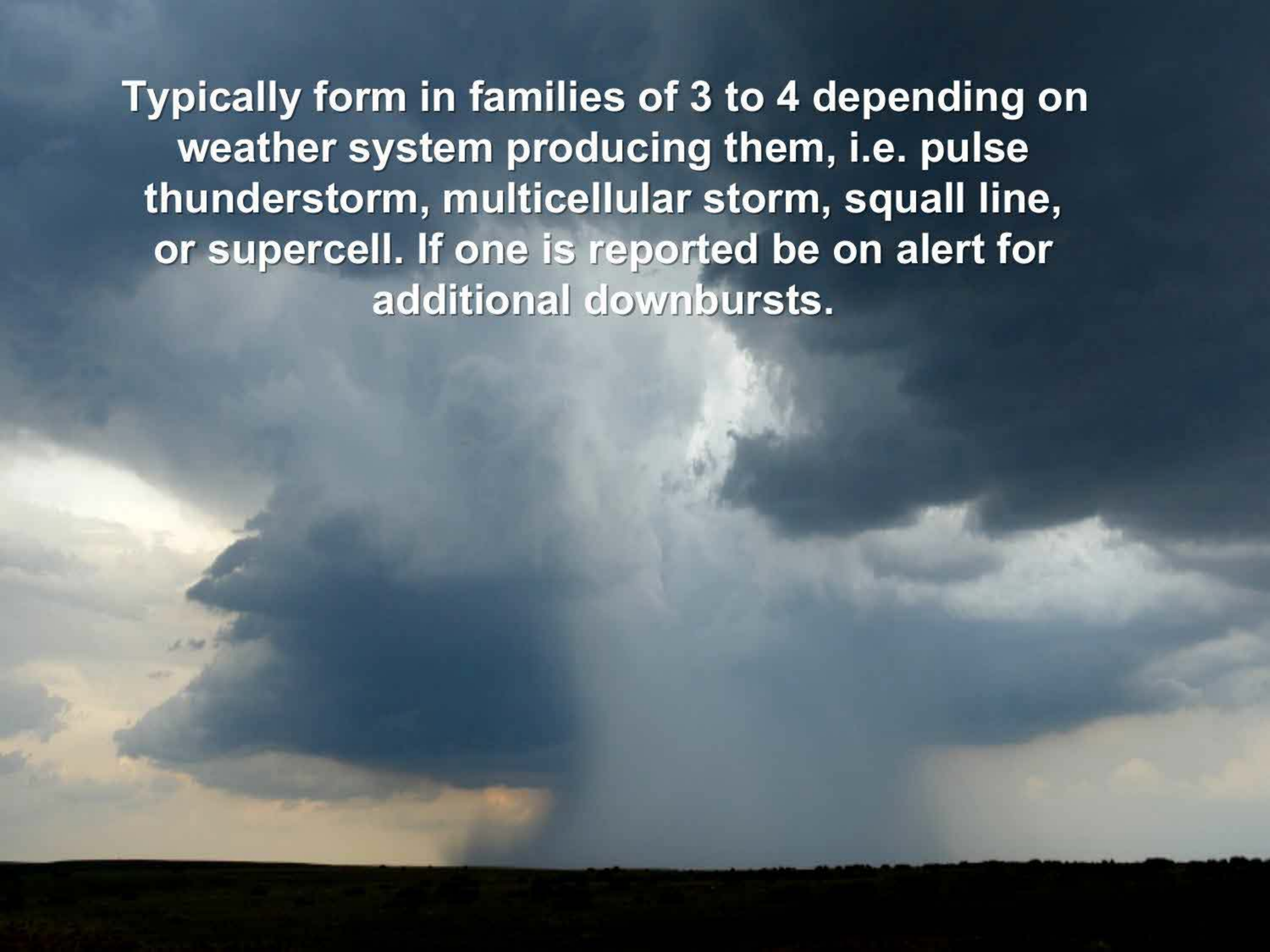
NTSB

NTSB



Downdrafts can exceed 6,000 FPM

NTSB


Typically form in families of 3 to 4 depending on weather system producing them, i.e. pulse thunderstorm, multicellular storm, squall line, or supercell. If one is reported be on alert for additional downbursts.

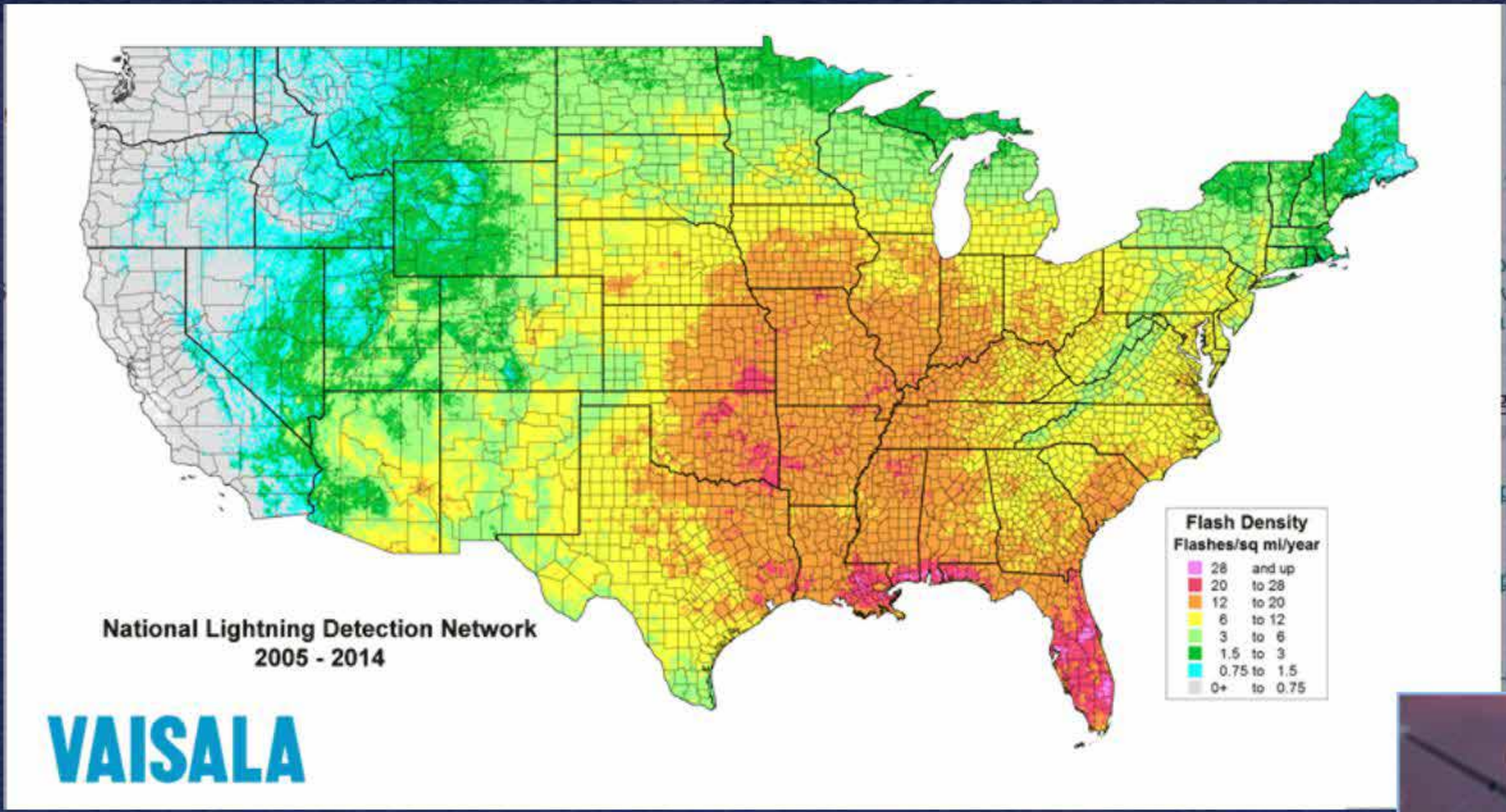
Arizona Microburst

Elements of a Weather Study

- Synoptic conditions
- Observations
- Upper air data
- Satellite imagery
- Radar imagery
- **Lightning data**
  - *Difference between a rain shower and a thunderstorms!*
  - *Only Cumulonimbus Clouds produce lightning*
  - **Exception to the rule – volcanic eruptions*

NTSB

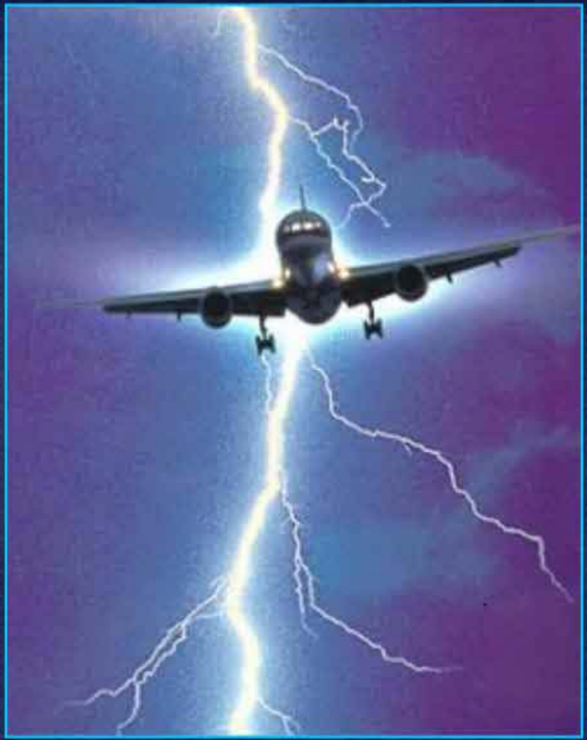
Lightning Data



National
Lightning
Detection
Network

https://www.wvs.corelogic.com/strikenet

Lightning Strikes



- **Frequently** - cause minor structural damage
- **Occasionally** - cause major or substantial damage
- **Rarely** - implicated as a probable cause of destruction of aircraft
  - 10 major accidents with over 370 fatalities worldwide due to lightning igniting fuel vapors

Elements of a Weather Study

- Synoptic conditions
- Observations
- Upper air data – soundings/ MDCARS
- Satellite imagery
- Radar imagery
- Lightning data
- **NWS Advisories and Forecasts**
  - * Most limited area of data retrieval

NTSB

NWS Text Products

- Area Forecasts (FA)
- Winds & Temperature Aloft (FD)
- In-Flight Weather Advisories
  - Convective SIGMETs (WST)
  - Weather Watches (AWW)
  - SIGMETs (WS)
  - AIRMETs (WA)
  - Center Weather Advisories (CWA)
- Pilot Reports (UA/UUA)
- Terminal Forecasts (TAF)
- Weather advisories/warnings (WW/AWW)
- Convective Outlook (AC)

Accessing NWS Text Products

NOAA NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Home | Climate Information | Data Access | Customer Support | Contact | About

Search

Home > HDSS Access System > Dataset Selection

HDSS Access System

Some of NCDC's data holdings are archived on a Hierarchical Data Storage System (HDSS), which includes a tape robotics system for data archived on tape. NCDC provides direct online access to these data though the HDSS Access System (HAS). Other services for archived data are available elsewhere on the NCDC website, so this is not a compilation of all HDSS-archived datasets. As with all of our online services, we provide the data and products at no cost to customers. Files are generally delivered in their native formats as archived by NCDC. Click on data categories below to view a list of available datasets. Information will include brief descriptions, periods of record, links to documentation, and ordering options.

NOAA Climate Data Records

The National Research Council (NRC) defines a CDR as a time series of measurements of sufficient length, consistency, and continuity to determine climate variability and change. More »

Land-Based

Land-based (in situ) observations are collected from instruments sited at locations on every continent. More »

- DATSAV3 Surface (TD9956)
- Integrated Surface Hourly Database (ISH/ISD) Ver2
- NOAAPort Gridded
- NOAAPort Text
- NOAAPort Text (NEW)
- Service Records Retention System (SRRS) Graphics
- Service Records Retention System (SRRS) Text Products

National Center for Environmental Information (NCEI)

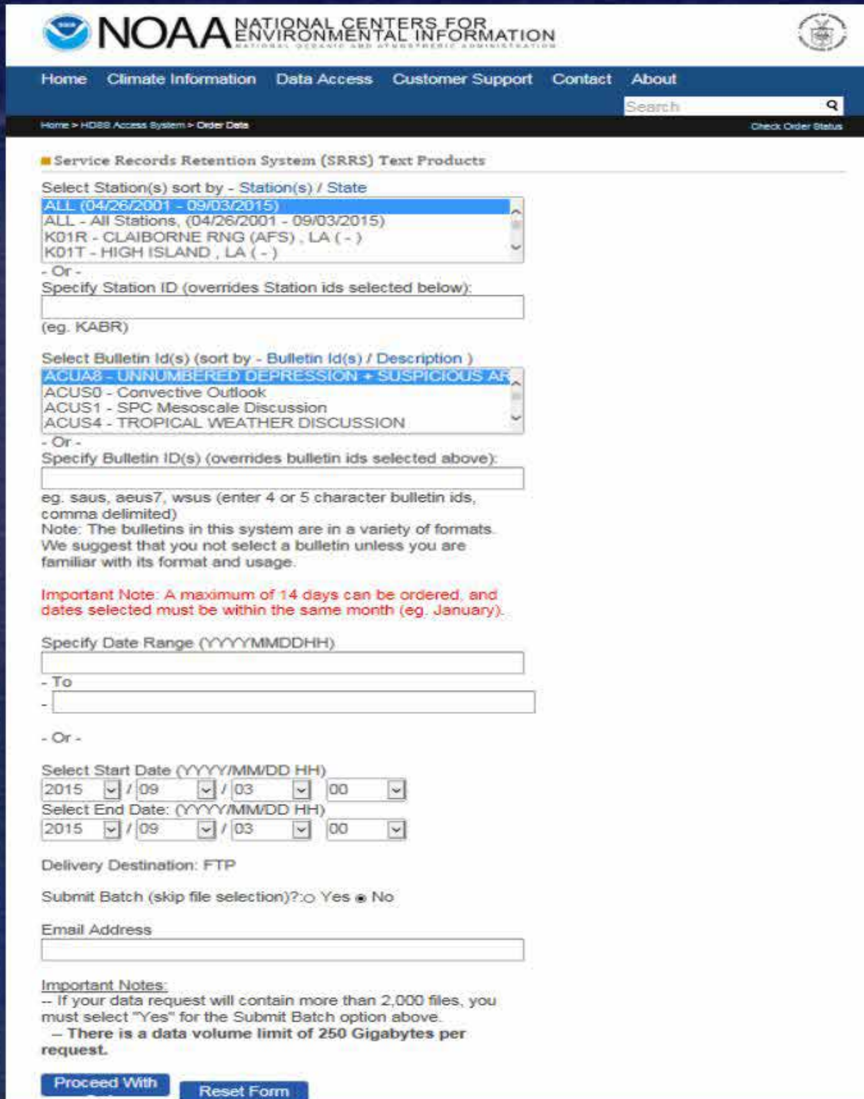
Hierarchical
Data
Storage
System

- Access Service Record Retention System (SRRS) –
  - Provides access to text data

Only source for full archive NWS text data

NTSB

http://www.ncdc.noaa.gov/has/has.dsselect



Stations

- KKCI - FA,WA,WS, WST
- KWNO - FD
- KWBC - UA,UB
- KWNS - AC, WW
- KNHC – WT
- *Need to know who issues advisory or forecast

Bulletin Type

- FAUS2 – Center (CWSU) Weather Advisory
- UBUS – State Pilot Report

Date/Time

Email

http://www.ncdc.noaa.gov/has/HAS.FileAppRouter?datasetname=9957ANX&subqueryby=STATION&applname=&outdest=FILE

NTSB

Weather Reports & Forecasts

- Pilot Reports (UA/UUA)

AMA UA /OV AMA090010 /TM 2217 /FL060 /TP E145 /TB MOD=

AMA UUA /OV AMA180018 /TM 2237 /FL055 /TP C402 /TB LGT-MOD OCNL SEV=

PVW UUA /OV LBB360020 /TM 2304 /FL055 /TP C402 /TB SEV /RM REPORTED HEAVY TURBULENCE PER ATC=

NWS Weather Forecasts & Advisories

- Terminal Aerodrome Forecast (TAF)

KAMA 261137Z 2612/2712 VRB04KT P6SM SCT150
FM261400 10013KT P6SM BKN200
FM262100 14015G25KT P6SM VCTS SCT050CB BKN150
FM270500 27011KT P6SM FEW010 SCT100=

Preflight/Departure

TAF KAMA 261722Z 2618/2718 15013KT P6SM BKN150
FM262100 14017G27KT P6SM SCT050
FM270600 27015KT P6SM FEW100
FM271400 28022G32KT P6SM SKC=

TAF AMD 1 KAMA 262000Z 2620/2718 13011KT P6SM BKN150
FM262200 14015KT P6SM SCT050
FM270600 27015KT P6SM FEW100
FM271400 28022G32KT P6SM SKC=

TAF AMD 2 KAMA 262105Z 2621/2718 13016KT P6SM BKN150
FM262200 14015KT P6SM SCT050
FM270600 27015KT P6SM FEW100
FM271400 28022G32KT P6SM SKC=

Accident 2145Z

TAF AMD 3 KAMA 262158Z 2622/2718 13016G26KT P6SM BKN150
TEMPO 2622/2624 4SM -TSRA BKN050CB
FM270600 27015KT P6SM FEW100
FM271400 28022G32KT P6SM SKC=

How did the local NWS Forecast Office Perform – Accuracy?

NTSB

NWS Weather Forecasts & Advisories

- Convective SIGMET current during the period:

MKCC WST 262055
CONVECTIVE SIGMET 19C
VALID UNTIL 2255Z
TX NM
FROM 70NE TCC-10NW AMA-20WSW LBB-40W TXO-10NE TCC-70NE TCC
AREA TS MOV FROM 24020KT. TOPS TO FL420.
HAIL TO 2 IN...WIND GUSTS TO 60KT POSS.

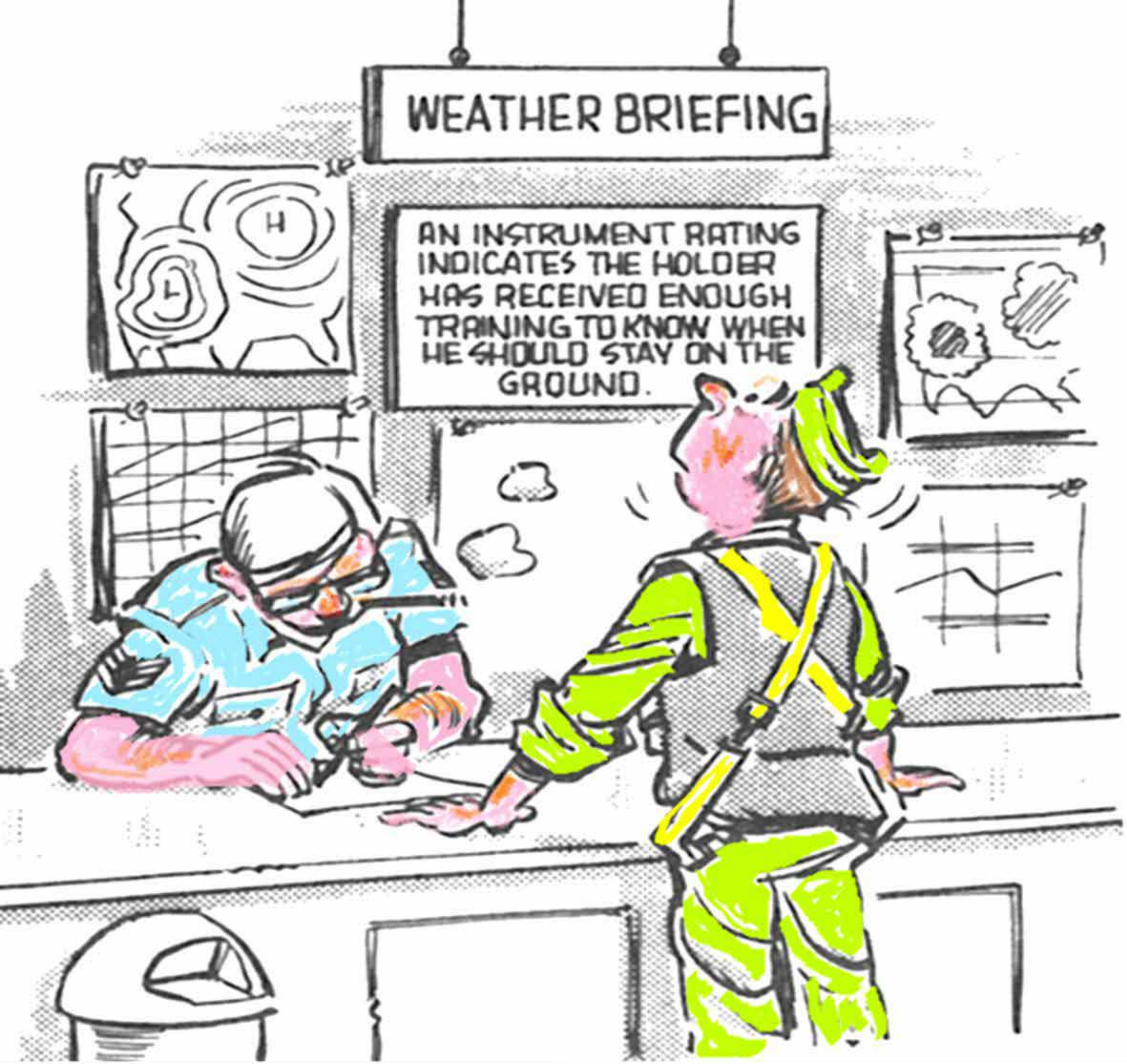
Accident 2145Z

MKCC WST 262155
CONVECTIVE SIGMET 22C
VALID UNTIL 2355Z
TX NM
FROM 70SSE TBE-50N AMA-30NE LBB-10WNW LBB-70SSE TBE
AREA SEV TS MOV FROM 24020KT. TOPS TO FL450.
HAIL TO 2 IN...WIND GUSTS TO 60KT POSS.

NTSB

Elements of a Weather Study

- Synoptic conditions
- Observations
- Upper air data – soundings/ MDCARS
- Satellite imagery
- Radar imagery
- Lightning data
- NWS Advisories and Forecasts
- **Weather briefing documents**


WEATHER BRIEFING
H
L
AN INSTRUMENT RATING INDICATES THE HOLDER HAS RECEIVED ENOUGH TRAINING TO KNOW WHEN HE SHOULD STAY ON THE GROUND.

Preflight Weather Briefing

- Did the crew receive an adequate weather briefing and what was provided?
- Weather documents issued
- Flight updates what updates received enroute?
- Was the weather condition properly forecast & advisories issued by the NWS or ATC?

NTSB

Recreating Weather Briefing

- Fill out Flight Plan
- Obtains Archive weather
  - Prog charts
  - Synopsis/Area Forecast
  - Severe Weather Outlook
  - AIRMETs/SIGMETs
  - METAR/TAFs
  - Radar/satellite imagery
  - Winds Aloft Forecast

http://pilottrainingsystem.com/

FREE

NTSB

Weather Briefing Documentation

- Pilot obtained preflight briefing through ForeFlight
- Also utilized Aero Weather
- Used MyRadar app for local radar imagery
- Observed approaching thunderstorms & attempting to beat storms back to the field

Elements of a Weather Study

- Synoptic conditions
- Observations
- Upper air data – soundings/ MDCARS
- Satellite imagery
- Radar imagery
- Lightning data
- NWS Advisories and Forecasts
- Weather briefing documents
- **Witness statements & interviews**

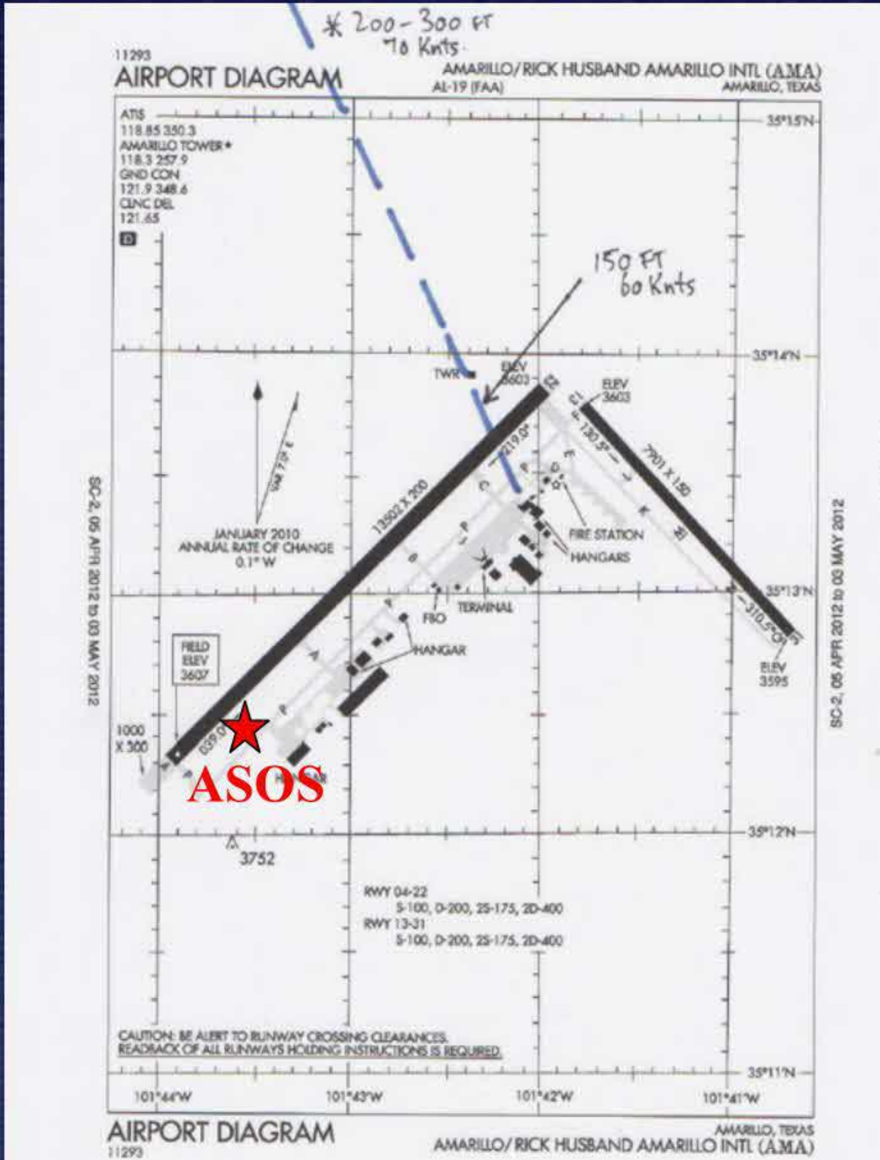
NTSB

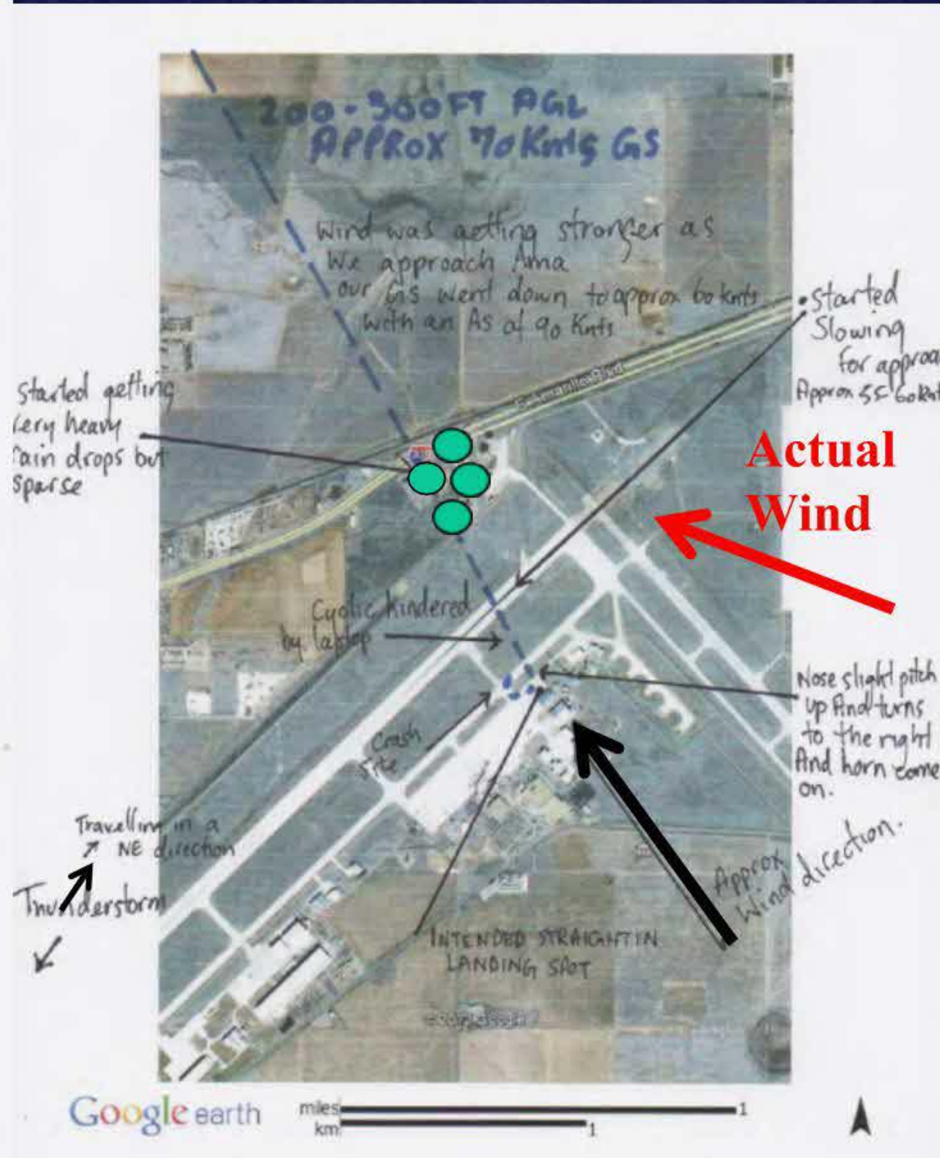
Interviews & Statements



- Flight Crew written statements, follow up
- Pilots others operating in the area
- Flight Dispatchers/Operations Center (if used)
- Witness statements cloud features, lightning, wind conditions, there take on the incident, aware of the conditions

NTSB





Pilot provided the following comments

NTSB

Elements of a Weather Study

- Synoptic conditions
- Observations
- Upper air data – soundings/ MDCARS
- Satellite imagery
- Radar imagery
- Lightning data
- NWS Advisories and Forecasts
- Weather briefing documents
- Witness statements & interviews
- **Astronomical data**

NTSB

United States Naval Observatory Astronomical Conditions

COMPLETE SUN AND MOON DATA FOR ONE DAY

USNO

Astronomical Applications Department

Data Services

Information Center

Publications

Software

About AA

Sitemap

Use these forms to obtain rise, set, and transit times for the Sun and Moon; civil twilight beginning and end times; and, lunar phase information for any year between 1700 and 2100. First, specify the date and location in one of the two forms below. Then, click the "Get data" button at the end of the form.

Use Form A for cities or towns in the U.S. or its territories. Use Form B for all other locations. Both forms are immediately below.

Be sure to read the Notes section located after the two forms, especially if you wish to use these data for legal purposes.

Form A - U.S. Cities or Towns

Year: 2016 **Month:** June **Day:** 13

State or Territory: District of Columbia

City or Town Name:

The place name you enter above must be a city or town in the U.S. The place's location will be retrieved from a file with over 22,000 places listed. Either upper- or lower-case letters or a combination can be used. Spell out place name prefixes, as in "East Orange", "Fort Lauderdale", "Mount Vernon", etc. The only exception is "St.", which is entered as an abbreviation with a period, as in "St. Louis". You need only enter as many characters as will unambiguously identify the place. The city or town name may be left blank if the State or Territory is District of Columbia.

Get data

Form B - Locations Worldwide

Year: 2016 **Month:** June **Day:** 13

Place Name Label: (no name given)

The place name you enter above is merely a label for the table header; you can enter any identifier, or none (avoid using punctuation characters). The data will be calculated for the longitude and latitude you enter below.

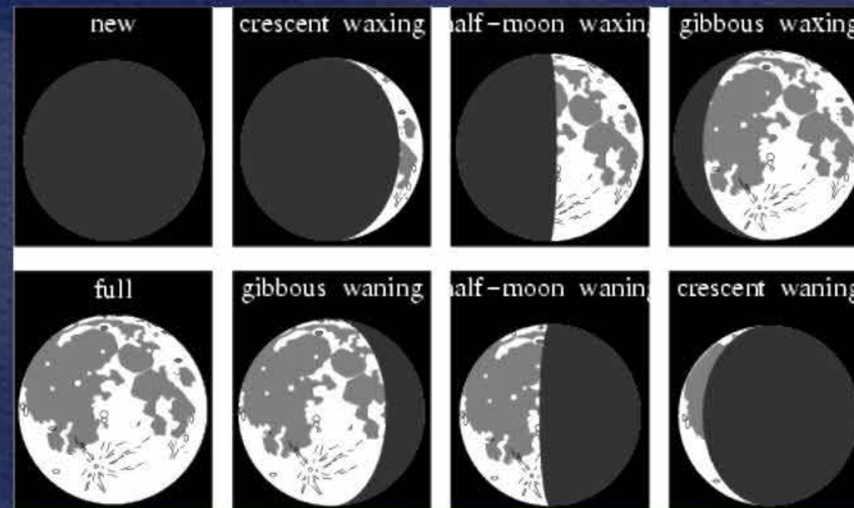
Note: Coordinate components should be entered as integers (no decimals).

Longitude: east west degrees minutes

Latitude: north south degrees minutes

http://www.usno.navy.mil/USNO/astronomical-applications/data-services/data-services

Astronomical Conditions



Astronomical data

- Official day/night?
  - "Night" end of civil twilight to morning civil twilight
  - Sunrise, sunset, and civil twilight
- Sun glare or night illumination issues?
  - Altitude, magnetic azimuth of sun and moon
  - Phase & illumination of moon

http://www.usno.navy.mil/USNO/astronomical-applications/data-servicesp://aa.usno.navy.mil/

Final Report

CFR response photo immediately after the accident

Probable Cause: *The pilot's failure to maintain helicopter control during landing in gusty wind conditions associated with a thunderstorm, which resulted in a loss of tail rotor effectiveness.*

NTSB

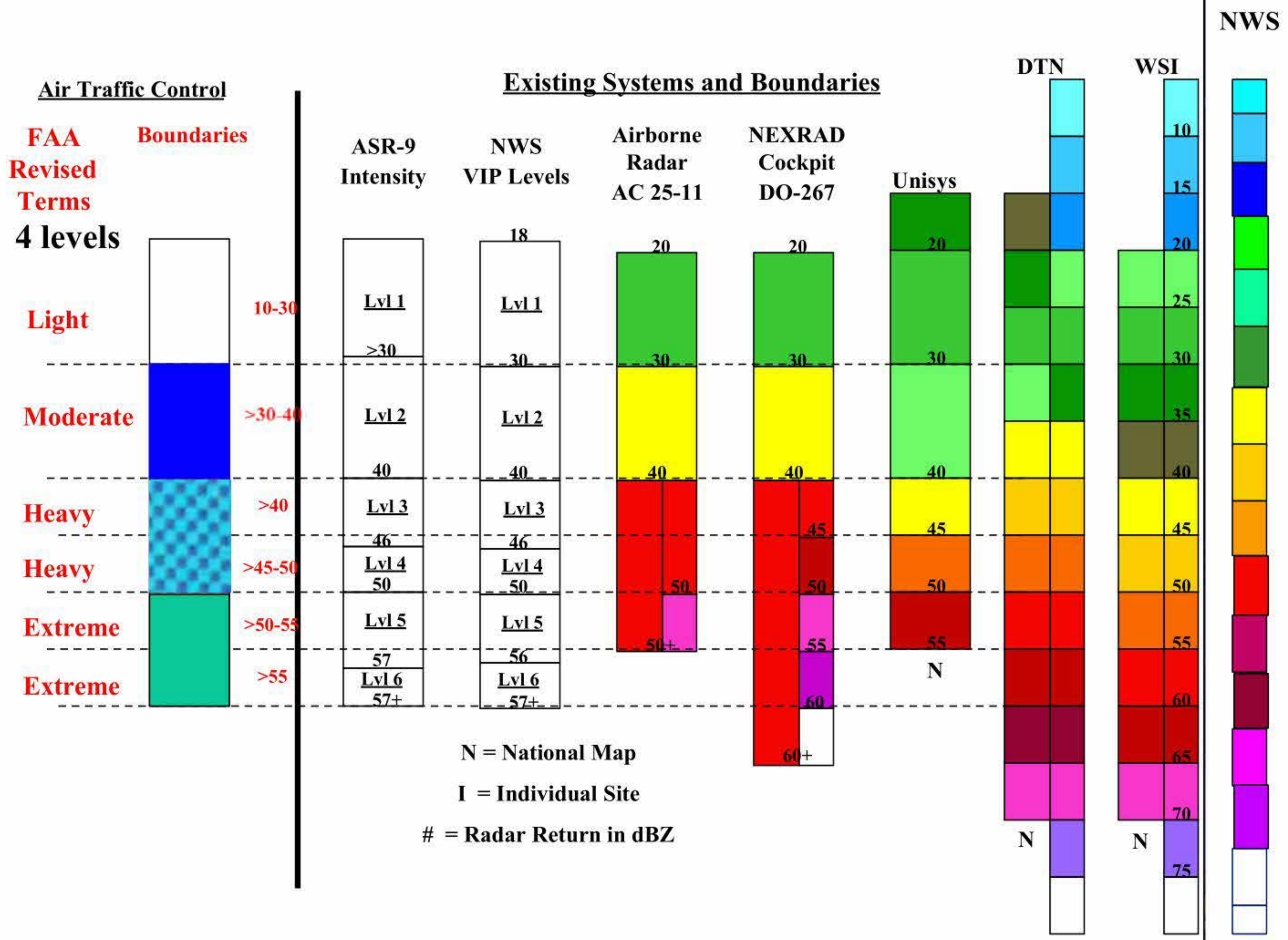

DO NOT
ENTER

DOE Flight Department Safety Manager

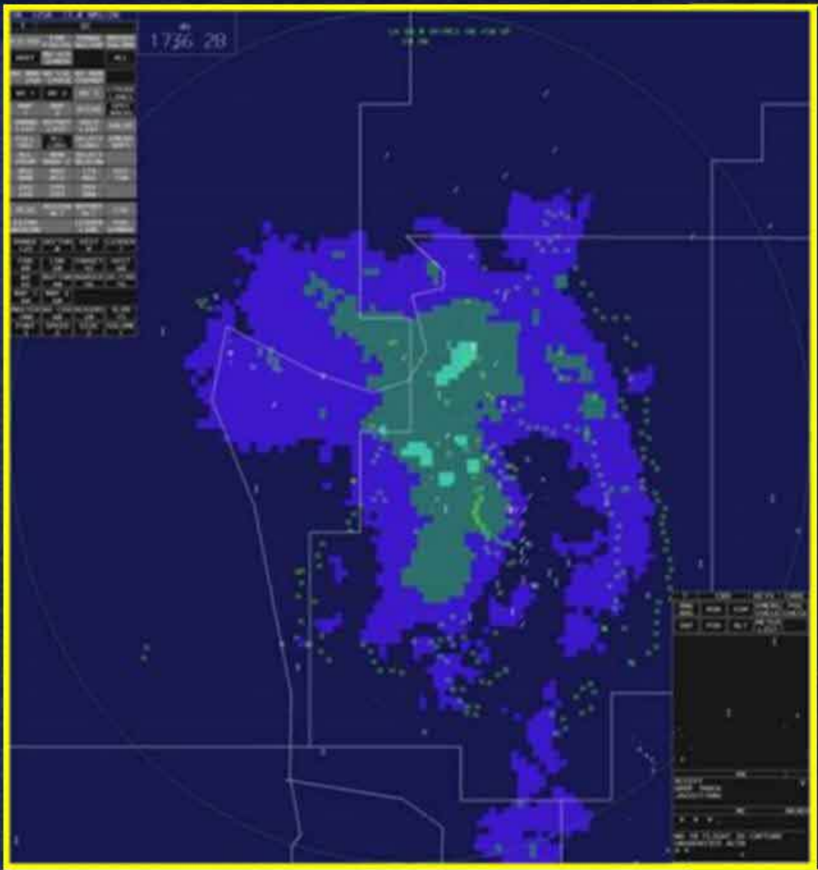
- DOE King Air enroute to perform survey work encountered developing thunderstorms, which resulted in loss of control
- Minor damage & injuries
- NTSB not involved
- Several individuals on board shaken by event
- Boss wants to know what happened and now!

ERA11LA344 – Gray, TN
Beech King Air, N15L
June 15, 2011

- Business flight
- Airborne X-band radar
- IMC at FL200 deviating downwind of around area of thunderstorms
- Encounters MOD-SVR turbulence & icing
- Results in loss of control of aircraft - uncommanded roll & dive, recovered at 8,000 feet (-12,000ft)
- Substantial damage to aircraft
- 2 uninjured but shaken pilots


Air Traffic Control
FAA Revised Terms
4 levels
Boundaries
Light
10-30
Moderate
>30-40
Heavy
>40
Heavy
>45-50
Extreme
>50-55
Extreme
>55
Existing Systems and Boundaries
ASR-9 Intensity
Lvl 1
>30
Lvl 2
40
Lvl 3
46
Lvl 4
50
Lvl 5
57
Lvl 6
57+
NWS VIP Levels
18
Lvl 1
30
Lvl 2
40
Lvl 3
46
Lvl 4
50
Lvl 5
56
Lvl 6
57+
Airborne Radar AC 25-11
20
30
40
50
50+
NEXRAD Cockpit DO-267
20
30
40
45
50
55
60
60+
Unisys
20
30
40
45
50
55
N
DTN
N
WSI
10
15
20
25
30
35
40
45
50
55
60
65
70
75
N
NWS
N = National Map
I = Individual Site
# = Radar Return in dBZ

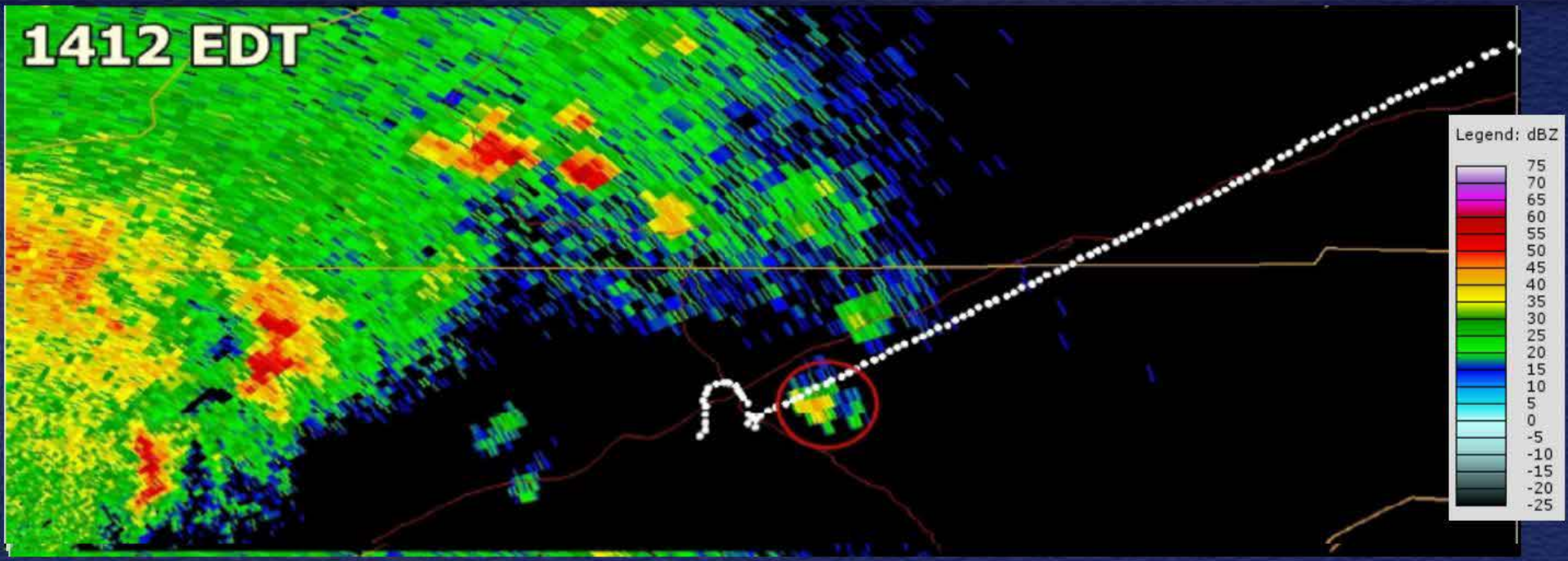
Weather and Radar Processor (WARP)



Reflectivity (dBZ) Ranges	Weather Radar Echo Intensity Terminology
<30 dBZ	Light
30-40 dBZ	Moderate
>40-50 dBZ	Heavy
50+ dBZ	Extreme

* Echoes less than 30 dBZ not displayed

NTSB

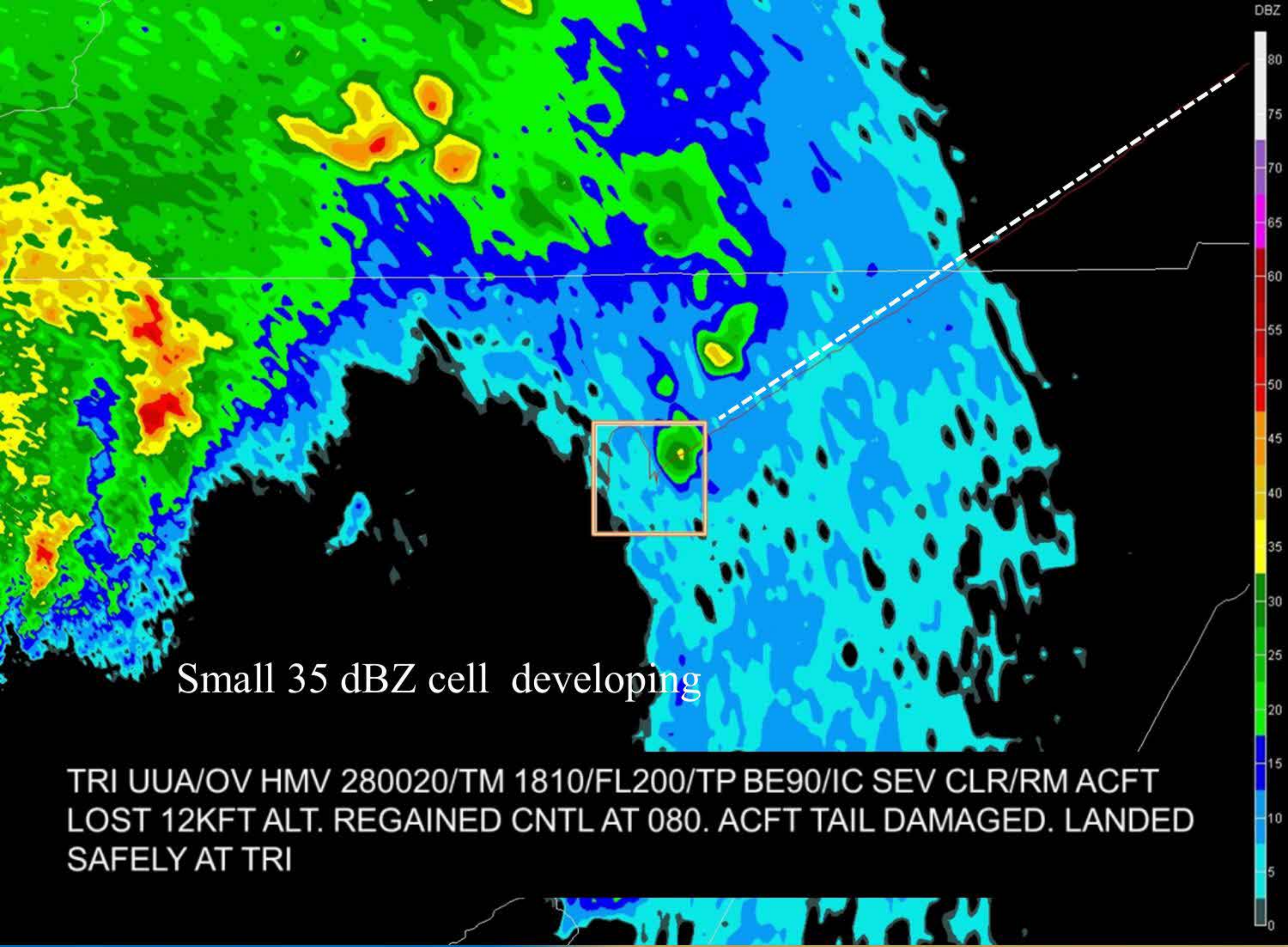


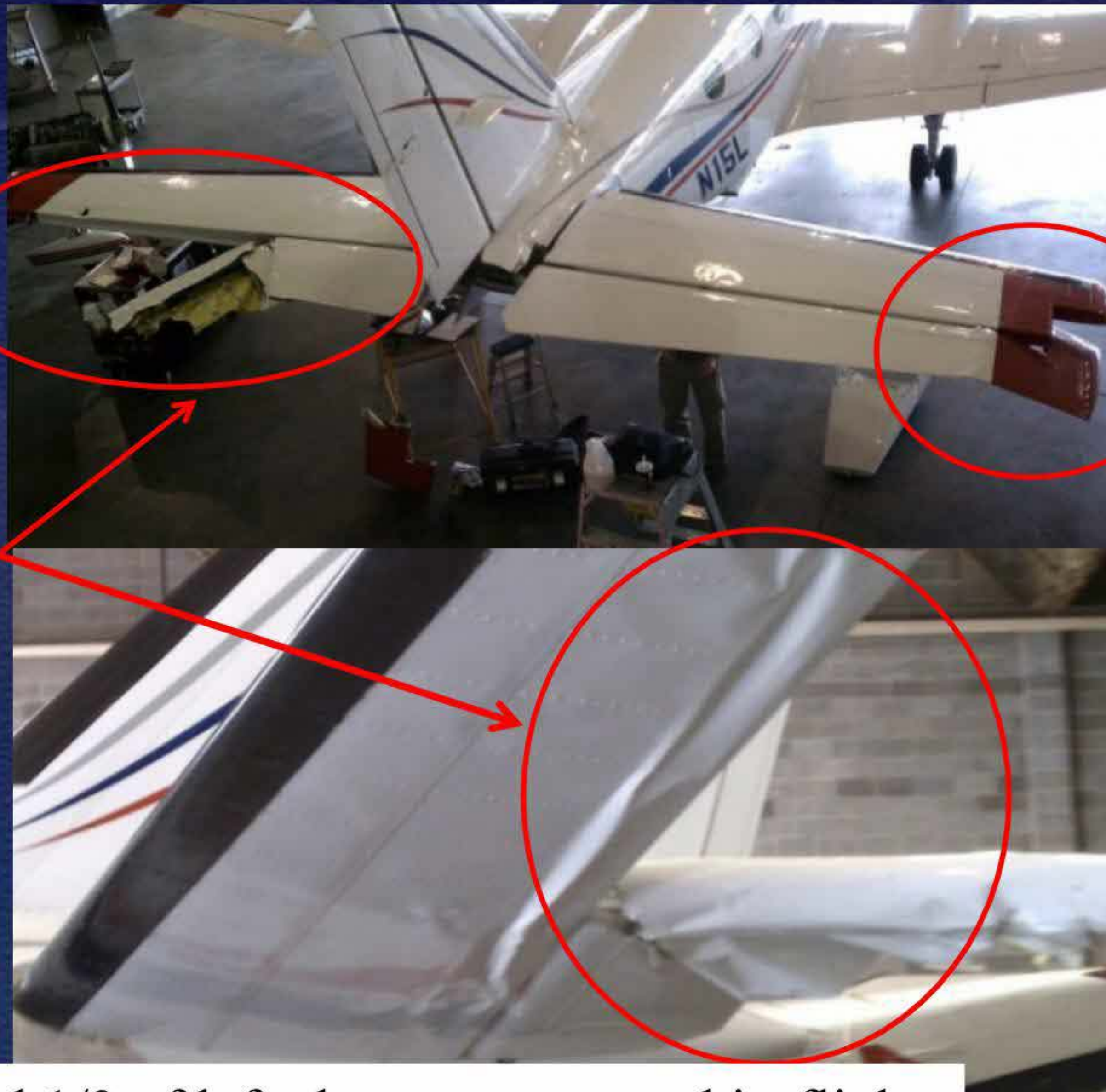
Echoes <15 dBZ not shown

Airborne X-band radar :

Light	20-30 dBZ
Moderate	30-40 dBZ
Heavy	40-50 dBZ

NTSB


DBZ
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
Small 35 dBZ cell developing
TRI UUA/OV HMV 280020/TM 1810/FL200/TP BE90/IC SEV CLR/RM ACFT LOST 12KFT ALT. REGAINED CNTL AT 080. ACFT TAIL DAMAGED. LANDED SAFELY AT TRI



Missing elevator

Damage

Outboard 1/3 of left elevator separated in-flight
Right elevator deformed downward

NTSB

Horizontal stabilizer bulkhead frame fractured and aft airframe deformed in several areas

NTSB

Weather Resource for Accident Investigation

- List of Internet sites that archive weather data and charts
- Aviation safety-related Internet sites
- Reference and conversion tables


Questions?
[redacted] (b)(6)
[redacted] (b)(6)

NTSB

Operational Factors

Captain David Lawrence
Senior Air Safety Investigator
Operational Factors Division - NTSB

National Transportation Safety Board

- Ops investigation
  - Duties
- Case Study
  - Onscene Activities
  - Follow-up Activites

Primary Duties

- Go-team for major accidents
  - 2 hour callout
  - Weekly rotational duties
  - Launch capabilities worldwide


VIA
Hannover




New Duty: Commercial Space Operations

Specific Duties

- Chairman of Ops group
  - FAA, Company, A/C manufacturer, union, or others as needed
- Investigate Part 121, 135 operations usually
- Corporate operations
- Part 91 (occasionally)
- Mostly, we handle the big ones . . .

[redacted]

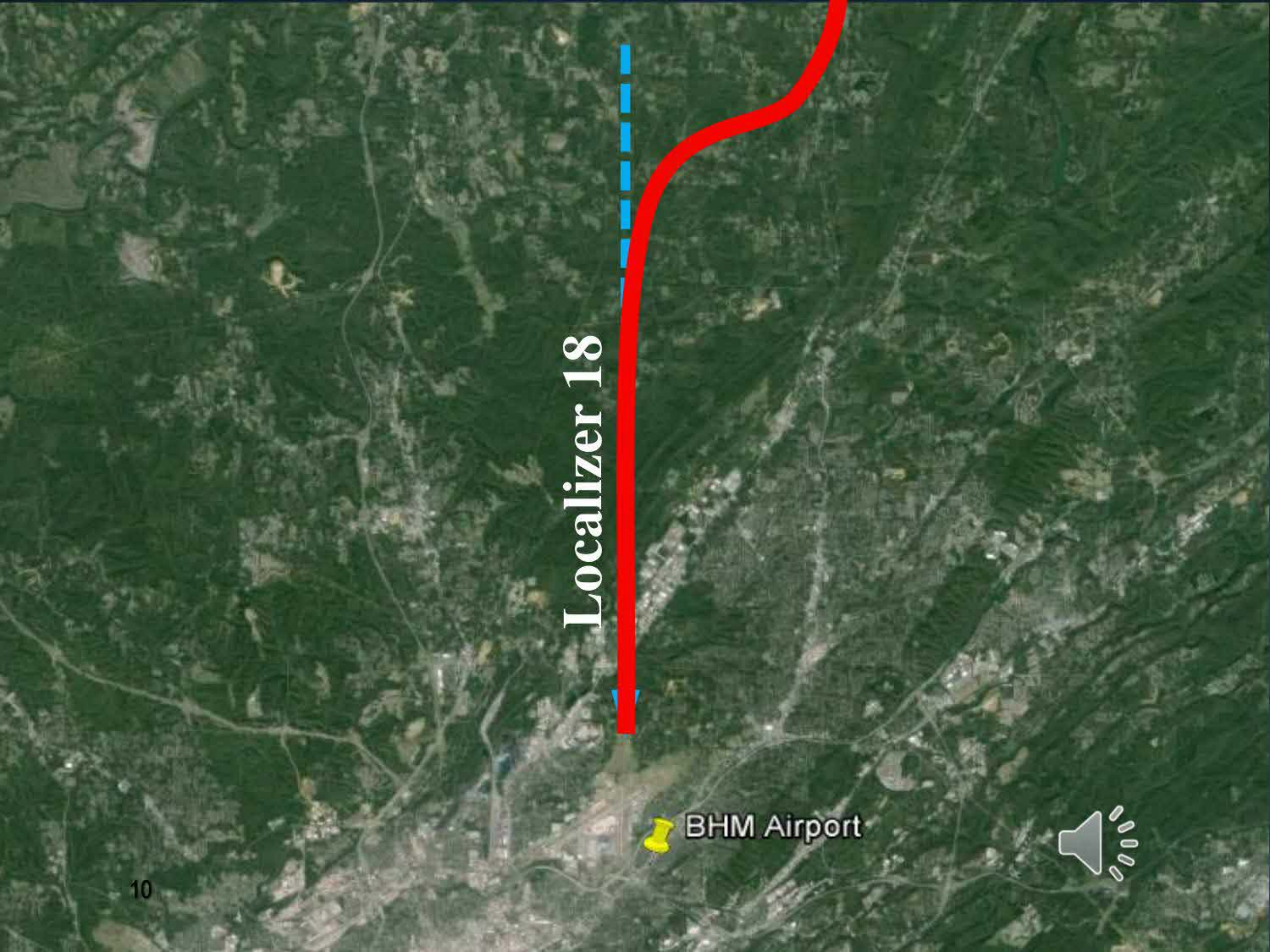
Case Study

Crash During Nighttime Nonprecision Instrument Approach

UPS 1354, A300-600
Birmingham, AL
August 14, 2013

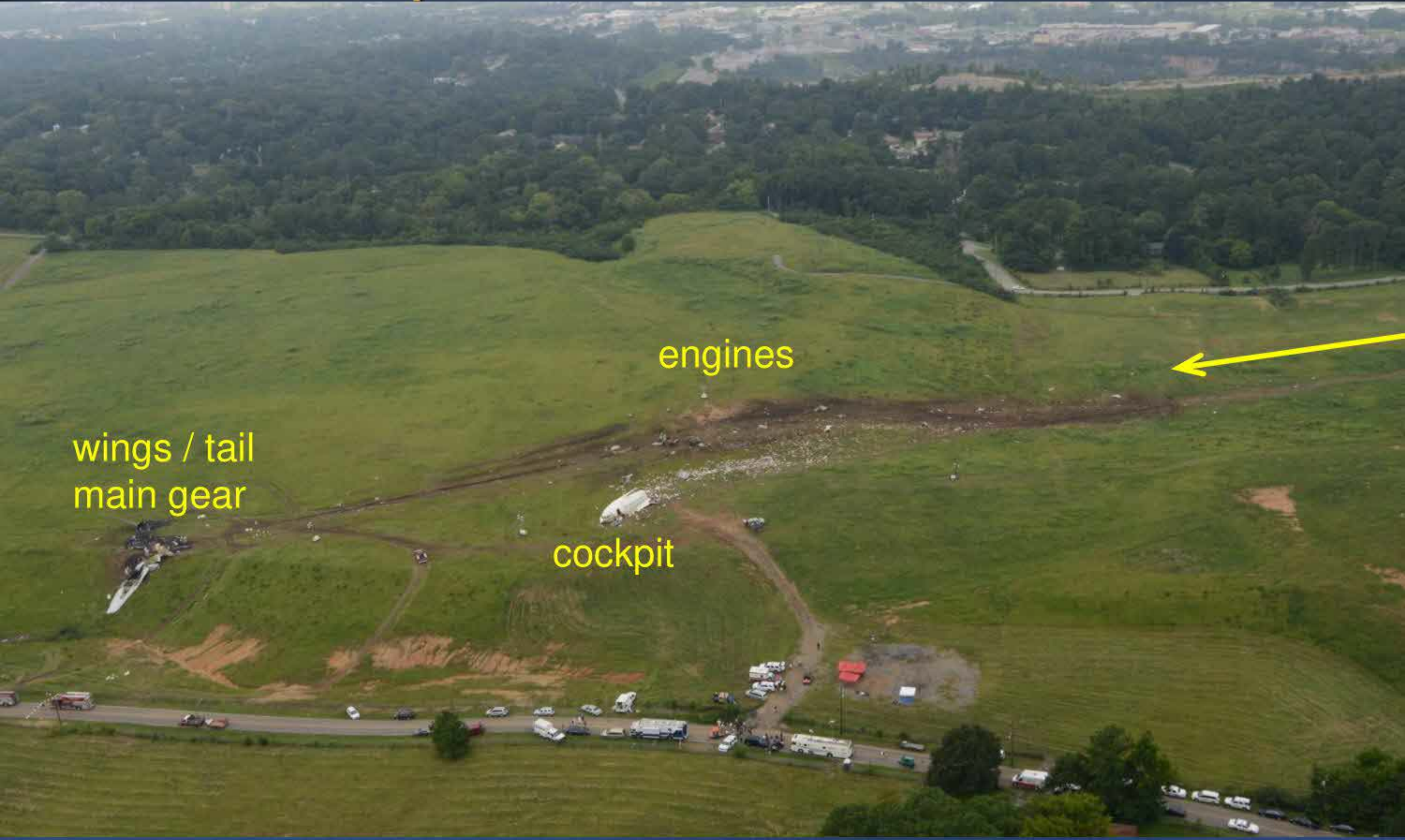
Basic Information

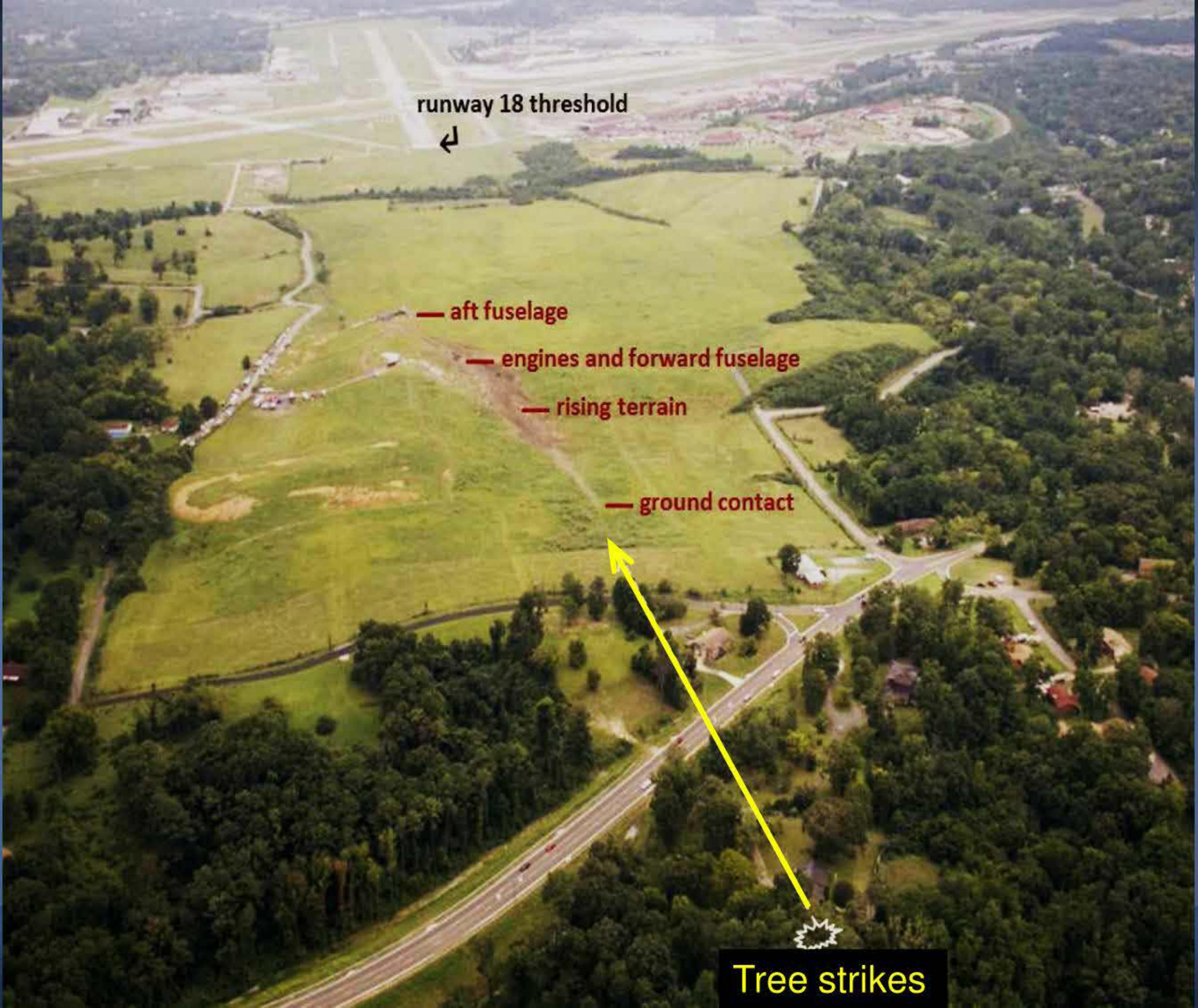
- Airplane destroyed
- 2 crewmembers fatally injured
- Departed Louisville, KY
- Scheduled arrival at 0450 local
- Full go-team launch


Localizer 18
BHM Airport


First Tree Strike
Main Wreckage

Main Impact Area




runway 18 threshold
aft fuselage
engines and forward fuselage
rising terrain
ground contact
Tree strikes

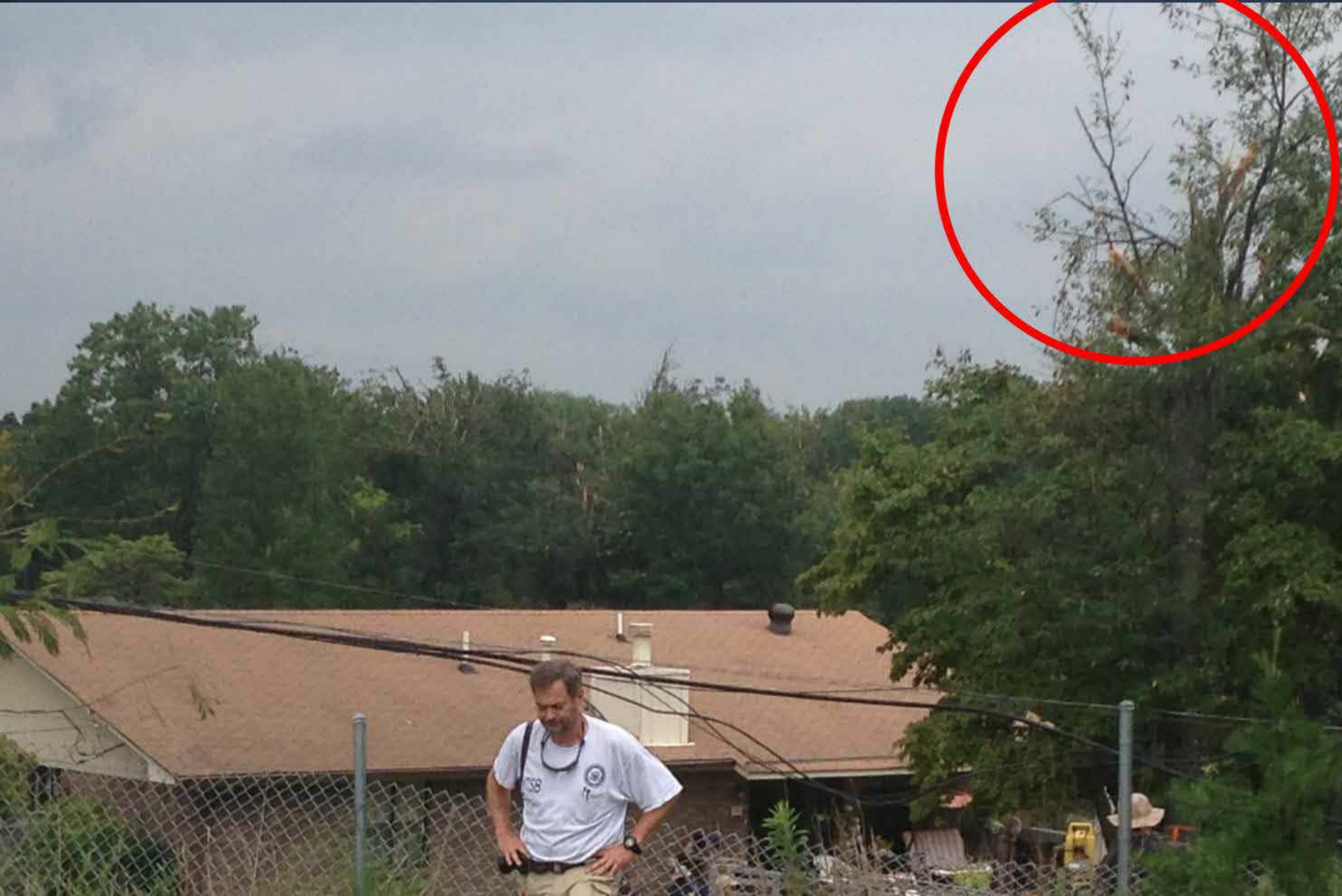
General review of accident site

General review of accident site

General review of accident site

General review of accident site

General review of accident site

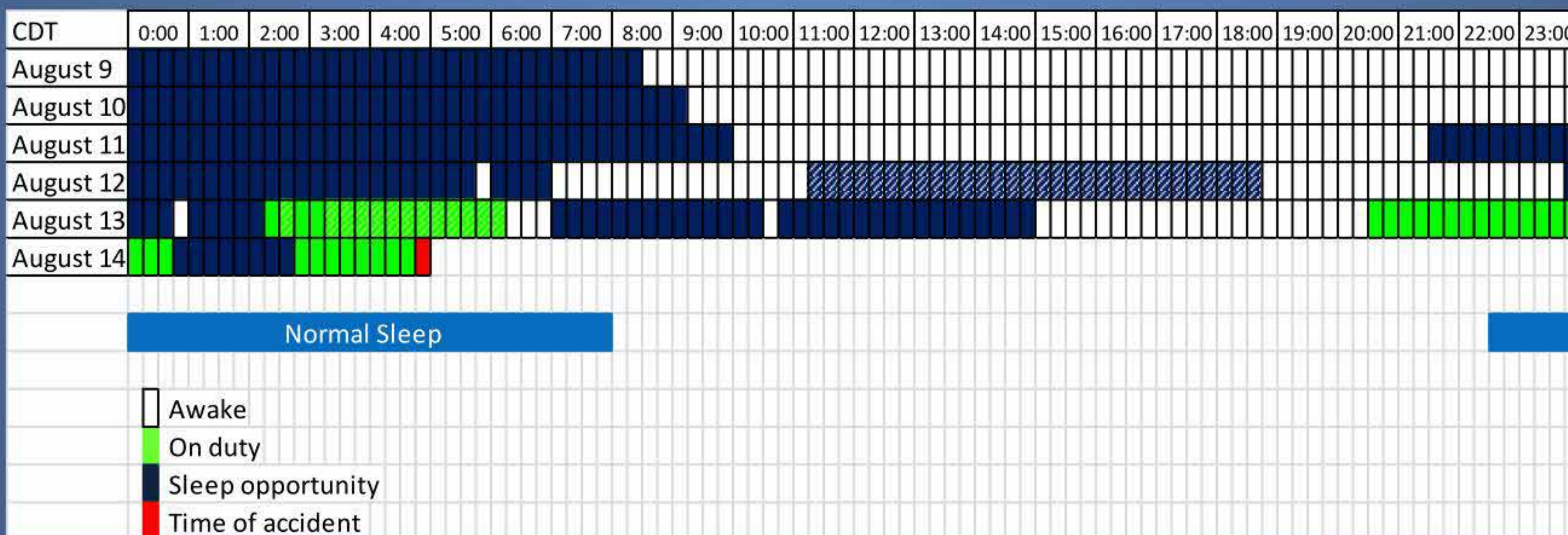


Document the cockpit

Document Crew's Personal Belongings

Review electronic devices

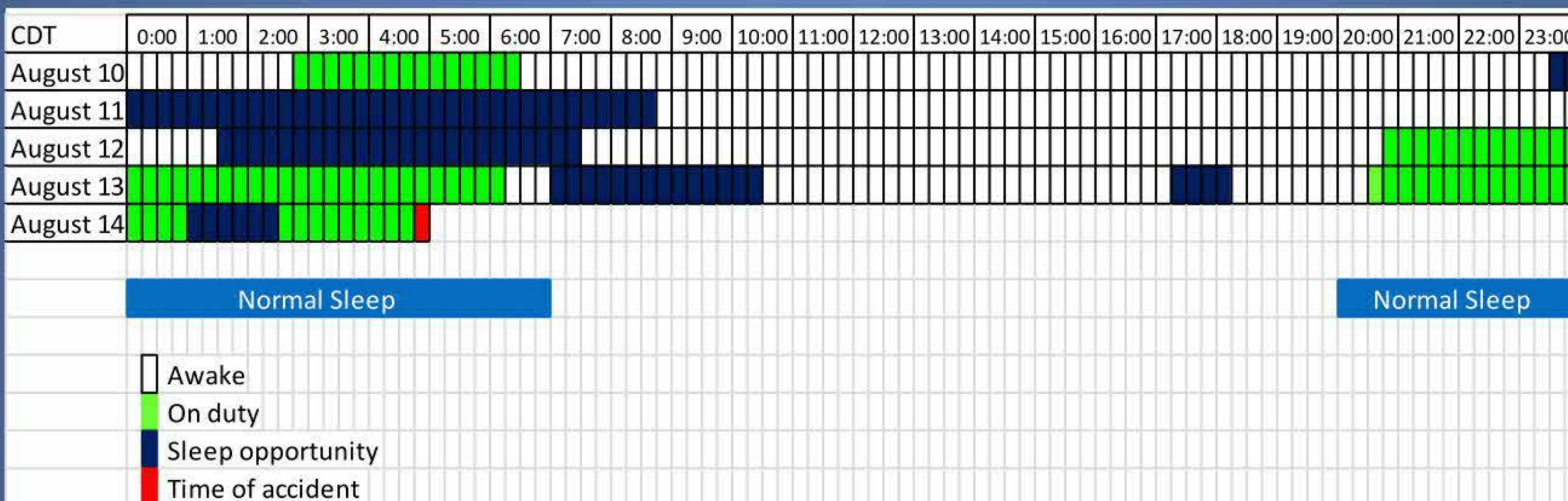
Captain’s Sleep/Wake History



Fatigue - Captain

- Off duty August 5-12
- Took steps to mitigate effects of fatigue
  - Aug. 12: Napped at home and acquired sleep room in Louisville
  - Aug. 13: Adequate opportunity to rest in Rockford
  - Aug. 14: Acquired sleep room in Louisville
- Accident occurred during window of circadian low

First Officer's Sleep/Wake History



Fatigue – First Officer

- Off duty August 10-12
- Mismanaged off duty time
  - Aug. 12: returned to duty with about a 3 hour sleep debt
  - August 13: less than 5 ½ hour sleep opportunity
  - August 14: acquired sleep room in Louisville
- Aware of fatigued state

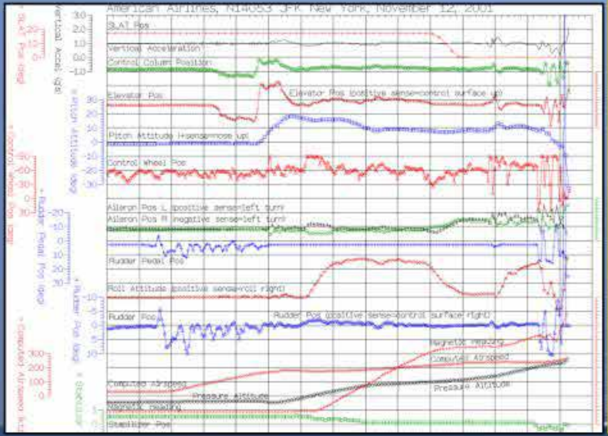
FO Text Messages

8/12/13 19:29:38	outgoing	Im getting sooo tired
8/12/13 19:35:30	outgoing	And its time i get ready
8/12/13 21:22:58	outgoing	 Hey, bak in the ol office, and im sleepy as a # :)
8/13/13 0:26:48	outgoing	Waitin on van
8/13/13 11:06:56	outgoing	Hey just dual fmc[7] failure last nite, thats always nice on ur ' first' nite ;)
8/13/13 11:07:09	outgoing	Just ol school navin
8/13/13 11:16:36	incoming	Oh yeah...that's great when ur tired as hell. I was snoozing by 830 but up at 5 to come to work. I'm still tired today. We are to old for that #. Lmao
8/13/13 11:18:26	outgoing	U got that rite, i fell asleep on every damn leg last nite- n rfd now, got here at 6 am n bed by 645 ish , now #[8] up, slept like 4 # hrs.... Van isnt till 8 tonite so hoping i will nap again this afternoon
8/13/13 11:19:29	incoming	Yeah u can get a nap in this afternoon. Grab some lunch and hit the bed again
8/13/13 11:20:31	outgoing	Thats da plan: sleep eat sleep eat sleep eat- works nice diet wise ha

CVR and FDR Recovery

CVR/FDR analysis

- Detailed review with CVR and FDR team
- Compare procedures and policies learned from field investigation
- Note: access to CVR is limited



Review dispatch paperwork

```
                              FLIGHT RELEASE

DISPATCHER                                         RELEASE TIME 08.49
  ACFT REG N1                                              DATE 08/14/13
 ACFT TYPE A300-600R                   VIA          T/O
                         ORG  DST      ALTN   ALTN  ALTN  TAKEOFF FUEL
IFR FLIGHT UPS1354/14 KSDF-KBHM    ....   KATL  ....      026.3

 FMS ROUTE KSDF SDEWO1 EWO BWG BNA RQZ KBHM
   REMARKS
          EXTRA FUEL FOR TANKER
                                                  FLIGHT CONTROL CONTACT
                                                   DOM
 SIGNATURE ...........................             INTI
====================================================================
====================================================================
                              FLIGHT RELEASE

DISPATCHER V                                       RELEASE TIME 08.49
  ACFT REG N155UP                                          DATE 08/14/13
 ACFT TYPE A300-600R                   VIA          T/O
                         ORG  DST      ALTN   ALTN  ALTN  TAKEOFF FUEL
IFR FLIGHT UPS1354/14 KSDF-KBHM    ....   KATL  ....      026.3

 FMS ROUTE KSDF SDEWO1 EWO BWG BNA RQZ KBHM
   REMARKS
          EXTRA FUEL FOR TANKER
                                                  FLIGHT CONTROL CONTACT
                                                   DOM
 SIGNATURE ...........................             INTI
====================================================================
OFP 7                      OPERATIONAL FLIGHT PLAN
--------------------------------------------------------------------
FLIGHT NBR UPS1354        DATE 08/14/13         SCHEDULE        PLAN
  ACFT REG N155UP                             KSDF STD 08.49  ETD 08.49
 ACFT TYPE A300-600R                               TXO 00.12
                        SELCAL ABHL                ETE 00.46  ETE 00.48
SPEED   CLB 320.M79       WIND M002                TXI 00.03  ETA 09.49
SCHD    CRZ CI40           ISA P11            KBHM STA 09.50  PTA 09.52
        DSC M80.300      ROUTE SDFBHMT01                      DIFF +0.02
--------------------------------------------------------------------
NO TANKERING RECOMMENDED
LOSS FOR EXTRA FUEL US$/1000 LBS. $7.00
====================================================================
TERRAIN CLEARANCE CHECK COMPLETED WITH NO LIMITATIONS
====================================================================
```

BHM arrival weather . . .

METAR KBHM 140853Z 00000KT 10SM BKN010 OVC075 23/22 A2997 RMK AO2 CIG 006V013 SLP138 T02330217 52000=

Dispatch paperwork

```
=====================
DESTINATION AIRPORT
=====================

KBHM/BHM
---------
  SA 140734 00000KT 10SM BKN010 BKN016 23/22 A2996
  SA 140712 00000KT 9SM SCT006 BKN016 23/22 A2997
  FT 140647 1407/1506 VRB03KT P6SM BKN004
            FM141300 VRB04KT P6SM SCT009 BKN015
            FM141500 01007KT P6SM FEW050 SCT250
  FT 140533 1406/1506 VRB03KT P6SM BKN004
            TEMPO 1406/1408 SCT005 BKN025
            FM141300 VRB04KT P6SM SCT009 BKN015
            FM141500 01007KT P6SM FEW050 SCT250
```

Dispatch weather did not include METAR remarks

ACARS weather received by the crew . . . .

```
†éQU QXSXMXSÚ.SDFER5X 140904/AUG13ÚWXR RESP Ú*******************  WEATHER
UPLINKED TO FLIGHT CREW  *******************ÚÚTAIL #:  N155UP
AIRPORT REQUEST:  SA   M    WEATHER REQUEST:  ETAR KÚÚWEATHER SENT TO
CREW: ÚÚBHM 140853Z     Ú   00000KT 10SM BKN010 Ú   OVC075 23/22
A2997=ÚSPECI KBHM 140848Z     Ú   33003KT 10SM OVC010 Ú   23/22
A2997=ÚMETAR KBHM 140753Z     Ú   00000KT 9SM OVC008  Ú   23/22 A2996Ú
```

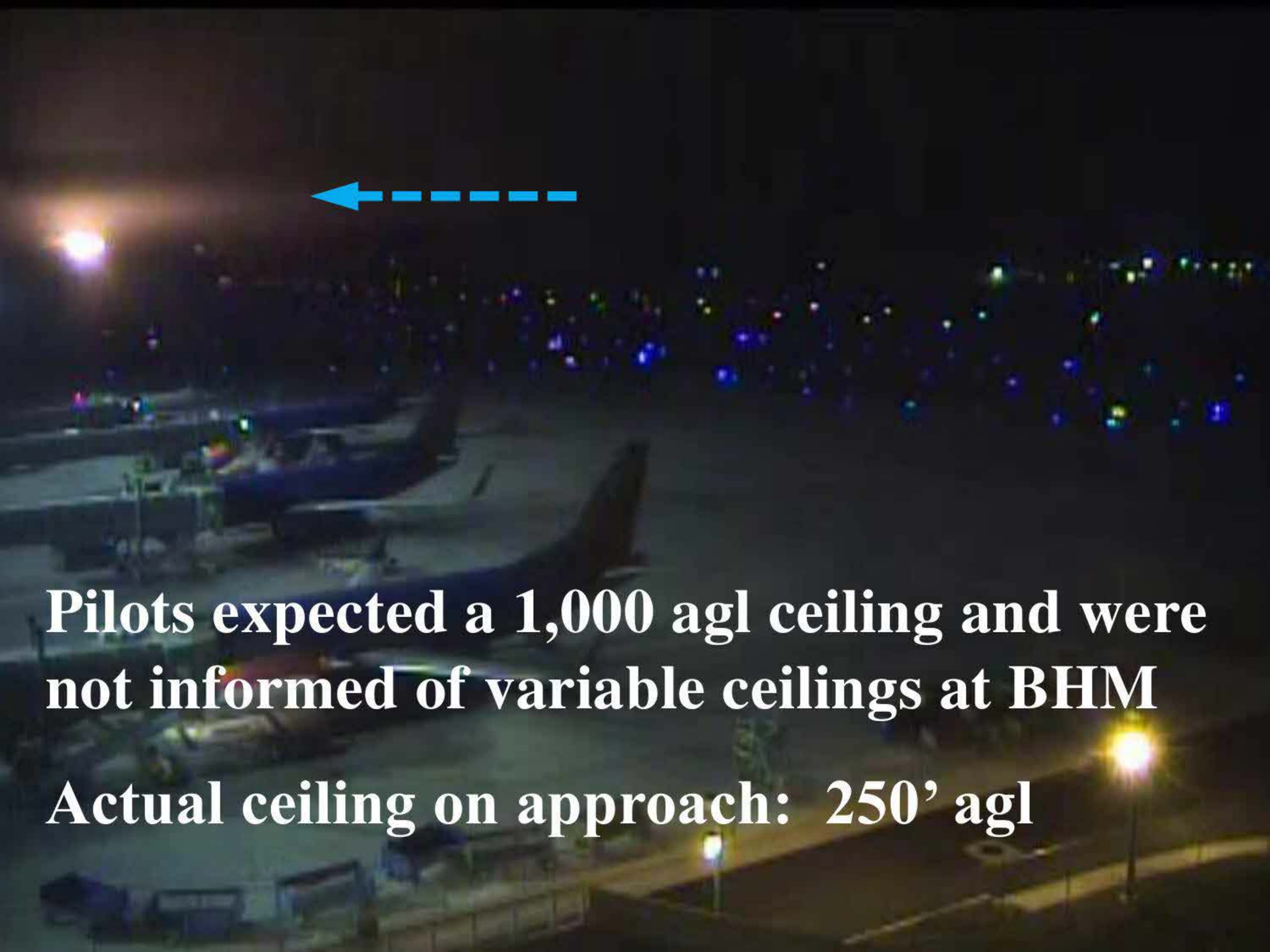
ATIS received by the crew . . .

Birmingham Airport information PAPA. Zero eight five three zulu observation. Wind calm,visibility one zero. Sky condition ceiling one thousand broken seven thousand five hundred overcast. Temperature two three dew point two two altimeter two niner niner seven. Localizer runway one eight in use. Landing and departing runway one eight. Notice to Airmen runway six/two four closed. All departing aircraft contact tower one one niner point niner for clearance, taxi and takeoff. Advise controller on initial contact you have PAPA.

METAR remarks for variable ceiling

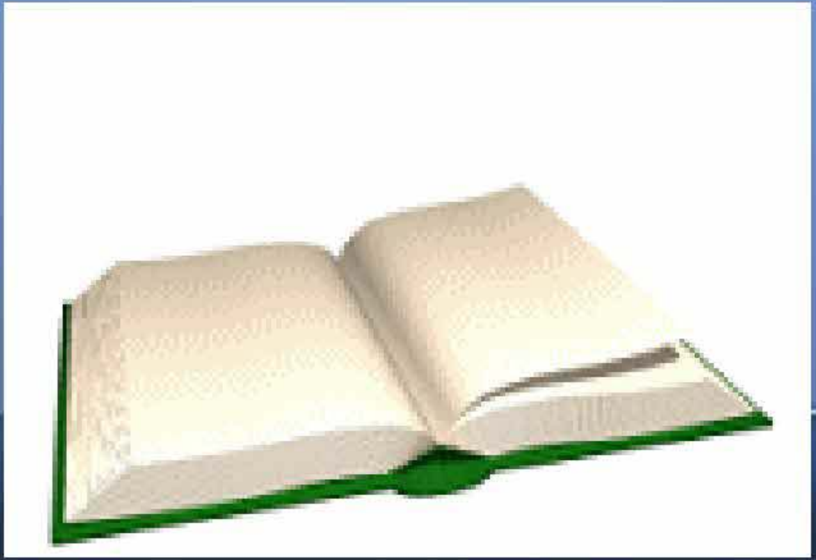
- UPS Dispatch paperwork did not include METAR remarks
  - UPS removed from the Lido software system
  - Pilots were not informed
- ACARS did not include METAR remarks
  - Lido was the source
- ATC did not include remarks in ATIS


37


Pilots expected a 1,000 agl ceiling and were
not informed of variable ceilings at BHM
Actual ceiling on approach: 250’ agl

Review of company manuals and records

- Airplane Operating Manual, QRH, Training Manual
- Safety manual, CRM manual
- Flight ops bulletins and company guidance (FOM)
- Pilot training records
- Pilot personnel records



Review Pilot backgrounds and training

	Captain	First Officer
Total Time	6406 hours	4721 hours
A300 Time	3265 hours	403 hours (SIC)
PIC Time	1516 hours (all A300)	1764 hours

Certificate and Medical Considerations

- Both pilots were properly certified and trained
  - Captain did have past training deficiencies
- Both pilots in good health
- Toxicology results negative
- No pre-existing illness
- No medications influencing performance

Conduct numerous interviews

- Pilots, witnesses, company management and training personnel, FAA
- Interviews occur on site, at HQ, or at training center
- For pilot interviews, we will coordinate with the company Director of Flight Safety
- Interviews are in person (preferable) or via phone

Review FAA information

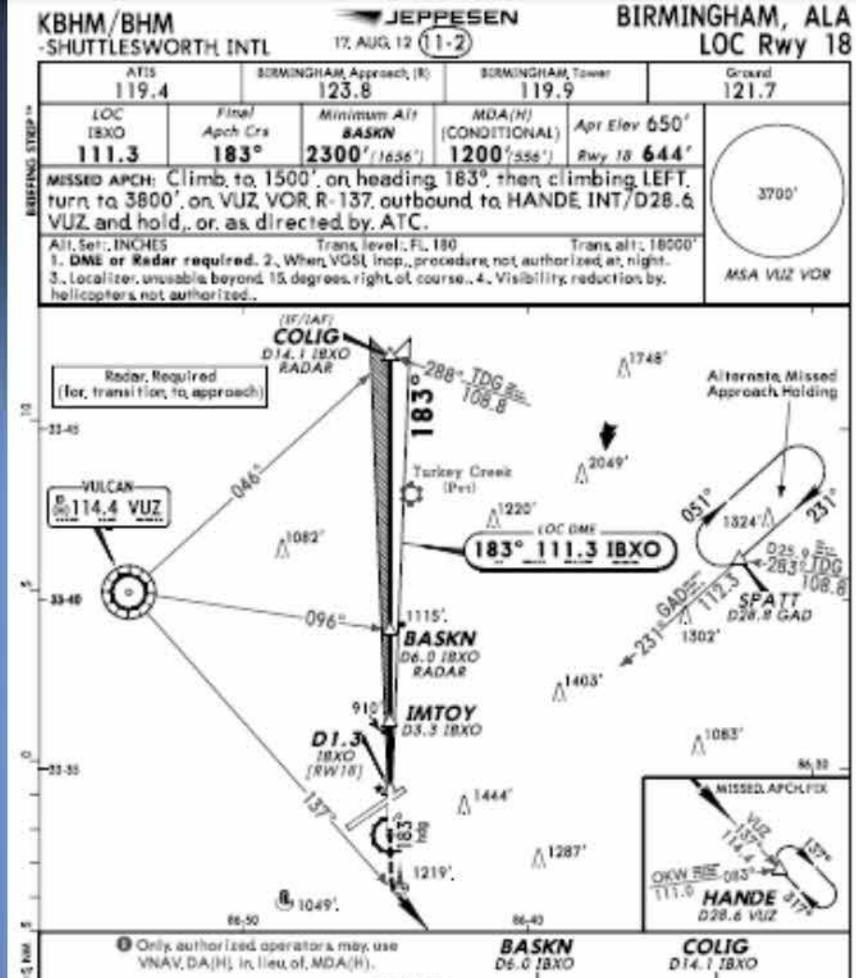
- Copies of any special inspection
- Request copies of all PTRS (program tracking and reporting system) or ATOS (air transportation oversight) inspections
  - Effectiveness of oversight
- Blue Ribbon packages
  - Pilot Certification records
  - Pilot Medical information

Review Pilot Procedures

- Localizer runway 18 approach to BHM is **nonprecision approach**:
  - Lateral guidance from airport (localizer)
  - Vertical guidance provided by flight management computer on airplane

Review Pilot Procedures

- Longer runway 6 NOTAM closed to 0500L
- Weather forecasted a 400-foot ceiling at arrival (ATL filed alternate)
- Runway 18 served by 2 non-precision approaches (LOC18 and RNAV18)
  - Both approach MDAs were 1200’ (556’ agl)
- Review of the localizer 18 chart used by the pilots



TERPS, AMEND 3A, 8 MAR 2012

TERPS	STRAIGHT-IN LANDING RWY 18		
	DAY		NIGHT
	MDA(H) 1200'(556') With IMTOY	MDA(H) 1380'(736') Without IMTOY	
A	1	1	NA
B			
C	1⅝	2	
D			

Review Dispatcher Procedures

- Dispatcher and pilot did not communicate:
  - Limited approach options to BHM (LOC18 NA at night, only 1 approach to the shorter runway)
  - Option of delaying the flight for the ILS
  - Lack of METAR remarks indicating a variable ceiling at BHM
    - UPS believed ATIS would include remarks
  - Forecasted ceiling below RNAV MDA (only approach to the only runway)

Review Pilot Procedures

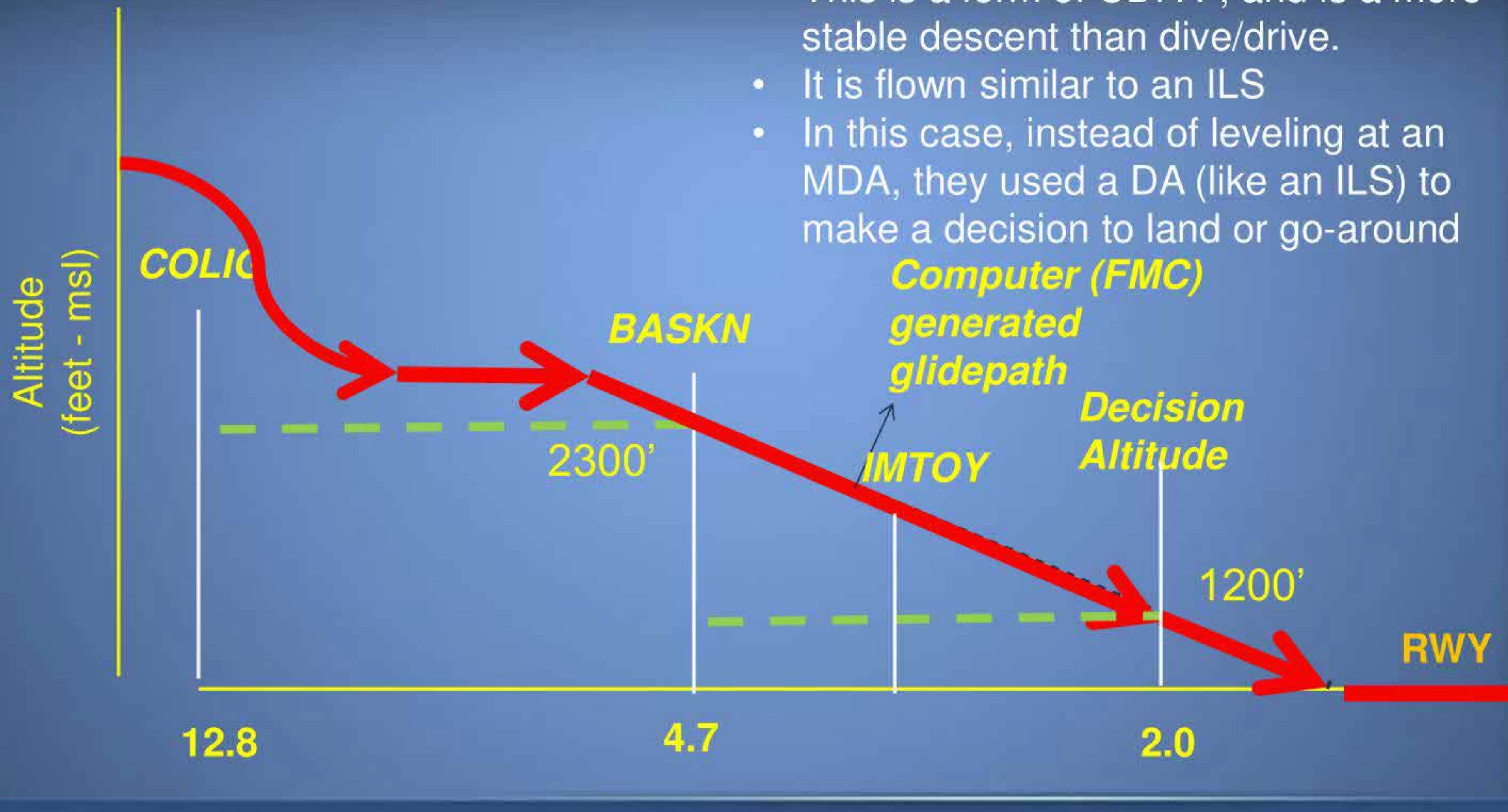
- Captain: pilot flying
- First officer: pilot monitoring
- Runway 6/24 closed for repairs between 0400 and 0500 local time
- Flight dispatched with planned approach to runway 18
- Captain briefed localizer approach to runway 18

Conduct Simulator Testing

- From simulator testing, CVR and FDR review, and electronic data recovered at the scene, we determined the accident sequence . . . .

What the crew planned and briefed to do: Profile Approach

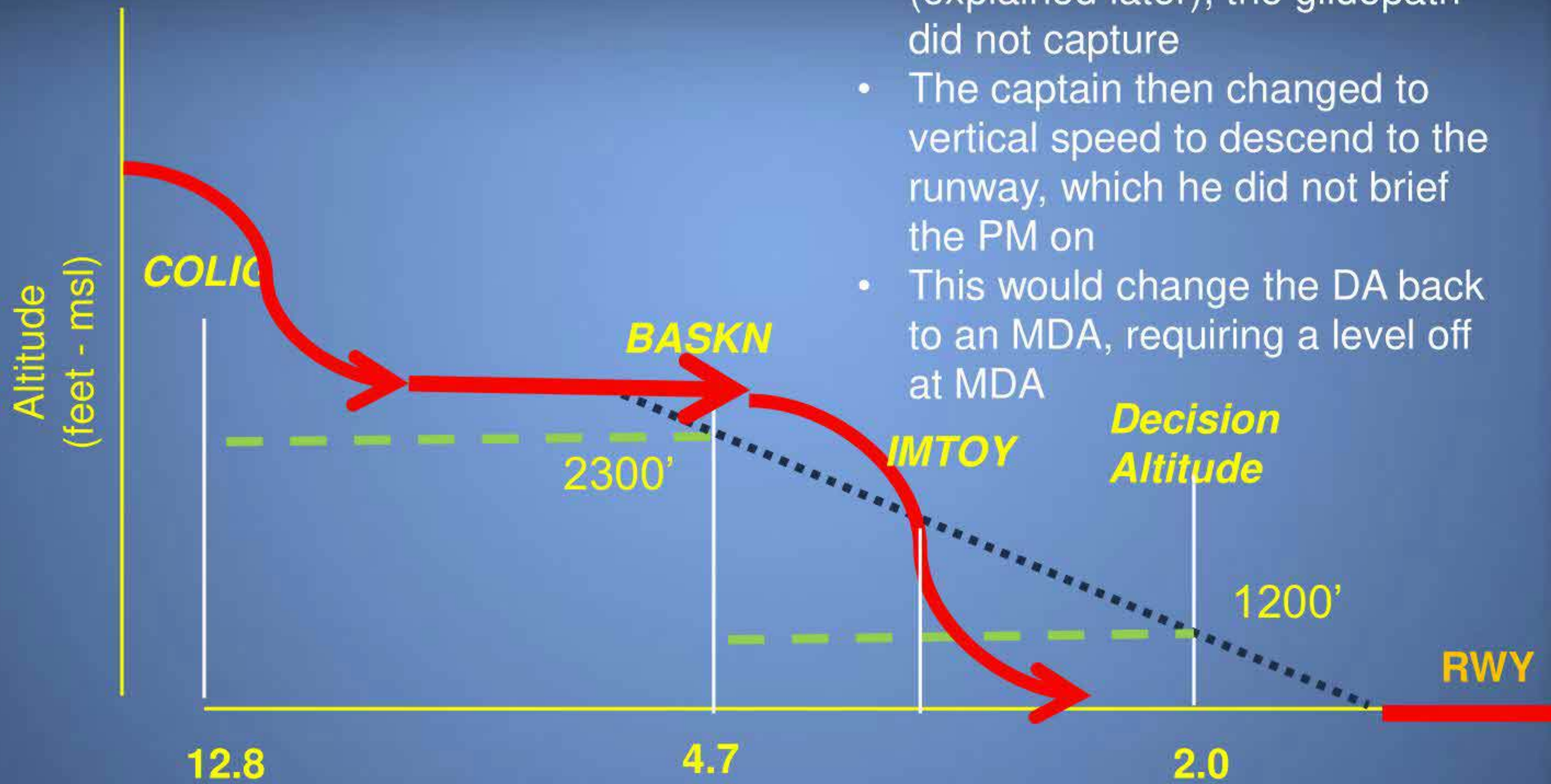
- The crew planned to descend via an FMC generated glidepath (profile approach)
- This is a form of CDFA*, and is a more stable descent than dive/drive.
- It is flown similar to an ILS
- In this case, instead of leveling at an MDA, they used a DA (like an ILS) to make a decision to land or go-around



* Constant Descent Final Approach

What the crew actually did: Profile Approach reverting to a "dive and drive"

- Because of errors in programming the approach (explained later), the glidepath did not capture
- The captain then changed to vertical speed to descend to the runway, which he did not brief the PM on
- This would change the DA back to an MDA, requiring a level off at MDA



Distance north of BHM runway 18 threshold, nmi

NTSB

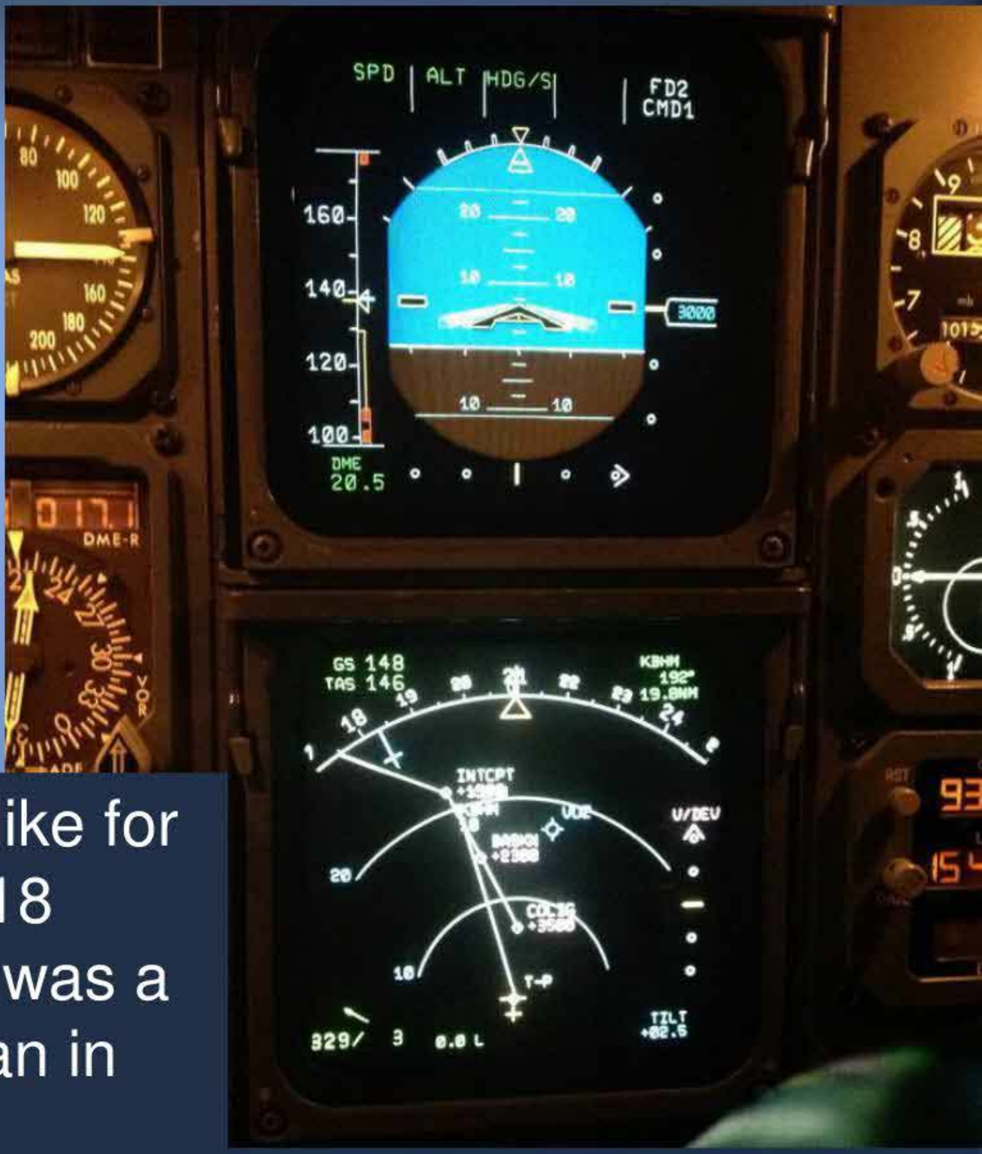
So what was the programming error?

- The flight departed KSDF and was cleared to fly direct to KBHM
- Prior to the top of descent, the Crew entered the LOC18 approach into the flight plan in the FMC
- The crew then briefed a Profile approach for the LOC18 at KBHM


Localizer 18
Approach
Navigating direct to
KBHM
KBHM

CDU

PFD / ND



This is what the screens looked like for the accident flight with the LOC 18 approach in the flight plan. This was a normal way to setup the flight plan in the CDU

What's a flight plan discontinuity?

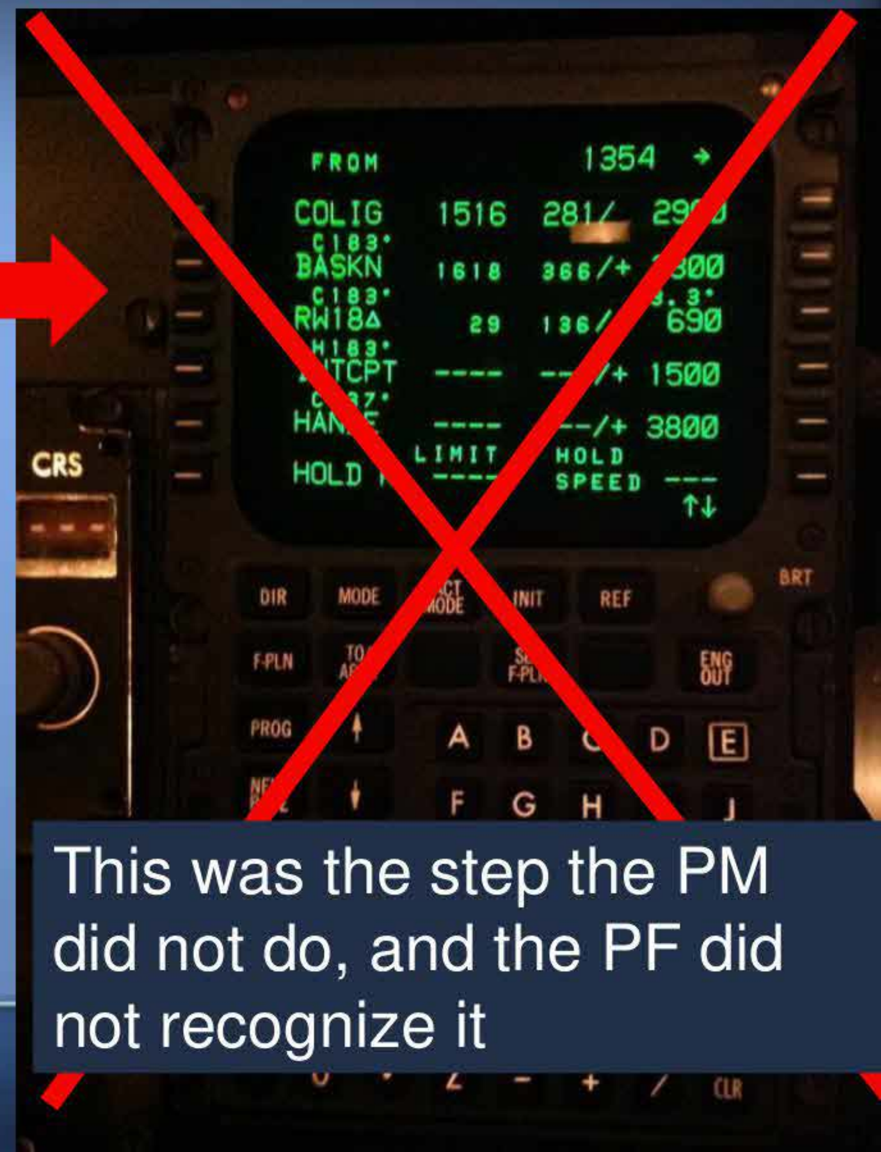
- The flight plan discontinuity is a break in the flight plan that the pilot must remove prior to executing the approach. This is called "sequencing the approach"

- As the crew approached KBHM, ATC gave them a heading to join the localizer.
- This took them off the direct routing to KBHM . . .

Localizer 18
Approach
Navigating direct to
KBHM
KBHM

Before sequencing

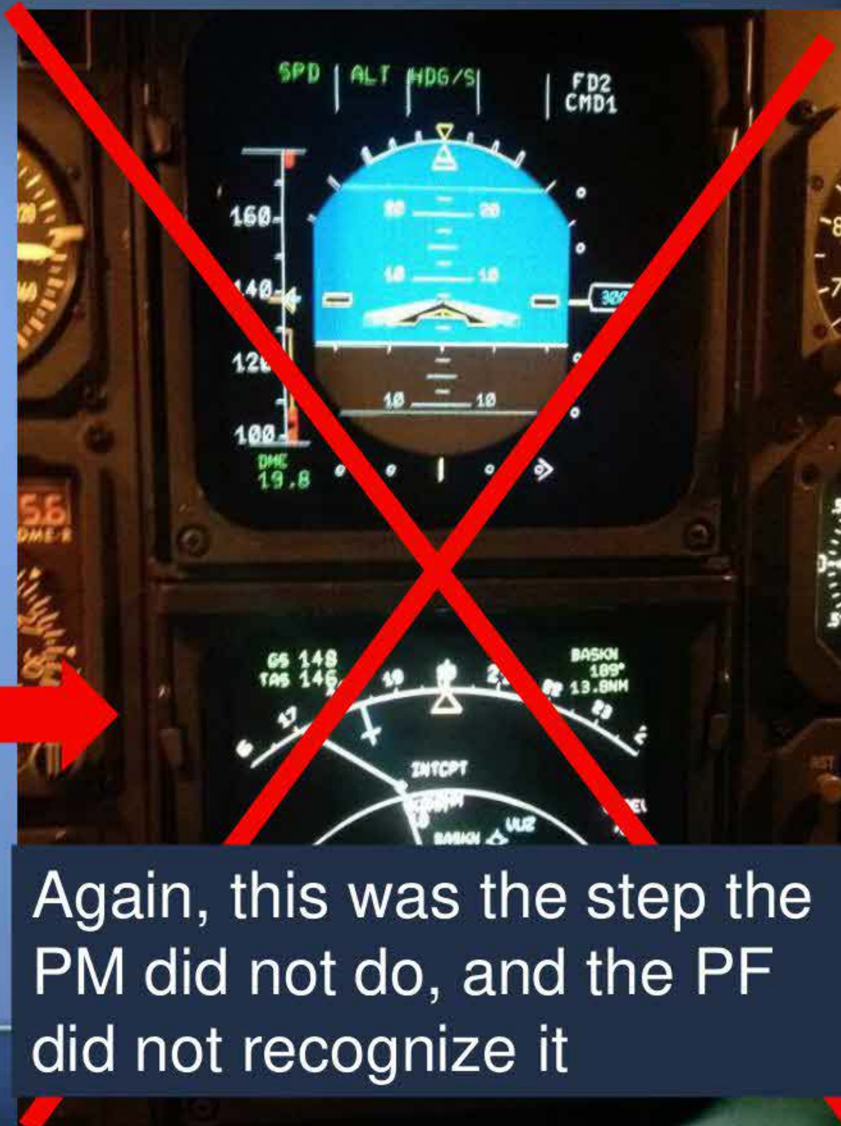
After sequencing



This was the step the PM did not do, and the PF did not recognize it

Before sequencing

After sequencing



Again, this was the step the PM did not do, and the PF did not recognize it

To capture the profile path, the pilot would push the "PROFILE" button on the Mode Control Panel (MCP*)

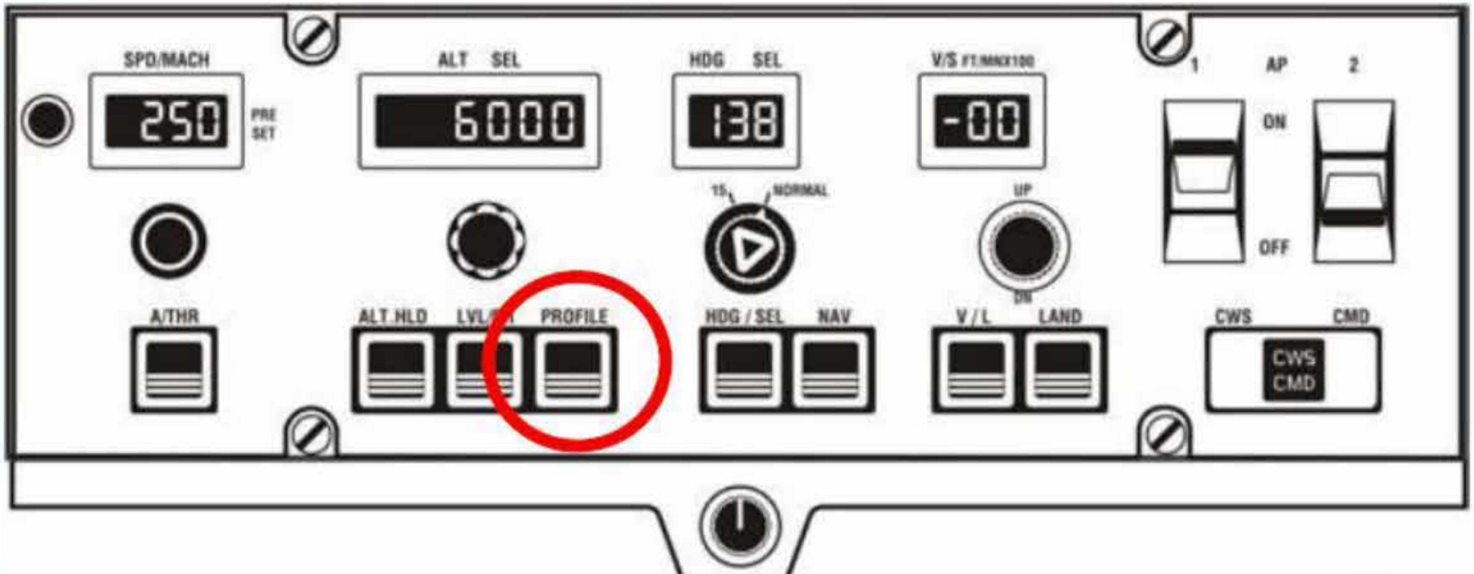


Figure 14: Profile button on the A300 Mode Control Panel (in red circle).[158]

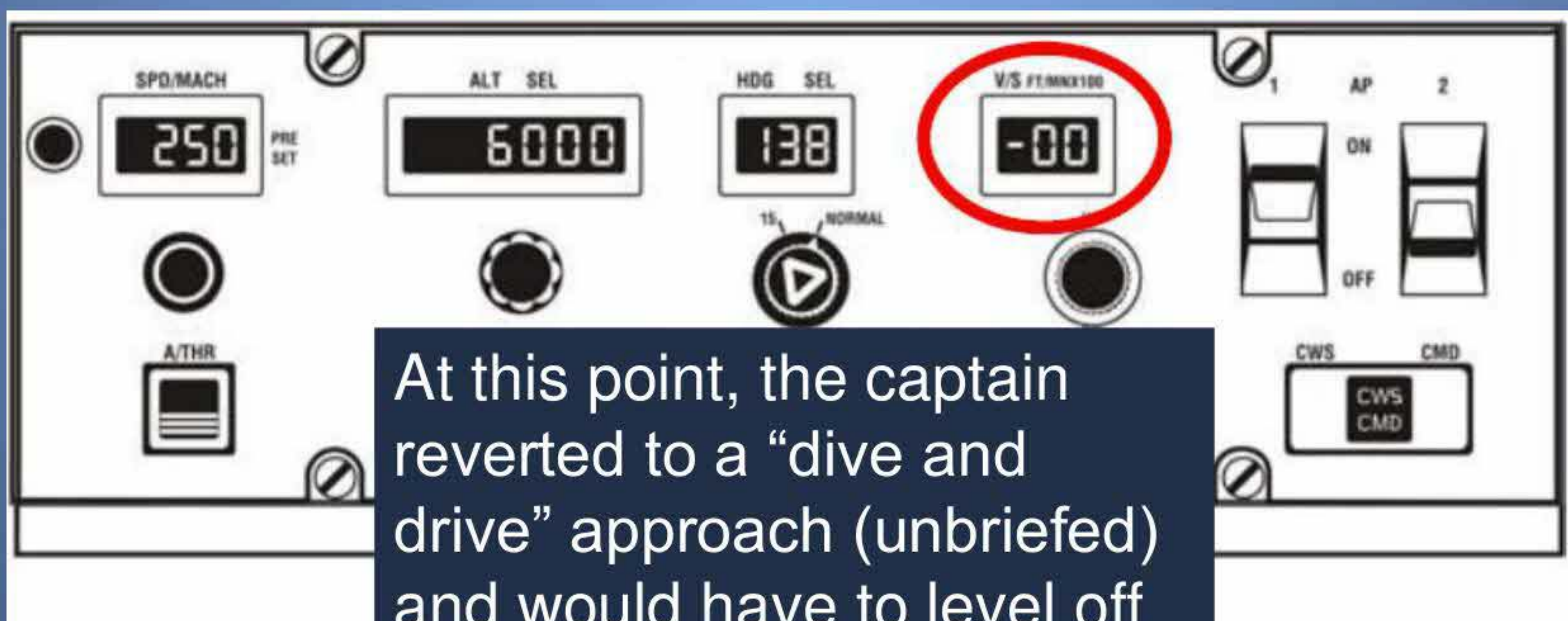
*The MCP is located on the glareshield in the cockpit

The FMA would then show “P.DES” in blue, indicating the glidepath was armed

Note: With the approach activated, P.DES will arm even with a flight plan discontinuity. There is no warning that the flight plan is not sequenced.

- With the flight plan not sequenced (discontinuity still in the flight plan) the autopilot could not capture the FMC generated glidepath
- The captain flew to the Final Approach Fix (FAF) 200’ higher than recommended, and past the FMC generated glidepath, which did not capture

- After passing through the FMC generated glidepath, the PF selected vertical speed (1500 fpm) and descended through 1000 ft. agl and through the MDA.



At this point, the captain reverted to a "dive and drive" approach (unbriefed) and would have to level off at MDA (did not occur).

Figure 17: Vertica

NTSB

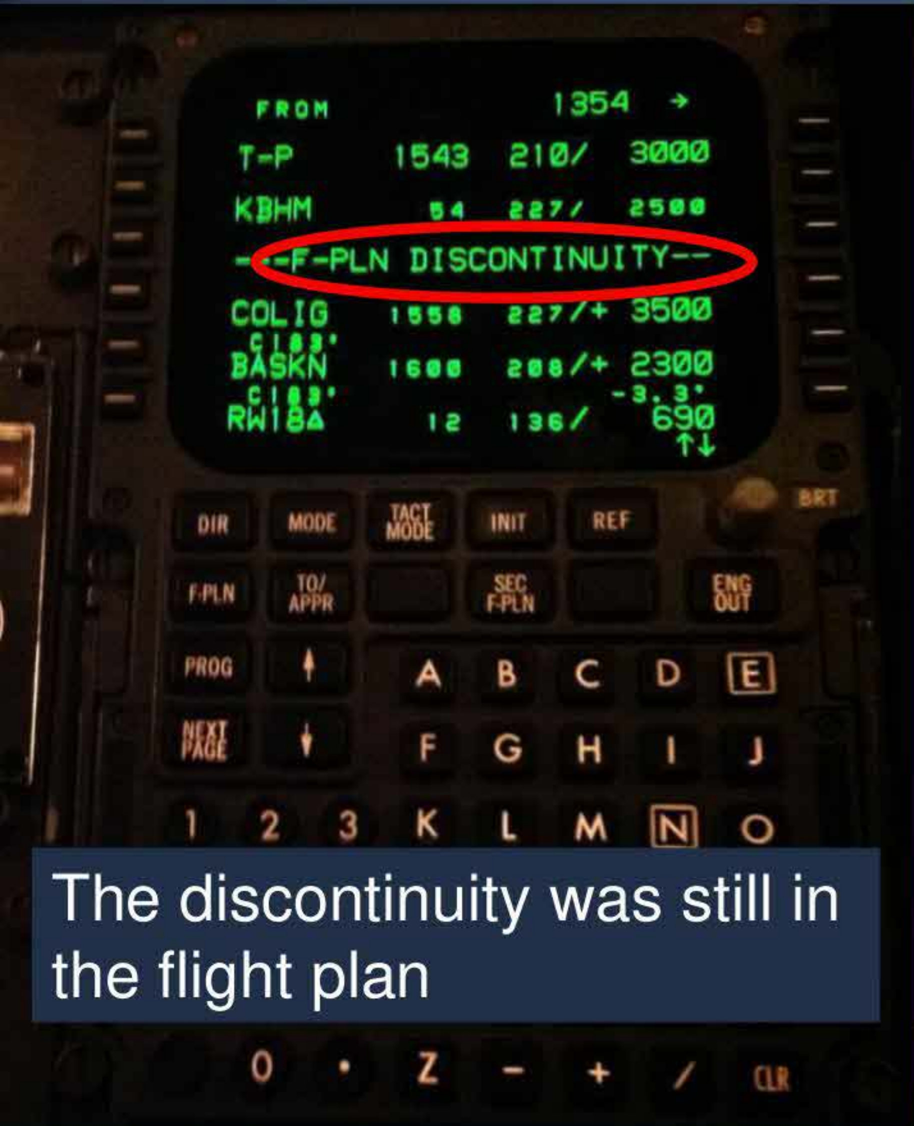
Flight Crew Performance

- Captain did not call for and first officer did not verify the approach
  - Vertical guidance provided was meaningless
- Captain did not descend to the FAF minimum crossing altitude
- Captain changed to vertical speed without communicating his intentions to first officer

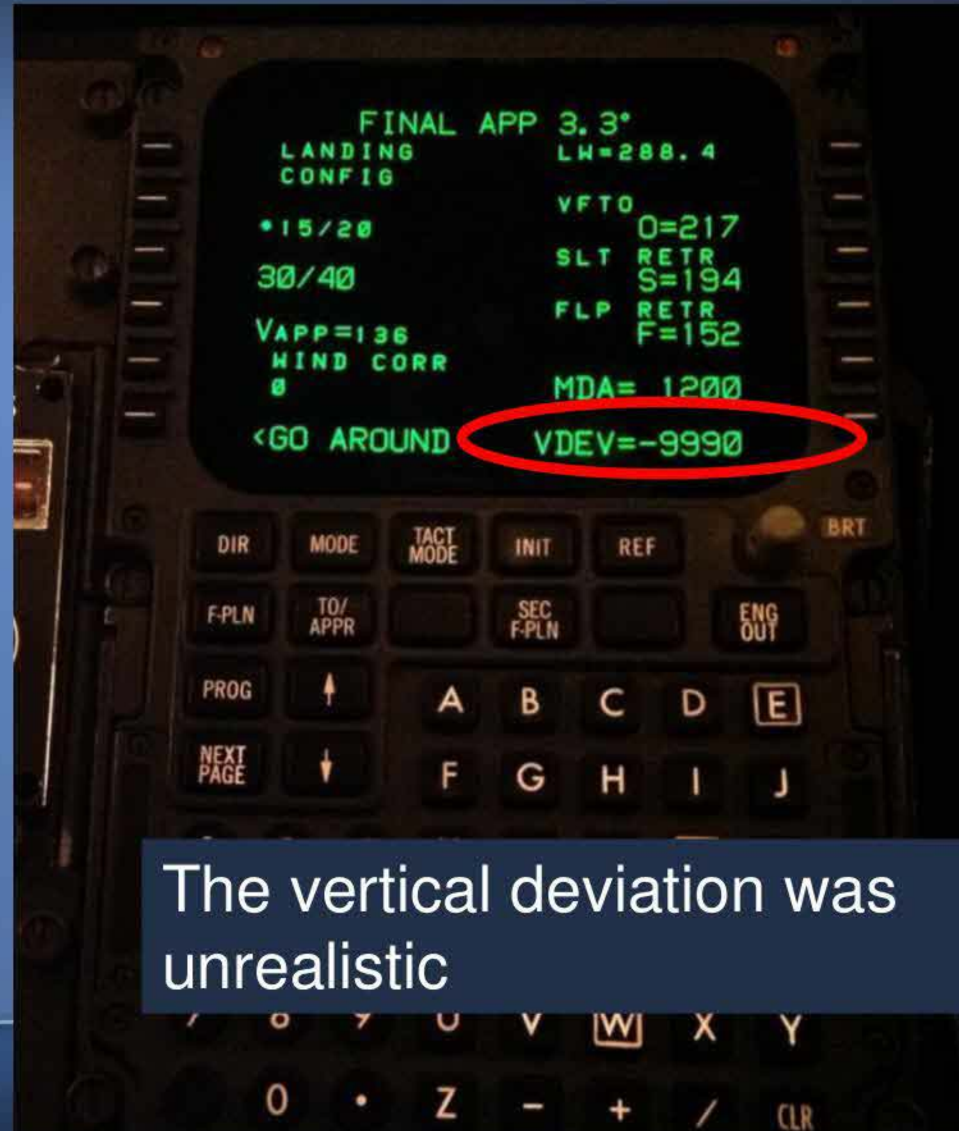
Flight Crew Performance (cont.)

- Crew did not monitor flight path
  - Did not recognize cues that approach not set up properly
  - At least 6 cues that should have alerted the crew that something was wrong

Visual Cues - CDU pages

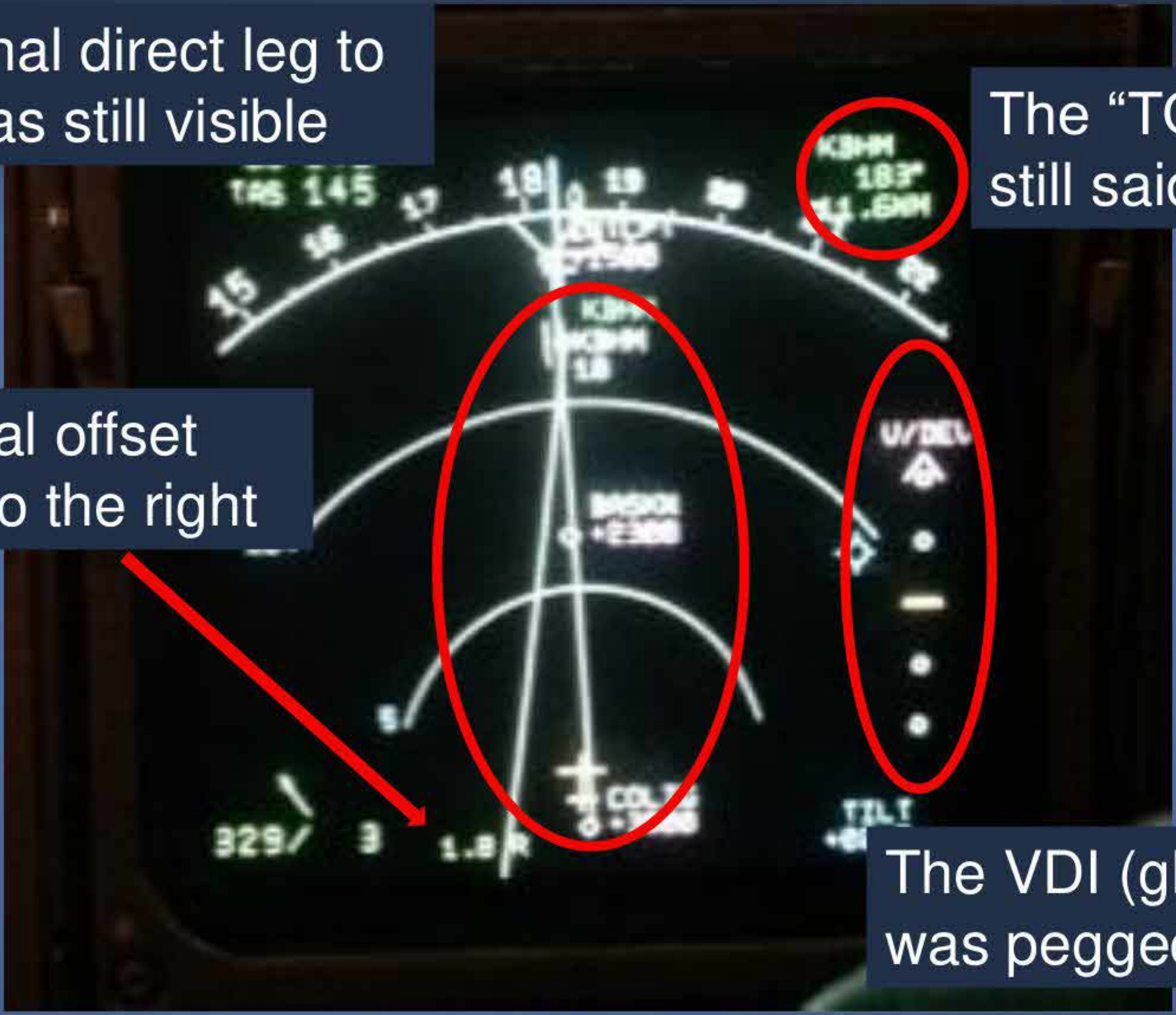


The discontinuity was still in the flight plan



The vertical deviation was unrealistic

Visual Cues - Navigation Display



The original direct leg to KBHM was still visible

The "TO" distance still said KBHM

The lateral offset showed to the right

The VDI (glidepath) was pegged full up

Flight Crew Performance (cont.)

- Crew did not follow SOPs
  - Continued unstable approach
  - Did not recognize at minimum altitude
  - First officer did not make required minimum altitude callouts
  - Captain descended below minimums

NTSB Hearings

Probable Cause

- The National Transportation Safety Board determines that the probable cause of this accident was the flight crew's **continuation of an unstabilized approach** and their **failure to monitor the aircraft's altitude** during the approach, which led to an inadvertent descent below the minimum approach altitude and subsequently into terrain. **Contributing** to the accident were (1) **the flight crew's failure to properly configure and verify** the flight management computer for the profile approach; (2) **the captain's failure to communicate** his intentions to the first officer once it became apparent the vertical profile was not captured; (3) **the flight crew's expectation** that they would break out of the clouds at 1,000 feet above ground level due to incomplete weather information; (4**) the first officer's failure to make the required minimums callouts**; (5) **the captain's performance deficiencies** likely due to factors including, but not limited to, fatigue, distraction, or confusion, consistent with performance deficiencies exhibited during training; and (6) **the first officer's fatigue** due to acute sleep loss resulting from her ineffective off-duty time management and circadian factors.

Recommendations

- Fifteen to FAA
- Two to UPS
- Two to IPA
- One to Airbus

Thank you

National Transportation Safety Board

Captain David Lawrence

[redacted] (b)(6)

[redacted] (b)(6)

National Transportation Safety Board

Systems Investigation Basics AS105 for DOE

Robert SwaimAerospace Systems Engineering InvestigatorNational Resource Specialist

Why investigate aircraft systems?

Did a system component fail and lead to accident? Example: Chafed wiring in fuel tanks creates spark energy.Determine whether systems were system in use? What effects if so? TWA800 air conditioning heated fuel vapors.Determine whether systems were mis-used An Airbus Captain turned off all power on initial climb. To know pilot actions leading to accidents AAL 767 near Cali, Columbia: Autopilot recorded keystrokesDetermine whether systems were available to the crew Numerous fuel exhaustion accidents in aircraft with fuel.FDR issues. Frequently no FDR or a faulty/incomplete data source

Types of DOE aircraft to plan for

Fixed Wing (8):5 B200 and B350 King Air2 Boeing 737-3001 Douglas DC9-33F

Rotary Wing (11):Bell 407Bell 4122 BK 117Bell 206L-4

Technology is great and has a place, BUT

Systems investigations are based inTalking to people Learning how each system functionsInconvenient travel to examine and do testsNOTSurfing the internet to “research”Playing “64 Questions” by emailBeing an office hermitA magic libraryDelegating to “Outside Experts”Sending parts to labs and waiting for magic results

Who examines systems at NTSB

SCOPE	Regional and straightforward about which system(s) involved	Aspects beyond capability or time of regional person	Unknown which system, major accident, interaction of systems, etc. (Or an ENG case with no Regional involvement)
PERSON(s)	Regional Investigator	Regional coordination with AS-40	AS-40 Systems Engineer

AS-40 Systems Engineering staff: Carolyn DeForge, Division Chief and prior Systems Investigator Scott Warren, Lead (workload coordination) and CT resource Bob Swaim, NRS, A&P, airline background, numerous lab contacts Tom Jacky, lots of investigations and recorder experience Steve Magladry, EE, ex-Boeing, Lots of investigations Adam Huray, numerous investigations and prior military work Mike Bauer, extensive recorder and flight test experience

This was a 737 - Was a system involved?

Thoughts from the person tasked with systems investigation:

I got a cool helicopter ride

Everybody expects me to do systems

Wait - There's not enough there to be a whole 737.

Oh wow.[sinking feeling]

Kenya Airways flight 507, B737-8AL, 5Y-KYA,May 5, 2007, 114 fatal near Douala, Camer

NTSB

On the ground how will you document this?

This is AFTER when you should know.

There's an airplane here?I just see mud.

I'd sweat to death in a bio suit

Poison snakes? Yes

Water borneparasit

Mud keepsSuckin

It can be overwhelming, so . . .

Have a method ***before*** arriving on scene

Think in terms of which systems need highest priority

Arrive with copies of airplane illustrations to mark upFind fo

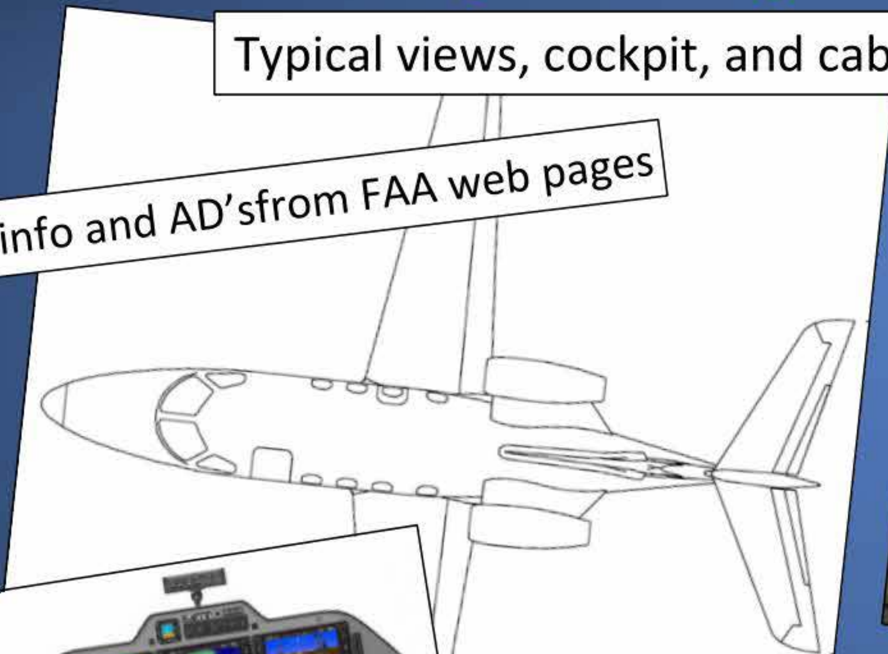
Have a method

Think in terms of which systems need highest priority

Arrive with copies of airplane illustrations to mark upFind

Typical views, cockpit, and cabinIllustrations (mfg website)

tion info and AD'sfrom FAA web pages



Online photos

NTSB

Have a method

Think in terms of which systems need highest priority

Arrive with copies of airplane illustrations to mark upFind fc

NTSB

Two on-scene methods

pit, or public has access (typ foreign), or short time is available

Small debris and time is available

Asiana 777 at SFO

Start herebefore disturbed

Then work frompoint of first contact

Four corners are obvious

Germanwings A320, France

Start at first ground contact and work forward to find four corners(Tail to nose then tips)

If enough investigators are available, one systems group can work the site generallywhile anoth

Attitude, Speed, and Four Corners

- First things to look for in ANY accident!First clue as to which systems may have been involved.

	Low forward speed	High forward speed
Highangle		
Lowangle		

NTSB

Attitude, Speed, and Four Corners

- First things to look for in ANY accident!First clue as to which systems may have been involved.

Low forward speed | High forward speed

Highangle

Note that speed is relative to aircraft size and type

Lowangle

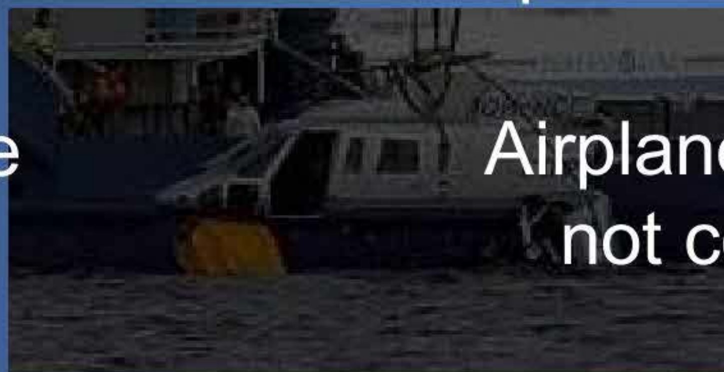
NTSB

Attitude, Speed, and Four Corners

- First things to look for in ANY accident!First clue as to which systems may have been involved.

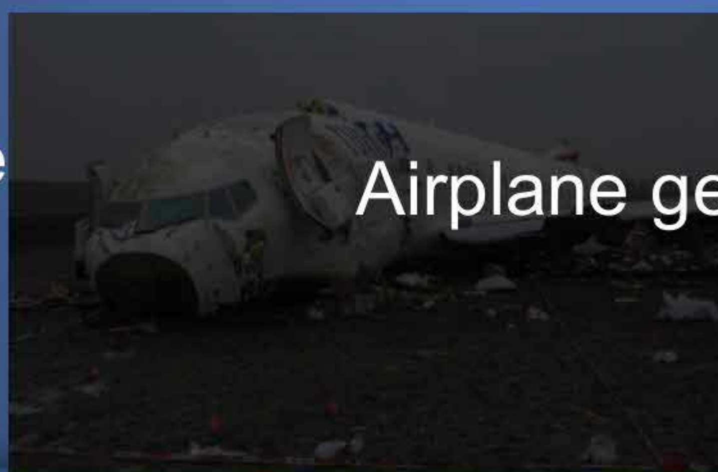
Low forward speed | High forward speed

Highangle



Airplane generally not controlled

Lowangle



Airplane generally flyable

Attitude, Speed, and Four Corners

There are exceptions

Example: Columbia, SC Learjet Model 60 accident. Tire failure and system design led to departing the runway

High forward speed

Pilot did not have control

Low angle

NTSB

Case #1: Four corners, impact attitude, and speed

What clues do you see already?

kers onground give scale

enya Airways flight 507, B737-8AL, 5Y-KYA,May 5, 2007, 114 fatal near Douala, Cameroon

NTSB

Case Study #1: High angle, fast impact

Start to prioritize systems to search forTime on site m

Smaller fragments imply higher speed

irectionof impact

enterlinecan imply winglevel (or inverted) attitude

Steep angleimplied bycrater

Initial width canimply wings level(or inverted

Steep anglebetween trees andground contact

Angle between impact direction and breadthof initial contact implies amount of roll

Case Study #1: High angle, fast impact

Initial clues prioritize anything related to pitch and control, and reduce the priority of power, fuel, the toilets, etc

Smaller fragments imply higher speed

Steep angleimplied bycrater

rectionof impact

desof centerlinecan imply winglevel attitude

Initial width canimply wings levelor

Steep anglebetween trees andgro

Angle between impact direction and breadthof initial contact implies amount of roll

NTSB

High angle fast impact implies control loss

Most of a 737 and remnants of 114 people are in this photo

It can be overwhelming, so . . .

The FDR hasn't been found in all this waterand mud

Now whatdo I do?

NTSB

Have a method

Think in terms of which systems need highest priority

Arrive with copies of airplane illustrations to mark upFind fo

Look at the individual parts and orient yourself

The APU was not essential to flightBut it was near one of the four corners

Don't be overwhelmed by the scene

Hydraulic valveFor flight controls? Flaps? Brakes?

No signs of fire in the cabin debris

Have an organization for your documentation.

By system works.

Time on site is limited. This person is being pro

This person is not. He could be put to use by asking him to search for something specific and report back.

Lots of systems are in a large aircraft! How do you organize notes about them?

If only one is in question, that is all you need to document.

If multiple, ATA Code 100 categorizes aircraft systems

ATA Code 100 provides organization

AIRCRAFT GENERALATA 01-04 Reserved for Airline
UseATA 05 TIME LIMITS/MAINTENANCE CHECKSATA 06
DIMENSIONS AND AREASATA 11 PLACARDS
AND MARKINGSATA 12 SERVICING - ROUTINE
MAINTENANCEATA 20 STANDARD PRACTICES –
AIRFRAMESYSTEMS:ATA 21 AIR CONDITIONING AND
PRESSURIZATIONATA 22 AUTO FLIGHTATA 23

L POWERATA
FIRE
FUELATA
IN
SYSTEMATA
32 LANDING GEARATA 33 LIGHTSATA 34
A 36
A 38
L -
TSATA 40
LASTATA 42
CABIN
NANCE
SYSTEMATA 46 INFORMATION SYSTEMSATA 47
IN FLIGHT
WERATA 50
TS

AIRFRAME:ATA 51 STANDARD PRACTICES AND STRUCTURES
- GENERALATA 52 DOORSATA 53 FUSELAGEATA 54
STABILIZERSATA 56
PROPELLERSATA 71
POWER PLANTATA 72 ENGINE -
RECIPROCATINGATA 73 ENGINE - FUEL AND CONTROLATA 74
IGNITIONATA 75 BLEED AIRATA 76
ENGINE CONTROLSATA 77 ENGINE INDICATINGATA
78 EXHAUSTATA 79 OILATA 80 STARTINGATA 81
TURBINES (RECIPROCATING ENGINES)ATA 82
ENGINE WATER INJECTIONATA 83 ACCESSORY
GEARBOXESATA 84 PROPULSION AUGMENTATIONATA 85
FUEL CELL SYSTEMSATA 91 CHARTSATA 92
Electrical System Installation

Have a method

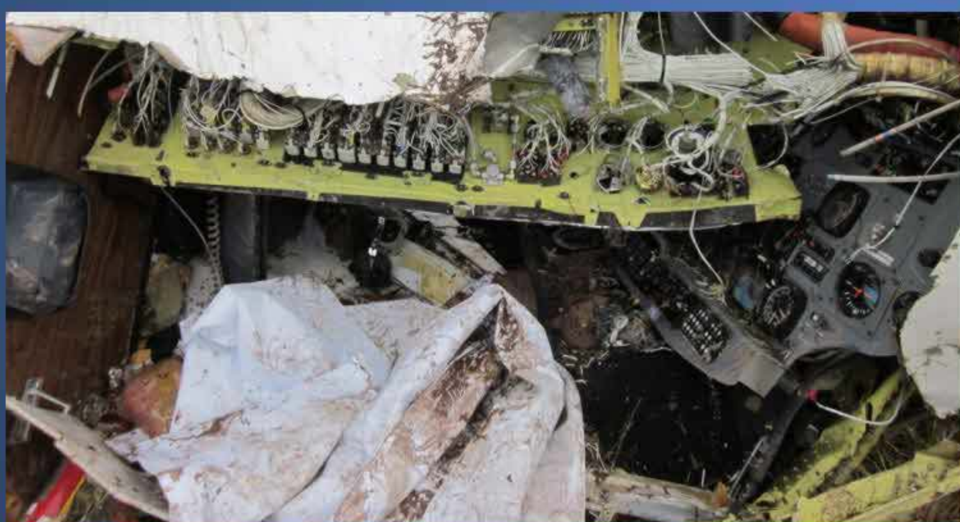
Think in terms of which systems need highest priority

Arrive with copies of airplane illustrations to mark upFind fo

NTSB

Documenting a destroyed cockpit

Mark up instrument panel diagrams or write down each indication and switch position. One ordering technique is to write descriptions in the order of scanning panels while flying.It is easier to have one person in the wet mess photographing, while dictating instrument and control positions, as a second person writes notes.You can stick a camera in tight spots and take notes from photos.



But how do you organize notes about this?

ATA Code 100 provides another cockpit organizer

TWA800 747 cockpit upon arrival

InstrumentsATA31

NavigationATA34

Ice/RainATA30

HydraulicsATA29

ElectricalATA 24

Flight controlsATA 27

FuelATA28

Landing gearATA32

PressurizationATA21

DoorsATA52

Fire Prot.ATA26

EquipmentATA25

Case study #2: What Angle? Speed of impact?

Scene:Wreckage in small areaHigh fragmentation & post-impact fireWitnesses saw extreme pitch up on takeoff

Sister ship

Complete airplane

3, 2003, 21 fatal in Beechcraft1900 accident at Charlotte,

Flight data recorder

NTSB

Case study #2: High angle, high speed impact

Scene:Wreckage in small areaHigh fragmentation & post-impact fireWitnesses saw extreme pitch up on takeoff

~~ATA 21 A/C & PRESSURIZATIONATA 22 AUTO FLIGHTATA 23 COMMUNICATIONSATA 24 ELECTRICAL POWERATA 26 FIRE PROTECTIONATA 27 FLIGHT CONTROLSATA 28 FUELATA 29 HYDRAULIC POWERATA 30 ICE AND RAINATA 31 INDICATING/RECORDATA 32 LANDING GEARATA 34 NAVIGATIONATA 35 OXYGENATA 36 PNEUMATICATA 37 VACUUM~~

January 3, 2003, 21 fatal in Beechcraft1900 accident at Charlotte, NC

NTSB

Have a method

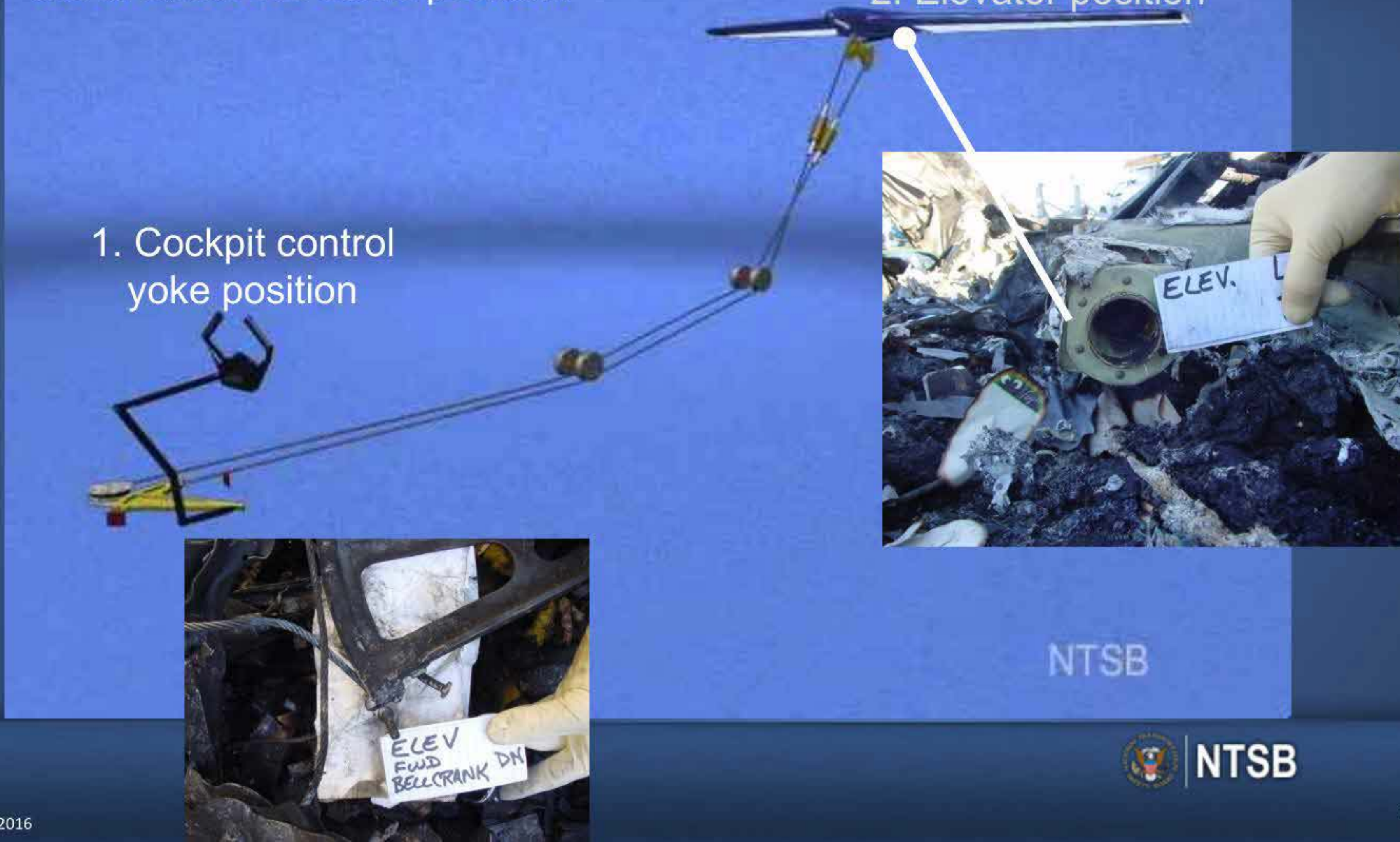
Think in terms of which systems need highest priority

Arrive with copies of airplane illustrations to mark upFind four corners for impact attitude and speedWalk the debris path to see if the airplane is all there   Shoot photos continuously while scene is un-trampled Watch for the recorders, but do not lose time to themDocument the cockpit before people change thingsDocument each system and indicator from both endsConsider what should be removed for later exam

NTSB

Each system has at least two ends
Each must be checked against the other

Find and document (in writing and photos) any witness marks for each and see if they are at about the same position.

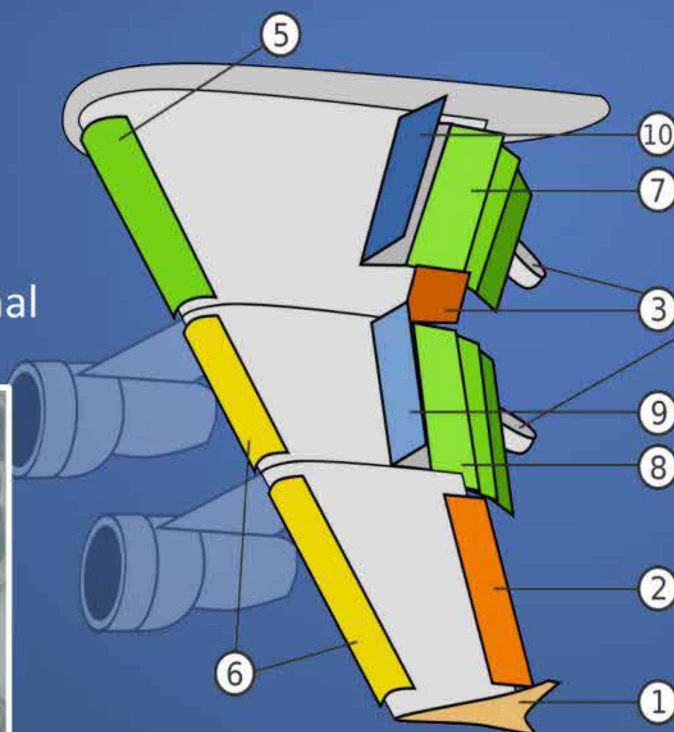


There can be a lot to document in some systems

Every cockpit control does something somewhere. Every indicator or recorded data has a source.Capture each end with photos and in writing.

Count jackscrew threads. Measure piston shaft extensions.Look fo

Marks on faceand internal



Repeat for each track and actuator

Case Study #2: Tail and pitch turnbuckles

nt and rear of the system was confusingin not matching the published limi

Rudder

Horizontaltail

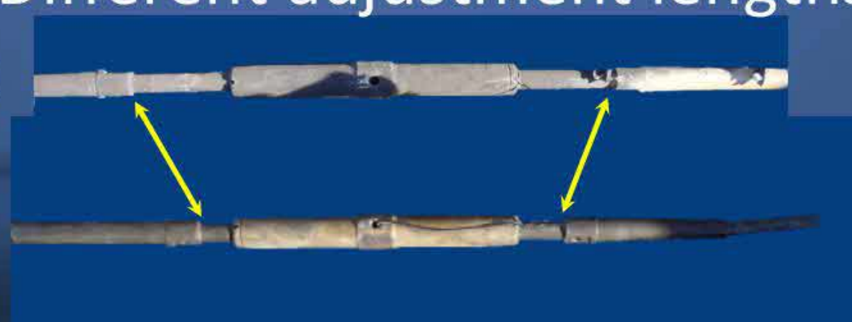
Verticalstabilizer

Pitch cableturnbuckl

Different adjustment lengths

Down turnbuckle

Up turnbuckle



NTSB

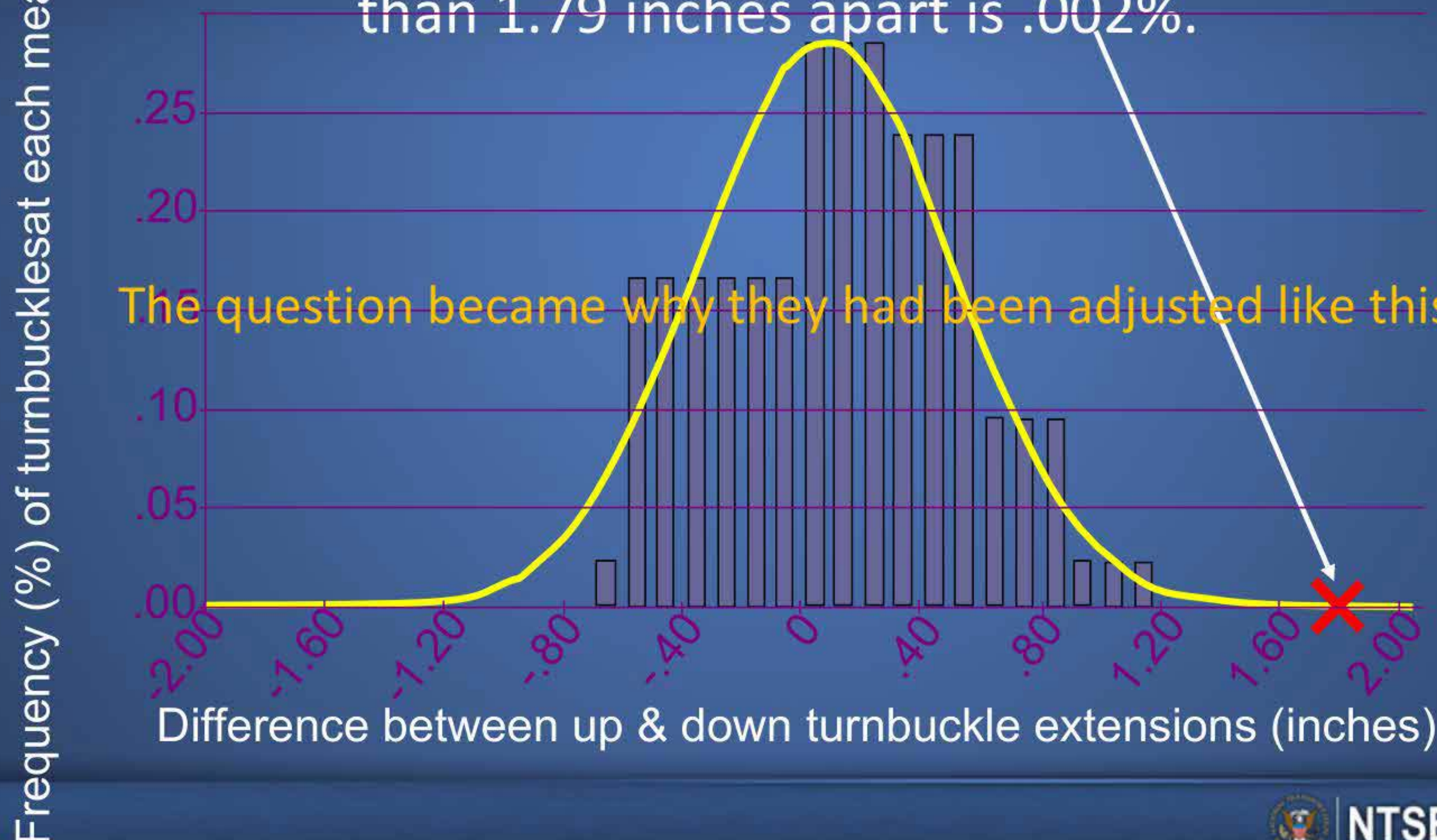
Case Study #2: Pitch control turnbuckles as found were at opposing limits of adjustment

Look for things which are odd or don't match

Using Statistics – Another clue

Comparison of turnbuckle extensions in 42 airplanes

The probability of an aircraft's turnbuckles to be greater than 1.79 inches apart is .002%.

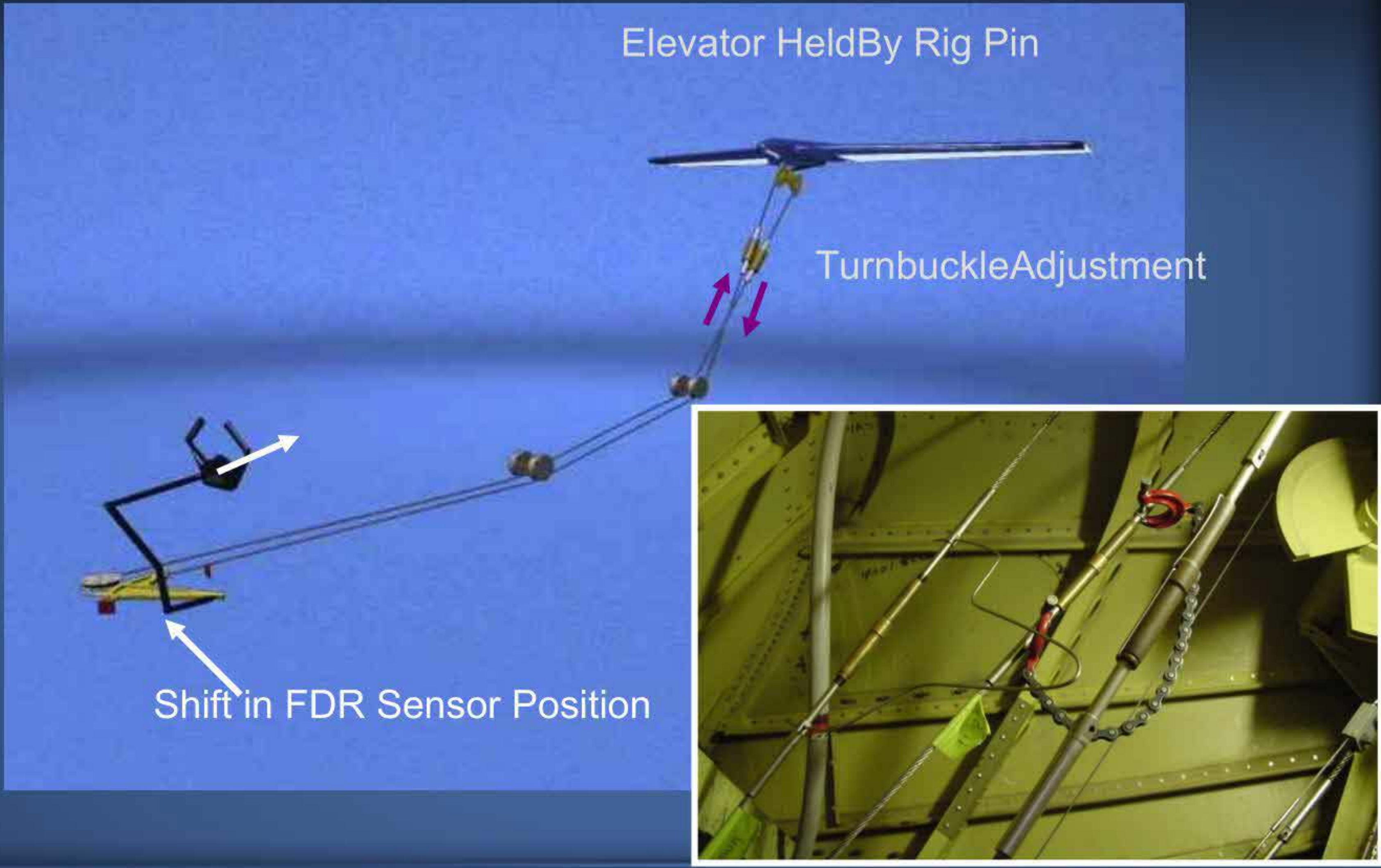


The question became why they had been adjusted like this?

Case Study #2: Do testing

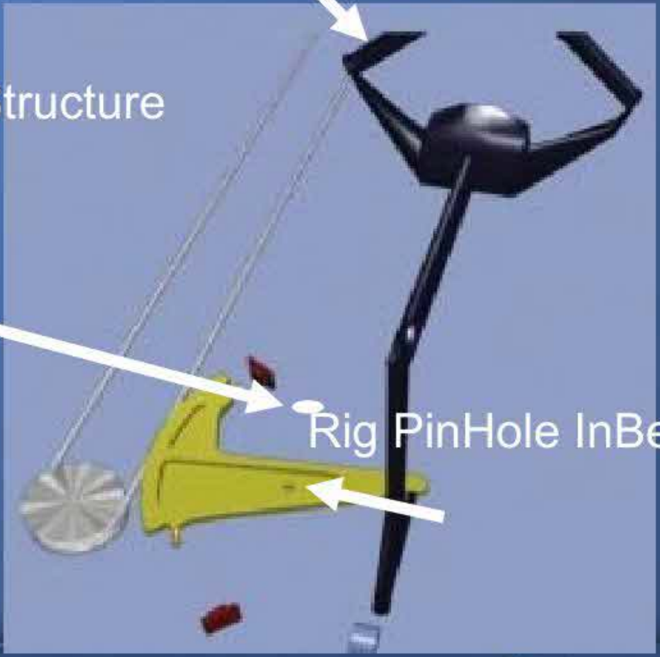
Rigging of pitch controls shown (aft rig pinning shown)

Case Study #2: Found that cable mis-rig altered the relation between FDR sensor and elevator



Case Study #2: The reason was that the design of the forward rig pin could miss hole in bellcrank

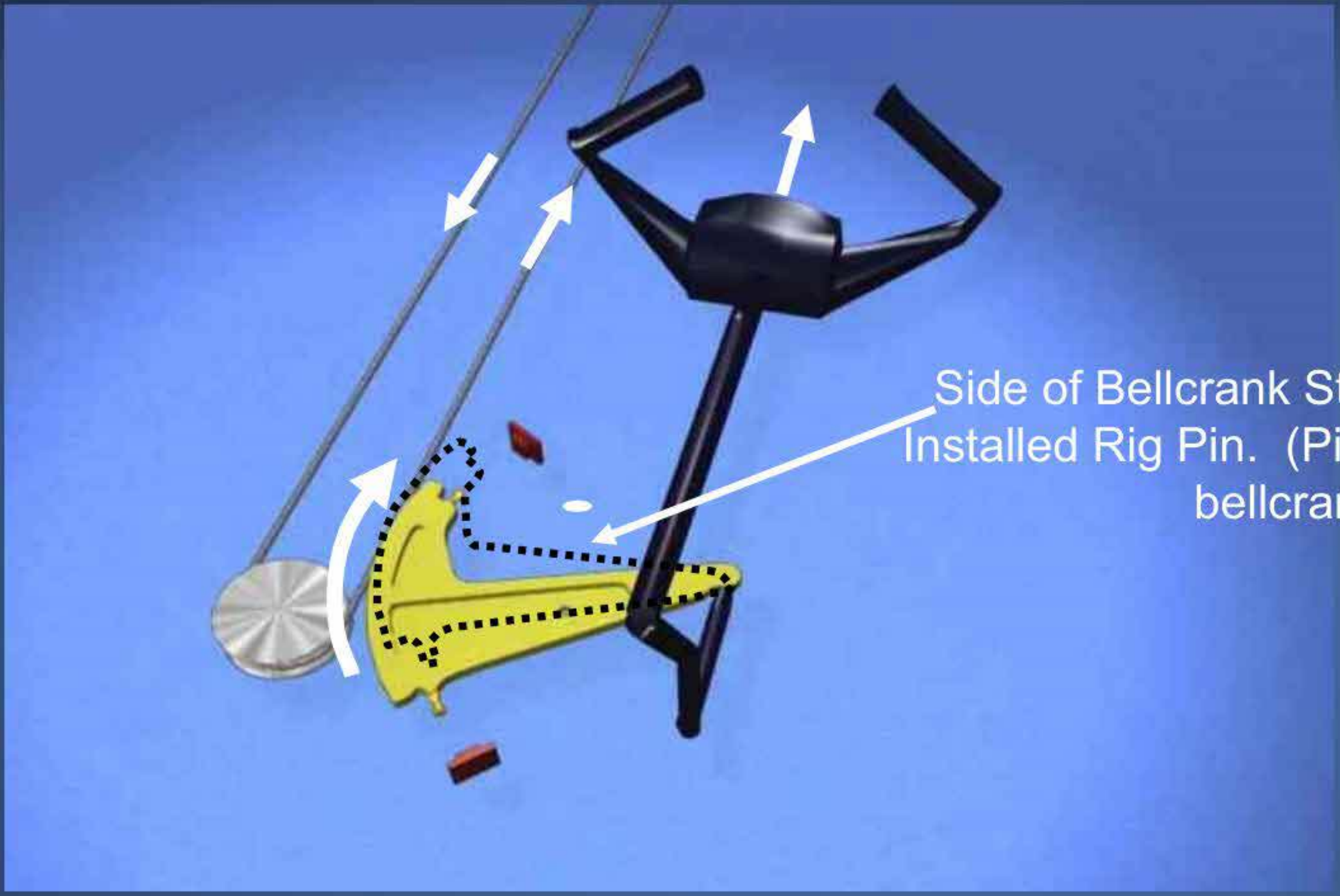
(View from aft)



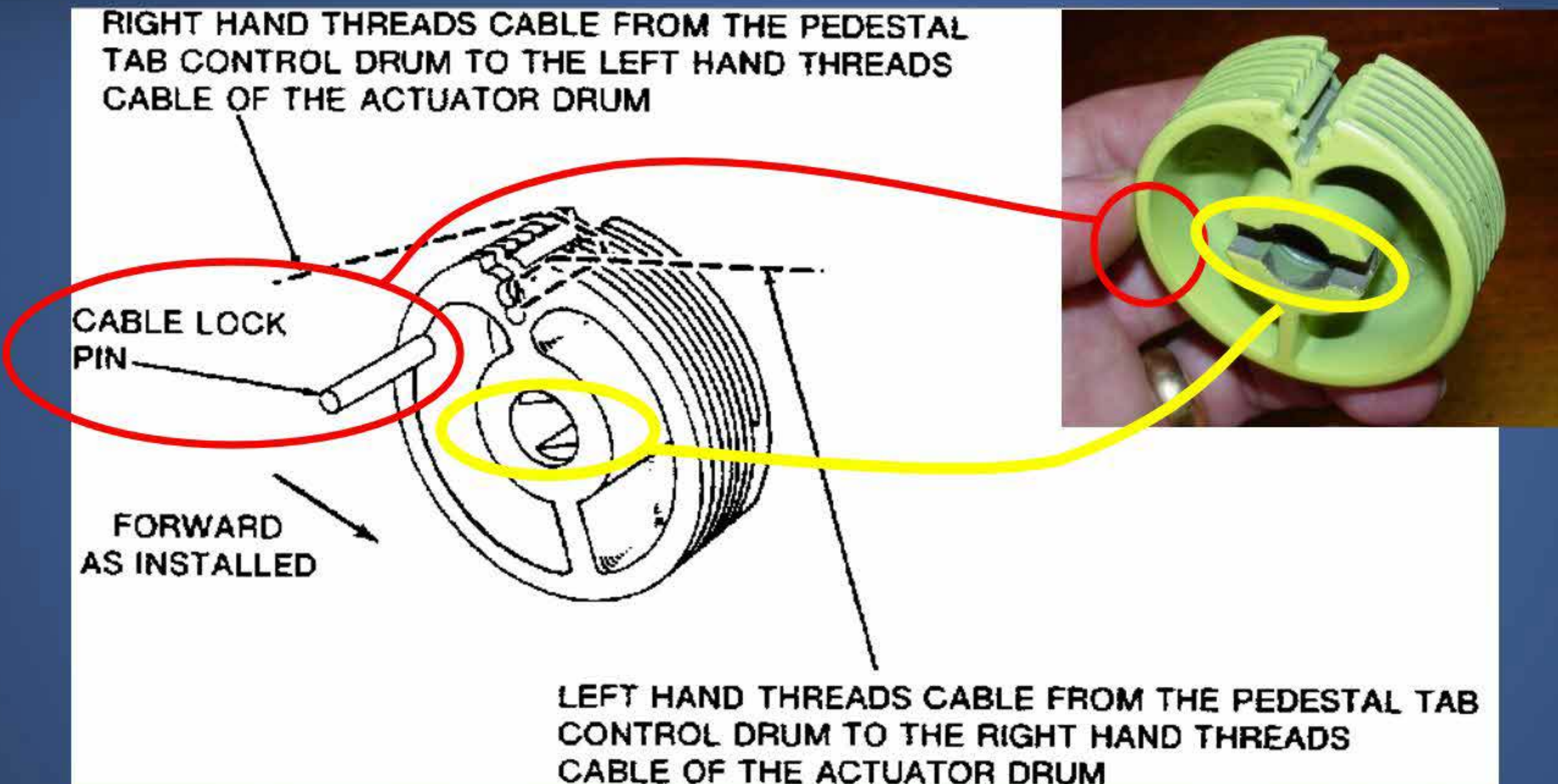
(View from forward)

NTSB

Case Study #2: Tightening elevator-down cable moved forward bellcrank aft to match FDR



Different airplane:
A similar pitch trim event occurred on takeoff.
The Beech 1900 work instructions were backward



From Colgan Air Flight 9446, Yarmouth, Mass, August 6, 2003

NTSB

Case Study #3: High angle, high speed -Implied loss of control

Scene:Found beneath final approach pathWreckage in small areaHigh fragmentation & post-impact fire

March 22, 2009, 14 fatal in PilatusPC-12 accident at Butte, Montana

NTSB

Case Study #3:
High angle, high speed -Implied loss of control

March 22, 2009, 14 fatal in PilatusPC-12 accident at Butte, Monta

First priority systems to consider:ATA 21 A/C & PRESSURIZATIONATA 22 AUTO FLIGHTATA 23 COMMUNICATIONSATA 24 ELECTRICAL POWERATA 26 FIRE PROTECTIONATA 27 FLIGHT CONTROLSATA 28 FUELATA 29 HYDRAULIC POWERATA 30ICE AND RAINATA 32 LANDING GEARATA 34 NAVIGATIONATA 35 OXYGENATA 36 PNEUMATICATA 37 VACUUMATA 61 PROPELLERSATA 71

Case Study #3:
High angle, high speed -Implied loss of control

March 2 009, 14 fatal in PilatusPC-12 accident at Butte, Monta

Implication was wrong!!!ALWAYS be willing to reconsider what you THINK you know!!!

ATA 21 A/
OWERATA 26
FIRE PROTECTIONATA 27
FLIGHT CONTROLSATA 28
FUELATA 29 HYDRAULIC
POWERATA 30 AND RAINATA 32
LANDI 34
NAVIGATIONA
OXYGENATA 36
PNEUMATICATA 37
VACUUM

The cause of the accident was icing in the fuel system which resulted in a left-wing-heavy fuel imbalance. The pilot lost control while maneuvering the left-wing-heavy airplane near the approach end of the runway.

Case Study #4: Low angle at relatively low speed

Low forward speed | High forward speed

Highangle

Lowangle

Feb 25, 2009, 9 fatal, B-737-800, Amsterdam, NL

NTSB

Case study #4 – Impact angle? Speed?

Scene:Wreckage under final approach.Tail struck first, nose high.Relatively short debris path.Big pieces, not little fragments.No post-impact fire.

Feb 25, 2009, 9 fatal, B-737-800, Amsterdam, NL

NTSB

Case study #4: Low angle, relatively low speed

Which systems to prioritize?ATA 21 A/C & PRESSURIZATIONATA 22 AUTO FLIGHTATA 23 COMMUNICATIONSATA 24 ELECTRICAL POWERATA 26 FIRE PROTECTIONATA 27 FLIGHT CONTROLSATA 28 FUELA HYDRAULIC POWER AND RAINATA 32 LAND 34 NAVIGATIONATA 35 36 PNEUMATICATA 37

Scene:Wreckage under final approach.Tail struck first, nose high.Relatively short debris path.Big pieces, not little fragments.No post-impact fire.

Feb 25, 2009, 9 fatal, B-737-800, Amsterdam, NL

NTSB

Case study #4: Low angle, relatively low speed

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Scene:Wreckage under final approach.Tail struck first, nose high.Relatively short debris path.Big pieces, not little fragments.No post-impact fire.

Feb 25, 2009, 9 fatal, B-737-800, Amsterdam, NL

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Have a method

Think in terms of which systems need highest priority

Arrive with copies of airplane illustrations to mark upFind fo

NTSB

Case study #4: Low angle, relatively low speed

Which systems to prioritize?ATA 21 A/C & PRESSURIZATIONATA 22 AUTO FLIGHTATA 23 COMMUNICATIONSATA 24 ELECTRICAL POWERATA 26 FIRE PROTECTIONATA 27 FLIGHT CONTROLSATA 28 FUELATA 29 HYDRAULIC POWERATA 30 ICE AND RAINATA 32 LANDING GEARATA 34 NAVIGATIONATA 35 OXYGENATA 36 PNEUMATICATA 37 VACUUM

Recovered:Airspeed indication partsAutopilot boxesAOA & stick shaker partsRadio altimeters

Feb 25, 2009, 9 fatal, B-737-800, Amsterdam, NL

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Case study #4: Low angle, relatively low speed

~~ATA 21 A/C & PRESSURIZATIONATA 22 AUTO FLIGHTATA 23 COMMUNICATIONSATA 24 ELECTRICAL POWERATA 26 FIRE PROTECTIONATA 27 FLIGHT CONTROLSATA 28 FUELATA 29 HYDRAULIC POWERATA 30 ICE AND RAINATA 31 INDICATING/RECORDATA LANDING GEARATA 34 35 OXYGENATA 36 PNEUM VACUUM~~

Probable Cause:Faulty radio altimeterAutothrottle went to idle.Stick shaker at 490 ft AGL.Crew noticed low airspeed too late.

Feb 25, 2009, 9 fatal, B-737-800, Amsterdam, NL

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Typical removable components

Electric or delicate:Avionics (
Nav and CommWiresInstrume
valves, pumps, filtersBrake ac
componentsHydraulic actuato
valvesOther:Tires

Autopilot Mode Control in Case Study #4

Avionics and electronics

Protect from water from beginning of investigation. Don’t know what may be needed later.Examine aircraft logs for write-ups.Test locally on another airplane? Or on bench?Do tests and exams at manufacturers when possible. Functional test procedure typically inadequate.Functional tests, environmental, tear-down exams.Review component records for repetitive squawks.Normal for manufacturers to say “can’t happen.”

Avionics Issues

- #1 Cause of problems is in pilot mis-use or lack of knowledge#1 Write-up is intermittent failures or indicationsNo Fault Found (NFF) is most common mx response#1 Technical problem is in wiring. 29% Conductors14% Connectors8% “Electric Panel”7% Avionics (Fault confirmed)First check power sources and ground pathManufacturer wire numbers are coded for system and circuit

Avionics Issues

- Have a plan for what to do with avionics before removing, And a specific procedure before test of each pieceIf removing boxes, try not to disturb electrical connectorsInclude enough wire to read wire numbersMost avionics facilities will FIRST reset or wipe memory Watch VERY closely for dried water stains and corrosion (green or black)Capture the memory (NVM) cards or at least pertinent revision levelsNavigation, engine monitors, fault monitors, etcIt is possible to recover memory from IC components (chips) exposed to fire. (very expensive!)

Software Issues

- Loading of incorrect software/firmware is #1 software issueExample #1: Obsolete and invalid data for mapping/navExample #2: Sudden crashes and resets may be conflicting software when multiple display controls or power control units are installedNew high speed avionic units don't' always play well with slow legacy digital bussesB-757/767 busses designed when the IBM PC-AT was new

Misleading data
Falsified data
Malicious software (Cyber)

Examples:Spoofed GPS signalsNav data intentionally mis-directs displaysOperational problems caused by intentional software alterations

These are a crimeStop work and protect evidence for DHS (FBI) investigationNTSB Investigators must notify established NTSB/DHS interface teamNTSB Contacts are Dennis Jones, Bob Swaim, & Erik Grosof

Case Study #5: Low angle, high speed

N501N

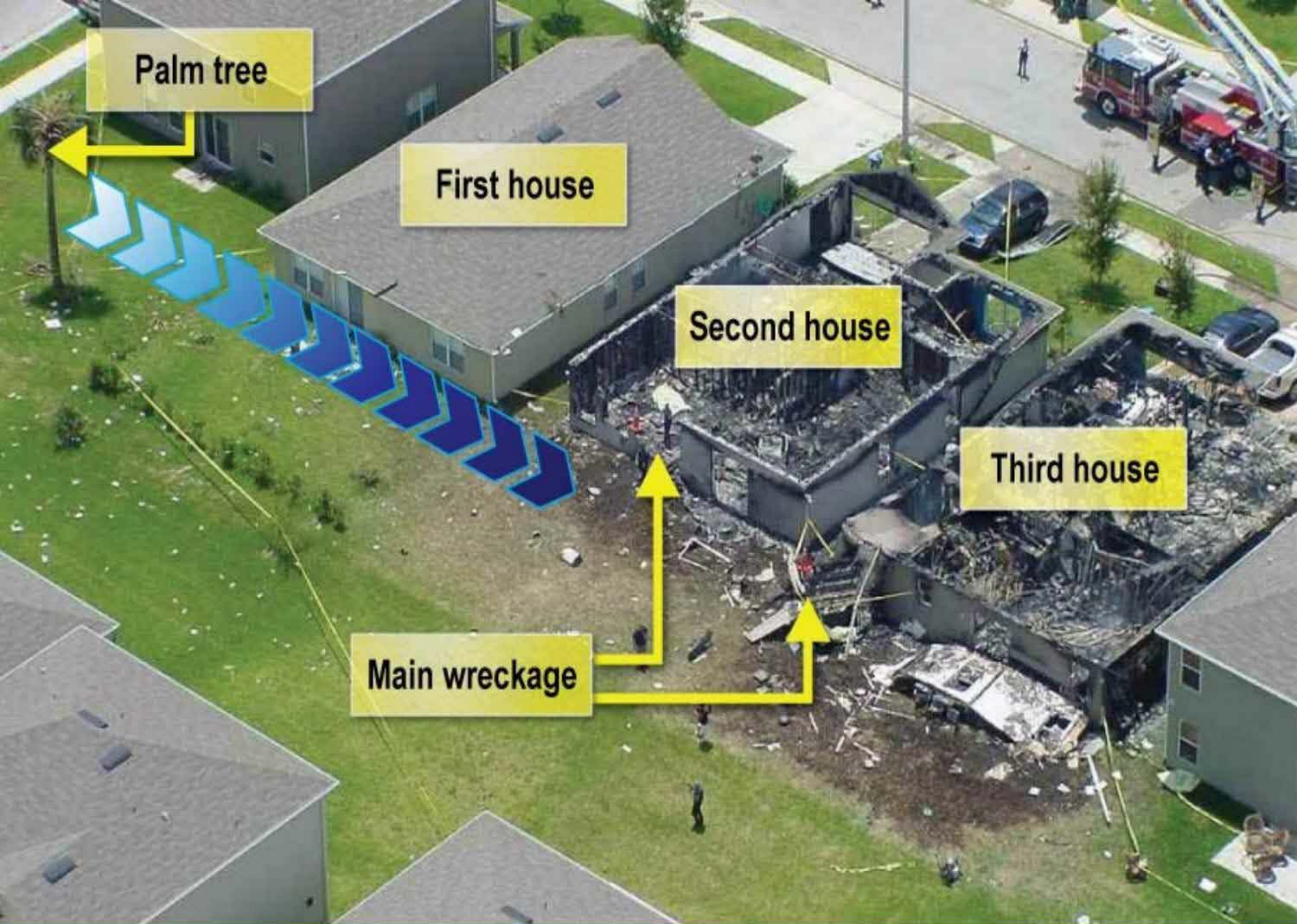
Accident Scene

July 10, 2007, Sanford ,Florida, Cessna 310R

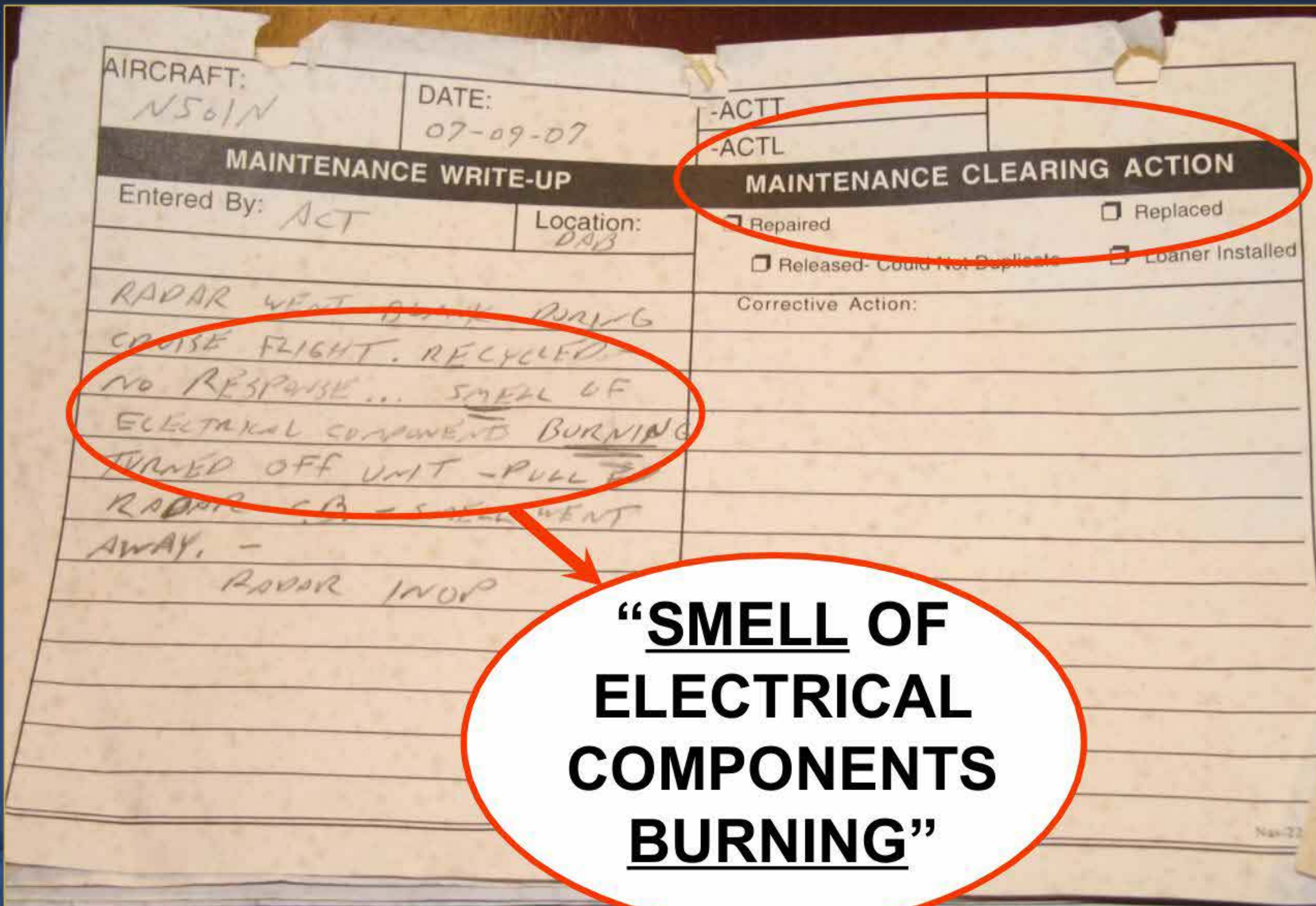
Case Study #5: History of flight

- Commercial pilot and ATP on personal flight Relatively short flight in good weatherPilots declared an emergency “smoke in the cockpit”Diverted to SanfordLast radio contactLess than 1 minute laterTerminated midsentence “shut off all radios, elec[trical]”

NTSB


Palm tree
First house
Second house
Third house
Main wreckage

Case Study #5: Maintenance discrepancy page



"**SMELL** OF ELECTRICAL COMPONENTS **BURNING**"

Case Study #5: Events - accident day

- Maintenance technician did not examine binder or airplaneATP dismissed radar issue as unimportant Pilots accepted airplane “as is”Weather radar circuit breaker likely reset for the flight. Habit and checklist.

Case Study #5: Findings

- Potential evidence of arcing, but not of wire source or timing Most electrical system components missing or severely damagedA few small wire fragments exhibited copper globules consistent with electrical arcingNot possible to positively identify which systems were involved from wire remains

Wiring routed beneath fire damage

Heatdamage (behind)

Radardisp

uitbreakerpanel

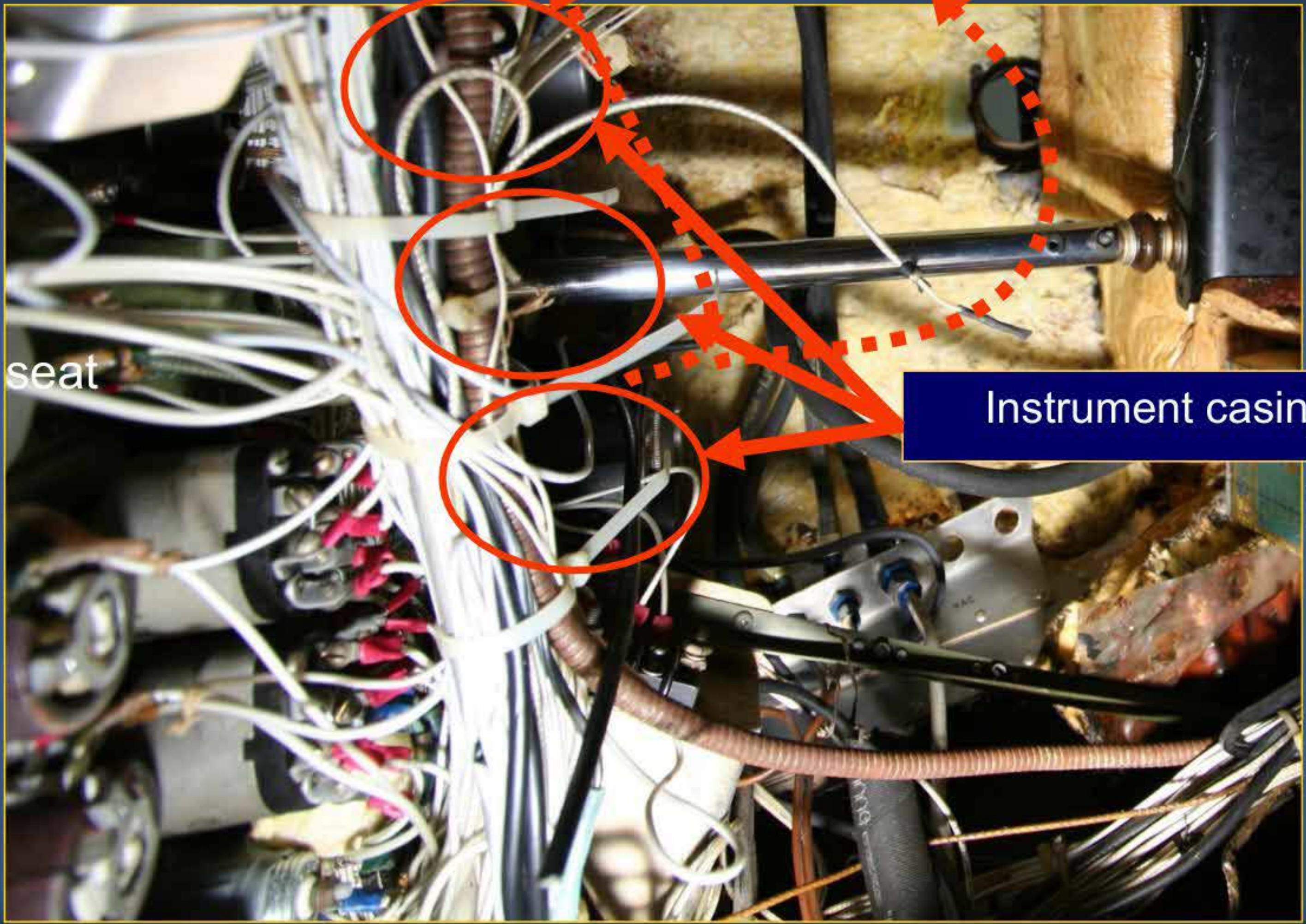
The dashed line shows the wiring path behind the instrument panel of a similar airplane

Wiring behind instrument panel

To radar display

Soot flow paths

towardpilot seat



Forward, towardn ose

To circuit breaker panel

(Exemplar airplane)

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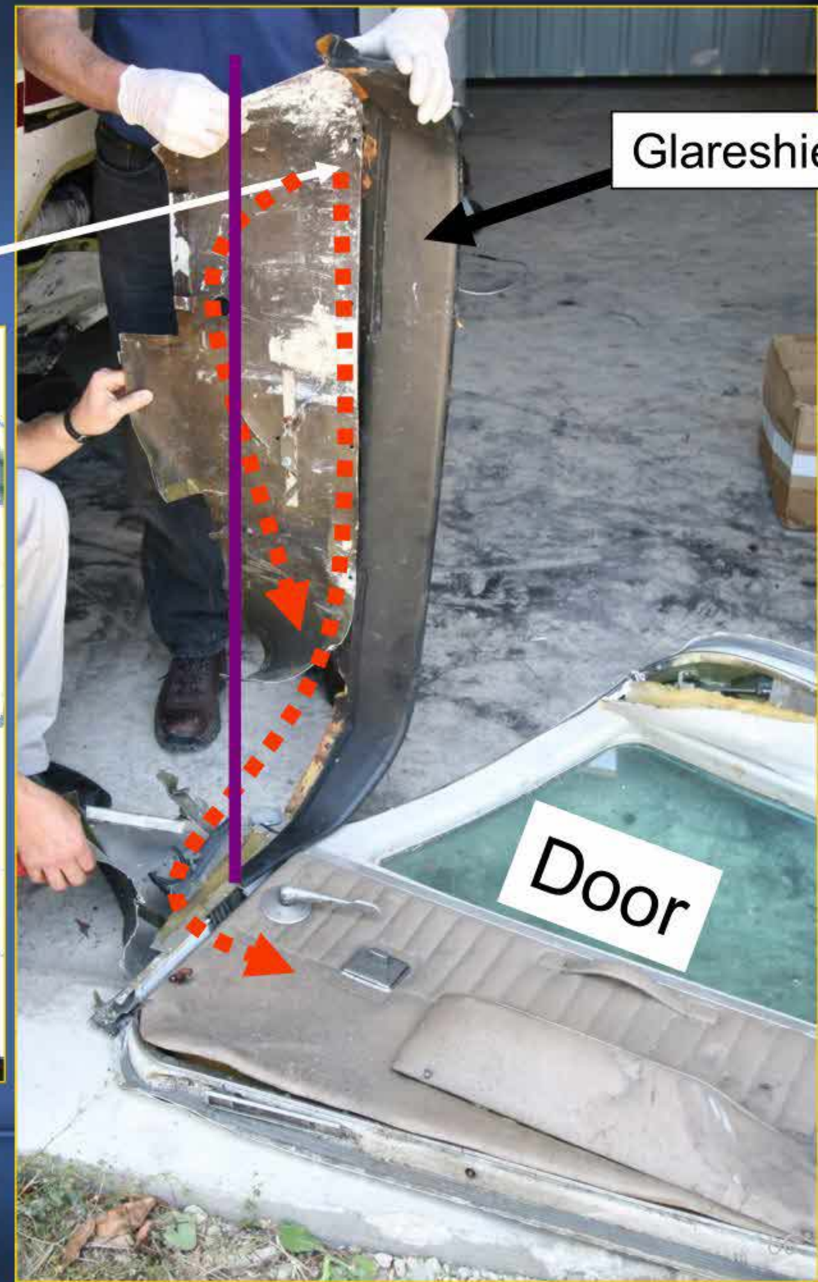
Case Study #5: Soot flow

Heat damageon bottom surface



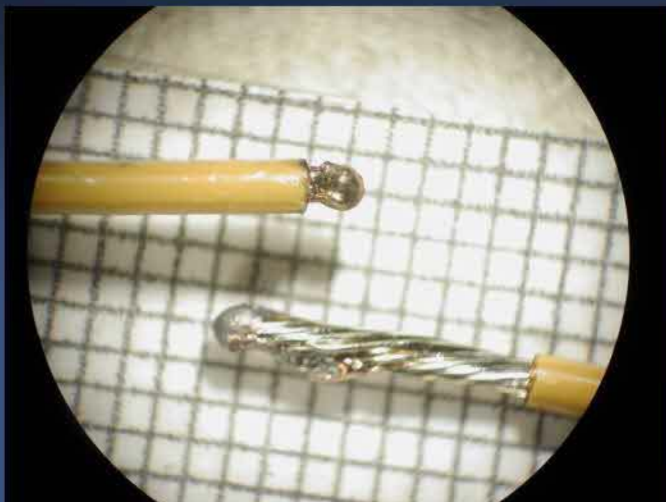
Case Study #5: PVC wire insulation

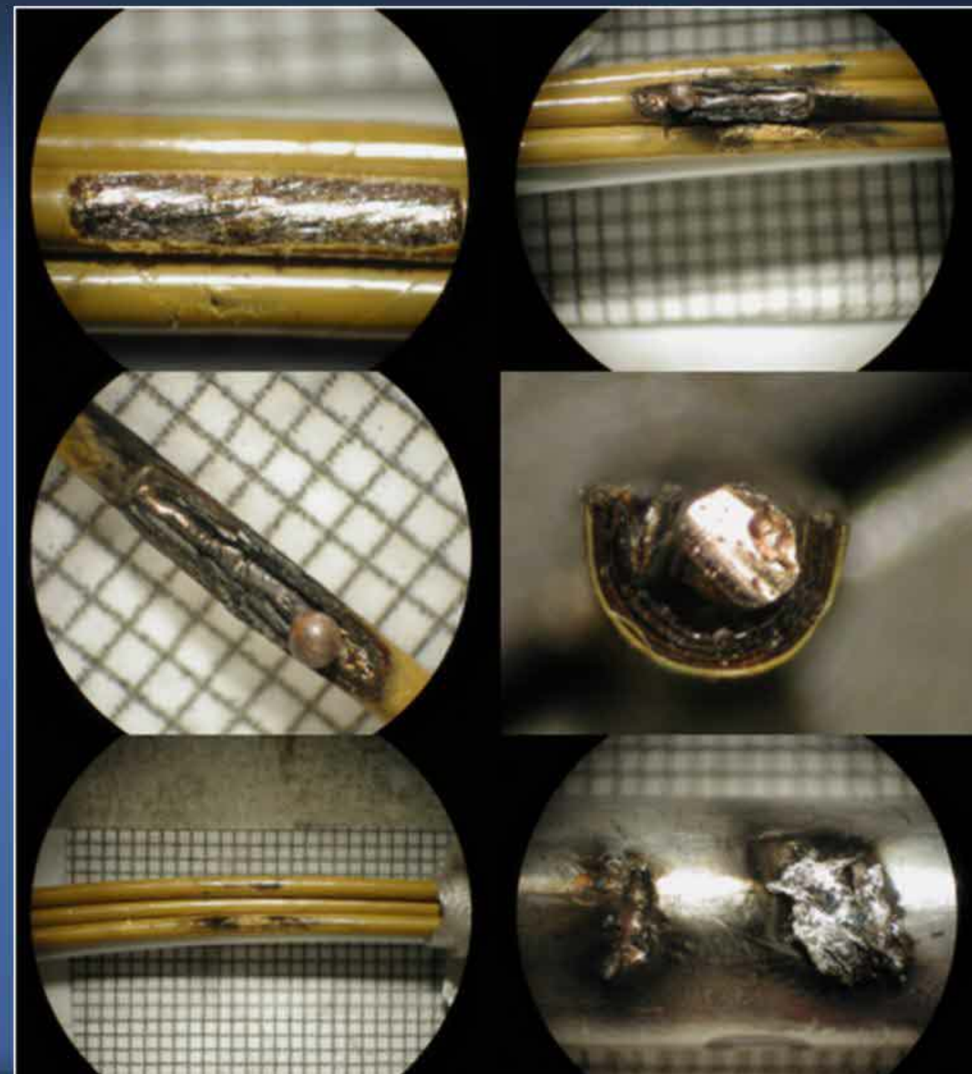
- PVC wire insulation found in wing remnantPVC-insulated wiring may or may not have been involved with initial failureIrritant of throat, eyes, and skinFull-airplane rewiring impractical

Case Study #5: Wire damage

- Pilot of previous day only stopped the symptoms by pulling circuit breakerMaintenance action was neededMAJOR WIRE LESSONS FOR INVESTIGATORS:The wiring system (EWIS) in complex aircraft leads to more maintenance action than any other systemInsulation damage is cumulativeOnce damaged, insulation not same as when approved for use

Additional wire notes



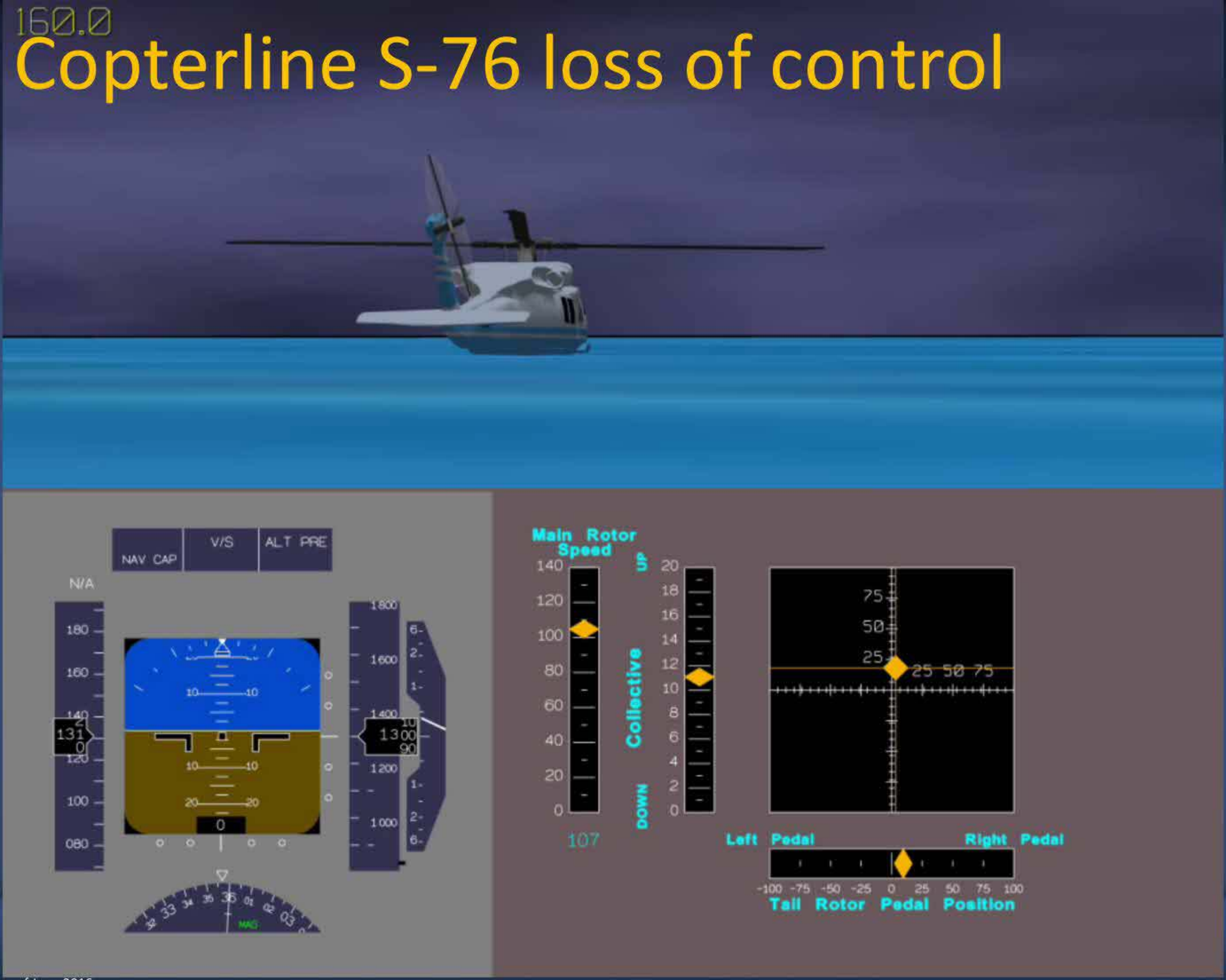


Case #6: Vertical impact, low speed after hydraulic swashplate actuator jam

Copterline S-76 impacted North Sea from cruise flight

dy have a solid idea about what happenedTHIS is the time to ca

Copterline S-76 loss of control



Systems Components

Like avionics, hydraulics typically require special testing and exam. CALL FOR ASSISTANCEYou lose control of your part and knowledge when it is sent to a lab or manufacturer.Being at the manufacturer or lab reveals details otherwise unobtainable. Examples:Technician observationsContext about observationsDiscussion about previous observations and issues

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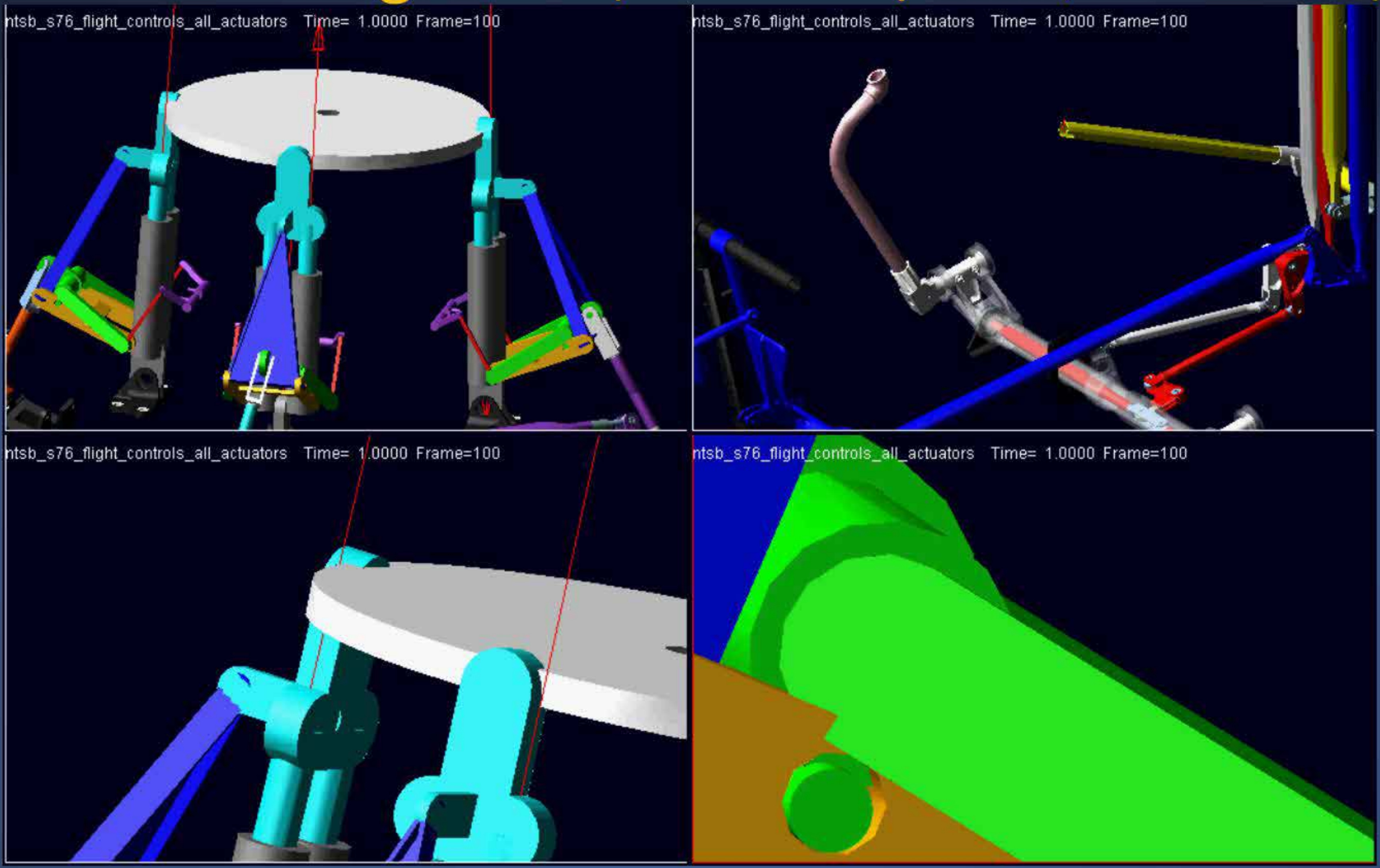
3D Modeling (AS-40 for Systems, RE for Aero)



Systems Component Techniques

Shipping submerged parts

Typically ship parts in water.The lids are sealed on with RTV.

The outside of this part was sprayed with ACF-50. Note internal corrosion.

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Tires and Brakes (Each tire is a proportion of braking)

Tires shown flipped toalign with gro

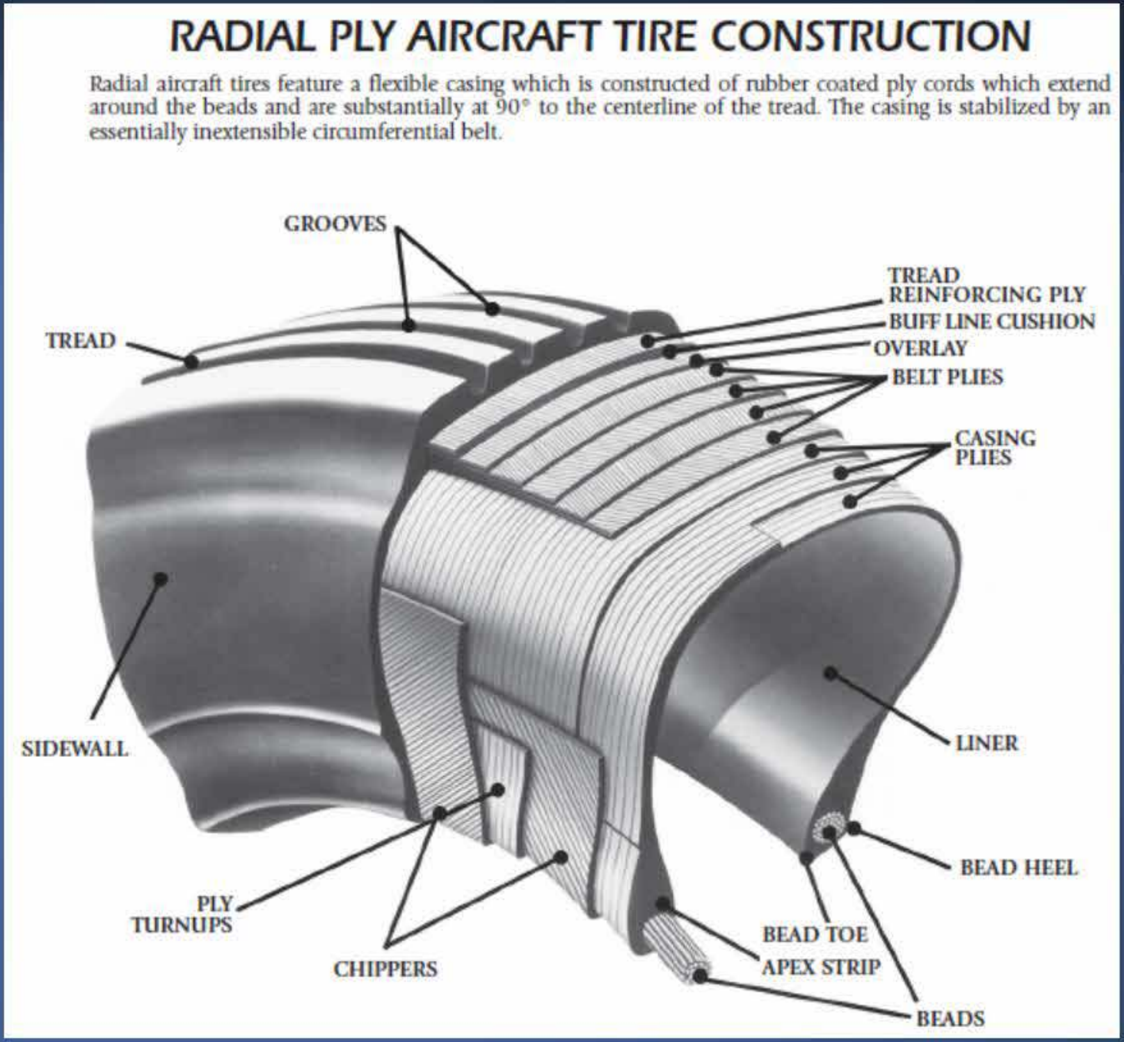
edFirst rwy mark8000 ft earlier

Tire/Wheel marks at runway endafter Columbia SC Lear 60 accident

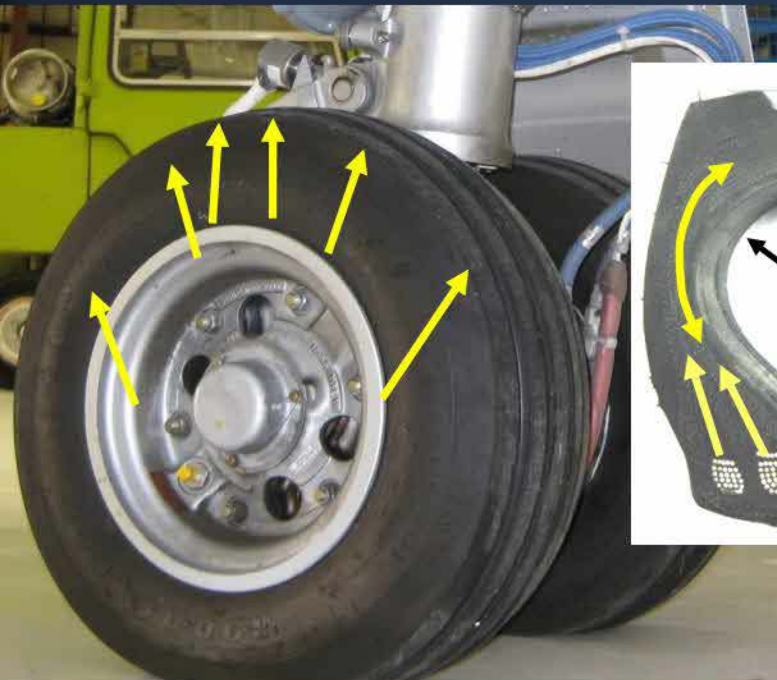
Three most important things about tires:

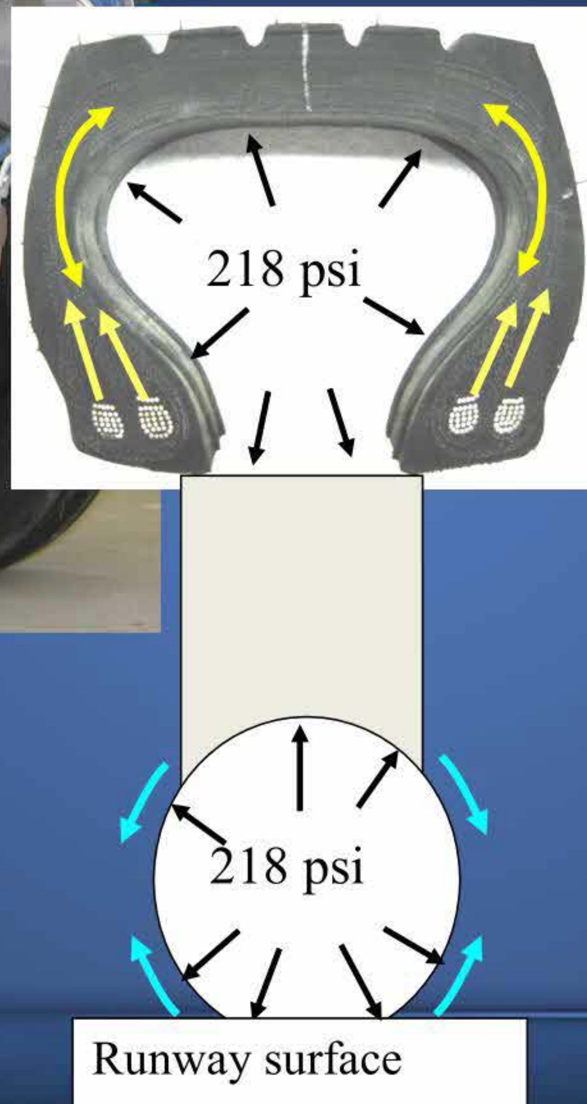
1. Inflation
2. Inflation
3. Inflation

Why?



Threads in tension lift the wheel by the beads.





hreads inTension

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Pressure controls the load on ply threads

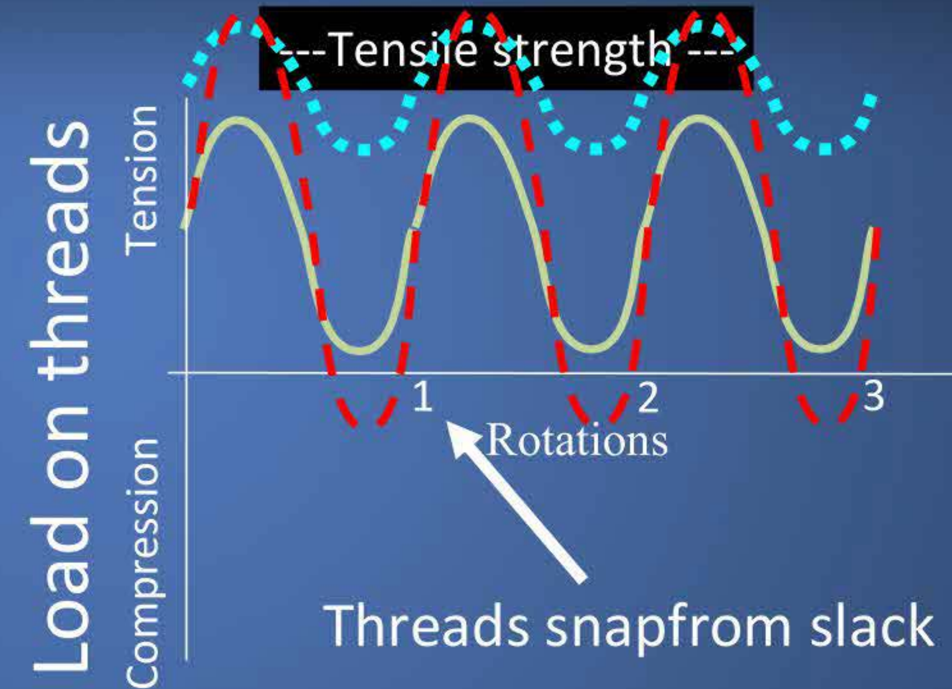
Fatigue life and sidewall deflection (flattening)

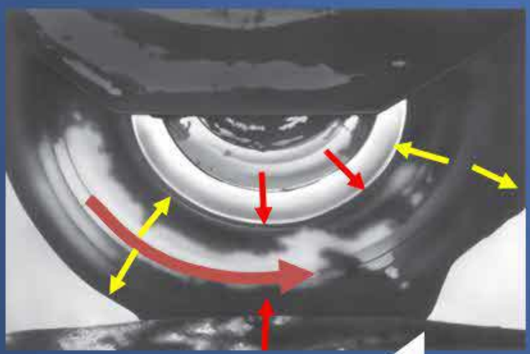
Impact of inflation pressure:

Over-Inflated

Properly-Inflated

Under-Inflated





Traction wave(rotating)

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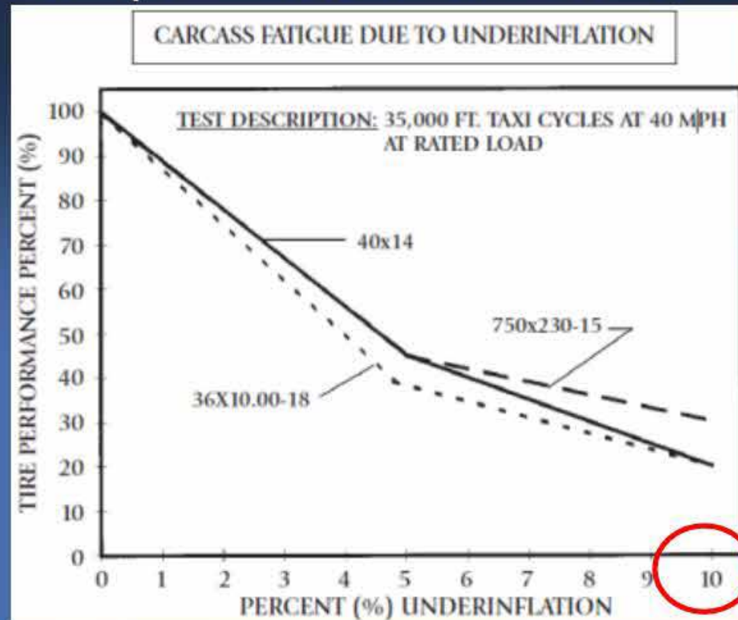
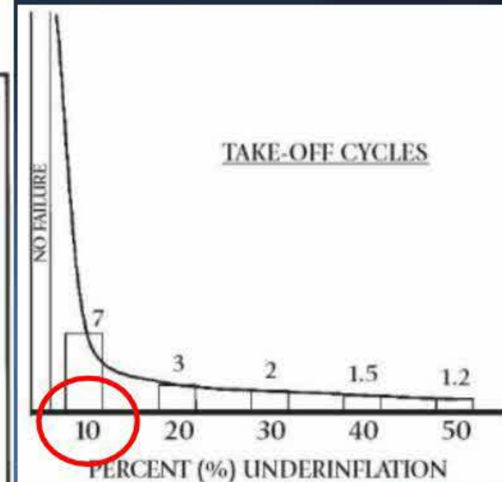
Illustrations from Goodyear Aircraft Tire Care & Maintenance Manual, available online

Tire Design

Underpressurized tires heat and lose fatigue life

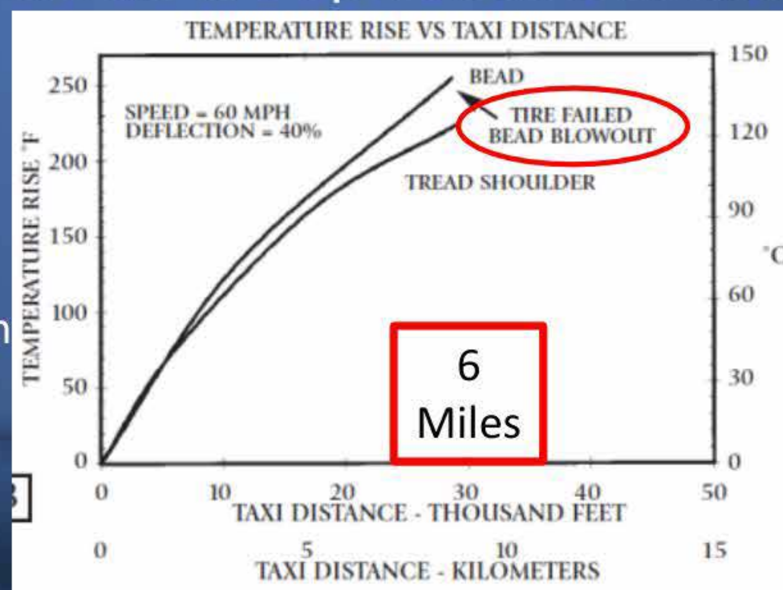




ick aircraft tiresidewalls retain

shold little heat so do nothave distan

Aircraft tire operation is limited



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Tires – Deflated Indications

Photos from different events

Hop showstire

Thinrubberstreak

Wheel flangecuts in runway.

Deflated here

Hollow centerof skid shows lac

Tread andsidewalls missing

No chine/groove marks show tread has worn through

Illustrations from Goodyear Aircraft Tire Care & Maintenance Manual, available online

Tire damage tells a story

Five examples

Skid
An oval-shaped flat spot or skid burn in the tread rubber. May extend to or into fabric plies. Remove if balance is affected, fabric is exposed, or tire is ruptured.

Tread Rubber Reversion
An oval-shaped area in the tread similar to a skid, but where rubber shows burning due to hydroplaning during landing usually caused by wet or ice-covered runways. Remove if balance is affected.

Open Tread Splice
A crack in the tread rubber where the joint (splice) separates in a radial (sideways) direction. Tires with this defect should be removed from service.

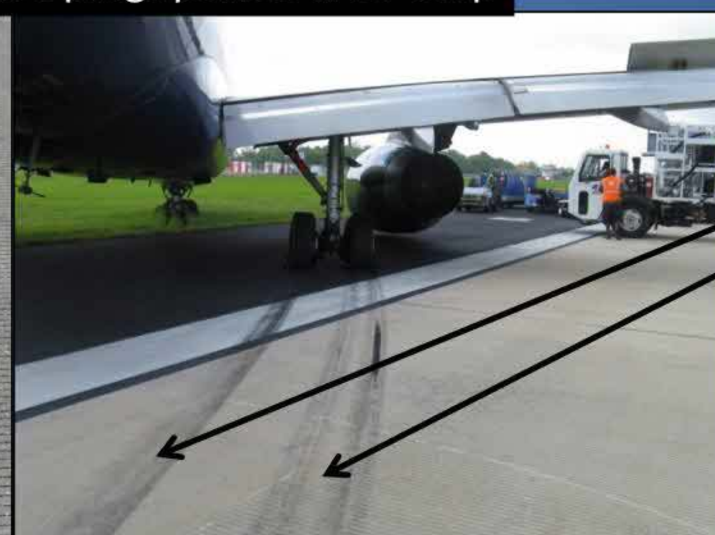
Chevron Cutting
Tread damage caused by running and/or braking on cross-grooved runways. Remove if chunking to fabric occurs or tread cut removal criteria are exceeded.

Sidewall fragment with arrowspointing to visible blue tintfrom heat damage

Antiskid Brakes

Antiskid did not function due lack of electric powerN

#3 fuse plugopened after stop



#3 Pressurized#4

Tire Brake To-Do

DANGER - Avoid if still hot or damaged until depress

Components – The eternal question:

Functional test first?

or

Disassemble first?

Instruments

Hard impact.

Mechanical altimeter - easy

Trying to clean, the facial features can be wiped off after fire

Instruments

What was the vertical speed at impact?

Instruments

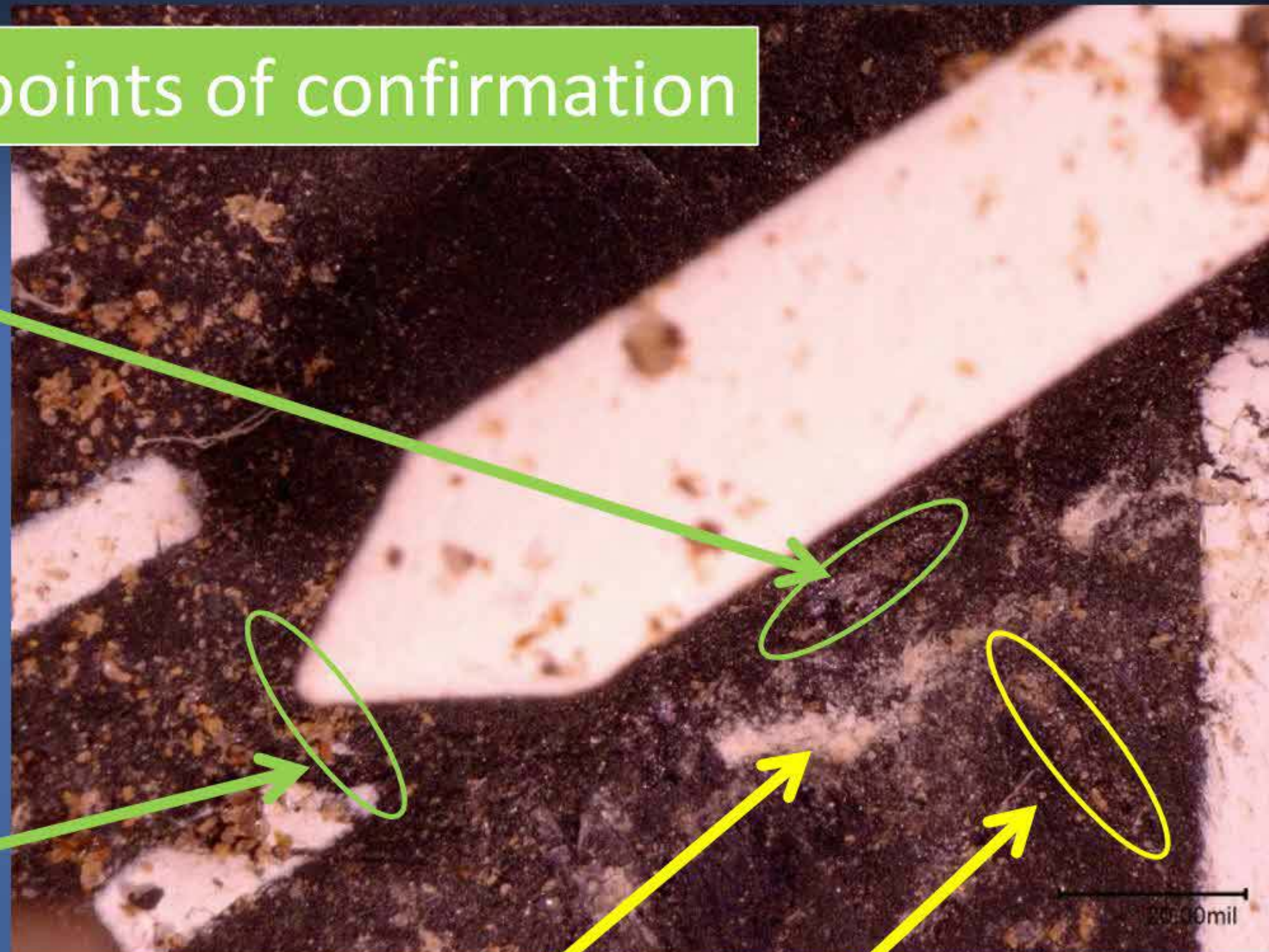
The as-foundneedle is loose

What here can relateIMPACT position?

Indications can change after initial impact.Don’t trust

Instruments

Need multiple points of confirmation



Cut in face alongedge of needle

Facial cut atradial length of tip

Misleading items:

Salt deposits

Cuts from glass face

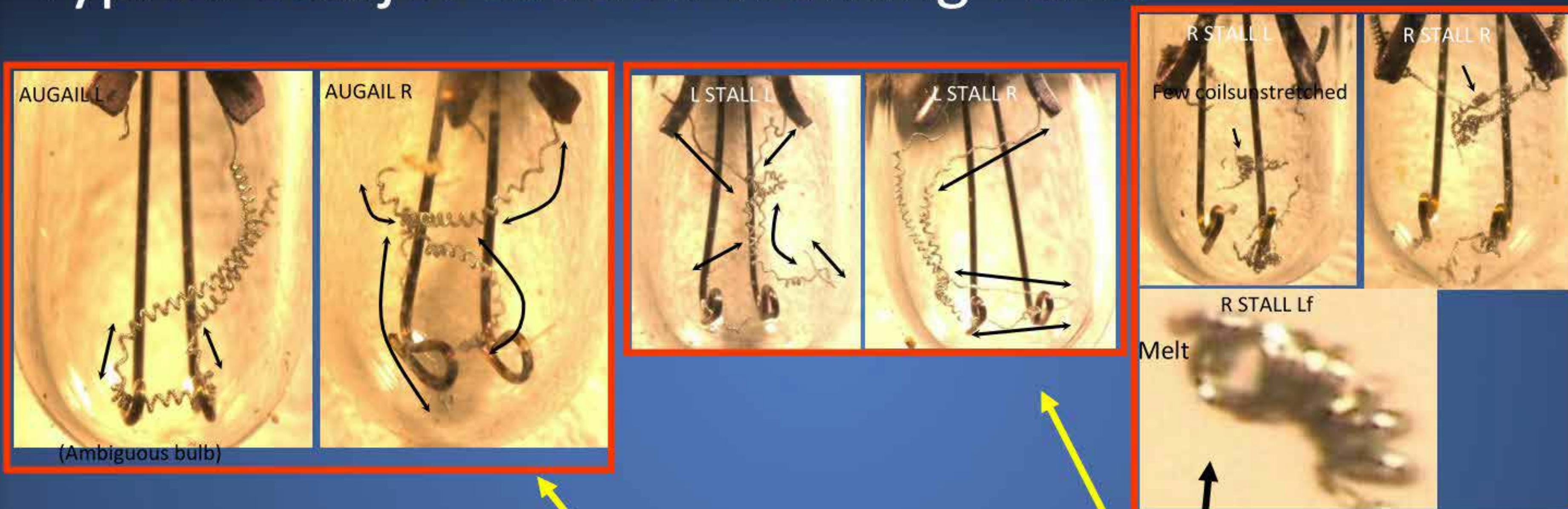
Lightbulb examination

Typical Learjet Caution Warning Panel

CUR LIM	LOW FUEL	L FUEL PRESS	R FUEL PRESS	SPOILER	DOOR	AUG AIL	PITOT HT	FUEL FILTER	L ENG ICE	R ENG ICE	L FUEL CMPTR	R FUEL CMPTR	L STALL	R STALL	L VG MON	R VG MON	MACH TRIM	DH
PRI INV	SEC INV	AUX INV	LO OIL PRESS	STAB OV HT	WSHLD OV HT	STEER ON	BLEED AIR L	BLEED AIR R	L GEN	R GEN	CAB ALT	WING OV HT	WSHLD HT	ALC AI	BAT 140	BAT 160	ENG SYNC	T O TRIM

Lightbulb examination

Typical Learjet Caution Warning Panel

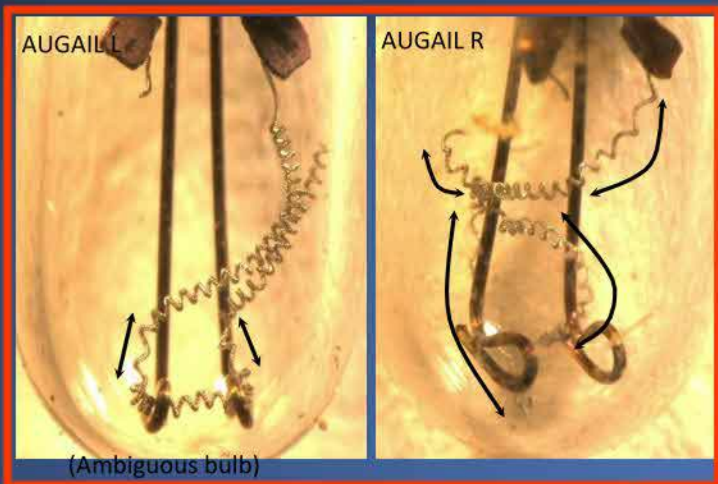


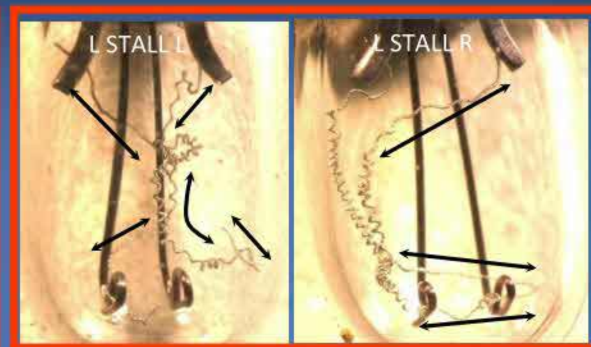
CUR LIM	LOW FUEL	L FUEL PRESS	R FUEL PRESS	SPOILER	DOOR	AUG AIL	PITOT HT	FUEL FILTER	L ENG ICE	R ENG ICE	L FUEL CMPTR	R FUEL CMPTR	L STALL	R STALL	L VG MON	R VG MON	MACH TRIM	DH
PRI INV	SEC INV	AUX INV	LO OIL PRESS	STAB OV HT	WSHLD OV HT	STEER ON	BLEED AIR L	BLEED AIR R	L GEN	R GEN	CAB ALT	WING OV HT	WSHLD HT	ALC AI	BAT 140	BAT 160	ENG SYNC	T O TRIM

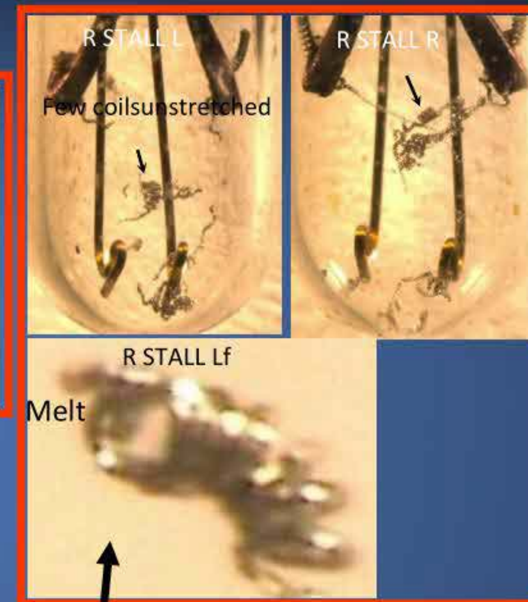
NTSB

Lightbulb examination

Typical Learjet Caution Warning Panel







N720RA bulb notes - As of Weds, 1/27 at 3:30pm by Swaim, 202-314-6394

CUR LIM	LOW FUEL	L FUEL PRESS	R FUEL PRESS	SPOILER	DOOR	AUG AIL	PITOT HT	FUEL FILTER	L ENG ICE	R ENG ICE	L FUEL CMPTR	R FUEL CMPTR	L STALL	R STALL	L VG MON	R VG MON	MACH TRIM	DH
PRI INV	SEC INV	AUX INV	LO OIL PRESS	STAB OV HT	WSHLD OV HT	STEER ON	BLEED AIR L	BLEED AIR R	L GEN	R GEN	CAB ALT	WING OV HT	WSHLD HT	ALC AI	BAT 140	BAT 160	ENG SYNC	T O TRIM

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Rubber items

- Rubber items generally do not have an expiration date (includes tires)Replace on conditionExceptions exist in mfg maintenance requirementsSome Part 121 maintenance has requirementsFittings on hose ends may have been hand assembled in the fieldNot as common in newer products or higher end

Fuel systems

- Perishable evidence!Is there any fuel? Record how much and in which tanksCapture sump fuel samplesEngine performance recorders (typically SD card) Floats type typical with light piston enginesNo accuracy requirement other than at emptyDon’t trust empty Capacitive (tube in tube) type is typical with jetsMuch more accuracy at any attitudeAccuracy can degrade with age

We have advanced NDI techniques

X-Ray, Static or real-time

PROS:in-house (RE), quick turn-around, I  ever

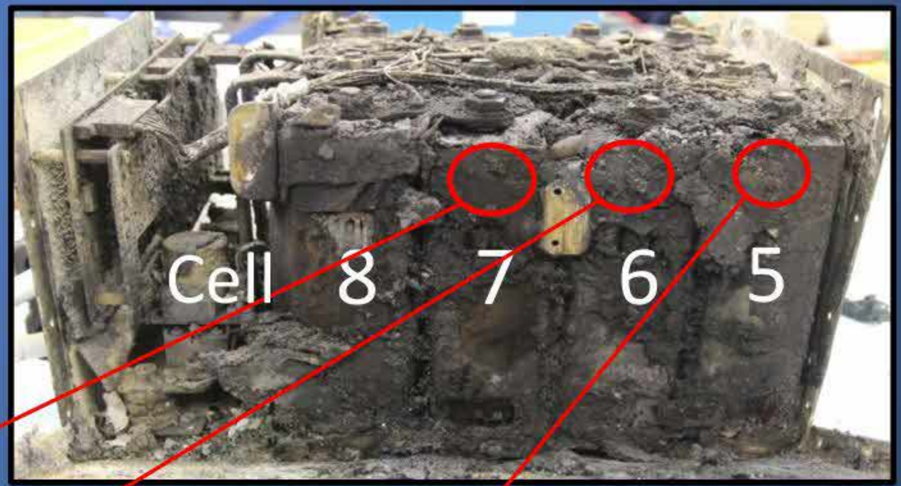
Image shows oval around wire damage in Lightning charge cable for an Apple iPhone.The wire on the opposite side is obscured. Can not tell if also damaged.

Computerized Tomography (CT) in 2D

PROS:

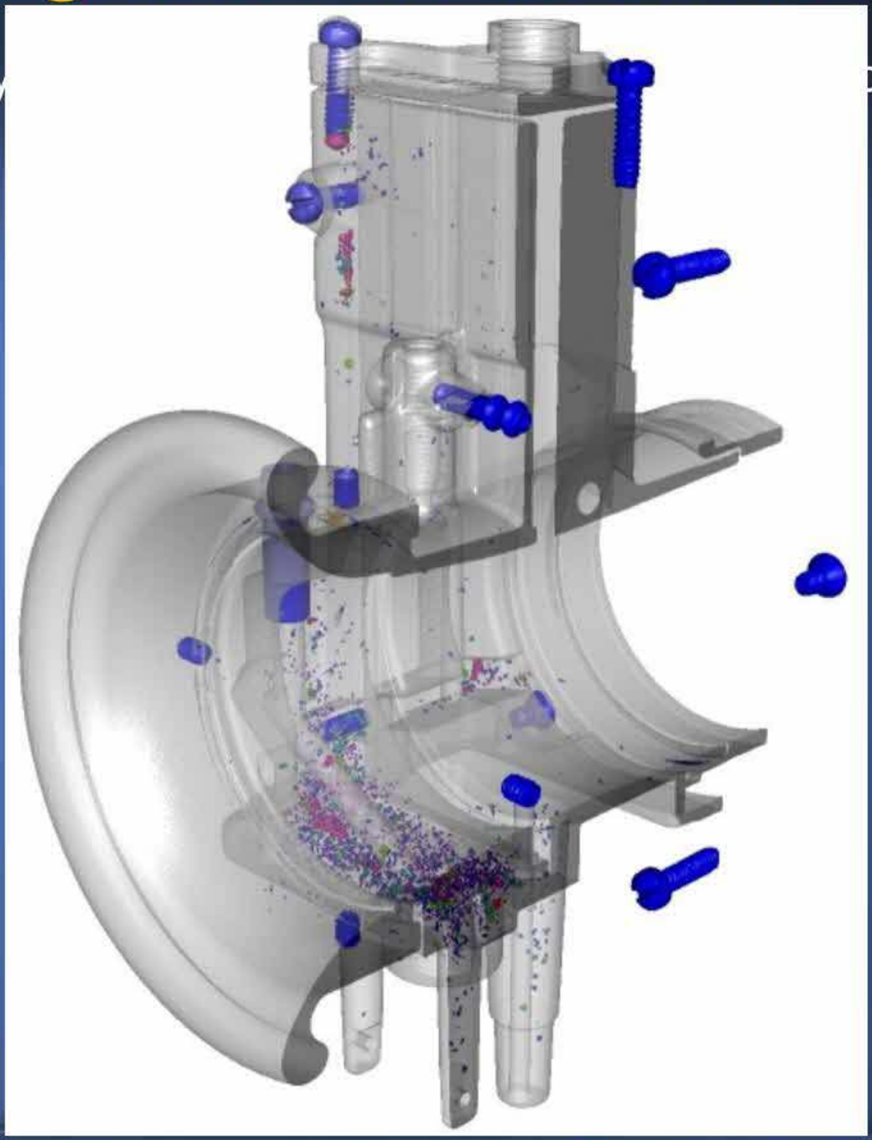
Similar to X-ray with benefit of selecting slices   Less expensive and quicker processing than 3DCONS: Sending out for scan, limits part size and slows turn-around.   Combined material densities can create shadows or prevent use.   Requires talented post-processing. (Scott Warren is AS-40 specialist)   Expensive

Two-dimensional CT images belowshow 787 Lithium-ion battery cells with fused (open) aluminum current conductors



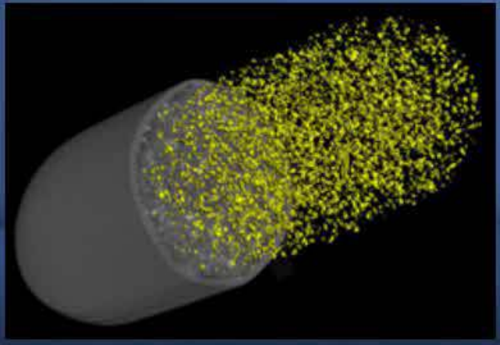
CT can provide knowledge before disassembly

Image at right of carburetor:Passages may



ced

To demonstrate potential resolution, this pharmaceutical capsule shows specks of medicine, not filler, isolated by material density.



Questions?

AS-40 Systems Investigators:Carolyn DeForge, Division ChiefScott Warren, Lead & CT SpecialistBob Swaim, NRSTom JackySteve MagladryMike HaufAdam HurayMike Bauer

National Transportation Safety Board

Medical Investigations

Nick Webster, MD, MPHMedical Officer

National Transportation Safety Board

Medical Staff

Chief Medical Officer – Mary Pat McKay MD, MPHMedical Officer – Nick Webster MD, MPH

Medical Investigation: Why do we care?

- ImpairmentIncapacitationSurvivabilityEvaluate certification processDetermine who was in control

Accident Investigation: Medical Questions

- Did natural disease or its treatment lead to impairment or incapacitation which contributed to the cause of the accident?If …. had occurred, would the accident have been survivable?

Information Sources

- Certification recordFamily membersFriends/Co-workersPharmacy recordsMedical recordsNotes, labs, specialty testingAutopsy findings
- ToxicologyEMS recordItems from crash sceneImagingVoice tapesRadar track (controlled substance prescription database)

Medical Records

- Certification recordMay include information on other providersOften limited – relies on self-reportPersonal medical recordsMay have multiple providersPharmacy records

Autopsy Information

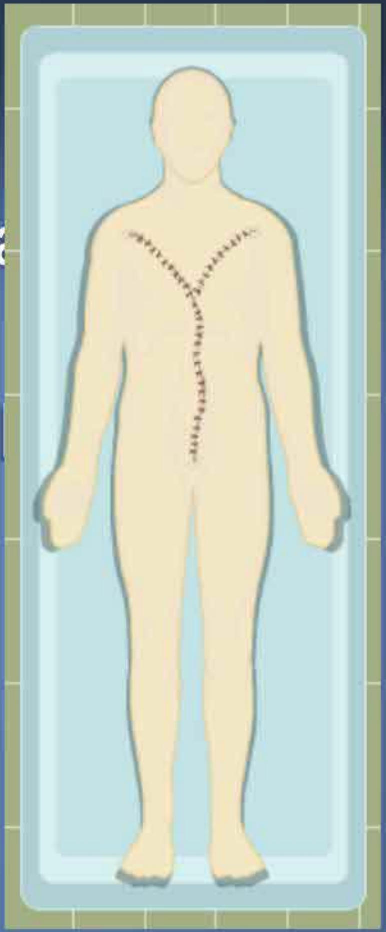
- Autopsy SystemsCoronerMedical ExaminerDeath InvestigatorAutopsy performed by pathologist

Autopsy
(Engineering investigation of the individual)

- An examination and dissection of a dead body for the purpose of identifying the deceased, determining the cause, mechanism, or manner of death, obtaining specimens for toxicological and specialized testing, retrieving physical evidence, and recording injuriesCause of DeathThe underlying disease or injury responsible for setting in motion a series of physiologic events culminating in deathManner of DeathA simple system for classifying deaths based in large part on the presence or absence of intent to harm, and the presence or absence of violenceThe choices are natural, accident, homicide, suicide, undetermined, and in some registration districts for vital statistics, unclassified

Complete Autopsy

- External examPhotographsX-ra exam“Y” incision Intracranial evaluationHistologyToxicology n of indwelling devices



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FAA Autopsy Program Team Contact Information

- Christy Hileman RHIA – [redacted], Cell [redacted]

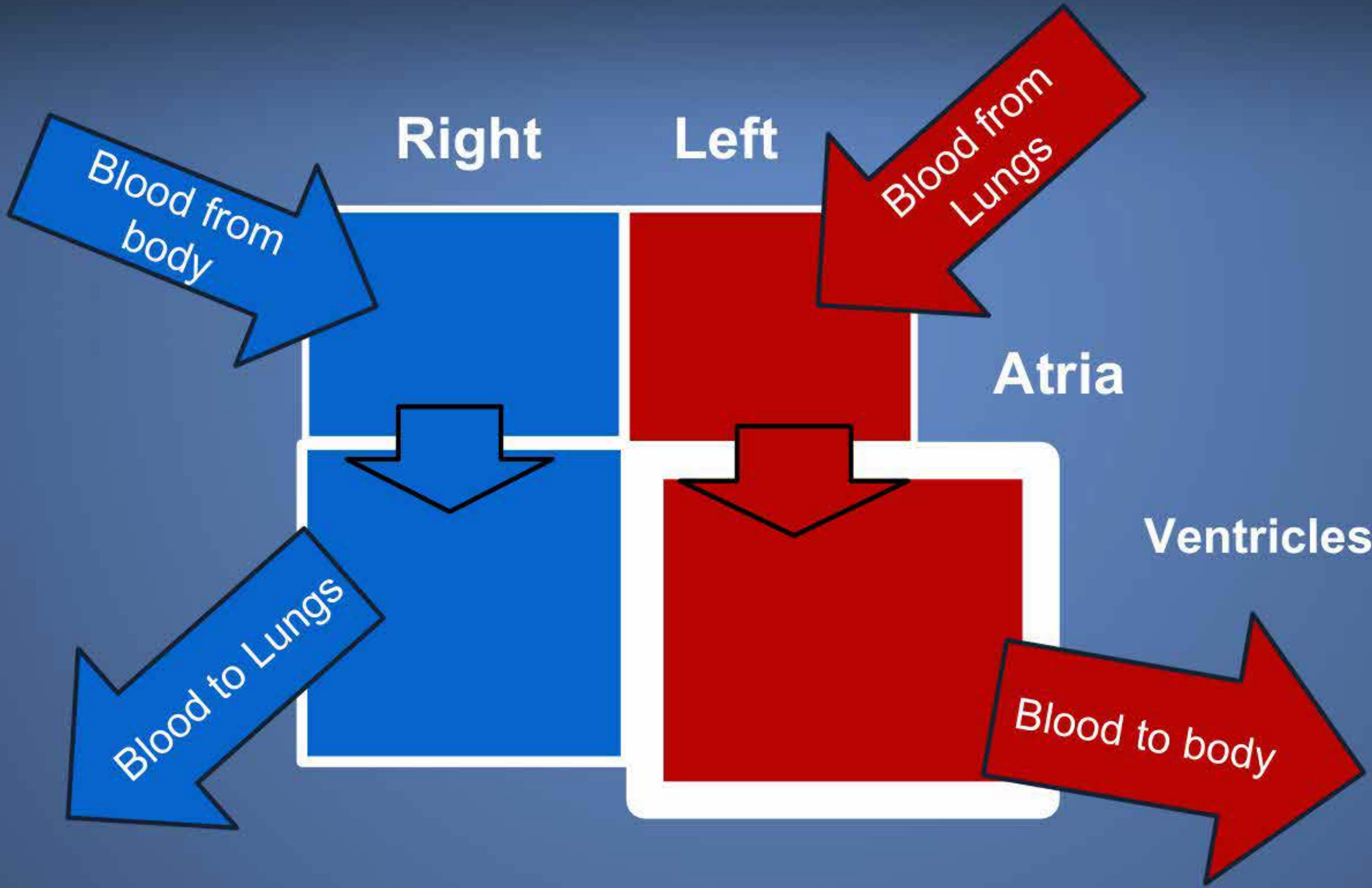
NTSB

Case 1:

CEN11LA239, Wellington, CO

- Loss of control into terrainNo identified mechanical defects82 year old pilot Coronary artery disease -> MI, CABGThird degree heart block -> pacemakerSpecial issuance, class III medical

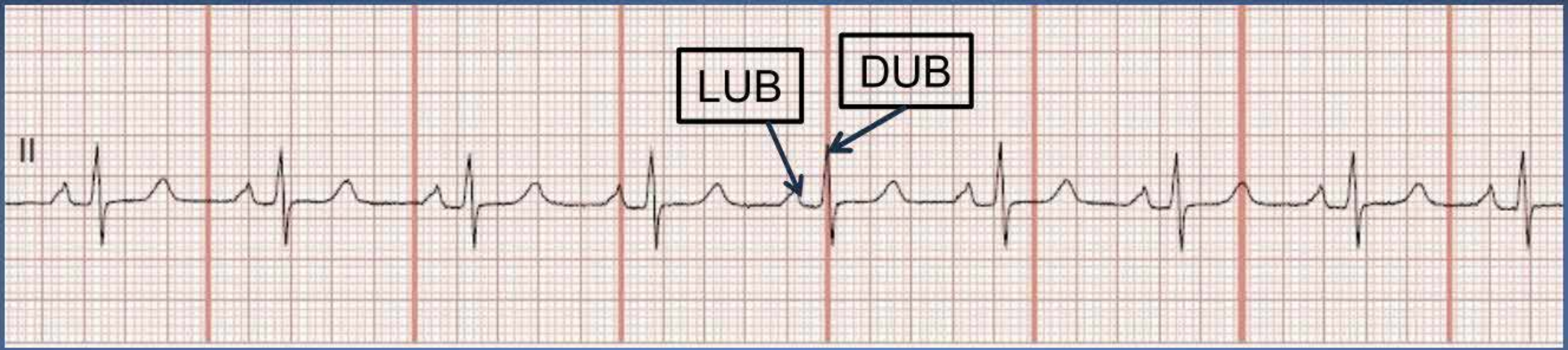
Cardiac anatomy and physiology



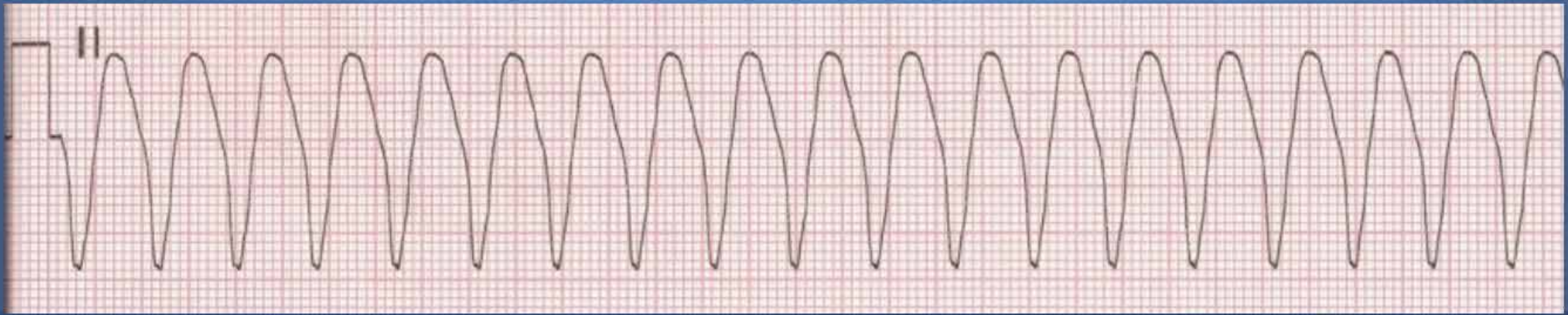
Case 1: Autopsy

- COD: “Multiple blunt force injuries”Lacerated aortaNo significant bleeding (90cc = “Severe” coronary artery disease Pacemaker readout: Ventricular tachycardia

Normal Sinus Rhythm



Ventricular Tachycardia



So, what happened?

- Loss of control Severe injury without significant bleedingEvidence of a terminal arrhythmia…Incapacitation from fatal ventricular arrhythmia

Case 2: Survivable?

- Cessna A185F, 3 POBApril in Blanding, UTSPOT locator and 406 ELTSpot locator was functioningFailed to arrive ~ 8:30pmControlled flight into terrainPost impact fire

Case 2: Initially survived

- Right seat occupant – found outside the plane with evidence of moving aroundCrash ~1540Missing ~2030Found ~ 0200

Case 2: Autopsy results

- No natural diseaseInjuries:Small subarachnoid hematomaRetroperitoneal hematomas; no sourceRight arm and left leg fractures

Trauma Centers

- Level I or II24/7 trauma surgeons, trauma team, specialty surgical careLevel III and IVTriage and stabilize

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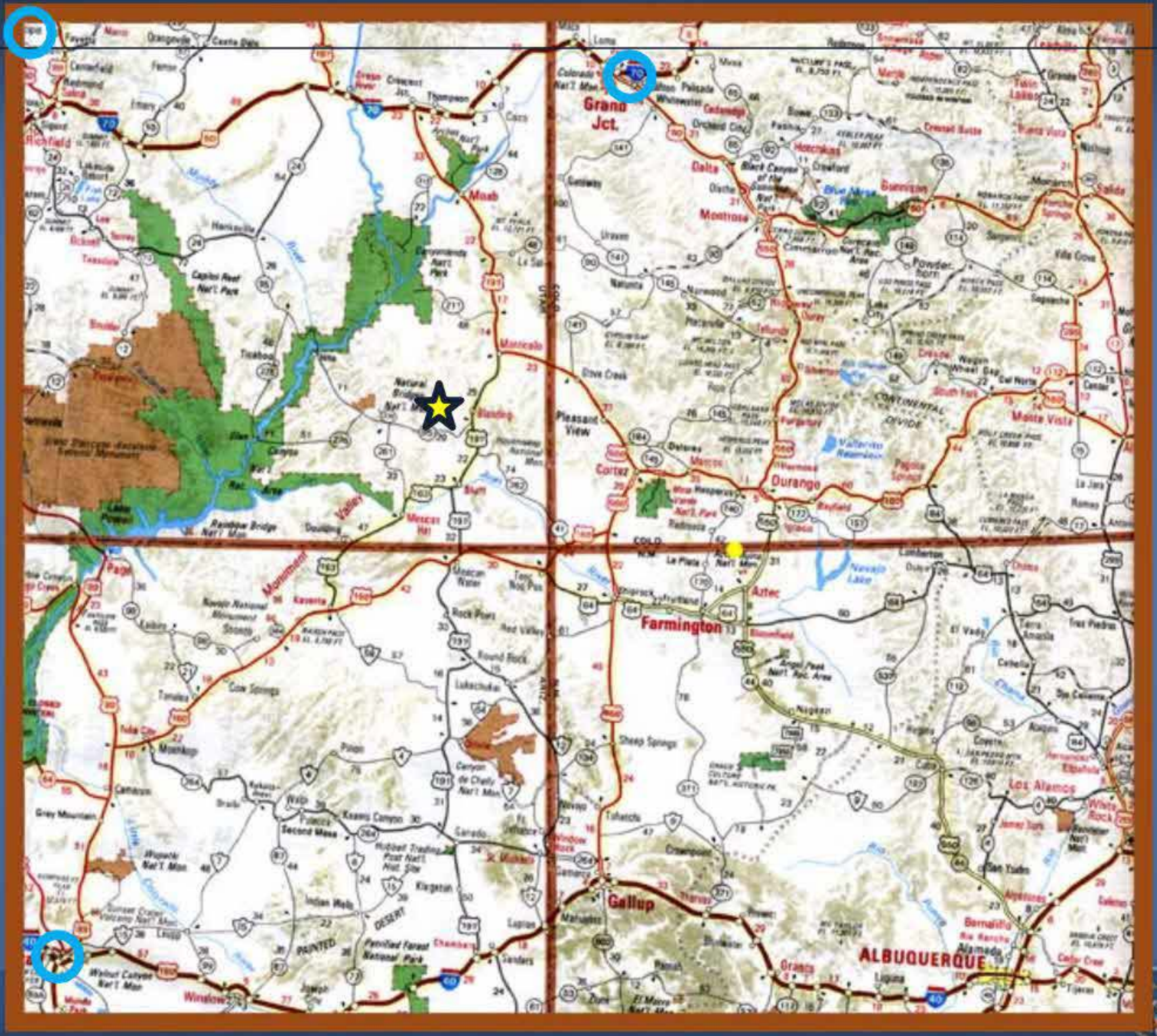
Geography



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Case 2: Should he have survived?

- If . . . the ELT had worked… and the search and rescue helicopter had found him… and the EMS helicopter had been availableThen~2.5 hours to paramedic care and another hour to a trauma center

Medical literature

- Previous studies of outcomes from similar injuriesAccount for delay in arrival at trauma center60% chance of long term survival

Autopsy Quality Issues

- Cause and manner of death usually pretty obviousLooking for the cause of the accident – not well understoodAsking for extra work

Autopsy Quality

Disease	Helpful	Not so helpful
Coronary artery disease	95% stenosis of the LAD 7 mm distal to the left main	"Significant" coronary disease
Heart attack	1.2 cm area of softened, discolored tissue apex of left ventricleHistology: myocytes with apoptosis and contraction bands	"Recent" myocardial infarction
Heart failure	4 chamber symmetric dilation to twice the normal size, heart weight: 680 gm, LV wall thickness 1.3 cm	Moderate to severe dilated cardiomyopathy
Valve disease	Dilation of the left atria to larger than the left ventricle, calcified three leaf mitral valve, opening estimated at 1.2 cm	Calcific mitral stenosis

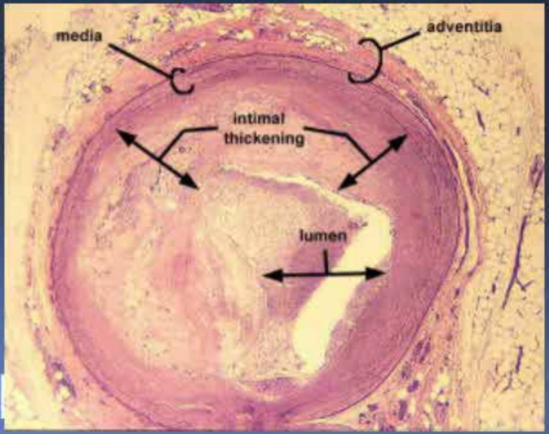
Case 3: WPR10GA231

- CHP traffic surveillance5 knots, clear, 25°C10amUncontrolle flight into terrain39 yea old pilotBack surgery

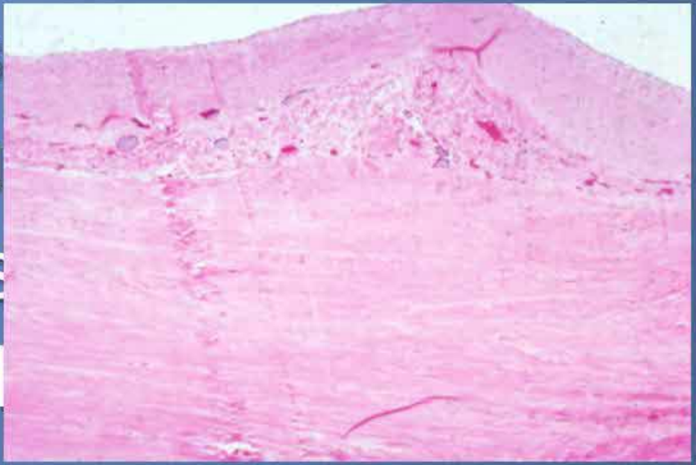
Case 3: Autopsy results

- Cause: Multiple blunt force injuriesManner: AccidentNatural diseaseSevere atherosclerotic disease2 x 2 x 1.5 cm area where the myocardium of the left lateral ventricular wall is interrupted and replaced by considerably softer, pale, tan tissue, resembling fat.

Case 3: Histology



- Right coronary artery:Concen
atherosclerosis with cholesterol crystal clefts Up to 90% stenos
ventricular wallTransmu
fibrosisFibrosis replaces
endocardial half of the th
wall



Case 3: Probable Cause?

- Undiagnosed severe coronary disease with remote heart attackUncontrolled flight into terrainNo mechanical defectsIncapacitation from an acute coronary event

Toxicology

- What are you looking for?Illicit substancesMedicationsAlcoholWhere can you look?Blood, urine, organs, vitreous, gastric contents, bile,

TOX-BOX
(Toxicology Specimen Box)

- GIVEN to the coroner or medical examiner by FAA investigators or shipped from CAMI to the medical examinerHighly recommended for sending specimensOne fatality per TOX-BOX

Toxicology testing

- Initial screenVerification QuantificationCaveats:Specimen unsuitable vs. drug not foundPresence doesn't = impairmentIs the condition or the treatment more impairing?

Toxicology caveats

- Post-mortem productionEthanol Methanol N-propanol N-butanolRedistribution

DOT testing: survivors

- Post-incident testing required for surviving flight crew: Urine onlyTHC (marijuana)Cocaine Amphetamines amphetamine, methamphetamine, MDMA, MDA, and MDEA Opiates codeine, morphine, and heroinPhencyclidine (PCP)

NTSB/CAMI testing for survivors

- Hospitalized survivorsAdmission specimens subpoenaUninjured survivorsLaw enforcement – requires probable cause and field sobriety testingVoluntary

Case 4: Milner, CO

- Piper ComancheVMC, flying above 11,000 mslFound by shepherd next dayStudent pilot certificate, issued 14 months priorLoss of control in flight

Case 4: Records and Autopsy

- 36 year old pilotThird class medical (clean)Personal medical recordsEpisode of faintingBradycardiaCOD: Blunt force trauma No natural disease

Case 4: Toxicology

- Medical ExaminerEthanol = 0.110 mg/dL+ amphetamines, + cannabinoidsCAMI toxicologyEthanol = 0.104 mg/dLTHC = 0.074 ug/ml

NTSB

Case 4: other items

- Prescription for medical marijuanaSix pack of beer, two opened

Case 4: What happened?

- Ethanol, marijuana and hypoxia:Impaired motor coordinationJudgmentAttentionEuphoriaImpairment by drugs and hypoxia led to loss of control

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E PLURIBUS UNUM

National Transportation Safety Board

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Conducting An Accident Investigation

Jill Demko, Technical Training OfficerNational Transportation Safety BoardAshburn, Virginia

Module Objectives

- 60-minute "How To" Accident Investigation OverviewInvestigative tips & tricksResourcesContact informationCase Study

What is an Accident?

What is an Accident?

Definition of an Aircraft Accident? (**a review**)
An occurrence associated with the operation of an aircraft which:takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in whichany person suffers death or serious injury, or in whichthe aircraft receives substantial damage

Unmanned Aircraft

What is the definition of an unmanned aircraft accident?

An occurrence associated with the operation of any public or civil unmanned aircraft system that takes place between the time that the system is activated with the purpose of flight and the time that the system is deactivated at the conclusion of its mission, in which:

1. Any person suffers death or serious injury; or

2. The aircraft has a maximum gross takeoff weight of 300 pounds or greater and sustains substantial damage.

What is an Accident?

Serious Injury (**a review**)	
Any injury which:Requires hospitalization for more than 48 hours, commencing within 7 days of the date that the injury was received;Results in a fracture of any bone (except simple fractures of fingers, toes, or nose);	Cont'd:Causes severe hemorrhages, nerve, muscle, or tendon damage;Involves any internal organ or;Involves 2nd or 3rd degree burns, or burns affecting more than 5% of the body surface

What is an Accident?

Substantial Damage (**a review**)	
Substantial Damage is… Damage or failure which:Adversely affects the structural strength, performance, or flight characteristics of the aircraft, and whichWould normally require major repair or replacement of the affected component	Substantial Damage is not…Engine failure or damage limited to an engine if only one engine fails or is damaged,Bent fairings or cowlingDented skinSmall punctured holes in the skin or fabricGround damage to rotor or propeller bladesDamage to landing gear, wheels, tires, flaps, engine accessories, brakes, or wingtips are not considered “substantial damage” for the purpose of this part.

What is an Accident?

Incidents

"An occurrence other than an accident associated with the operation of an aircraft, which affects or could affect the safety of operations."- 49 Code Federal Regulations 830.2

Notification and Reporting

The operator of an aircraft shall immediately and by the most expeditious means available notify the nearest NTSB Field Office when an aircraft accident or any of the following incidents occur:Flight control system malfunctionInability of any crew member to perform normal flight duties as a result of injury or illnessIn-flight fireDamage to property, exceeding $25,000Aircraft collision in flight

Notification Requirements

Updated Incidents (830.5)

•Uncontained engine failure (turbine)Release of propeller blade (not ground)Failure 50% of EFIS, EICAS, PFD, PND, etc.TCAS resolution advisory with risk of collisionDamage to helicopter tail or main rotor blades, including ground damage, that requires major repair or replacement of the blade(s)

Types of Accident Investigations

- MajorFi
  Collecti

Major (MA) Investigation

- Large aircraftHigh visibilityNormally handled by HQ “go team”Regions may be part of investigationRegions may be in charge

Field (FA) Investigation

- Regional investigator (IIC) and partiesTypically involves a fatalityRegional IIC = manages all aspects

Limited (LA) Investigation

- NTSB does not travel to the accident siteFAA can act as the “eyes and ears” of the NTSB at the sceneFAA 9 areas of responsibilityAdditional NTSB requestsProbable cause by NTSBFAA asking as part of FAA investigation or NTSB investigation?

Data Collection (CA) Investigation

- One-time reportKnown circumstancesNo obvious safety issues/mechanical issuesNo fatalities or “critical” serious injuriesNot high public visibility

Incident (IA) Investigations

Gemini Air Cargo MD-11F, Overrun into EMAS

Foreign (RA) Accidents

Suspected Criminal Behavior

- Requires consultation between the Chairman of the NTSB and the US Attorney GeneralIf circumstances reasonably indicateIntentional criminal actFBI takes leadIf Federal law enforcement agency suspects criminal activity may have been caused by intentional criminal act:NTSB preserves evidence of criminal act

Criminal Events

Preparing to Launch

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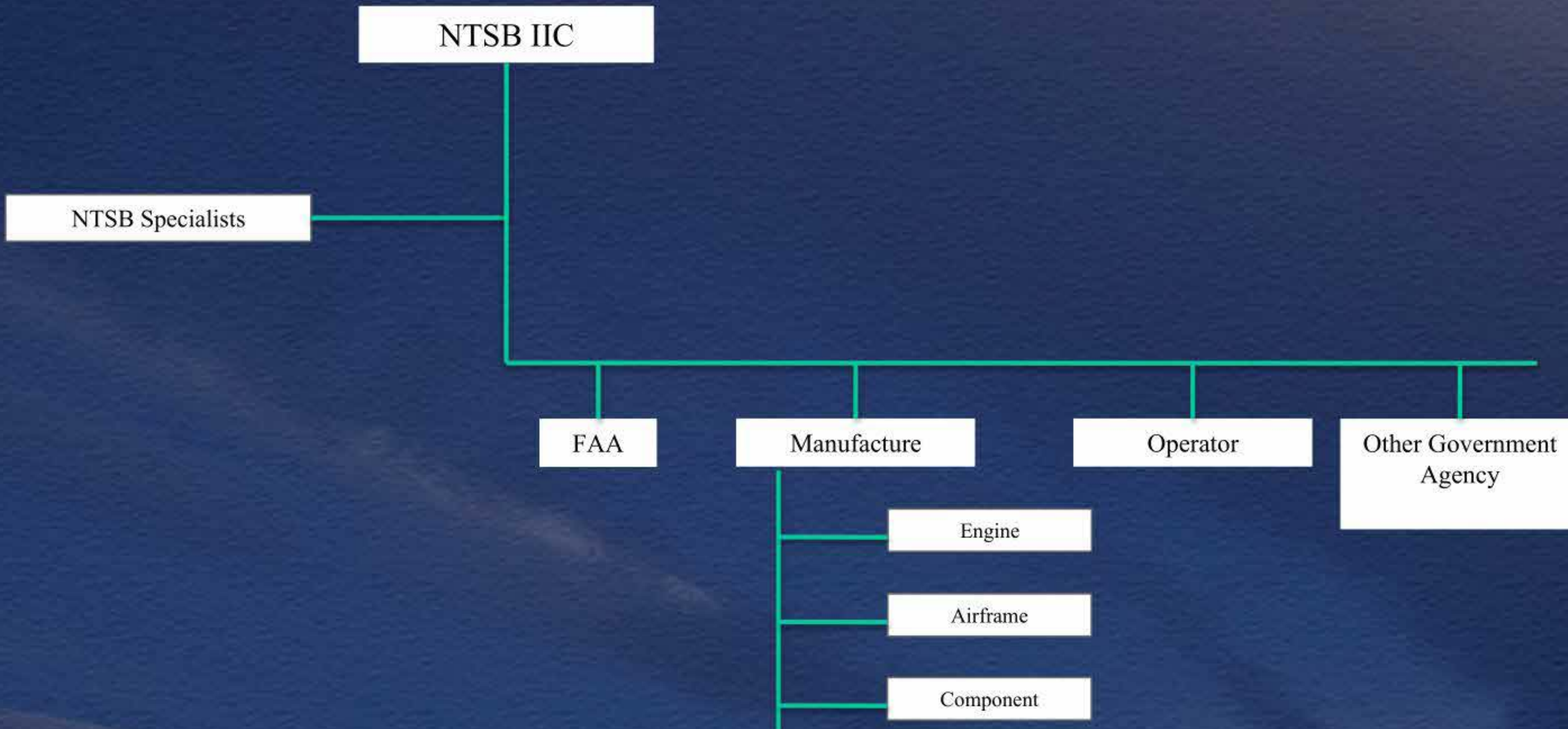
Go-Bag Equipment

Go-Bag

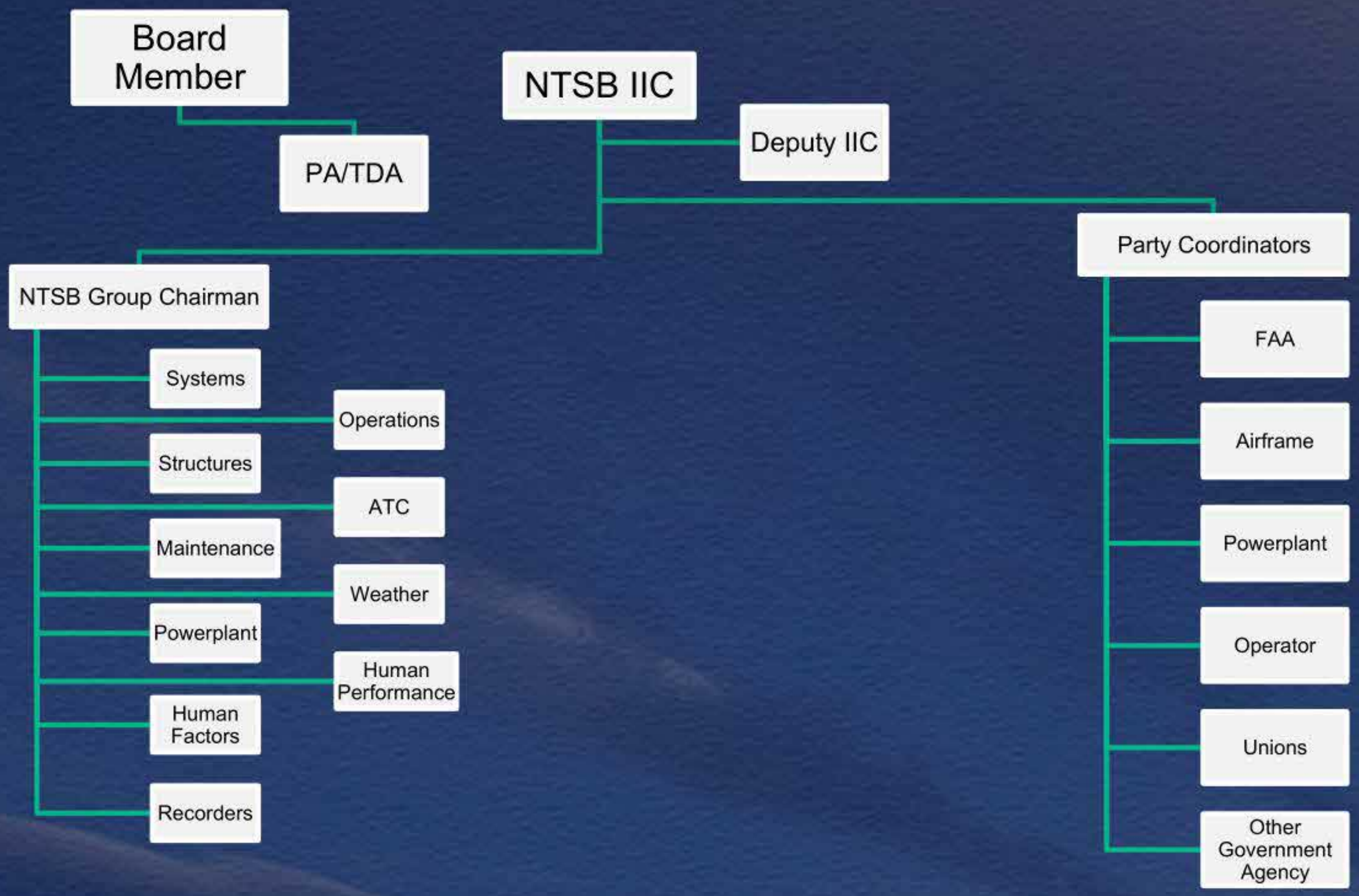
Coordination of Participants

Organizational Chart: Regional Investigation



Coordination of Participants

Organizational Chart: Major Investigation



Coordination of Participants

Board Member

- On scene spokespersonInteracts with the media, Family Affairs activities, and federal, state and local authorities No investigative role

Before Launch Checklist

Before Launch Checklist	
✓ Parties notified?Additional assistance requested?Site secured? On-scene hazards?Condition of airplane?	✓ Photos taken?Victims removed?Tox testing/autopsy planned?ETA to Site Commander?Directions to site?

The Launch Part I: Arrival On Scene

Managing the Chaos

- Accident locationType of aircraftNumber of fatalitiesSize of teamExamination logistics

On Scene Checklist

- ✓ On-Scene DocumentationEnvironment and Perishable InfoWreckage PathFour CornersFlight Control/Engine ContinuityEvidence of Engine PowerRecorders; GPS/NVM; VideoWitness InterviewsSite Contacts

Protecting Personnel

Site Safety

Is this safe?

Site Hazards - Rules for Investigators

You will have more of this in a separate module…..this is only a summary….

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Site Hazards – Rules for Investigators

- SAFETY FIRST! - Responsibility for TeamLimit AccessAppropriate Equipment & TrainingDetermine HazardsBiological HazardsMechanical HazardsHealth HazardsEnvironmental Hazards

Site Hazards – Rules for Investigators

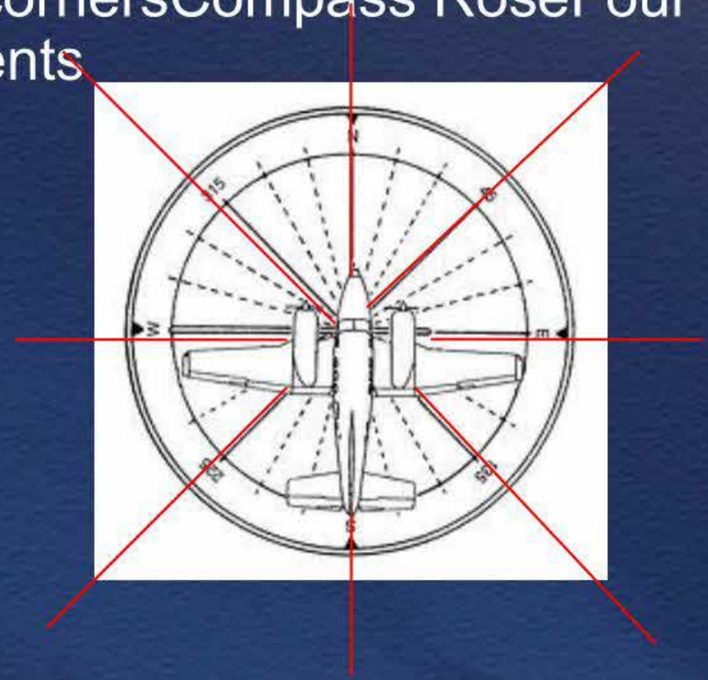
- ✓ Biological (know how to dispose of biohazard; assure team is trained and equipped)Mechanical (know how to contact BRS; know which aircraft have airbags/parachutes/seats) Environmental (know what kind of shoes/layers to bring)Health (bring appropriate PPE)

Additional Site Considerations

- Angry landownersEndangered speciesAngry AnimalsPoisonous PlantsPublic spectacleHigh crime areasElectrical WiresSewage….and other unfavorable accident site locations

Initial Walk-Through: Procedure

Initial Walk-Through
Procedure
• Aerial photographsAircraft four cornersCompass RoseFour cardinal points15 Degree segments



Initial Walk-Through: Procedure

Aerial Photos

Initial Walk-Through: Procedure

Aerial Photos

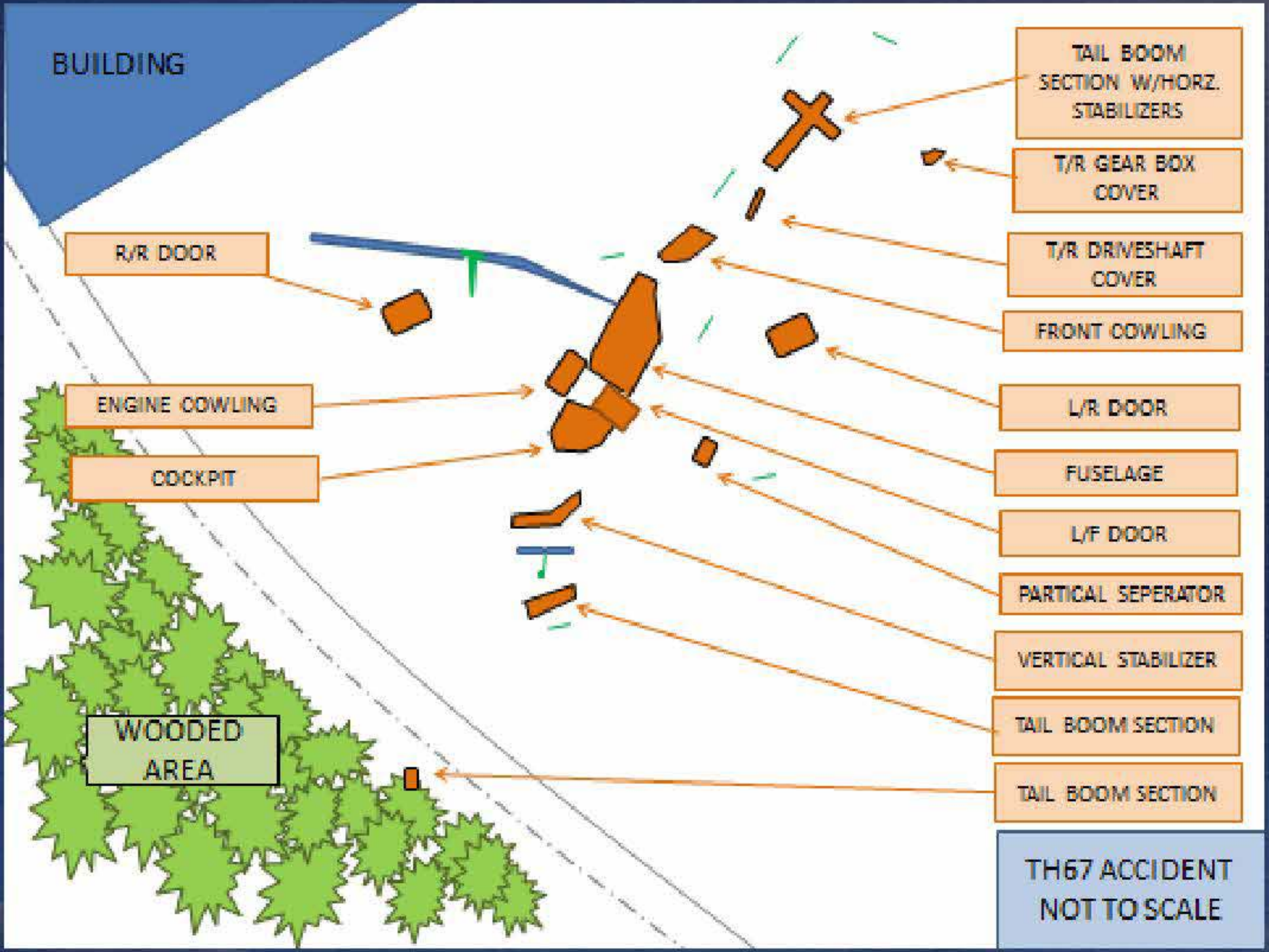
Initial Walk-Through: Procedure

Aerial Photos

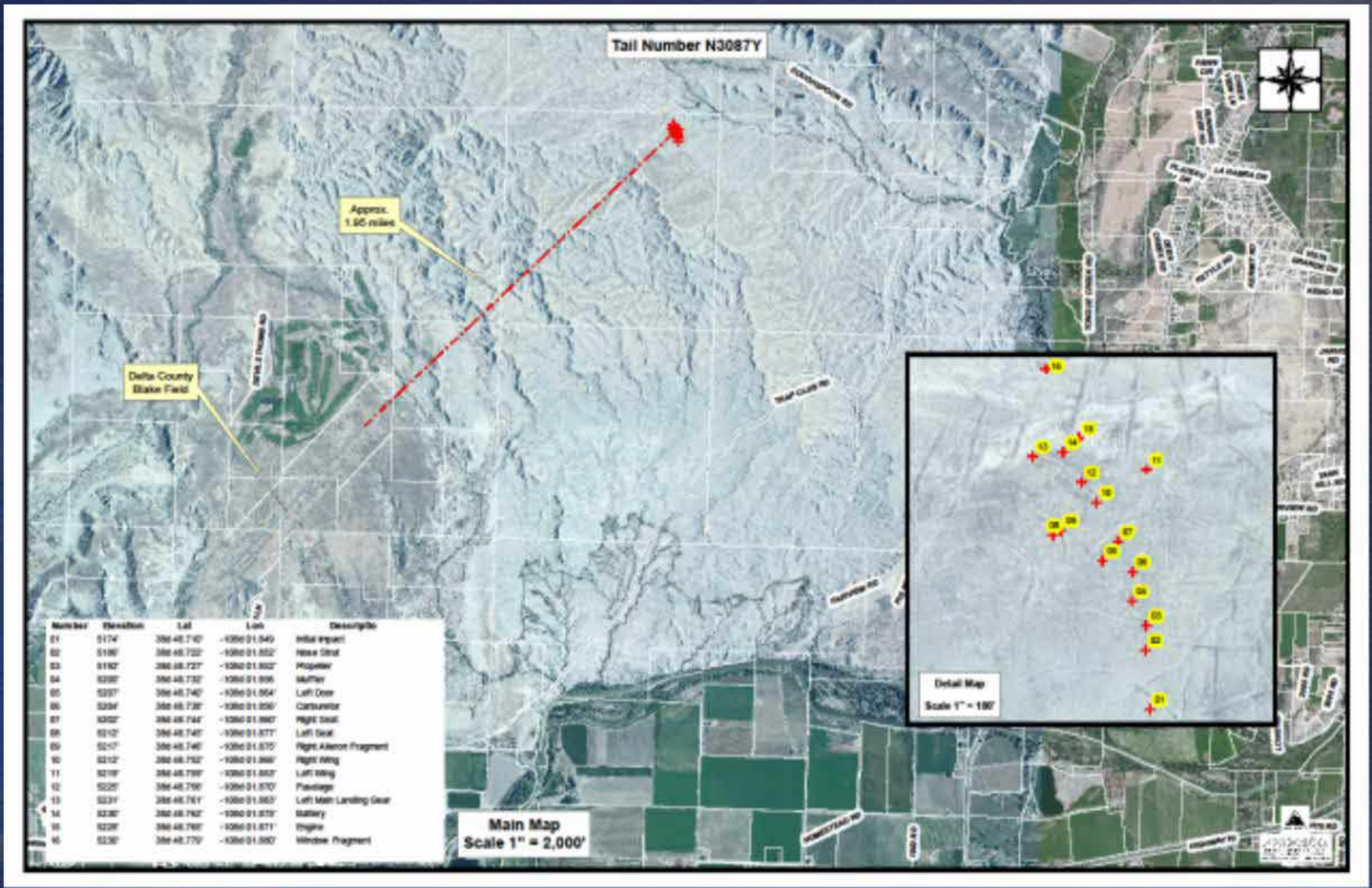
Wreckage Documentation

Wreckage Diagramming	
GridStraight-lineMost Common	PolarCompact accident sites“Smoking hole” accident sites

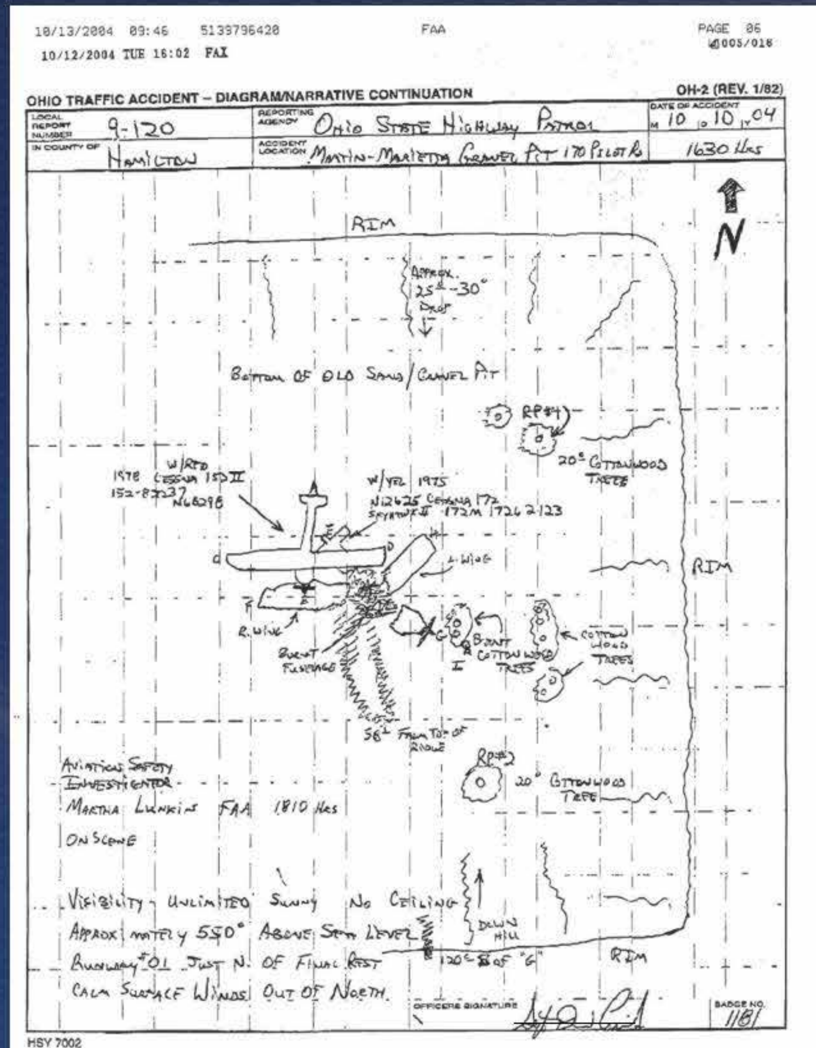
Wreckage Diagramming



Wreckage Diagramming



Wreckage Diagramming


10/13/2004 09:46 5133796420 FAA PAGE 06
005/018
10/12/2004 TUE 16:02 FAX

OHIO TRAFFIC ACCIDENT – DIAGRAM/NARRATIVE CONTINUATION OH-2 (REV. 1/82)

LOCAL REPORT NUMBER 9-120	REPORTING AGENCY Ohio State Highway Patrol		DATE OF ACCIDENT M 10 D 10 Y 04
IN COUNTY OF Hamilton	ACCIDENT LOCATION Martin-Marietta Gravel Pit 170 Pilot Rd		1630 Hrs

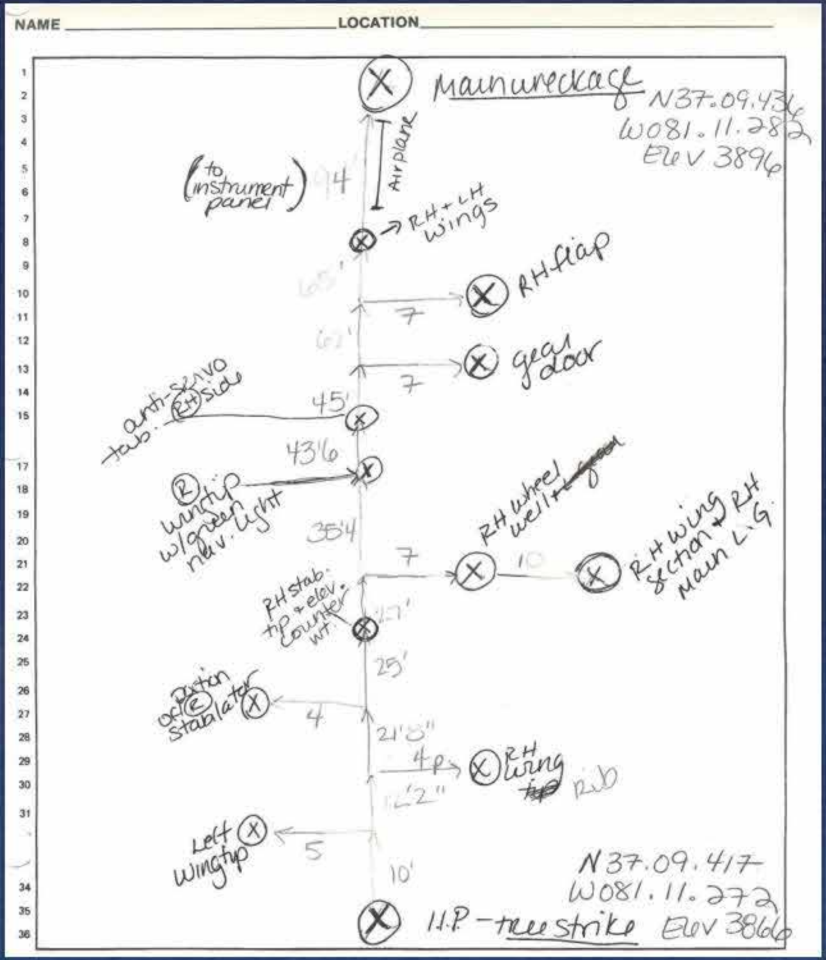
Aviation Safety Investigator
Martha Lunkin FAA 1810 Hrs
On Scene

Visibility - Unlimited Sunny No Ceiling
Approximately 550' Above Sea Level
Runway #01 Just N. of Final Rest
Calm Surface Winds Out of North.

OFFICERS SIGNATURE BADGE NO. 1181

HSY 7002

Wreckage Diagramming



Wreckage Documentation/Photos

Wreckage Examination/Photos

Surrounding TerrainTree Strikes/DefoliageApproach Paths: Magnetic BearingGround ScarsWreckage Path: Pieces of debrisCheck Surveillance equipment

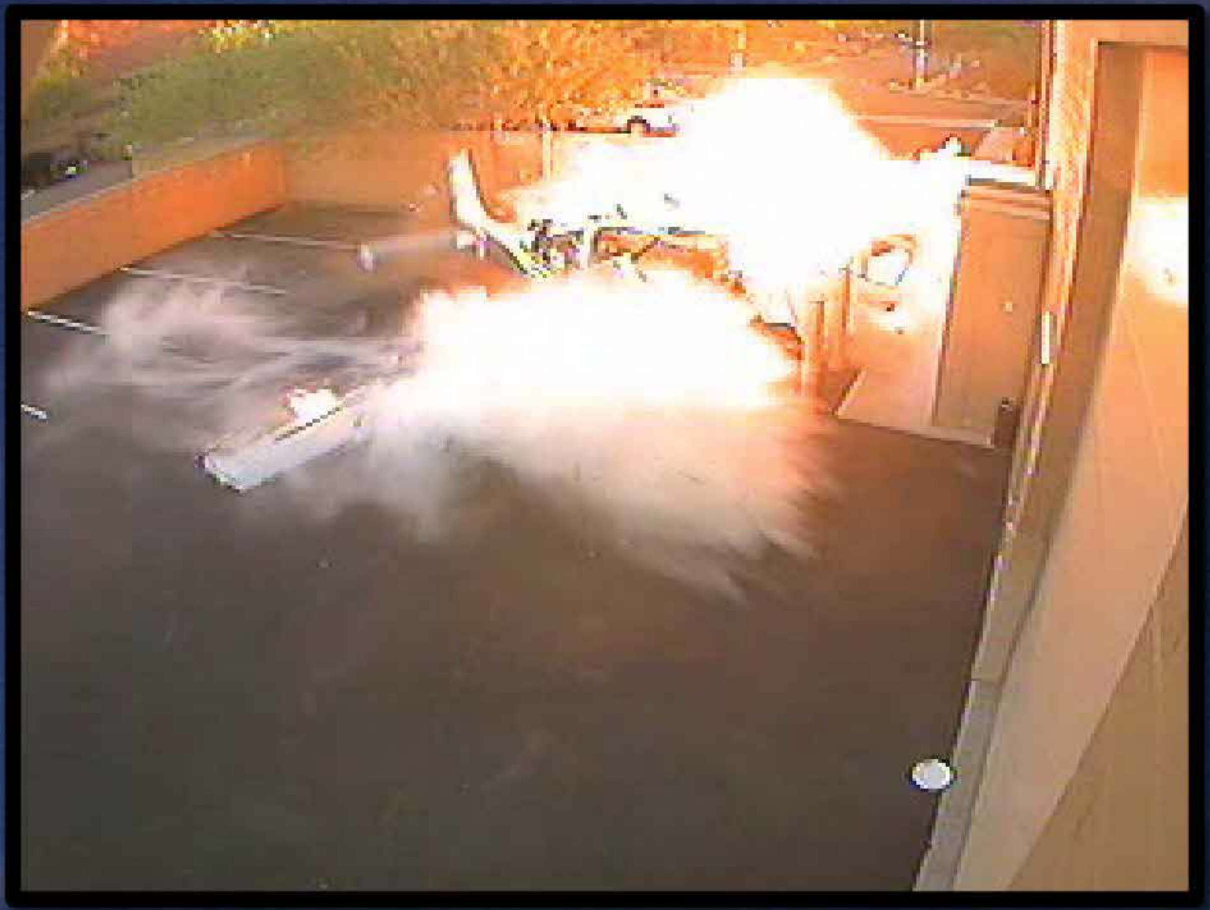
Wreckage Documentation/Photos

Wreckage Documentation/Photos

Wreckage Documentation/Photos

Wreckage Documentation/Photos

Wreckage Documentation/Photos



Wreckage Documentation/Photos

Wreckage Documentation/Photos

Checklists

Checklists

Personal and Safety Specific Items

- Proper clothing should be the first consideration. Selection of good serviceable clothing capable of withstanding rough usage is recommended. Selection should be appropriate to climate and environment. Multiple layers may be the best choice for colder climatic conditions where exertion is anticipated. (Turtleneck Sweater, Fleece Pullover, Long underwear, Lederhosen, Snow Pants, Winter Gloves, Wool or fleece Socks)
- Footwear appropriate to the accident site terrain/conditions (steel-toed shoes, hiking boots, rubber over-boots, or waterproof boots, as necessary for conditions).
- Coveralls and/or hooded sweatshirt and coat or jacket.
- Rain gear.
- Headgear (hardhat, stocking cap, and/or NTSB baseball hat).
- Back pack for tools and equipment. Should have sturdy frame and be ergonomic. (Fannie Pack for small tools)
- Canteen and/or thermos. Take enough water and/or sports drinks for expected climate conditions and length of investigative activities (in hot arid climates, need 1-gallon of fluid per person per day minimum).

Documentation

Surrounding Terrain

Tree Strikes/Defoliage

Documentation

Surrounding Terrain

Tree Strikes/Defoliage

Documentation

Surrounding Terrain

Evidence of Power

Documentation

Surrounding Terrain

Ground Scars

Documentation

Surrounding Terrain

Ground Scars

Documentation

Surrounding Terrain

Paint Transfer

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Documentation

Surrounding Terrain

Glass

Documentation

Perishable Evidence
• Recorders/RecordingsGround scarsAircraft fluid (fuel, oil, hydraulic fluid)LogbooksMedication (live and deceased pilots)Icing/weather conditionsAircraft contents (weight and balance)

Documentation

Perishable Evidence

Documentation

Perishable Evidence

Documentation

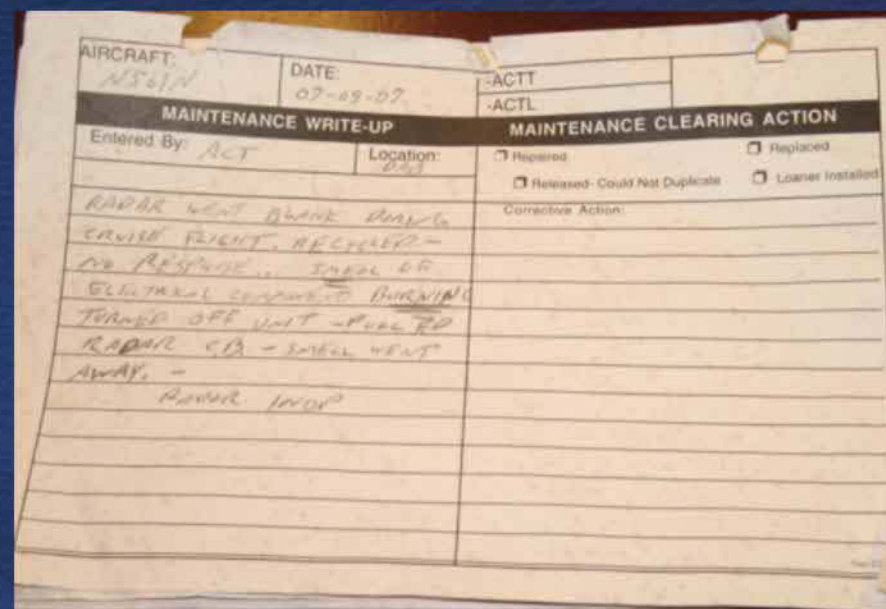
Perishable Evidence

Documentation

Perishable Evidence

Documentation

Perishable Evidence



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The Launch Part II: The Investigation (cont'd)

Accident Site Photography

Taking Good Photos

Wreckage Examination/Photos

- Be SystematicEstablish a flowFraming the SubjectCapture orientation of subject with respect to wreckage/terrainOrganizationPerishable EvidenceOrientationPhotos To Scale

Taking Good Photos

Organization of Photos

LYCOMING

Air Safety Investigation

d/b/a Lycoming Engines, a division of Avco Corporation

ACCIDENT INVESTIGATION REPORT

PHOTO LOG

DATE OF MISHAP:	---------------	AIRCRAFT MODEL:	Cessna T182T
REGISTRATION:	----------	ENGINE MODEL:	---------------
LOCATION:	----------- -- --	SERIAL NUMBER:	-------------

GENERAL EXAMINATION PHOTOGRAPHS

1-6	Engine as received
7-13	Engine as first viewed
14-19	Engine mounted to disassembly ring
20	Crankshaft gear and idler gears
21-22	Engine data tag
23-24	Oil filter element
25-27	Accessory housing
28-31	Oil pump gears and body
32-33	Oil pump body and oil pump drive
34	Spark plugs
35-47	Cylinders, pistons, pins and plugs
48-54	Connecting rods and bearings
55-56	Camshaft
57	Valve action and valves
58-61	Main bearings
62-66	Left crankcase
67-70	Right crankcase
71-72	Crankshaft
73-74	Oil sump
75	Fuel injector nozzles
76	Flow divider and fuel lines
77-78	Flow divider
79-85	Fuel injector servo and inlet housing attached
86-87	Magnetos
88	Starter
89	Fuel pump and fuel flow transducer
90-91	Scavenge pump, fuel pump, vacuum pump drive adapters
92-95	Turbo charger
96	Exhaust system and slope controller
97-98	Tail pipe, bypass valve and clamps
99	Slope controller
100	Intake pipes
101	Miscellaneous molten metal material

Taking Good Photos

Photo Orientation

Taking Good Photos

Photo Orientation

Taking Good Photos

Photo Orientation

Taking Good Photos

Scale Photos

The Launch Part II: The Investigation (cont'd)

Wreckage ExaminationCheat Sheet!

Wreckage Examination

Wreckage Examination/Photos

Wings

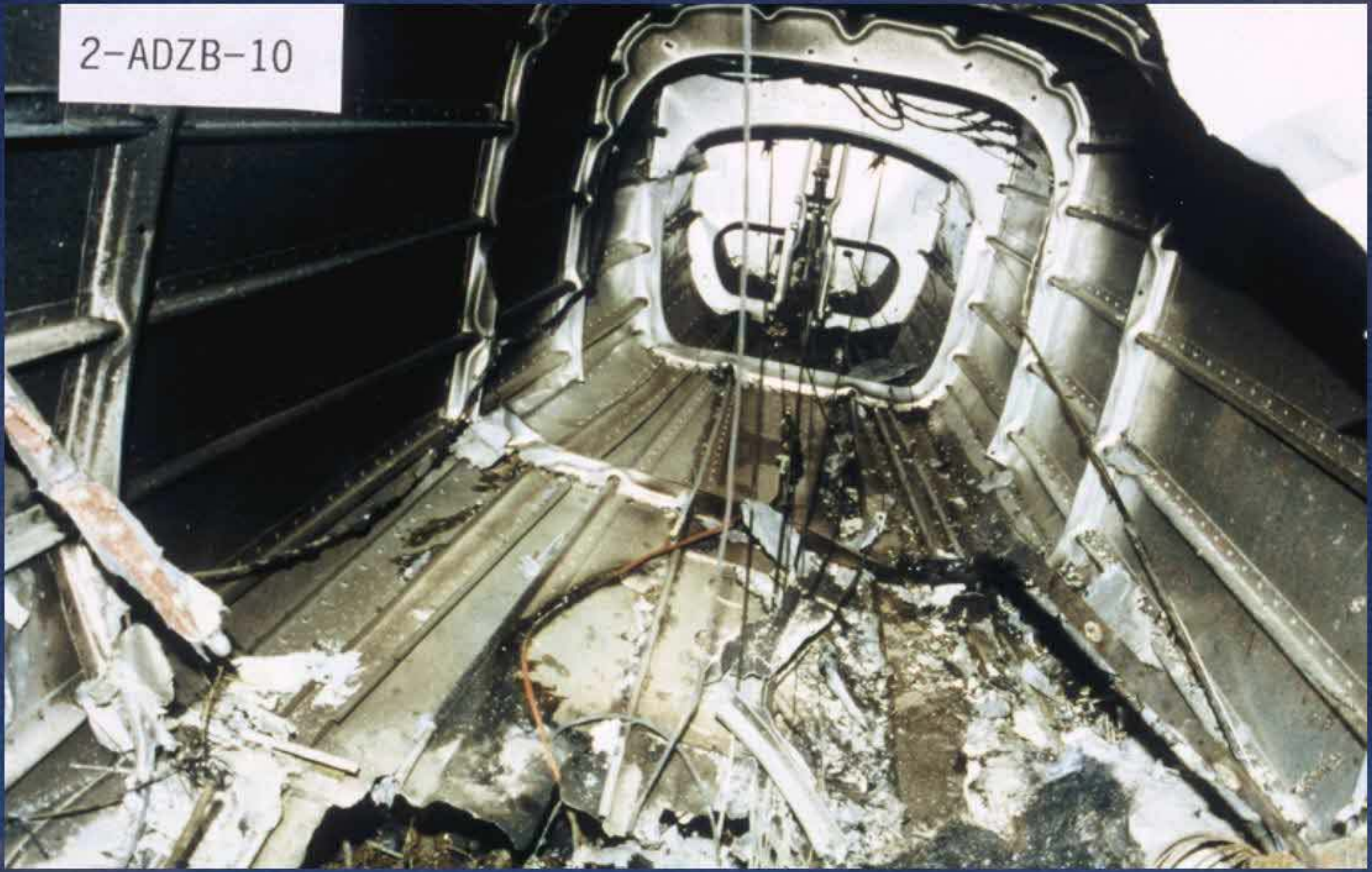
Wreckage Examination

Flight Controls

- Trace flight controls from cockpit to flight control surfacesDescribe breaks“Flight Control Continuity”Trim Tab ActuatorsFlap Drive Mechanism

Wreckage Examination

Flight Controls



Wreckage Examination

Flight Controls

The Launch Part III: The On-Scene Wrap Up

The On-Scene Wrap-Up

Investigative Duties (on-scene)

Document Wreckage and SiteGather/Retain EvidenceDisseminate Information to Party MembersField NotesOrganize Wreckage RecoveryMake additional requests for information (if unable on-scene can request from office):FAA statementATC radarweather reportlaw enforcementcoroner

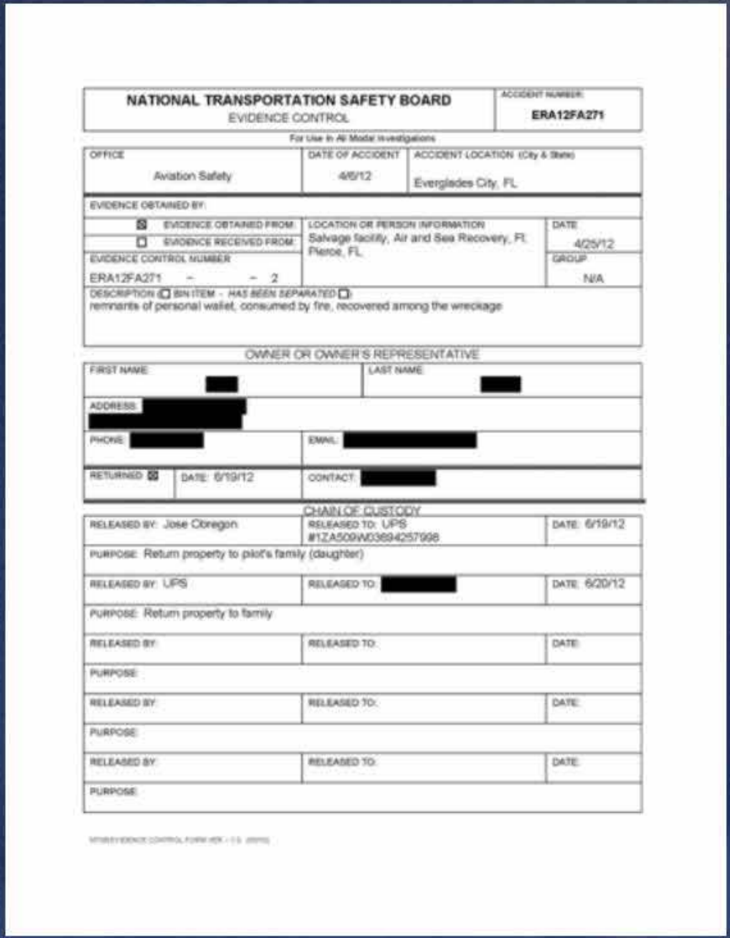
The On-Scene Wrap-Up

Evidence Retention	
• What to retain:CVR/FDRAvionicsInstrumentsFuel samplesLogbooks (mx & pilot)MedicationCamerasCell phones	• What not to retain: Personal effects (**however, we may retain to make sure they get returned to the family**)

The On-Scene Wrap-Up

Evidence Retention

- How to document:Photos, photos, photos!Document item, condition, part number/serial numberEvidence formL.E. procedures (tape bag, initial, etc.)Evidence return (close the loop!)



NATIONAL TRANSPORTATION SAFETY BOARD EVIDENCE CONTROL	ACCIDENT NUMBER: ERA12FA271

For Use in All Modal Investigations

OFFICE	DATE OF ACCIDENT	ACCIDENT LOCATION (City & State)
Aviation Safety	4/6/12	Everglades City, FL

EVIDENCE OBTAINED BY:

	LOCATION OR PERSON INFORMATION	DATE
☒ EVIDENCE OBTAINED FROM: ☐ EVIDENCE RECEIVED FROM:	Salvage facility, Air and Sea Recovery, Ft. Pierce, FL	4/25/12
EVIDENCE CONTROL NUMBER ERA12FA271 – – 2		GROUP N/A

DESCRIPTION (☐ BIN ITEM - HAS BEEN SEPARATED ☐)
remnants of personal wallet, consumed by fire, recovered among the wreckage

OWNER OR OWNER'S REPRESENTATIVE

FIRST NAME: [redacted]	LAST NAME: [redacted]
ADDRESS: [redacted]	
PHONE: [redacted]	EMAIL: [redacted]
RETURNED ☒ DATE: 6/19/12	CONTACT: [redacted]

CHAIN OF CUSTODY

RELEASED BY	RELEASED TO	DATE
RELEASED BY: Jose Obregon	RELEASED TO: UPS #1ZA509W03694257998	DATE: 6/19/12
PURPOSE: Return property to pilot's family (daughter)		
RELEASED BY: UPS	RELEASED TO: [redacted]	DATE: 6/20/12
PURPOSE: Return property to family		
RELEASED BY:	RELEASED TO:	DATE:
PURPOSE:		
RELEASED BY:	RELEASED TO:	DATE:
PURPOSE:		
RELEASED BY:	RELEASED TO:	DATE:
PURPOSE:		

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The Launch Part IV: The Follow Up

The Follow-Up

Further Inquiry	
FirstOrganize Digital Photography into Folders & DirectoriesPursue New InformationRequest ATC InformationPolice & Autopsy ReportsToxicology	ThirdPropeller & Engine TeardownComponent Teardowns/ExamsAirport/NAV Aid InformationFueling HistorySurvival FactorsAccident/Incident History
SecondResearch LogbooksFAA Pilot & Aircraft DataHuman Factors IssuesMore Witness InterviewsSchedule Component ExamsRecorder Downloads (CVR, GPS, etc.)	FourthCoordinate HQ SupportToxicology/Autopsy Follow-Up & AnalysisBegin to Compose Draft ReportSafety RecommendationsManage the Workload

The Follow-Up

Organization of Photos (*a review slide…*)

Air Safety Investigation

ACCIDENT INVESTIGATION REPORT

PHOTO LOG

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REGISTRATION:	----------	ENGINE MODEL:	----------
LOCATION:	----------	SERIAL NUMBER:	----------

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96	Exhaust system and slope controller
97-98	Tail pipe, bypass valve and clamps
99	Slope controller
100	Intake pipes
101	Miscellaneous molten metal material

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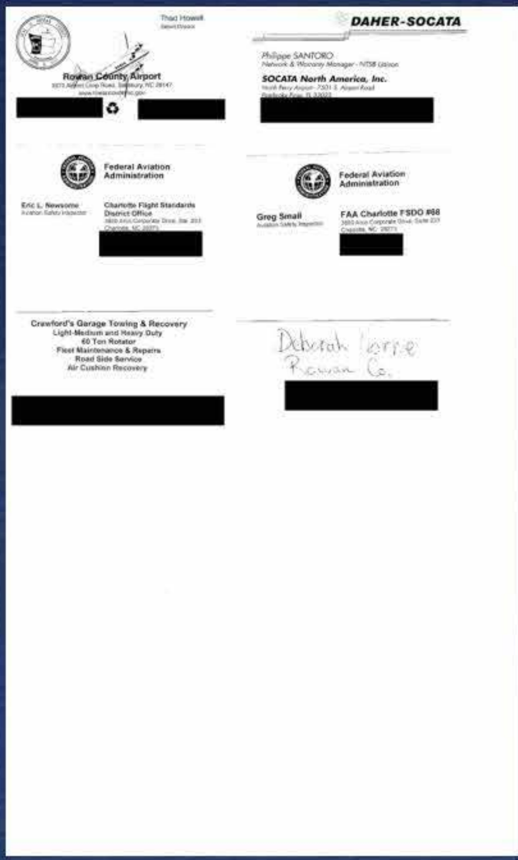
The Follow-Up

Contacts & Logbooks


Thad Howell

Rowan County Airport

[redacted] [redacted]

DAHER-SOCATA

Philippe SANTORO

Network & Warranty Manager - NTSB Liaison

SOCATA North America, Inc.

[redacted]

Federal Aviation Administration

Eric L. Newsome

Aviation Safety Inspector

Charlotte Flight Standards District Office

[redacted]

Federal Aviation Administration

Greg Small

Aviation Safety Inspector

FAA Charlotte FSDO #88

[redacted]

Crawford's Garage Towing & Recovery

Light-Medium and Heavy Duty

60 Ton Rotator

Fleet Maintenance & Repairs

Road Side Service

Air Cushion Recovery

[redacted]

Deborah [illegible]

Rowan Co.

[redacted]

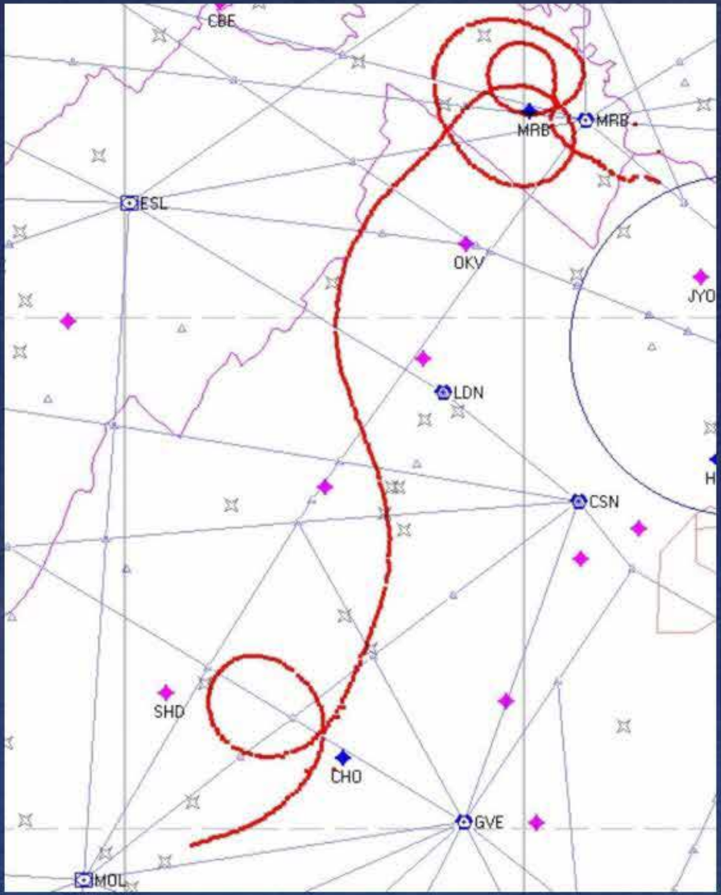
The Follow-Up

Pilot & Aircraft Information

- Obtain all available aircraft informationLogbooksEnginePropeller

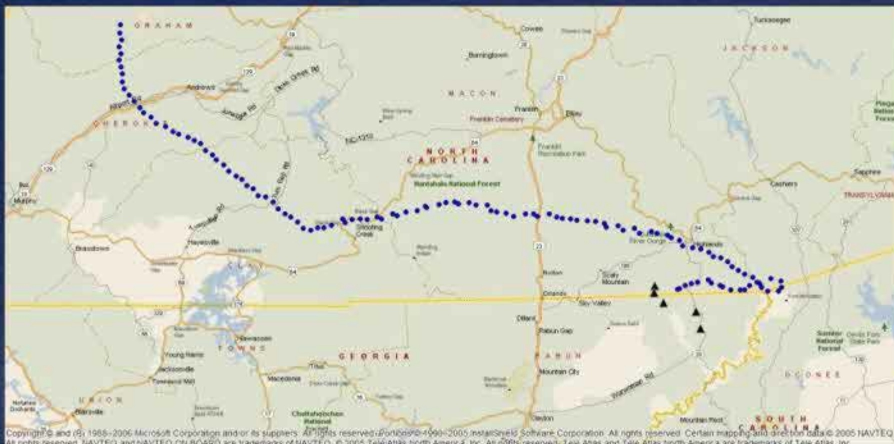
The Follow-Up

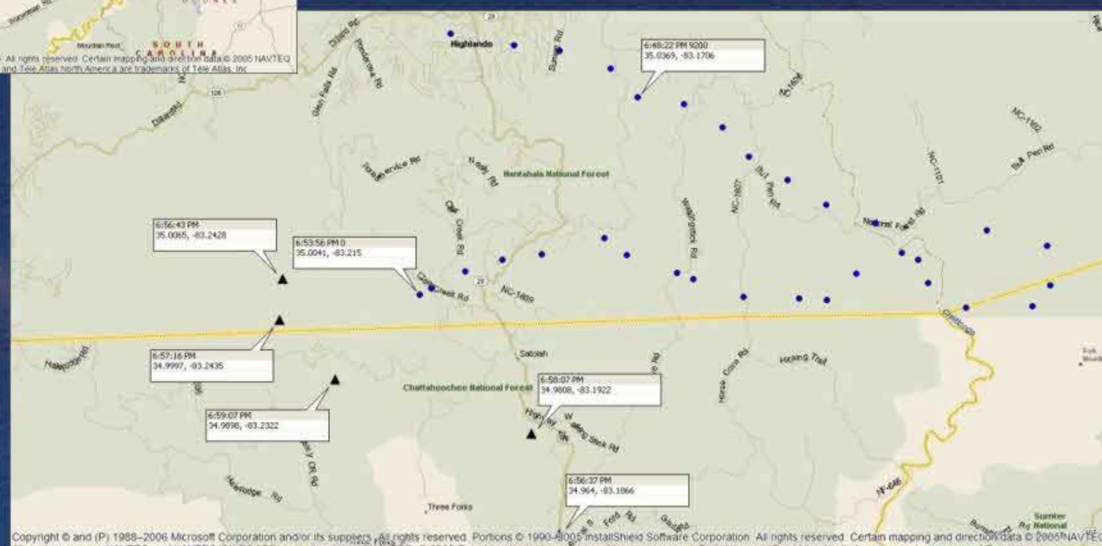
Radar Data Analysis



The Follow-Up

Radar Data Analysis





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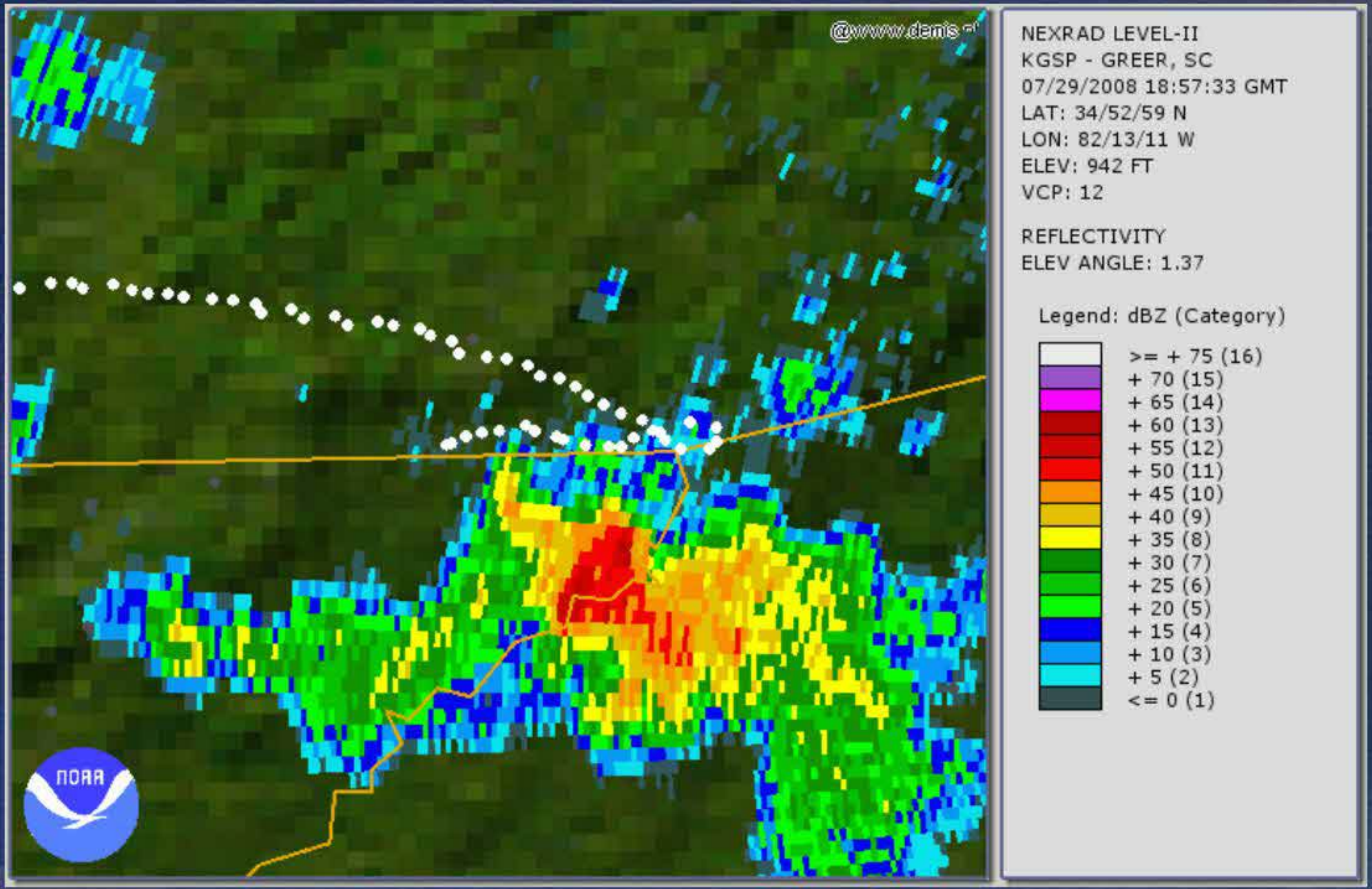
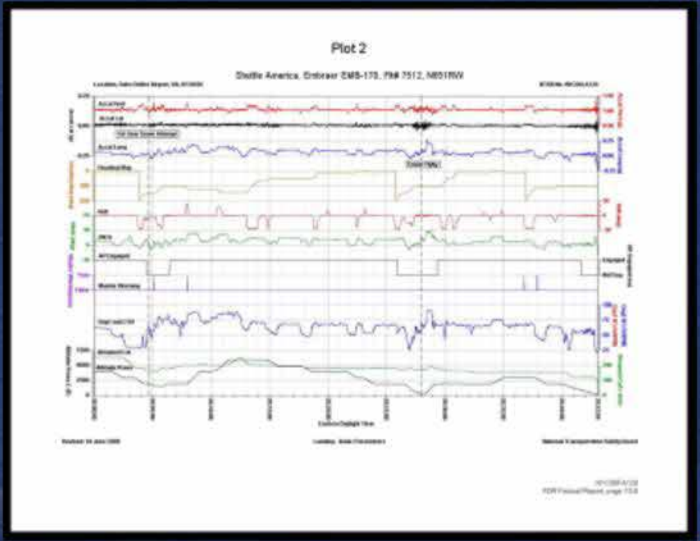
The Follow-Up

Weather Data Analysis



The Follow-Up

Records Lab



The Follow-Up

Other Recorder Downloads

NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, D.C. 20594

April 25, 2006

Video/Image Study Report

NTSB Accident Number:
NYC05FA117A/B

by Douglass P. Brazy

A. <u>ACCIDENT</u>

Location: Lewes, DE
Date: July 10, 2005
Time: 1052 Eastern Daylight Time
Aircraft: Rutan Long EZ, registration N78LC, Van's RV-8, Registration N899RM

B. <u>GROUP</u>

N/A

C. <u>SUMMARY</u>

On July 10, 2005, at 1052 eastern daylight time, a homebuilt Rutan Long EZ, N78LC, and a homebuilt Van's RV-8, N899RM, were substantially damaged during a midair collision and subsequent impact in the Delaware Bay near Lewes, Delaware. The certificated commercial pilot flying the Long EZ and the certificated private pilot flying the RV-8 were fatally injured. Visual meteorological conditions prevailed, and no flight plan was filed for either flight conducted under 14 CFR Part 91.

NYC05FA117A/B – Video Factual Report

Page 1 of 21

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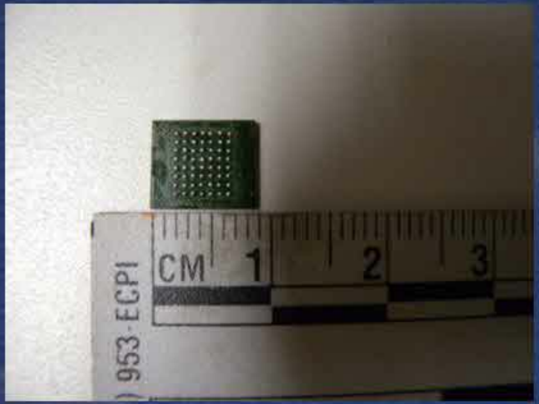
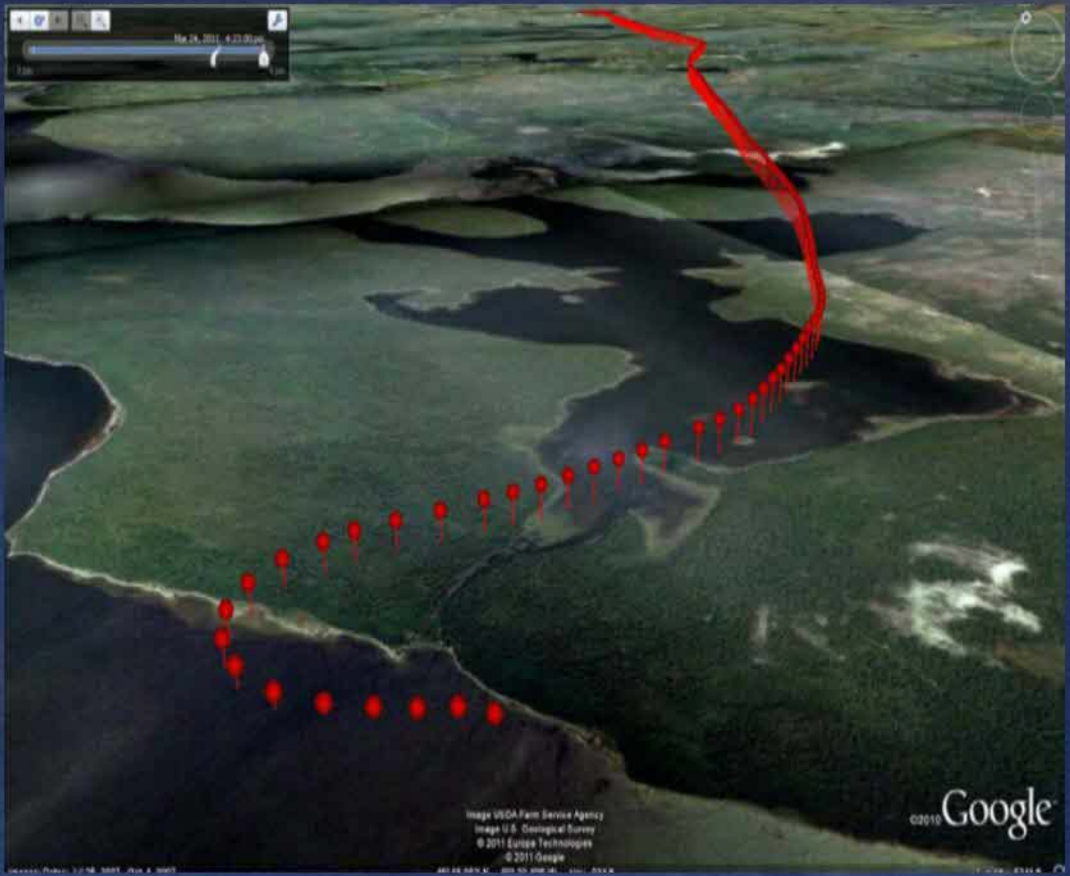
The Follow-Up

NVM: Portable GPS Receiver





The Follow-Up

PFD/MFD

Primary Flight Display

Multi Function Display

The Follow-Up

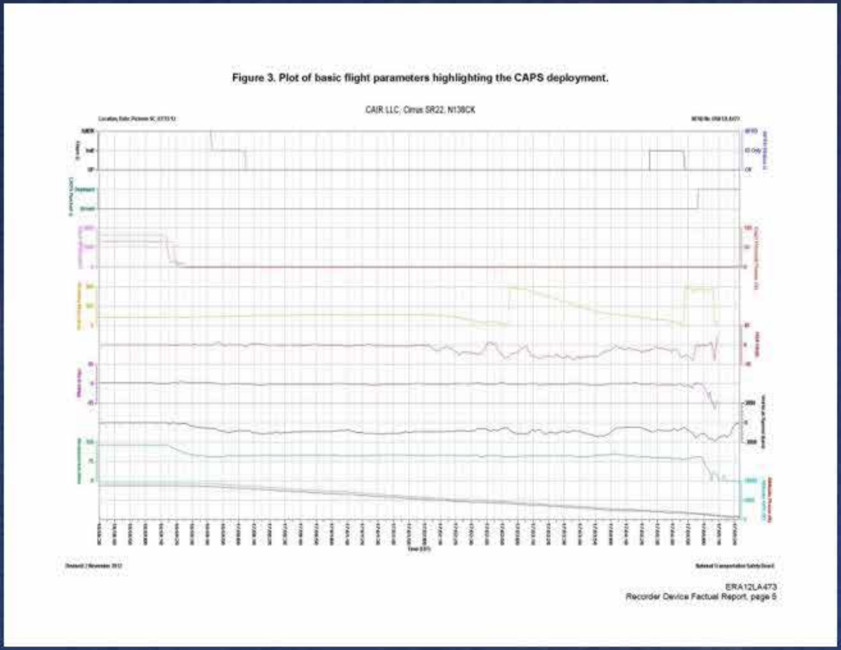
PFD/MFD

The Follow-Up

PFD/MFD

The Follow-Up

Other Recorder Downloads – RDM



The Follow-Up

Cell Phones

- Recent calls/textsCameraSearch and Rescue

The Follow-Up

Toxicology

- Beware of positive results for alcohol (decomposition)Compare with other info sourcesPositive results may warrant further investigation.Pilot medical records should be obtained from the FAAThe pilot's personal medical records may need to obtained via the family or by subpoena.

The Follow-Up

Autopsy

- Detailed overview of the injuriesUnderlying health issuesSurvival factorsPilot at controls

The Follow-Up

Human Factors

- 72-hour historyMedical r

(fatigue)

The Follow-Up

Material's Lab Examination

The Follow-Up

Material's Lab Report

NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

January 26, 2009

MATERIALS LABORATORY FACTUAL REPORT

A. ACCIDENT

Place : Reno, Nevada
Date : September 1, 2008
Vehicle : Lockheed P2V-7S (SP-2H), N4235T
NTSB No. : SEA08GA194
Investigator : Thomas Little (ASI-NWRA)

B. COMPONENTS EXAMINED

11th stage compressor disc, P/N 60E575- turbojet engine, S/N 211235, mounted in the #1 pos

C. DETAILS OF THE EXAMINATION

The forward and aft faces of the as-recei displayed in figure 1. The disc was fractured into contained about half of the rim and one third of th web and the entire bore were contained in the larg compressor rotor extension shaft attached. The 60E575-2, made from type 302, corrosion resistant

FAA databases identify N4235T as a Lockh 150282 manufactured in 1962. Neptune Aviation S holder, operating the aircraft in the restricted categ the aircraft were originally manufactured by Westinghouse Electric Corp. The current type certificate (E-265) is held by Steward-Davis Incorporated. The subject compressor disc came from the #1 (left) engine, S/N 211235 and had reportedly accumulated 950.1 hours total time since new (TTSN) and 619.1 hours since (Navy) overhaul (TSOH) including 491.4 hours in service with Neptune Aviation.

Initial optical examinations of the fractures revealed extensive post separation damage to the majority of the fracture surface on the smaller pieces. The fracture on the larger piece was relatively undamaged and clear fracture features were visible on the

[1] Bureau of Naval Weapons, NAVWEPS 02B-110BC-3, Table VIII, dated 15 July 1962, material specification PDS 6599-2.

The Follow-Up

Follow-Up Examination

Salvage Yard

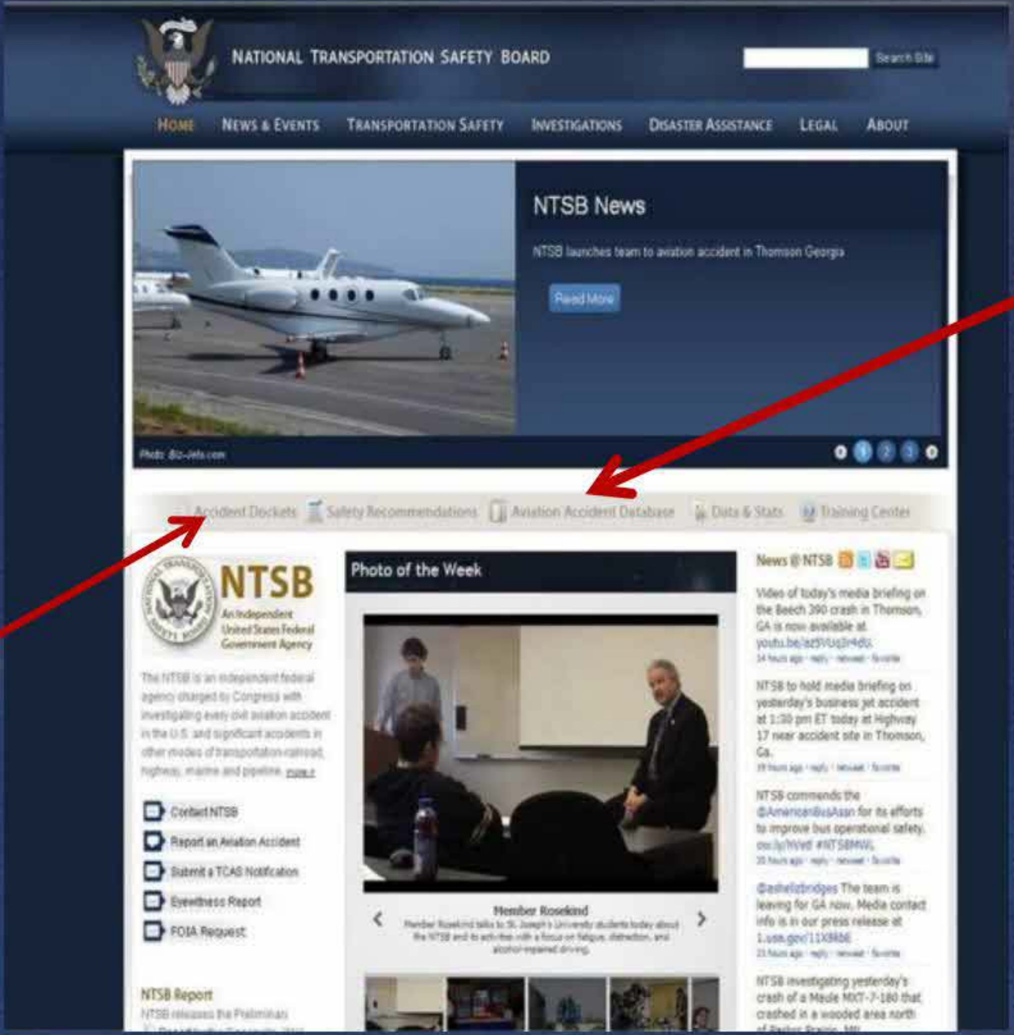
NTSB Assets Available

- Materials LabRecorders LabInvestigator ManpowerInvestigator (Specialist) Expertise (objective viewpoint):MeteorologistsAir Traffic Control SpecialistsStructures (Engineering Manufacturer Investigators

NTSB Contact Information

NTSB's 24-hour Response Operations Center: 844-373-9922www.ntsb.gov

Resources



Reports

Public Dockets

NTSB TRAINING CENTER

Resources

- NTSB Training Center CoursesNTSB websiteASI resources: http://www.asiresource.com/FAA: https://www.faa.gov/ISASI: http://www.isasi.org/

Summary

✓Pack go-bag early, and oftenFirst hours/days of investigation = Communication is criticalEmergency plansManage chaos = know resourcesSite hazardsPerishable evidence

Summary

- ✓ Accident Site PhotographyScaleOrganizationRetain evidence recording devicesDon't forget surrounding terrain evidence!Beware of confirmation bias!

Are all Accidents Preventable? (Or could a good pilot just have a bad day?)

Thank You For Your Time

NTSB TRAINING CENTER

NATIONAL TRANSPORTATION SAFETY BOARD

E PLURIBUS UNUM

NTSB *TRAINING CENTER*


NATIONAL TRANSPORTATION
E PLURIBUS UNUM
SAFETY BOARD

Major Investigations

Tim LeBaron
IIC / US Accredited Representative

The Office of Aviation Safety

Responsible for the Safety Board's aviation accident investigations

Regional Offices

- Investigate general aviation accidents and small incidents involving air carriersSupport major investigations≈ 45 general aviation/field investigators

Major Investigations

- Investigate accidents and incidents involving FAA Part 121 air carriersCommercial Space≈ 50 HQ investigators and 5 IICs

Desk Investigations

- Turbulence events resulting in serious injuries Substantial damage that doesn't require travel

A Partial Go-Team

Dispatched to non-fatal accidents or incidents that involve safety issues or circumstances that warrant investigation such as: Newly certificated aircraft Air traffic control issues

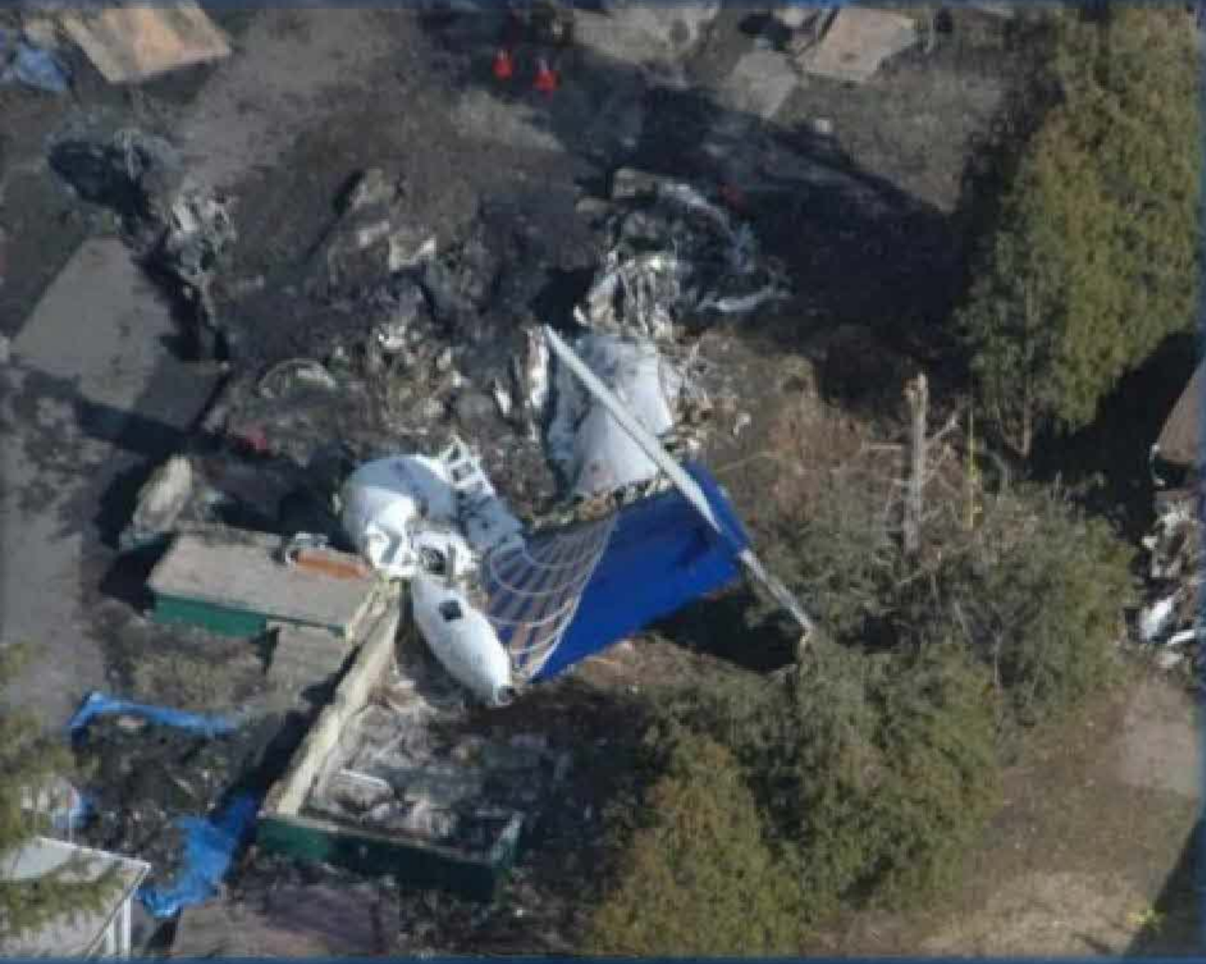
- High accident potential
- Significant public interest

An International Go -Team

Dispatched with an NTSB Accredited Representative and Advisors to major accidents that are investigated by foreign states per (ICAO ANNEX 13). The basis for participation is: US operator US designed / manufactured / certificated aircraft

- US registered aircraft US citizens fatally injured Significant public interest

A Full Go-Team



Dispatched to major accidents – those involving a major carrier or commuter airliner having substantial damage, multiple injuries or deaths.

A Full Go-Team

- Led by Investigator-In-Charge (IIC)Includes Group Chairmen, Board Member, Member's assistant, public affairs and transportation disaster specialistsPrepared to launch within 2 hours of notification

The Launch

- Immediate and substantial communications with the FAA and representatives of the organizations involved, including non-U.S. authoritiesFAA airplane may be used to transport team to accident site

The Launch

- Communications Center arranges logistical support for the team's arrival on the scene

The Launch

- Regional offices move quickly to secure the accident site, gain control of the wreckage, coordinate with local fire and rescue authorities, retrieve flight recorders and establish liaison with media

Arrival On-scene

- Survey accident siteEstablish command post (serves as point of contact)Arrange communications Confirm security arrangementsConfirm biohazard precautions with local authorities

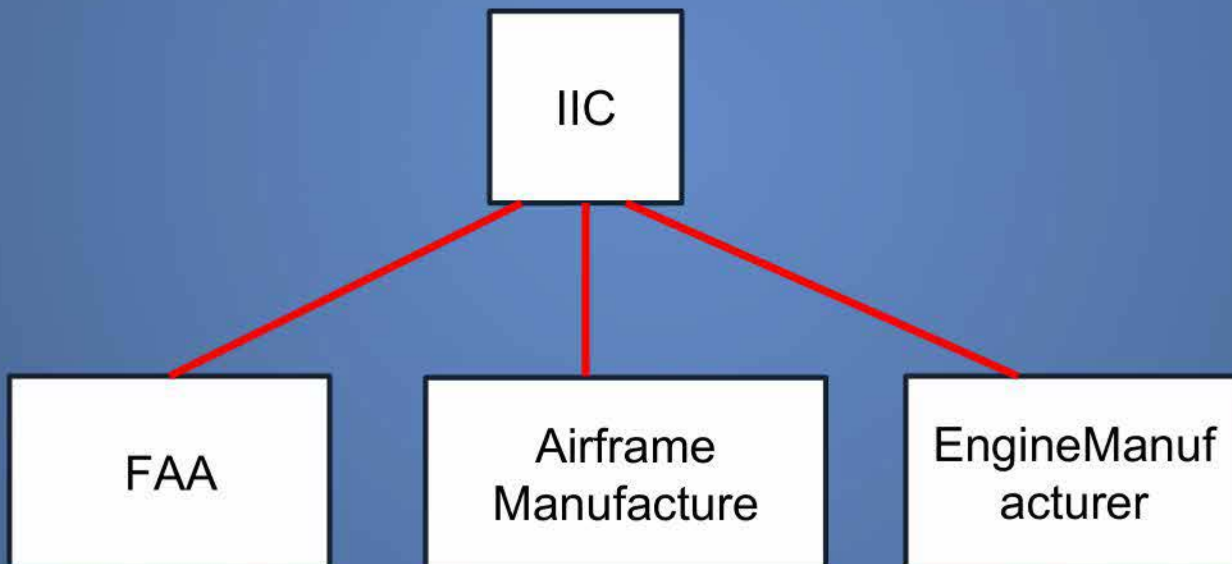
Organizational Meeting

Managed by the IIC, the organizational meeting is designed to: Establish order Identify NTSB participants Designate parties and party coordinators

Organizational Meeting

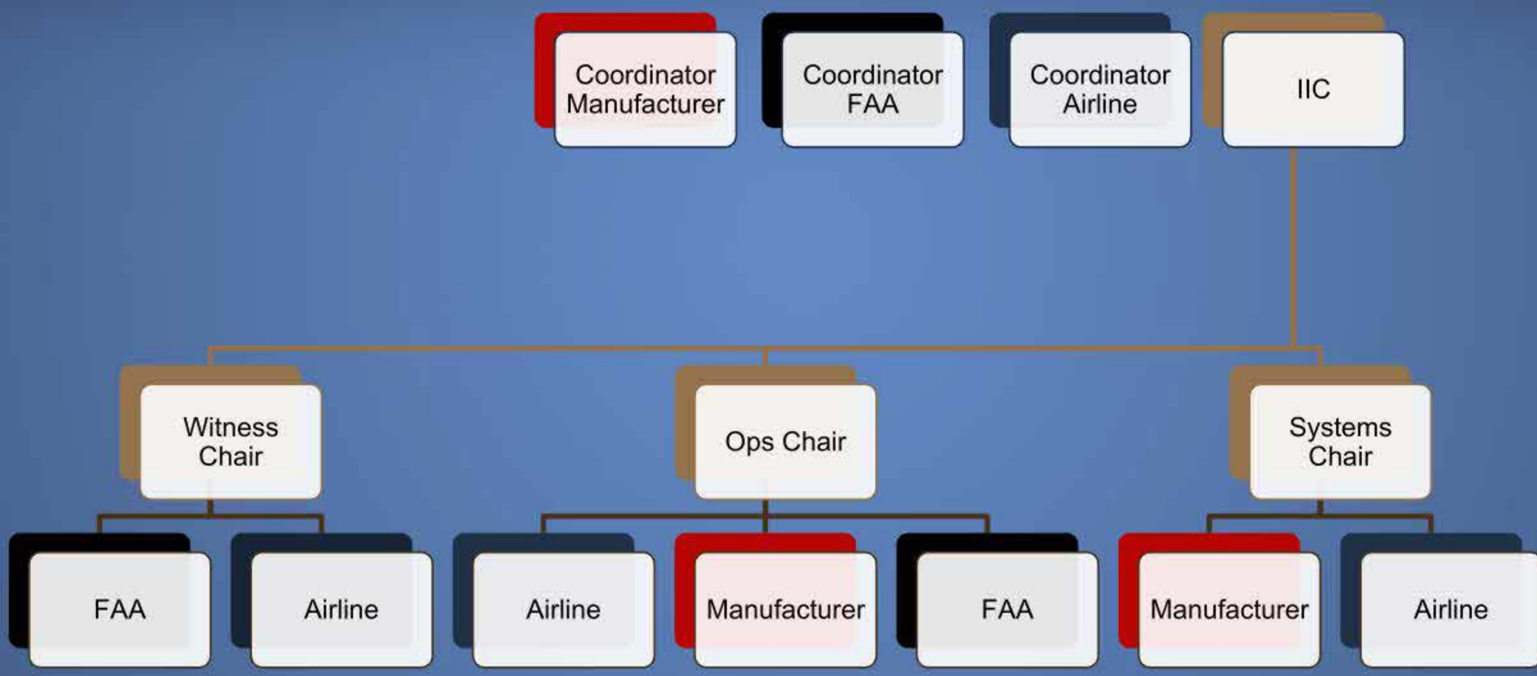
- Approve official observersReview rules of conduct of the investigationReview on-site safety precautionsIdentify accredited representatives and advisorsEstablish and organize groups

On Scene Organization Chart



NTSB

On Scene Organization Chart



NTSB

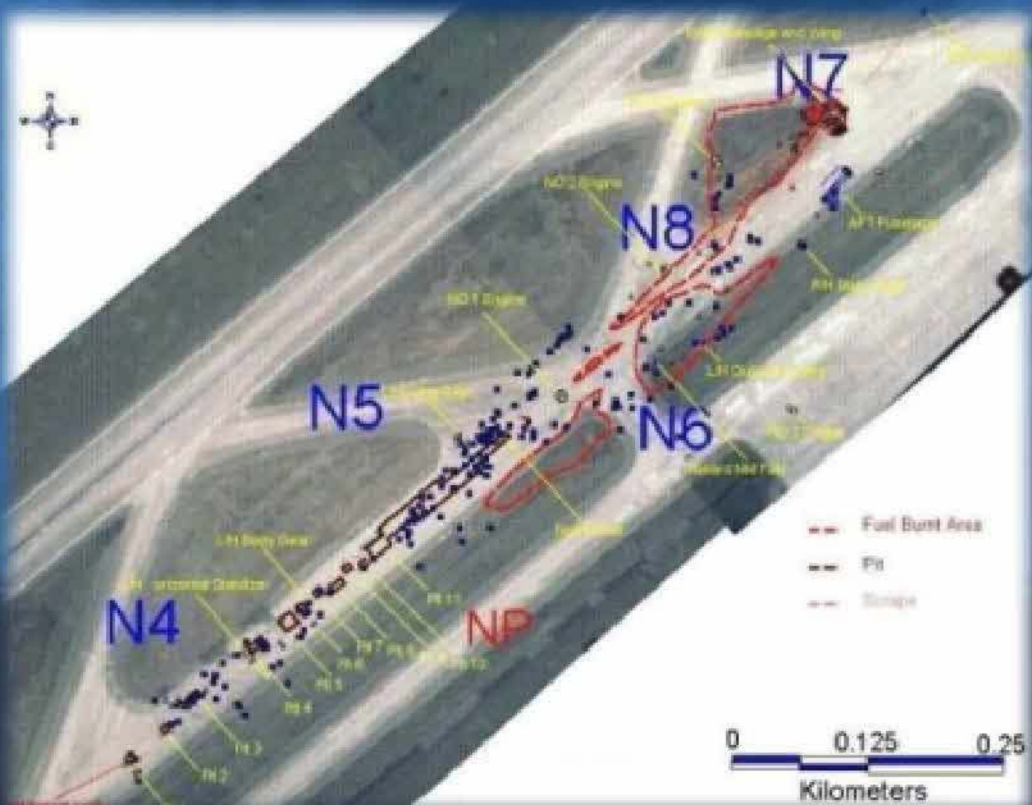
Composition of Investigative Team

The on-scene investigative team typically consists of groups in the following disciplines:

- **Structures**

Composition of Investigative Team

- **Structures**

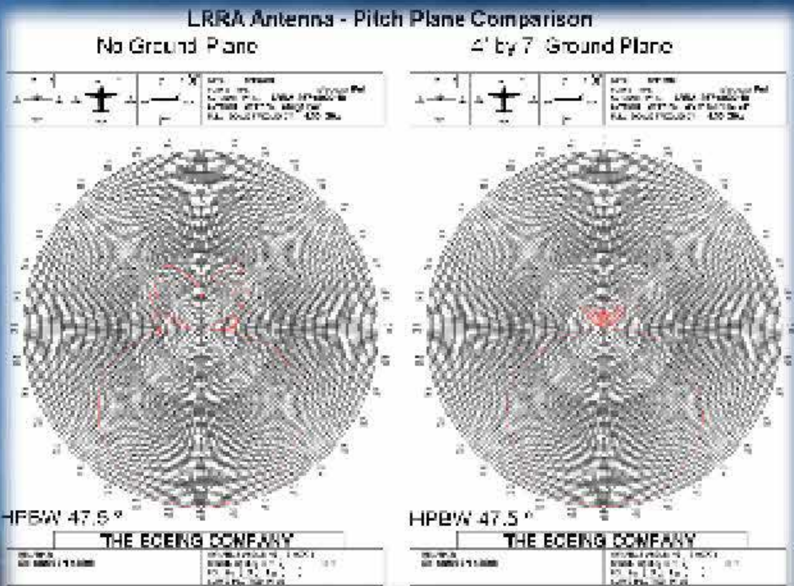


Composition of Investigative Team

- Systems

Composition of Investigative Team

- Systems



Composition of Investigative Team

- **Powerplants**

Composition of Investigative Team

- **Powerplants**

Composition of Investigative Team

◆ Maintenance Records

MAINTENANCE & ENGINEERING

Major Repair Tracking

Major Repairs
- Add a Repair
- Review Repairs

EA Log
- Get a New EA ID
- Review Log

Reports
- DTE Report

FCBS Lists
- B737
- B757
- B767
- B777
- MD80

FCAS Lists
- B737
- B757

Review Major Repairs

MRT #	AC	Date	Description	Location	Damage Type	Repair Type	Status	DTE
025843	5CS	4/16/10	Doubler External	L/H fuselage St...	ImpactAccident	New	Active	OPEN
025207	5CS	3/12/10	Other	LW and RW upper...	Corrosion	New	Active	CLOSED
025144	5CS	3/9/10	Splice Repair	STA 700 at LBL ...	Crack	New	Active	CLOSED
025142	5CS	5/27/93	Other	"Void" invalid...	Unknown	Existing	Removed	NOTREQUIRED
014760	5CS	8/20/08	Splice Repair	str 24L sta 166...	Corrosion	New	Active	OPEN
014671	5CS	8/14/08	Part Replacement	cabin A zone #2...	Corrosion	New	Active	NOTREQUIRED
014670	5CS	8/14/08	Part Replacement	A zone #1 seat ...	Corrosion	New	Active	NOTREQUIRED
014668	5CS	8/14/08	Doubler External	station 1720 LB...	Corrosion	New	Active	NOTREQUIRED
014648	5CS	8/13/08	Doubler External	station 1720 RB...	Corrosion	New	Active	NOTREQUIRED
014646	5CS	8/13/08	Doubler External	station 1720 LB...	Corrosion	New	Active	NOTREQUIRED
007668	5CS	9/24/07	Other	R/H Winglet Ins...	NotBlueprint	New	Active	CLOSED
007667	5CS	9/24/07	Other	L/H Winglet Ins...	NotBlueprint	New	Active	CLOSED
005478	5CS	8/14/00	Part Reinforcement	STA 1825 S6R ha...	NotBlueprint	Existing	Active	TBD
005477	5CS	8/11/00	Part Reinforcement	Floor beam STA ...	Corrosion	Existing	Active	CLOSED
005476	5CS	8/11/00	Part Reinforcement	Floor beam STA ...	Corrosion	Existing	Active	CLOSED
005475	5CS	8/11/00	Other	RH strut door	Wear	[illegible]	[illegible]	[illegible]

Composition of Investigative Team

- Operations

Composition of Investigative Team

Operations

Interview:	**Todd Wesley Brann**
Date/Time:	**Dec. 30, 2010; 1700 EST**
Location:	**Via telephone; JAC Airport conference room**
Present:	**Roger Cox, Katherine Wilson – NTSB; Thomas Lange – Boeing; Robert Hendrickson – FAA; John David – APA (Allied Pilots Association; Head of Accident Investigation; First Officer)**
Represented by:	**Ray Duke - APA**

During the interview First Officer (FO) Brann stated the following:

His current position was First Officer B757/767 domestic operations. He was 48 years old and his date of birth was ----------------. His date of hire at American Airlines (AA) was January 16, 1992. He had flown the B757/767 about 5.5 years (6 years as of May 2011), and he had about 3500 hours on the airplane. He held an ATP and airplane multi engine land certificates and a type rating on the B757/767. The limitations section stated B757/767 circling VMC only and B757/767 limited to FAR 121.543 for operations at AA. He had about 11,800 hours total pilot flight time, including 10,000 at AA and 1,800 in the USAF. He also had about 1,800 hours of flight engineer time in the B-727 and DC-10. He did not have any recent leave or absence from flying that might have affected his currency to fly the 757.

He had flown to Jackson Hole (JAC) since mid-December 2010 with the incident captain. The incident landing was his 4th time into the airport since mid-December and he had also flown into JAC a few months previously. He said flying into JAC in the winter, they dealt with slippery runway conditions, airplane loads were full and they had to be careful of takeoff and landing weights, the high elevation and the "slippery airport". He said the airport was a high emphasis airport and they had a lot more than normal to deal with; they had to be on their toes and be thinking of everything to get in and out of there safely. He said it was normal to start planning

Crew Duties

General

Normally, crew duties are divided between the Captain and First Officer during ground operations; and between Pilot-Flying and Pilot-Monitoring ...light. Although crew duties are divided, each pilot should always ... an awareness of the other pilot's activities.

...duties are assigned to each crewmember so that maximum crew ...tion and efficiency may be maintained regardless of changes in ...rings.

...-Flight Inspection will normally be accomplished by the First Officer ...n international flights. However, at the Captain's discretion, the ...t Inspection may be accomplished by any pilot individually, or may ...between the pilots.

... the concern of one pilot will be directed primarily to the control of ...ane. The Captain will designate which pilot is responsible for flying ...ane and that pilot will not perform any duties which could or would ...rom this primary responsibility.

... particular procedure specifies otherwise, whenever the Pilot-Flying ...o transfer control of the airplane to the Pilot-Monitoring, the ...ng will state to the Pilot-Monitoring – *"You have the airplane."* The ...nitoring, after taking control of the airplane, will state – *"I have the ..."* indicating that the transfer of control has taken place.

...neral practice, the Pilot-Monitoring will normally accomplish certain ...uch as handling of flaps, gear, radio communications, etc.

... Officer will normally not make gear or flap configuration changes ...irst obtaining the Captain's concurrence.

...l panel is set up for crossfeed and it becomes necessary for either ...eave the cockpit, a tank-to-engine configuration shall be established ...other pilot's return.

...cedures Checklist

Composition of Investigative Team

- **Survival Factors**

Composition of Investigative Team

- Airports

Composition of Investigative Team

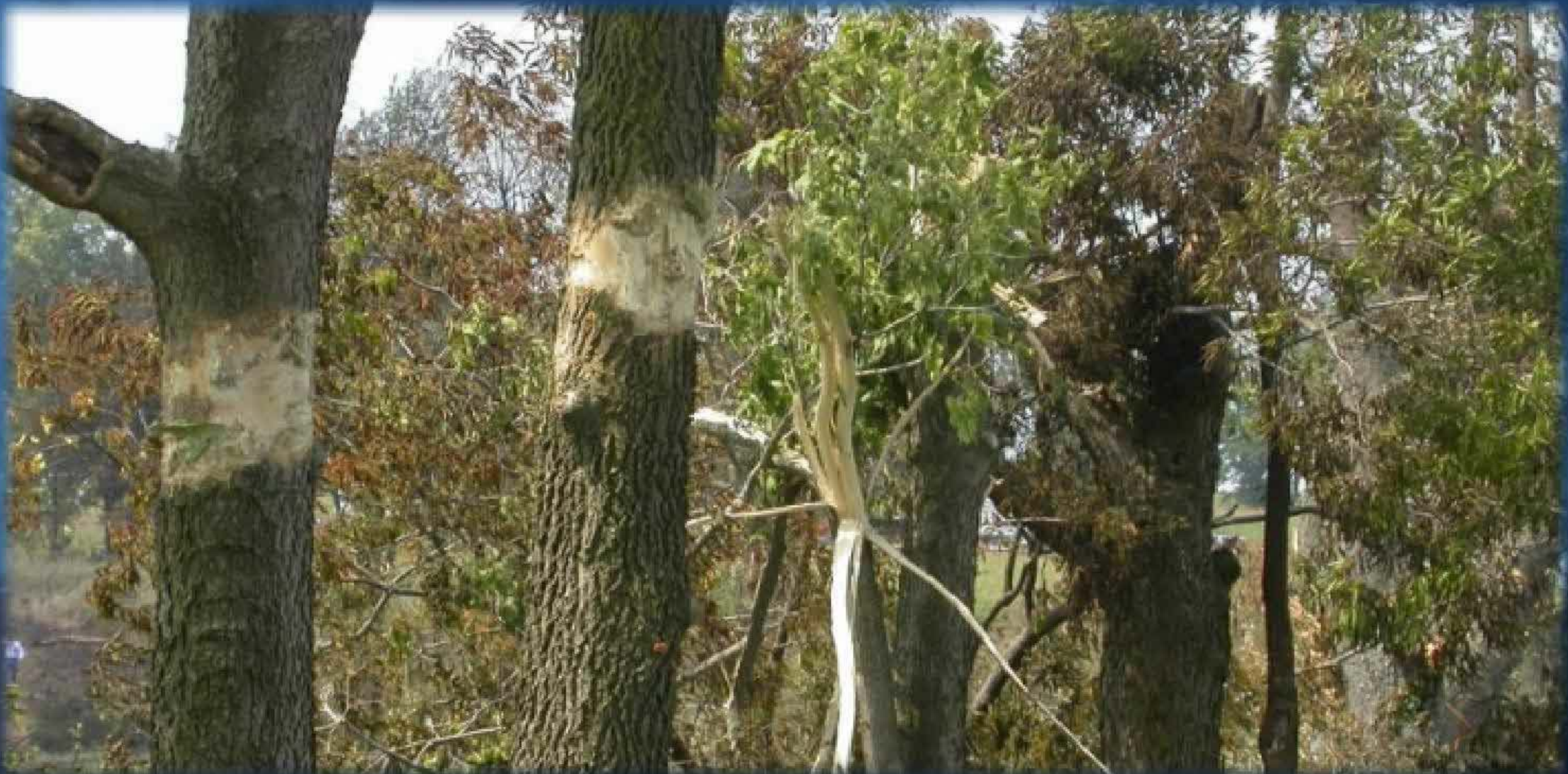
- Airports

Composition of Investigative Team

- ATC

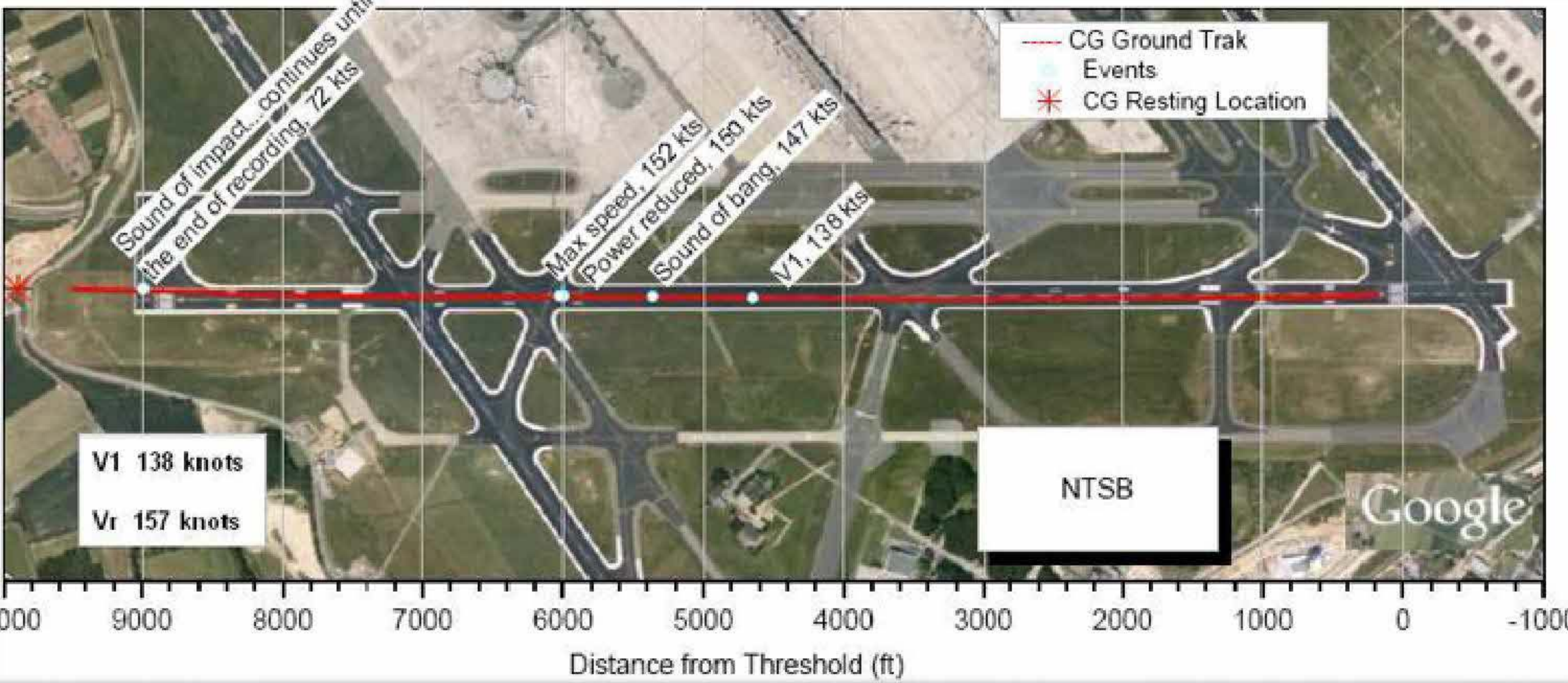
Composition of Investigative Team

- Airplane Performance



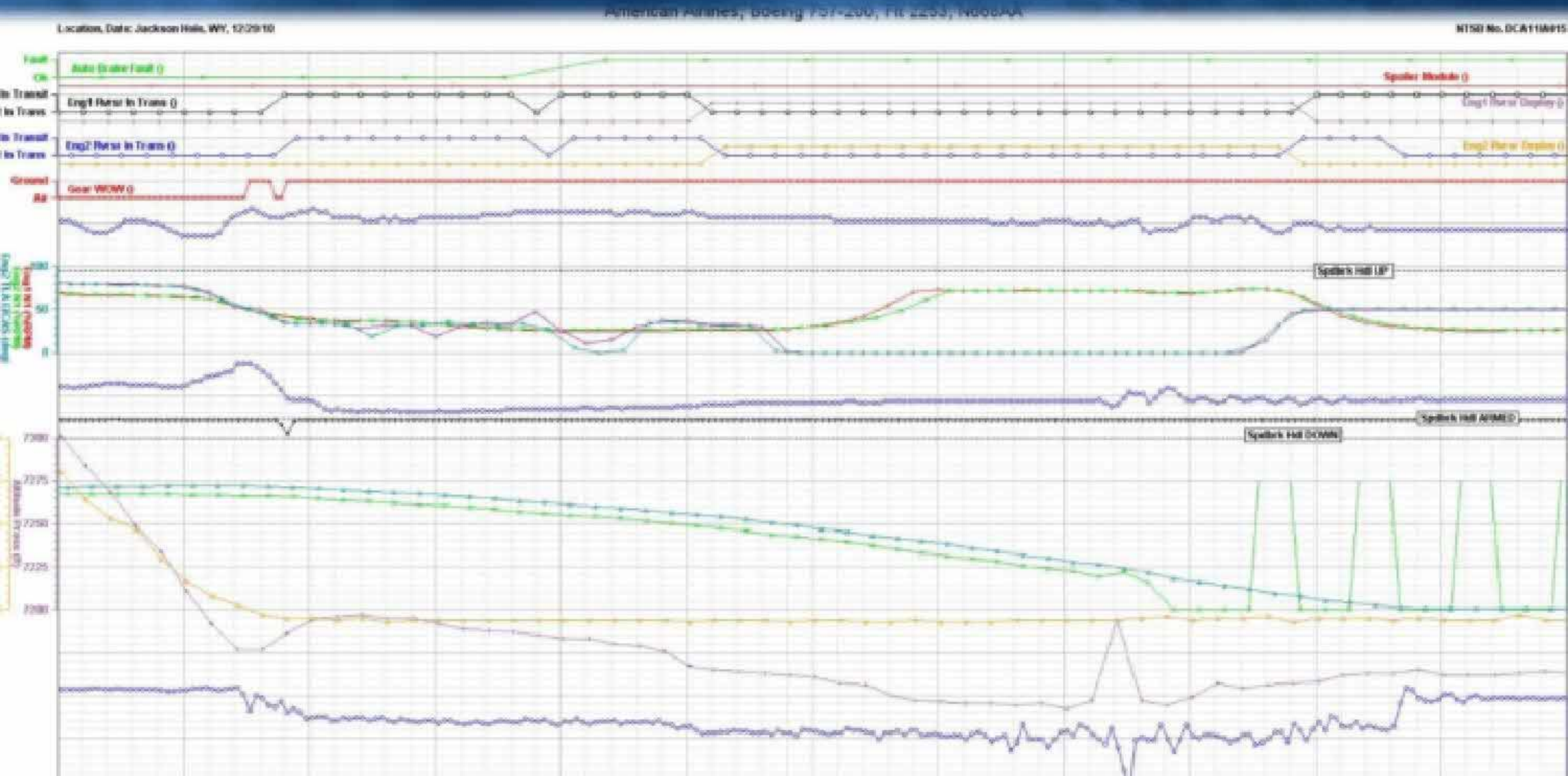
Composition of Investigative Team

- **Airplane Performance**



Composition of Investigative Team

- **Flight Data Recorder**



Composition of Investigative Team

◆ Cockpit Voice Recorder

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:31:12.8 **HOT-1**	there's the turn.		
11:31:18.0 **HOT-2**	come'n inside of QUIRT I got the localizer thank you ninety seven hundred feet please.		
11:31:20.4 **HOT-1**	altitude capture.		
11:31:23.9 **HOT-1**	ninety seven.		
11:31:24.8 **HOT-2**	ninety seven.		
11:31:32.0 **HOT-2**	and approach is armed.		
11:31:33.9 **HOT-1**	'kay good.		
		11:31:36.4 **RDO-1**	Jackson ah tower American twenty two fifty three is at QUIRT.
		11:31:42.1 **TWR**	American twenty two fifty three Jackson tower report FAPMO.

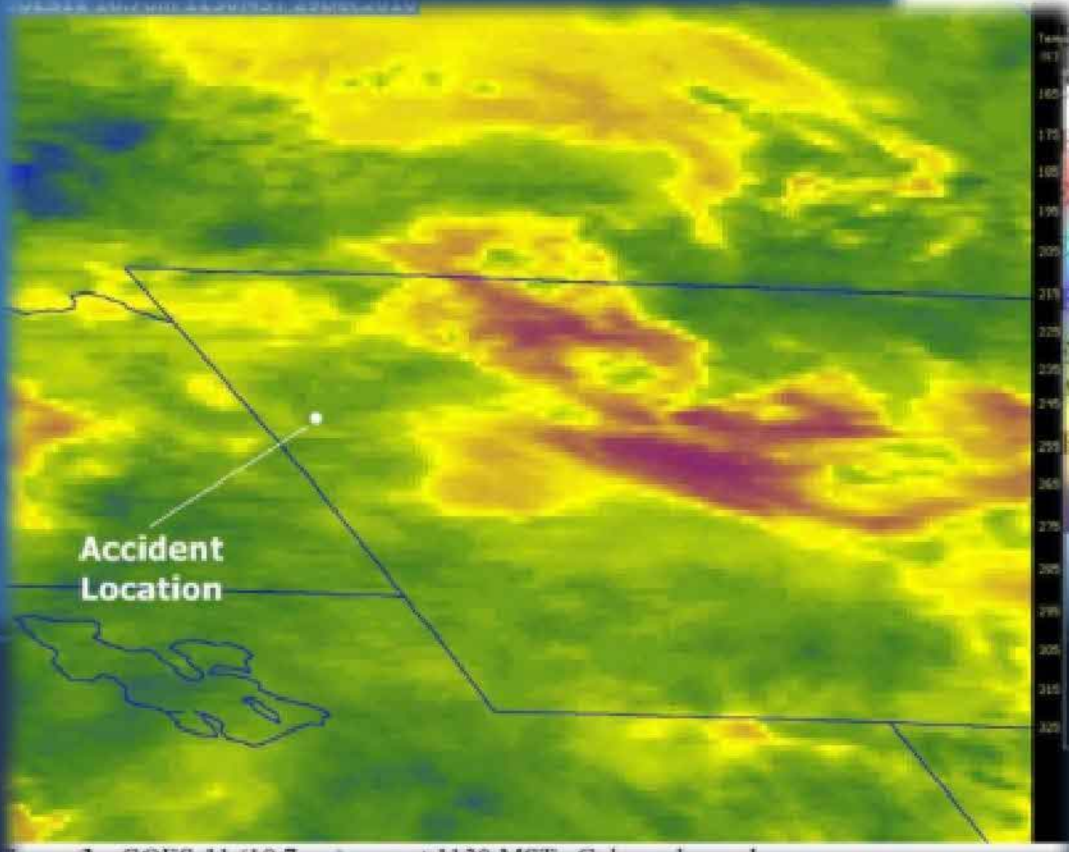
Composition of Investigative Team

- **Meteorology**

<u>Surface Observations</u>

Jackson Hole Airport (KJAC) in Jackson Hole, Wyoming, was equipp
Weather Observing System-3 (AWOS-3). The following reports were is
an official weather observer was logged into the AWOS-3 system.

METAR KJAC 291355Z 23014KT 3/4SM OVC012 M05/M07 A29
CI KJAC 291441Z 22012KT 1/2SM SN OVC010 M05/M07 A
TAR KJAC 291451Z 22013KT 1/4SM SN OVC008 M05/M07
CI KJAC 291545Z 22013KT 1SM -SN OVC010 M05/M07 A2
TAR KJAC 291555Z 21013KT 3/4SM -SN OVC010 M05/M07
TAR KJAC 291656Z 22011KT 3/4SM -SN BKN004 OVC010
CI KJAC 291725Z 23009KT 1/2SM SN BKN004 OVC010 M
TAR KJAC 291751Z 22007KT 3/4SM -SN BKN004 O
2915
CI KJAC 291843Z 24010KT 1SM -SN BKN004 OVC019 M



igure 3 – GOES-11 (10.7um) scan at 1130 MST. Color-enhanced

Composition of Investigative Team

- **MATERIALS LABORATORY**

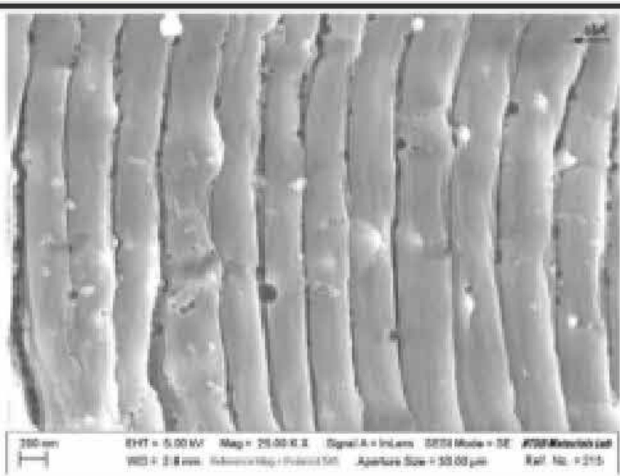
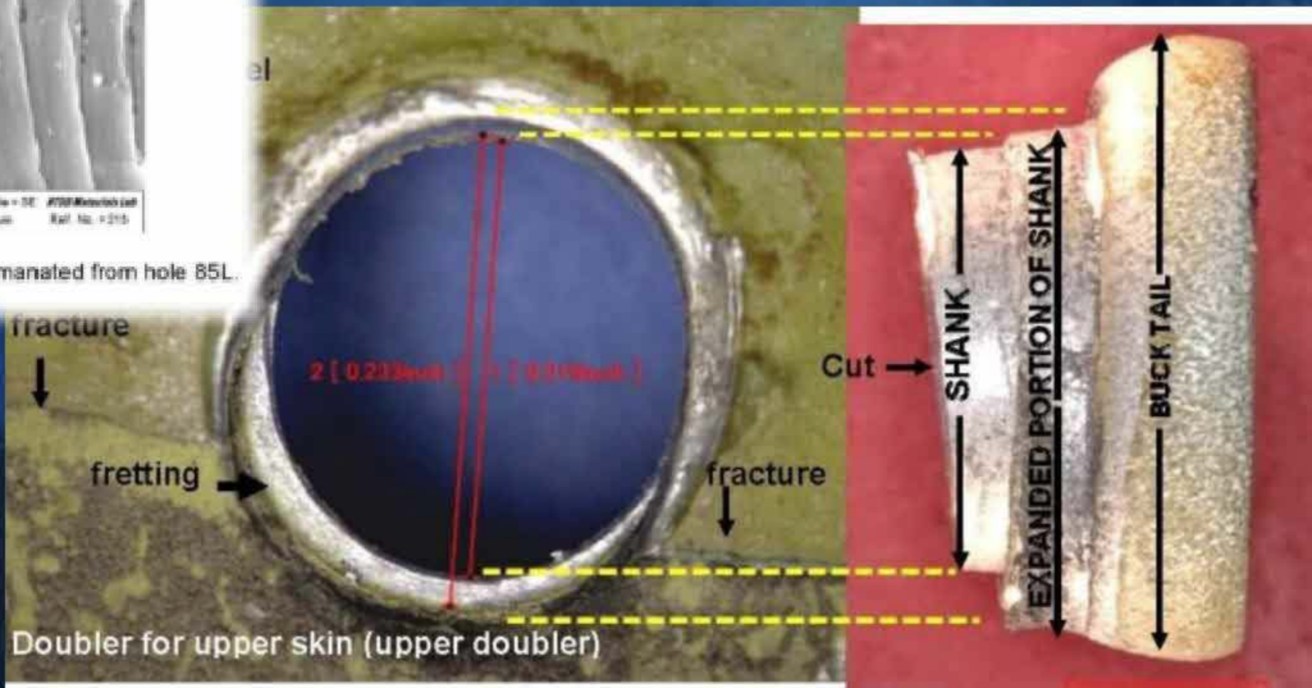


Figure 9. Photograph of typical fatigue striations that emanated from hole 85L.



Composition of Investigative Team

Other potential groups:
Human Factors Radar data Maintenance records Hazmat

Composition of Investigative Team

Other specialized groups are formed as necessary:

- Human performance
- Hazardous materials
- Fire/explosion
- Witness interviews

Composition of Groups

- Group chairmanFAA (entitled by law)Technically qualified party membersAdvisors to accredited representative team

Group Process

- Groups develop a factual account of the on-scene findings – and document in field notesGroups work very closely under the direction of the group chairmen -- and remain intact for the duration of the investigation (on-scene 7-20 days and follow-up usually not less than 6 months)

Progress Meetings

- At the end of each day, a progress meeting is held, led by the IIC and attended by all members of the investigative team. No one other than the investigative team may attend these meetingsAt the meeting, group chairmen summarize their findings from the day and present their plans for the next dayFactual information reported at the daily progress meeting is summarized and reported to families and media by the Board Member, IIC, or public affairs specialist on scene

Press Briefings

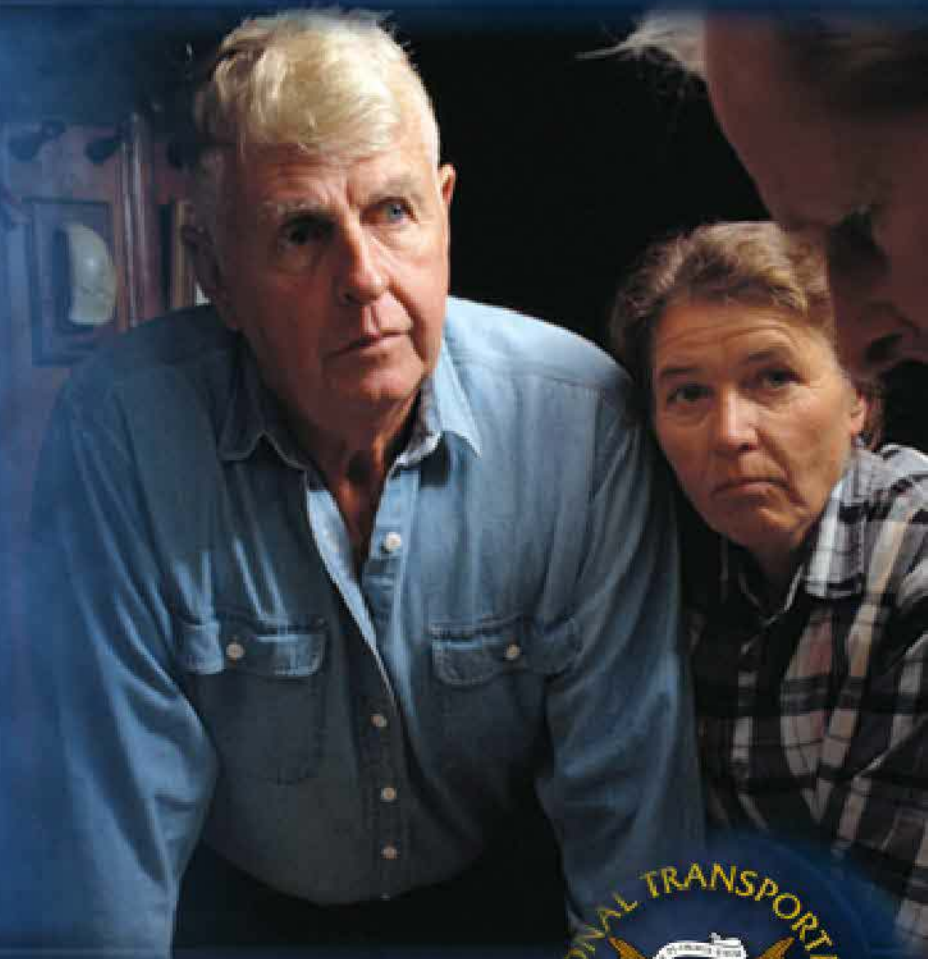
- Factual information is reported to the media daily in briefingsThe NTSB Board Member or IIC are the sole spokespersons for the investigation

Press Briefings

- Parties are prohibited from speaking to the media regarding the investigation and may be removed from the investigation for doing so

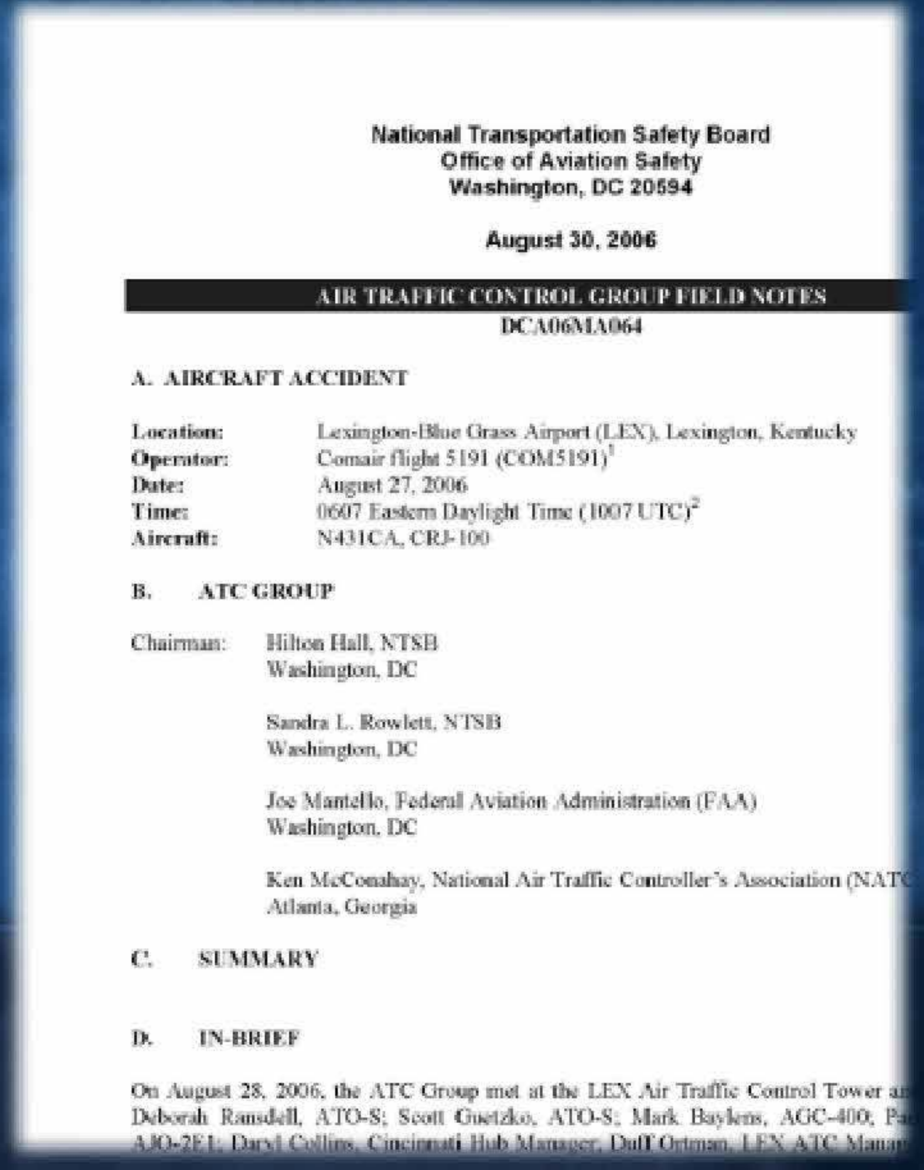
Family Briefings

- Factual information is provided to the families by the Board Member, the IIC or the Transportation Disaster Assistance staff representative prior to the media briefing



Completion of On-Scene Phase

- Before being released from the scene, all group members must:Assist in the completion of field notes of the evidence gathered on-sceneSign the field notesNo group member is released until approved by the IIC


National Transportation Safety Board
Office of Aviation Safety
Washington, DC 20594

August 30, 2006

AIR TRAFFIC CONTROL GROUP FIELD NOTES
DCA06MA064

A. AIRCRAFT ACCIDENT

Location:	Lexington-Blue Grass Airport (LEX), Lexington, Kentucky
Operator:	Comair flight 5191 (COM5191)[1]
Date:	August 27, 2006
Time:	0607 Eastern Daylight Time (1007 UTC)[2]
Aircraft:	N431CA, CRJ-100

B. ATC GROUP

Chairman: Hilton Hall, NTSB
Washington, DC

Sandra L. Rowlett, NTSB
Washington, DC

Joe Mantello, Federal Aviation Administration (FAA)
Washington, DC

Ken McConahay, National Air Traffic Controller's Association (NATC
Atlanta, Georgia

C. SUMMARY

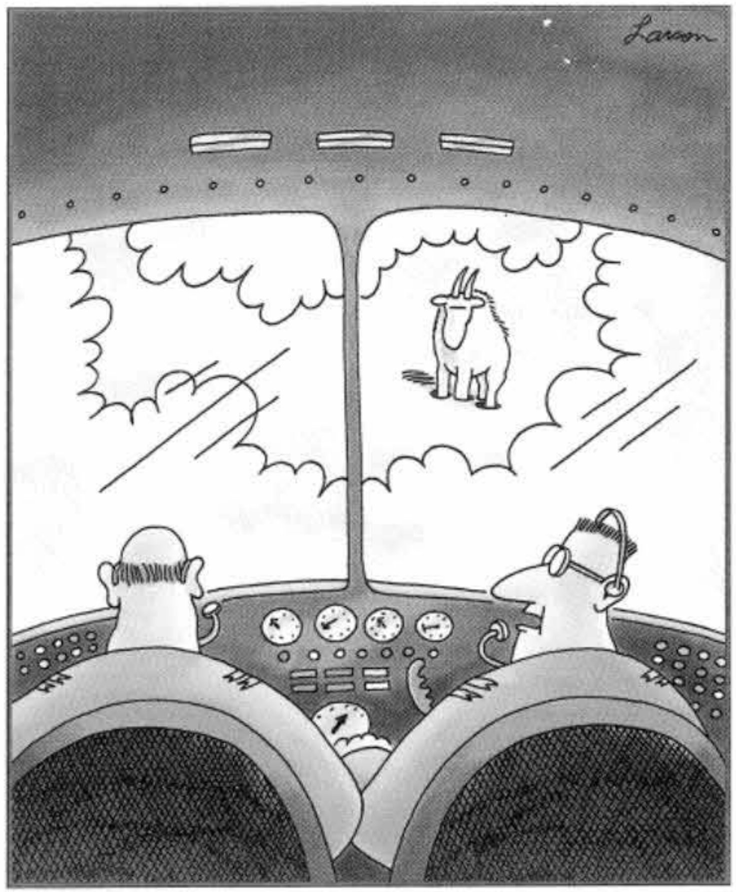
D. IN-BRIEF

On August 28, 2006, the ATC Group met at the LEX Air Traffic Control Tower a
Deborah Ransdell, ATO-S; Scott Gnetzko, ATO-S; Mark Baylens, AGC-400; P

Law Enforcement

- FBI responds routinely
  Shares information with teamIf NTSB investigators suspect any foul play, it is brought to the immediate attention of FBIIf circumstances reasonably indicate that an accident may have been caused by an intentional criminal act, FBI assumes the lead in the investigation and NTSB provides technical support as requested
  (formal agreement between NTSB Chairman and Attorney General)

ANY QUESTIONS?



"Say … what's a mountain goat doing way up here in a cloud bank?"

NATIONAL TRANSPORTATION SAFETY BOARD

Post On-Scene Investigation and Report Preparation

Group Activities

Additional investigative work continues after the on-scene phase. This work is carried out at the NTSB laboratory, airline or manufacturer, and independent testing facilities. Examples include:

- Engine tear-downs
- Component testing
- Simulator studies

Group Activities

Off-scene group work is carried out under the same rules and procedures as on-scene

Sworn testimony may be taken in depositions on-scene or at a later date to obtain additional factual information. These sessions are: Conducted by the IIC and group chairman Attended by group party members

Witnesses testifying are entitled to a representative

Docket No. SA - 816

Exhibit No. 9A

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

SYSTEMS GROUP CHAIRMAN'S
FACTUAL REPORT OF INVESTIGATION

Upon completion of all investigative work, the group chairman's factual report is distributed to all group members for review and comments

Public Hearing

Public hearings are normally convened for major catastrophic, high public interest accidents involving complex national safety issues. The full Board votes on staff recommendations to convene or not to convene a public hearing

Public Hearing

The Board holds an investigative hearing to:Gather testimony to expand on issues identified in the investigation, andPublicly present the findings to date to demonstrate that a complete, open, and objective investigation is being conducted

Public Hearing Participants

Public hearings include:An NTSB Board Member who serves as the presiding officerA Board of Inquiry composed of senior NTSB managersA technical panel composed of IIC and group chairmen

Public Hearing Participants

Public hearings include:Parties designated by the Chairman of the Board of Inquiry (not necessarily the same parties that were on-scene)Accredited representative(s)Witnesses

Conduct of a Public Hearing

Witnesses are questioned in this order by a: Technical panel Party spokesmen Board of InquiryA second round of clarification questions may be permitted in the same order

Technical Review

All parties are encouraged to attend a technical review of thefactual record of the accident. The purpose of the meeting is to:Ensure the accuracy of the factual recordReview the need for additional investigative workDiscuss further avenues of investigative activities regarding the scope and depth of the investigation

Party Submissions

Parties are encouraged to submit their own analysis and probable cause of the accident as well as proposed recommendations

Preparation of the Final Report

Parties do not participate in the preparation of the final report; however,

- Party submissions are reviewed by staff before preparation of the final report For investigations conducted under Annex 13 to ICAO, the foreign accredited representative receives a copy of the draft final report for comment

Draft Final Report

A draft final report and party submissions are reviewed and approved by the five Board Members

Board Meeting

- The Board reviews and discusses the draft final report with staff in a public meetingMajor issues are explored at lengthThe final report, conclusions, probable cause and recommendations are adopted

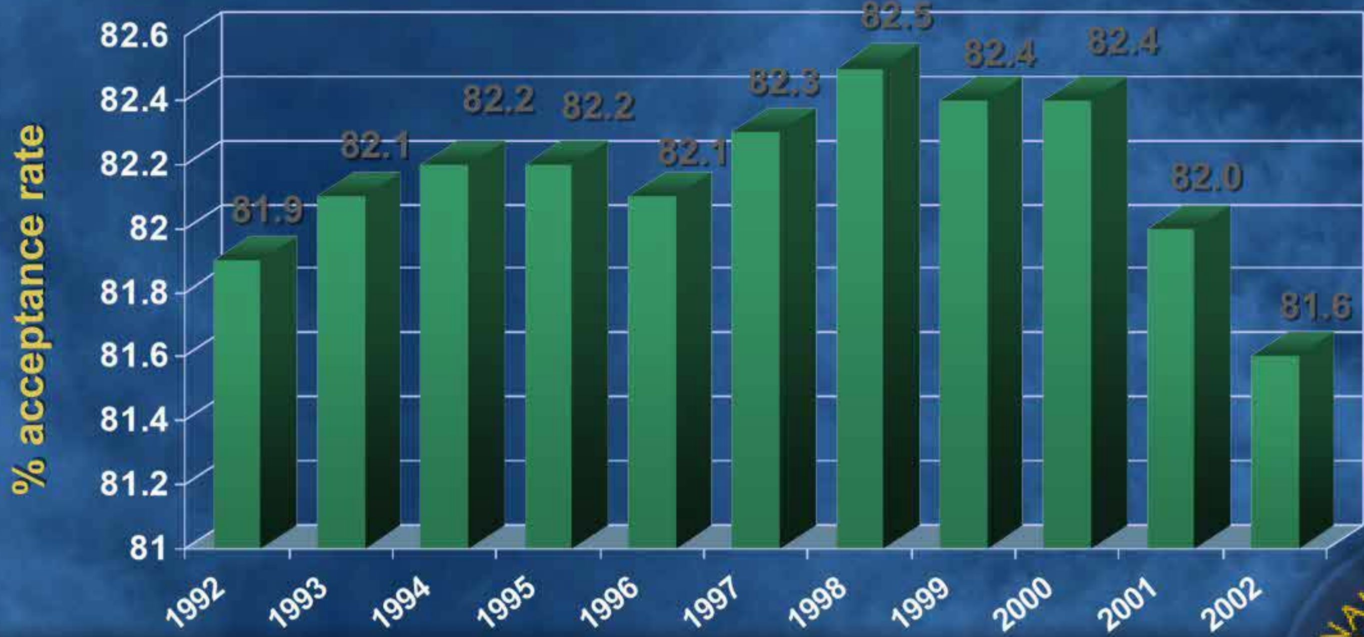
Safety Recommendations

- Are the major product of the Safety BoardDesignates the party or person expected to take actionDescribes the action the Board recommendsStates the safety need to be satisfiedResult in immeasurable safety improvements that save lives, reduce injuries, cut economic losses and eliminate the emotional trauma of an accident

NATIONAL TRANSPORTATION SAFETY BOARD

Acceptance Rates by Year

All Modes



Petition for Reconsideration

If a party chooses to request a reconsideration of the report, conclusions, and probable cause as adopted by the Board, they may file a petition for reconsideration if they can: Provide new evidence Demonstrate an analysis not previously considered

Major Investigations

Party Process

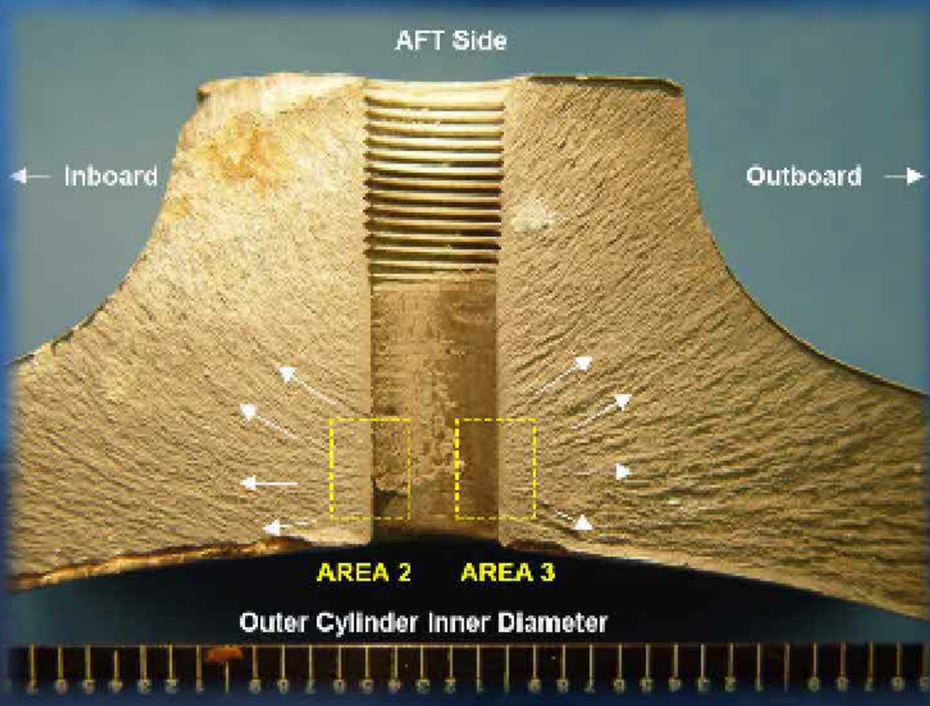
The Party Process

- The Safety Board investigates more than 2,000 aviation accidents and incidents a year and about 500 rail, highway, marine and pipeline accidents. With only about 400 employees, the NTSB accomplishes this task by leveraging its resources and designating parties to its investigations.

The Party Process

- NTSB regulations state, in part, that "parties shall be limited toThose persons, government agencies, companies and associations whose employees, functions, activities or products were involved in the accident or incident, and…

The Party Process



…who can provide suitable qualified technical personnel to actively to assist in the field investigation"

The Party Process

- The IIC designates parties on sceneThe participation of accredited representatives from foreign countries is established under the provisions of ICAO Annex 13

The Party Process

- The NTSB has complete discretion over which organizations it designates as parties, except FAA, which is a party by law

The Party Process

- Typically, parties include:FAA (by law)Air carrierAirframe manufacturerEngine manufacturer

The Party Process

- Major component manufacturerPilot, ATC, maintenance and flight attendant union representativesLocal airport and law enforcement

The Party Process

- Absolutely no news media, company media relations, individuals occupying legal positions or insurance personnel are permitted to participate in any phase of the investigation, including meetings

Who to Send to an Accident

- Parties to an investigation should send the following:Party coordinator/ spokespersonEmployees with expertise in the technical areas

Party Coordinator

- Should not be assigned to a groupSupervises the group members from his/her organizationWorks directly to support the IIC

Party Coordinator

- Must be able to speak for and make decisions for the organization they representRemains near or in contact with the IIC/command center at all timesIs responsible for ensuring that NTSB rules are followed

Party Form

NTSB Investigation No.____________________
Date of Accident: ____________________
Accident Location: ____________________

CERTIFICATION OF PARTY REPRESENTATIVE[1]

knowledge that I am participating in the above-referenced accident or incident investigation, on behalf of my ployer who has been named a party to the National Transportation Safety Board (NTSB) safety investigation, the purpose of providing technical assistance to the NTSB's evidence documentation and fact-finding activities. derstand that as a party participant, I and my organization shall be responsive to the direction of NTSB person- and may be expelled from the investigation for conduct that is prejudicial to the investigation or inconsistent NTSB policies or instructions. No information pertaining to the accident, or in any manner relevant to the estigation, may be withheld from the NTSB by any party or party participant.

rther acknowledge that I have familiarized myself with the attached copies of the NTSB *Accident/Incident estigation Procedures* (49 C.F.R. Part 831) and "Information and Guidance for Parties to NTSB Accident and dent Investigations," and will comply, and ensure all employees and representatives of my organization will ply, with these requirements. This includes, but is not limited to, the provisions of 49 C.F.R. §§ 831.11 and 13, which, respectively, specify certain criteria for participation in NTSB investigations and limitations on the emination of investigation information.

party representative may occupy a legal position or be a person who also represents claimants or insurers. I ify that my participation is not on behalf of either claimants or insurers, and that, although factual information ined as a result of participating in the NTSB investigation may ultimately be used in litigation (at the appropri- time, and in a manner that is not inconsistent with the provisions of 49 C.F.R. § 831.13 and 49 U.S.C. § 1154), participation is to assist the NTSB safety investigation and not for the purposes of preparing for litigation. I certify that, after the NTSB IIC releases the parties and party participants from the restrictions on dissemina- of investigative information specified in 49 C.F.R. § 831.13, neither I nor my party organization will in any assert in civil litigation arising out of the accident any claim of privilege for information or records received as ult of my participation in the NTSB investigation.

rther acknowledge my responsibility to ensure that the NTSB is informed in writing, immediately and with cificity, when information or records provided to the NTSB, in any format, or other investigative activities, are ect to United States export controls, classification or licensing requirements, or sanctions restrictions. Similar- commercially sensitive and/or proprietary material provided to the NTSB investigation should be clearly ked in accordance with the provisions of 49 C.F.R. Part 831.6.

____
nature Date

____
e & Title

- All party members are required to sign a form titled "statement of party representatives to NTSB investigations" which specifies that all members of their organization have read the applicable rules and regulations governing the investigation and agree to abide by them.

Party Specialists

- **Must be a full-time employee of the party (no consultants)Must possess needed expertise in group subject**

Party Specialists

- Work under direct supervision of the group chairmanMust abide by the NTSB's rules and procedures

Party Specialists

- No independent investigations by parties or group members are permittedNo information will be withheld from the NTSB

What to Prepare For

- Upon a launch to a major investigation, group team members should be prepared for:Extended work hours lasting 7 to 21 daysTravel to off-site locations for follow-up group activities (such as tear down activities)

What to Prepare For

– **Potential for extreme environmental, physical and psychological stress while on -site“Team concept” cooperation and spiritOnce a specialist is assigned to a group, substitutions are highly discouraged**

Protective Measures

- Any party specialist who will participate in wreckage retrieval should have current tetanus and hepatitis-B inoculationsFederal regulations require investigators to wear personal protective equipment (PPE) while on scene to protect against bloodborne pathogens like hepatitis-B and HIVParty members must supply their own PPE

Lines of Authority for Conflict Resolution

- Director, Office of Aviation Safety
  IIC – accredited representative
  Party coordinator Group chairman
  Group member

Group Representation

- Group members are responsible for pointing out discrepancies in factual reportsIssues regarding the scope of the investigation, findings or the content of factual notes should be resolved with the group chairmanIf issues cannot be resolved at this level, the party coordinator and group chairman should apprise the IIC for resolution

Group Representation

NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, DC 20594

SURVIVAL FACTORS GROUP CHAIRMAN'S FACTUAL REPORT

December 21, 2006

ACCIDENT

Operator	:	Comair, Inc.
Aircraft	:	Bombardier CL-600-2B19 [N431CA]
Location	:	Lexington, KY
Date	:	August 27, 2006
Time	:	0609 Eastern Daylight Time[1]
NTSB #	:	DCA06MA064

SURVIVAL FACTORS GROUP[2]

Group Chairman	:	Jason T. Fedok National Transportation Safety Board Washington, DC
Member	:	Mark H. George National Transportation Safety Board Washington, DC
Member	:	Paul S. Nelson Air Line Pilots Association Hebron, KY
Member	:	D. Scott Lanter Blue Grass Airport

- If a satisfactory resolution is not forthcoming, the coordinator should request that the IIC raise the issue to the chief, major investigations division for resolutionA full set of all final group chairman's factual reports with attachments are provided to party coordinators upon completion

Discussions About the Investigation

- Parties and group members are prohibited from speaking about investigative findings with the news media or publicGroup members should advise their coordinators of information derived from the investigation, but should refrain from speculating or analyzing unsubstantiated information

Field Notes

- All group members assist in documenting the factual data gathered on-sceneSign the field notesAnnotate any differences

National Transportation Safety Board
Office of Aviation Safety
Washington, DC 20594

August 30, 2006

AIR TRAFFIC CONTROL GROUP FIELD NOTES
DCA06MA064

A. AIRCRAFT ACCIDENT

Location:	Lexington-Blue Grass Airport (LEX), Lexington, Kentucky
Operator:	Comair flight 5191 (COM5191)[1]
Date:	August 27, 2006
Time:	0607 Eastern Daylight Time (1007 UTC)[2]
Aircraft:	N431CA, CRJ-100

B. ATC GROUP

Chairman: Hilton Hall, NTSB
Washington, DC

Sandra L. Rowlett, NTSB
Washington, DC

Joe Mantello, Federal Aviation Administration (FAA)
Washington, DC

Ken McConahay, National Air Traffic Controller's Association (NATC
Atlanta, Georgia

C. SUMMARY

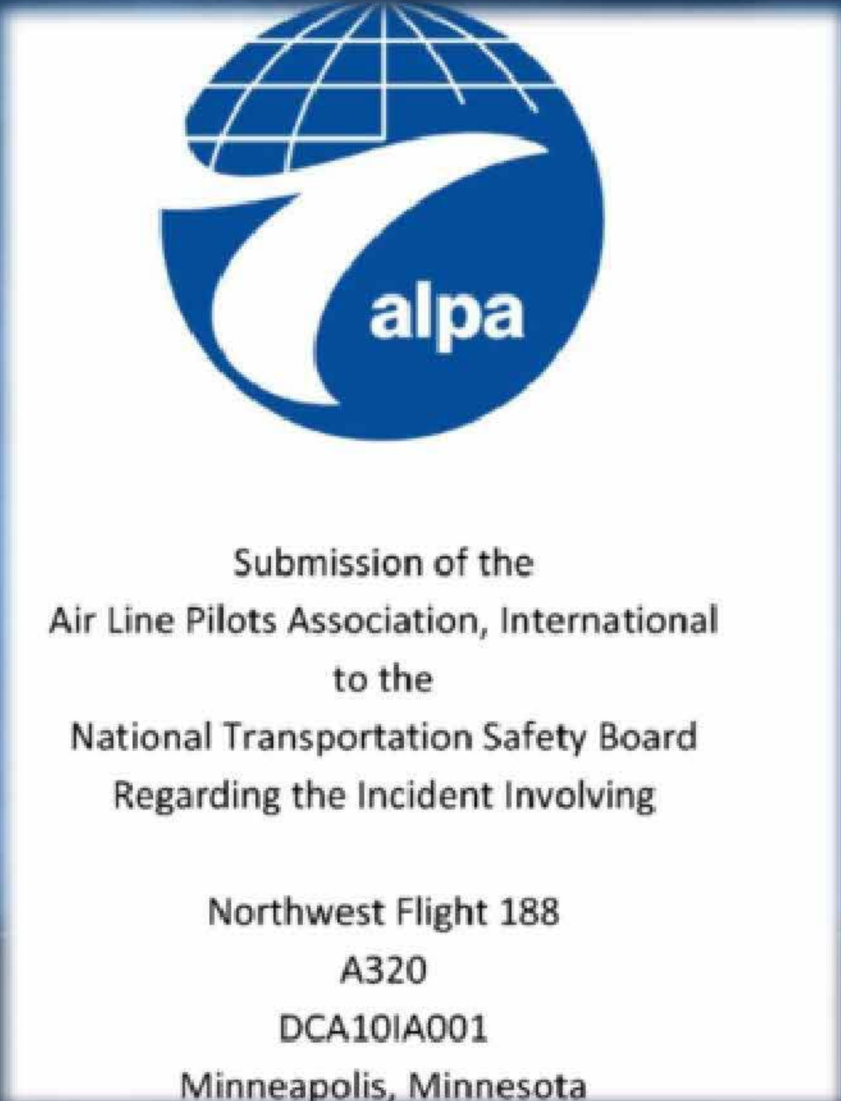
D. IN-BRIEF

On August 28, 2006, the ATC Group met at the LEX Air Traffic Control Tower a
Deborah Ramsdell, ATO-S; Scott Gutzko, ATO-S; Mark Baylens, AGC-400; P
AJO-2E1; Daryl Collins, Cincinnati Hub Manager; Duff Ortman, LEX ATC Mana

Post On-Scene Phase

- Parties in good standing are invited to participate is several ways after the on-scene phase. They will be asked to participate in:Scheduled hearings held in furtherance of the investigationFollow-up tests, interviews or studies initiated by their groupThe technical review of the completeness of the factual portion of the investigation

Submissions & Final Report



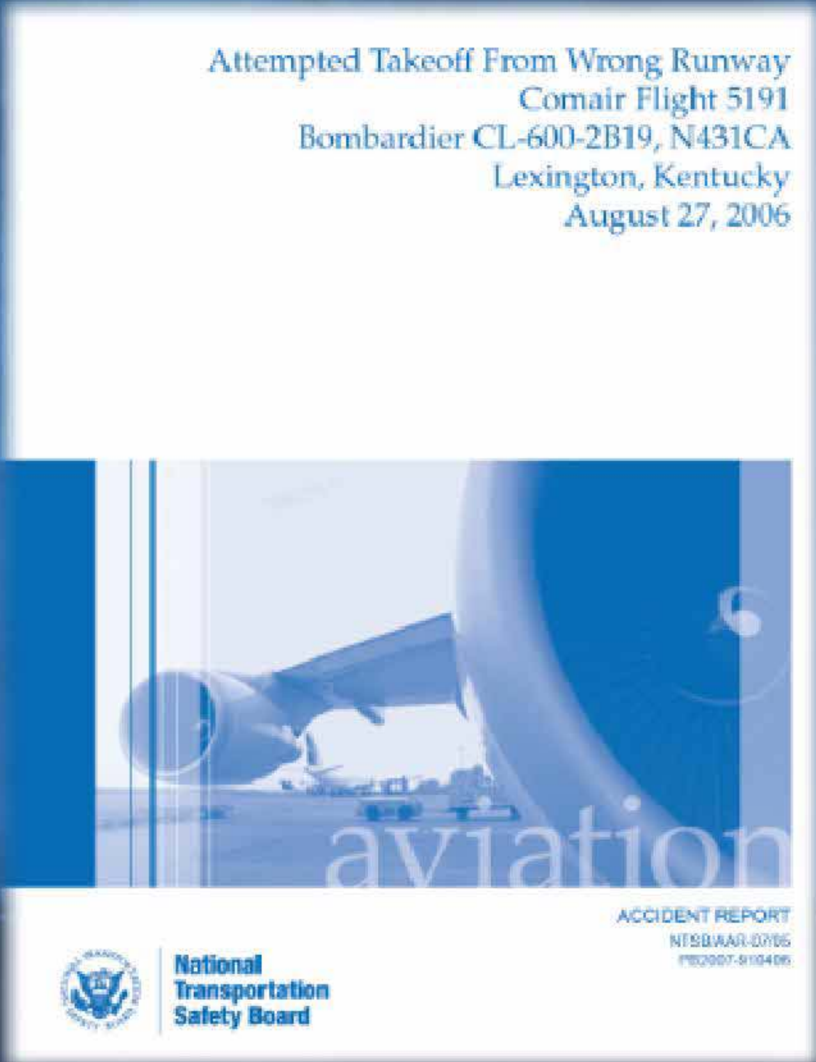
alpa

Submission of the
Air Line Pilots Association, International
to the
National Transportation Safety Board
Regarding the Incident Involving

Northwest Flight 188
A320
DCA10IA001
Minneapolis, Minnesota

- Parties do not participate in the analysis of the draft final report, howeverParties can contribute to the analytical process by submitting their own findings, recommendations and probable cause based on the factual reports

Submissions & Final Report

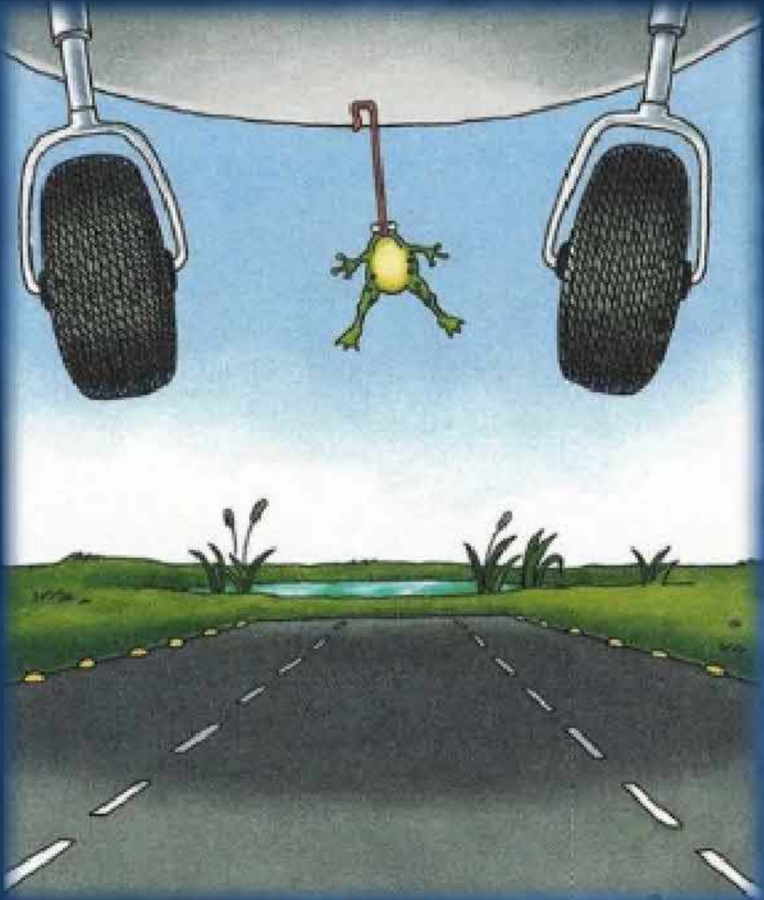


- These ‘party submissions’ become part of the public docket and are considered by staff and the Board Members before adoption of the final report by the Board

Other Party Responsibilities

- **Parties are encouraged to take immediate corrective action to prevent a similar accident if factual information uncovered during the investigation warrants such action. The party coordinator is expected to apprise the IIC of any such actions before they are taken**

ANY QUESTIONS?



NTSB RULES AND AUTHORITY FOR CONDUCTING AIRCRAFT ACCIDENT INVESTIGATIONS

Jim RodriguezOffice of General Counsel

History of the Agency

- In the beginning…Civil Aeronautics Board

History of the Agency

- **Congress establishes NTSB by statuteLocated within the DOT**

History of the Agency

- Independent Safety Board Act of 1974Severed ties with DOT and all other m

NTSB AUTHORITY

Title 49, United States Code Chapter 11 (49 U.S.C. §§ 1101 - 1155)and Title 49, Code of Federal Regulations Parts 800-850

Structure of the NTSB Board

- The National Transportation Safety Board consists of 5 Members, appointed by the President, by and with the advice and consent of the Senate. Members serve 5-year staggered terms.

STRUCTURE OF THE NTSB BOARD

- 2 Members are designated by the President to serve as Chairman and Vice Chairman. They each serve 2-year terms. The Chairman's nomination requires Senate confirmation.




Tasks of the Board

- Promote safety in transportation by:Investigating certain accidentsDetermining the facts, conditions, and circumstances of accidentsDetermining the probable cause of the accidentIssuing transportation safety recommendationsConducting safety studies

49 C.F.R. §800.3

Tasks of the Board (continued)

- Reviewing other agency action on appeal:Denials by the FAA Administrator of applications for airman certificates, & orders modifying, amending, suspending, or revoking certificates issued by DOT Secretary, or imposing civil penaltiesDecisions of US Coast Guard Commandant on appeals from orders of ALJs suspending, revoking, or denying mariner licenses, certificates, or documents

49 C.F.R. §800.3

BACK TO INVESTIGATIONS…

- … shall investigate or have investigated:Aircraft
accidentsRailroad ac
accidentsMajor mari l
clause

Authority of the Board

The NTSB shall inv
involving civil aircr
a public aircraft oth
Armed Forces or b

49 U.S.C. § §1131,
1132

The Party System

Parties to the investigation are limited to (1) those persons, government agencies, companies, and associations (2) whose employees, functions, activities, or products (3) were involved in the accident (4) AND who can provide suitable qualified technical personnel to actively assist in the investigation.

49 C.F.R. §831.11

THE PARTY SYSTEM

- **Only the FAA is afforded the “right” to participate in aviation investigationsParty representatives (except federal agencies) sign a “Certification of Party Representative,” or a “Statement of Party Representatives to NTSB Investigation”**

49 U.S.C. §113249 C.F.R.
§831.11(a)(1)

Excluded From Party System

- Specifically excluded are representatives of claimants or insurers and occupants of legal positionsIIC works with insurance personnel to:Allow to establish a claimTell of investigative plansRelease wreckage with approval of owner (if possible)Provide same factual info given to family and press

49 C.F.R. §831.11(a)(3)

OTHER AGENCIES AND NTSB

- **All covered federal agencies - not just law enforcementAn investigation by the Board under para (1)(A)-(D) or (F) … has priority over any investigation by another department, agency, or instrumentality of the US Govt.   The Board shall provide for appropriate participation   by other departments, agencies, or instrumentalities in the investigation. But those depts, etc, may not participate in the decision of   the Board regarding the probable cause of the accident.**

49 U.S.C. §1131(a)(2)(A)

SUSPECTED CRIMINAL BEHAVIOR

- Requires consultation between the Chairman and the US Attorney GeneralIf circumstances reasonably indicate an intentiona al act, then the FBI takes the leadIf a l law enforcement agency suspects an intentional criminal actThen the NTSB preserves evidence of criminal act

EXAMPLE

Feb 18, 2010Pip
TXWhich agenc
investigation?W

Less Recent Example

Nov 12, 2001Be
587Which agen
investigation?W

OTHER AGENCIES AND THE NTSB

- Other depts, agencies, or instrumentalities of the Govt may still have the authority to investigate an accident, or to obtain information from parties and from witnesses. Both the NTSB and those other governmental entities will ensure that appropriate information is exchanged in a timely manner.

49 U.S.C. §1131(a)(2)-(3)

Notification & Reporting

The operator shall immediately and by the most expeditious means available, notify the nearest NTSB field office when an aircraft accident or any listed incidents occur.

49 C.F.R. §830.5

NOTIFICATIONS AND REPORTING

- **ApplicabilityUS registered aircraft anywhereForeign aircraft in US territories and possessionsIncludes certain public aircraft operations**

49 C.F.R. §830.1

PUBLIC AIRCRAFT OPERATIONS

OVERSIGHT OF PUBLIC AIRCRAFT OPERATIONS

- **An aircraft:Used only for U.S. GovernmentorOwned and operated, or exclusively leased for at least 90 contin[uous] days, by a government of a State, the District of Columbia, or a territory or possession of the U.S.Limited exception for Search and Rescue purposesMay not be operated for a Commercial Purpose (with one limited exception) nor for carriage of passengers not associated with a governmental function.**

49 U.S.C. §§ 40102(a)(41), 40125; 49 C.F.R. §830.2; A/C 00-1.1A

DEFINITIONS: AIRCRAFT ACCIDENT

- An occurrence associated with the operation of an aircraft which:Takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in whichAny person suffers death or serious injury, OR in whichThe aircraft receives substantial damage

49 C.F.R. §830.2

More Definitions

- **Fatal injuryAny injury which results in death within 30 days of the accident.Serious injuryRequires hospitalization for >48 hrs, beginning w/in 7 days of the date injury received;Fracture of any bone (except simple fractures of fingers, toes, or nose); Severe hemorrhage; nerve, muscle, or tendon damage;2nd- or 3rd-degree burns, or burns affecting >5% of the body surface;Involves any internal organ.**

49 C.F.R. §830.2

DEFINITION: SUBSTANTIAL DAMAGE

- Damage or failure which:Adversely affects the structural strength, performanc or flight characteristics of the aircr AND whichWould normally require repair or replacement of the affected component

49 C.F.R. §830.2

EXCLUSIONS TO SUBSTANTIAL DAMAGE

- Engine failure or damage limited to an engine if only one engine fails or is damagedBent fairings or cowlingDented skinSmall punctured holes in the skin or fabricGround damage to rotor or propeller bladesDamage to landing gear, wheels, tires, flaps, engine accessories, brakes, or wingtips

DEFINITION: INCIDENT

- **An occurrence other than an accident associated with the operation of an aircraft, which affects or could affect the safety of operations**

NATIONAL TRANSPORTATION SAFETY BOARD

Entry and Inspection

- An officer or employee of the NTSB:On display of appropriate credentials and written notice of inspection authority, may enter property where a transportation accident has occurred or wreckage from the accident is located and do anything necessary to conduct an investigation; andDuring reasonable ma ct any record, process, c or fa lated to an accident i ation is chapter.

49 U.S.C. §1134

DEALING WITH INTERVIEWEES

Interviewees

- **Rights of intervieweesAny person interviewed by an authorized representative of the Board during the investigation, regardless of the form of the interview has the right to be accompanied, represented, or advised by an attorney or non-attorney representative.**

49 C.F.R. § 831.7

INTERVIEWEES

- The investigator cannot:Grant immunity from prosecutionAssure confidentiality

However, a person may object to public disclosure of information and the Board may withhold it under an exemption to the FOIA if its release is found not to be in the public interest. 49 CFR 831.6(b).

Disclosure of Information

- Most Information is publicly availableTrade Secrets ActVoluntary Submissions of InformationCockpit Recordings and Transcripts

Miscellaneous Legal Provisions

- Board Accident Reports may not be used or admitted into evidence in any civil action for damages (49 U.S.C. 1154(b); 49 C.F.R. §835.2)Factual Accident Reports may be admitted (49 C.F.R. §835.2)Board employees may testify once for all civil litigations (49 C.F.R. § 835.5)Scope limited to factual information; no opinion testimony (§ 835.3)Board employees may not appear in court for civil litigation (49 C.F.R. § 835.5)Testifying in criminal matters   (49 C.F.R. § 835.10)

NTSB TRAINING CENTER