# Using MORT

## Color Coding

RED — LTA

GREEN — OK

BLUE — Need More Information

BLACK — Not Applicable

# Using MORT

- Add to diagram if necessary
- Use **SD1-6 & MA1-3** to organize assessment
  - Lower levels provide specific justification & recommendations
- Not just one right way to ID problem areas
- *Be reasonable!*
  - Concentrate your efforts on the most important things & don't sweat the small stuff
  - No such thing as a "perfect" safety program

To: boconnor <boconnor@hq.nasa.gov>
From: Faith Chandler <fchandle@hq.nasa.gov>
Subject: Re: Fwd: MORT
Cc:
Bcc:
Attached:

Bryan,

Wayne and I are putting together some preliminary charts on NASA Investigation Policy that may be of assistance.
We are here to assist you in what every you or the team may need.

At 07:00 AM 2/3/2003 -0500, you wrote:
> Faith,
> Thanks, we are probably still another day or two from deciding on our analysis technique. I'll keep this and Larry Gregg himself as an asset in mind.
> Thanks,

> At 12:33 PM 2/2/2003 -0500, you wrote:
> > Bryan,
> >
> > Here are some overview charts on "MORT" from the NSTC instructor Larry Gregg.
> >
> > From: "GREGG, LARRY (JSC-NT) (MEI)" <larry.gregg1@jsc.nasa.gov>
> > To: "'fchandle@mail.hq.nasa.gov'" <fchandle@mail.hq.nasa.gov>
> > Cc: "JOHNSON, ELMER R. (JSC-NS) (NASA)" <elmer.r.johnson@nasa.gov>
> > Subject: MORT
> > Date: Sat, 1 Feb 2003 11:50:13 -0600
> > X-Mailer: Internet Mail Service (5.5.2653.19)
> >
> > Attached is the section of the MI class where I talk about MORT. There are a few cartoons and such, and I just left them in there. Please feel free to contact me directly if there is ANYTHING I can do.
> >
> > <<MORT.ppt>>
> >
> > Larry Gregg
> > 281-244-1278

~~~~~~~~~~~~~~~~~~~~~~~~

Faith Chandler
~~~~~~~~~~~~~~~~~~~~~~~~

NASA Headquarters
Office of Safety and Mission Assurance
Code Q Rm 5x40
300 E Street, S.W
Washington, D.C 20546

202-358-0411
202-358-2778 (fax)

~~~~~~~~~~~~~~~~~~~~~~~~

O'C

Bryan O'Connor
Associate Administrator
Office of Safety and Mission Assurance
~~~~~~~~~~~~~~~~~~~~~~~~

To: HCAT@hq.nasa.gov
From: Faith Chandler <fchandle@hq.nasa.gov>
Subject: Fwd: NEED HELP ???
Cc:
Bcc:
Attached:

Bill,

Here is an offer of assistance from my colleague at the DOE. He has performed many investigations.
Faith

X-Server-Uuid: 0bf4d294-faec-11d1-a39a-0008c7246279
From: "Vernon, Dennis" <Dennis.Vernon@eh.doe.gov>
To: "'Faith Chandler '" <fchandle@hq.nasa.gov>
Subject: NEED HELP ???
Date: Sun, 2 Feb 2003 21:02:41 -0500
X-Mailer: Internet Mail Service (5.5.2655.55)
X-WSS-ID: 1223124820783-01-02

Faith:

I know that you must be very busy, so I'll just get to the point. Please advise what assistance, if any, you wish for either me or my Department to provide for your investigation.

As you know, I'm currently planning to conduct an accident investigation training class in Alburqurque, New Mexico the end of February. However, I am more than willing to postpond this training class to a later date in order to render any assistance that I, my training staff cadre and/or other DOE experienced accident investigators can provide. Just let me now what assitance, if any, you want us to provide.

Best Wishes,

Dennis Vernon
DOE Accident Investigation Program Manager
Office of Special Projects and Investigations
Corporate Safety Assurance
Environment, Safety and Health
U.S. Department of Energy

Office: (301) 903-4839

To: Rutledge_Peter
From: Faith Chandler <fchandle@hq.nasa.gov>
Subject: Bryan's presentation
Cc:
Bcc:
Attached: C:\Documents and Settings\fchandle\My Documents\Columbia\CAIB draft.ppt;

Pete,

Here is a quick look at what I have to date.
I can include other analysis techniques if desired.

Once you have reviewed and edited, perhaps Bryan can determine if this is too much or too little information.

To: Richardson_Pamela
From: Faith Chandler <fchandle@hq.nasa.gov>
Subject: Fwd: Presentation
Cc:
Bcc:
Attached: C:\Documents and Settings\fchandle\My Documents\attach\CAIB - Investigation Overview.ppt;

Pam,

This was sent to Bryan yesterday

From: FTCHANDLER@aol.com
Date: Tue, 4 Feb 2003 19:12:26 EST
Subject: Presentation
To: boconnor@hq.nasa.gov,
CC: fchandle@hq.nasa.gov
X-Mailer: AOL 7.0 for Windows US sub 10625

Bryan,

Here is the presentation that provides a quick overview of NASA accident investigaiton.

I have also prepared a short presantation on MORT, which I will send in a second email. Some of the pictures have made it difficult to email.

These presentations are intended to follow Wayne's presentation on NASA policy.

I can add addtional information on analysis techniques and/or examples.

Any guidance would be greatly appreciated.

Thanks.

Faith Chandler

Mission Success Starts With Safety

# NASA Mishap Investigation Policy and Methodology

## February 4, 2003

Office of Safety and Mission Assurance
NASA Headquarters

# Agenda

- NASA Policy & Guidelines
- Purpose of Investigation
- Board's Tasks
- Investigation Tools & Methods
- Data Collection
- Time Line, Fault Tree, Event & Causal Factor Tree & Root Cause Analysis
- Report
- Summary

# Purpose of Investigation

- **The purpose of NASA mishap investigation process is solely to determine cause and develop recommendations to prevent recurrence.**

- **This purpose is *completely distinct from* any proceedings the agency may undertake to determine civil, criminal, or administrative culpability or liability, including those that can be used to support the need for disciplinary action.**

***NASA Policy Directive (NPD) 8621.1H***

# Board's Responsibilities

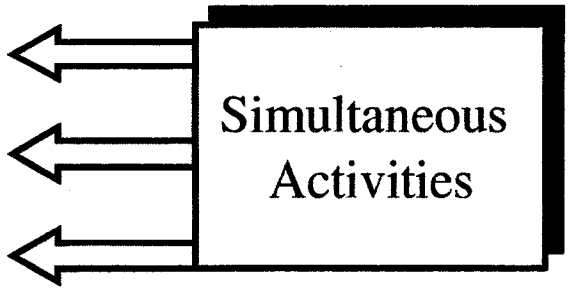
- Determine "what happened" (facts).
- Evaluate ALL possible reasons "why" it happened.
  - Identify findings: proximate causes, root causes, contributing factors and other significant observations.
- Document facts that support findings.
- Generate recommendations.
- Develop the report.

*(See NPG J-3 for Mishap Board Checklist)*

# Investigation Techniques and Methods

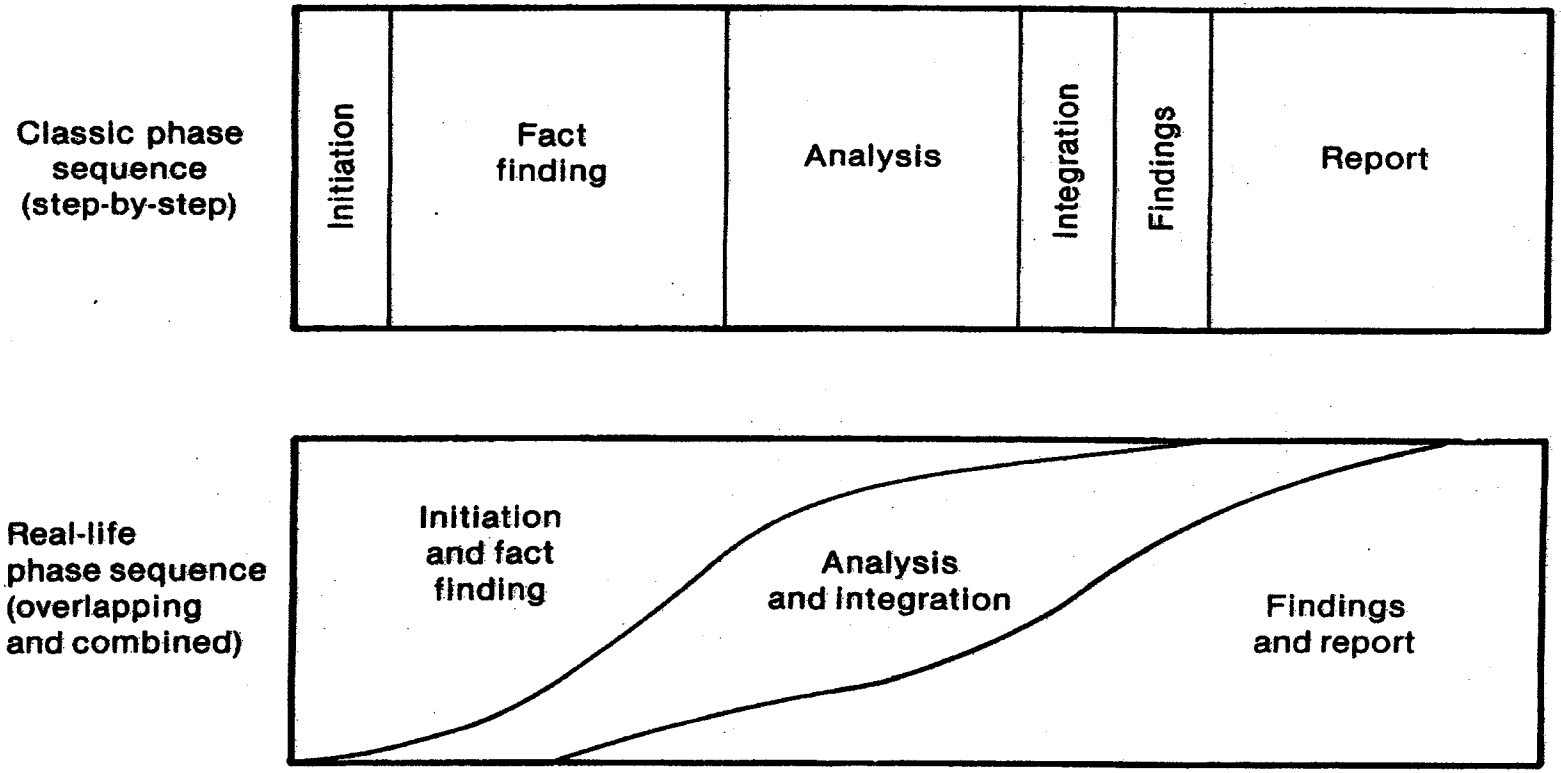
## Comprehensive systematic method (a suggested practice)

- Gather data.
- Create time line.
- Create fault tree.




- Merge fault tree and time line to create events and causal factor tree.
- Further investigate root cause.
- Perform cause test.
- Document root cause, contributing factor(s) and other significant observations.
- Each finding (root cause, contributing factor or observation) should have a recommendation in the final report.

# Implementing the Process



# Investigation Techniques and Methods

- Depth of investigation is determined by the severity of the mishap and potential for reoccurrence.
- A variety of methods can be used to determine the causes and contributing factors.
- Methods listed, suggested, and briefly described in NASA Procedures and Guidelines for Mishap Reporting, Investigating & Recordkeeping (NPG 8621.1):
  - Evidence and data analysis
  - Events and causal factors diagramming
  - Fault tree analysis
  - Management Oversight and Risk Tree (MORT)
  - Root cause analysis
  - Change analysis

# Data Collection

## Initially Focus on "WHAT HAPPENED"

- NOT "Why It Happened."
  Do Not Fixate on Causes.

- NOT "How Do We Prevent It Again or Solve the Problem."

Investigating an Incident and Fixing the Problem are Two Separate Things... Keep Them Separate.

# Data Collection

## Fact Finding - "What Happened"

**Comprehensive Search Should Include:**

- Hardware
- Software
- Procedures& Communications
- Facilities
- Environment
- People (technicians, operators, maintainers, supervisors, management, and executives)
- Company/Organization

# Data Collection – Some Sources of Data

- Audio (during accident, of meetings e.g., PAR, COFR)
- Video & photographs
- Computer aided design, 3-D simulation, flight simulation
- Telemetry & radar
- Hardware design drawings, as-built configuration & debris
- Quality records on materials & processes (manufacturers, suppliers, operations, engineering)
- Maintenance & inspection records
- Info. on chemical, radiation, thermal, structural, mechanical, electrical and biological changes in system or processes
- Existing fault trees & FMEAs
- Hazard analysis & safety analysis
- Risk assessment and PRA
- Policies and procedures (including stamped job cards/procedures)
- Problem reports, corrective action reports, anomaly reports and/or mishap reports
- Interviews & initial witness statements
- Time cards, training records, certification records
- Medical evidence
- Company records (budget, layoffs, past reports, hiring practices)
- Weather data

# Data Collection: Interviews

- Interview as soon as possible.
- Prepare for the interview (prepared questions, recording devices, comfortable room).
- Obtain witness permission before taking notes or recording.
- Explain interview purpose (Use NASA written statement)
- Establish rapport with the interviewee.
- Get facts (name, company, witness location, duty, etc).
- Begin with open ended statement: "Can you tell me in your own words what you know about the accident?"
- Use neutral questions "Then what did he do?"
- Request suggestions on prevention strategies.
- Listen, Listen, Listen....
- Get interviewee agreement on content of statement.
- Provide interviewee with copy of statement and/or recording.
- Provide call back information.
- Thank them.

# Statement to Witnesses

## NASA Procedures and Guidelines (NPG) 8621.1

The purpose of this safety investigation is to determine the root cause(s) of the mishap that occurred on _____, and to develop recommendations toward the prevention of similar mishaps in the future. It is not our purpose to place blame or to determine legal liability. Your testimony is entirely voluntary, but we hope that you will assist the board to the maximum extent of your knowledge in this matter. Your testimony will be documented and retained as part of the mishap investigation report background files but will not be released as part of the investigation board report.

NASA will make every effort to keep your testimony confidential and privileged to the greatest extent permitted by law. However, the ultimate decision as to whether your testimony may be released may reside with a court or administrative body outside NASA.

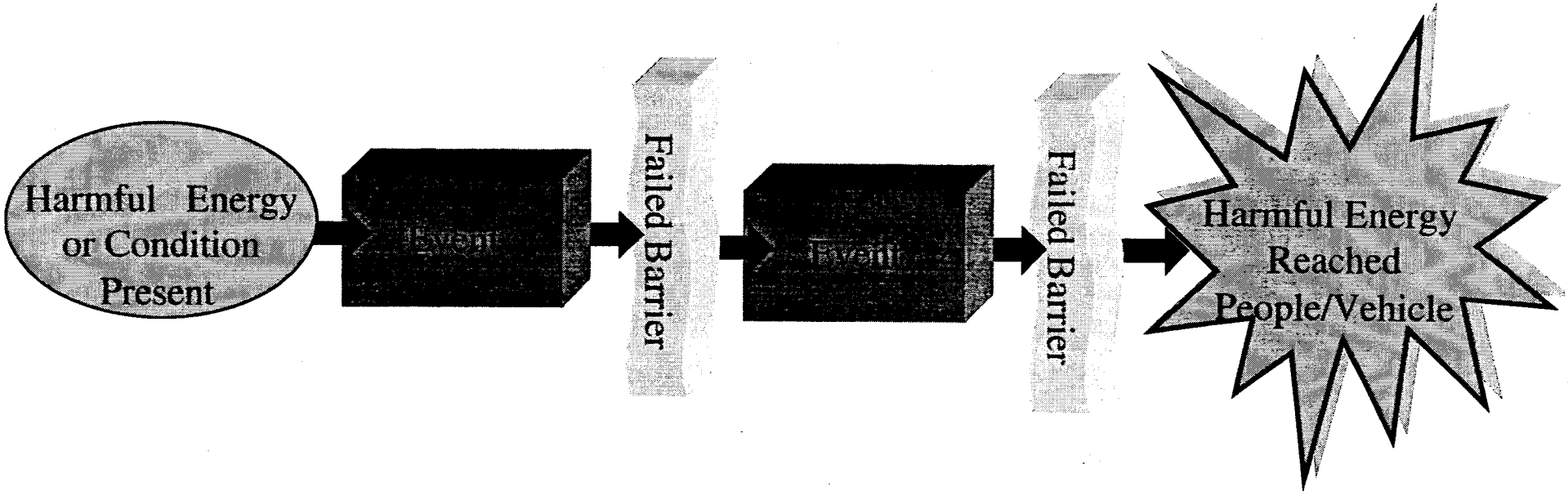
For the record, please state your full name, title, address, employer, and place of employment.

# Data Collection: Interviews

**Interview problem areas to avoid:**

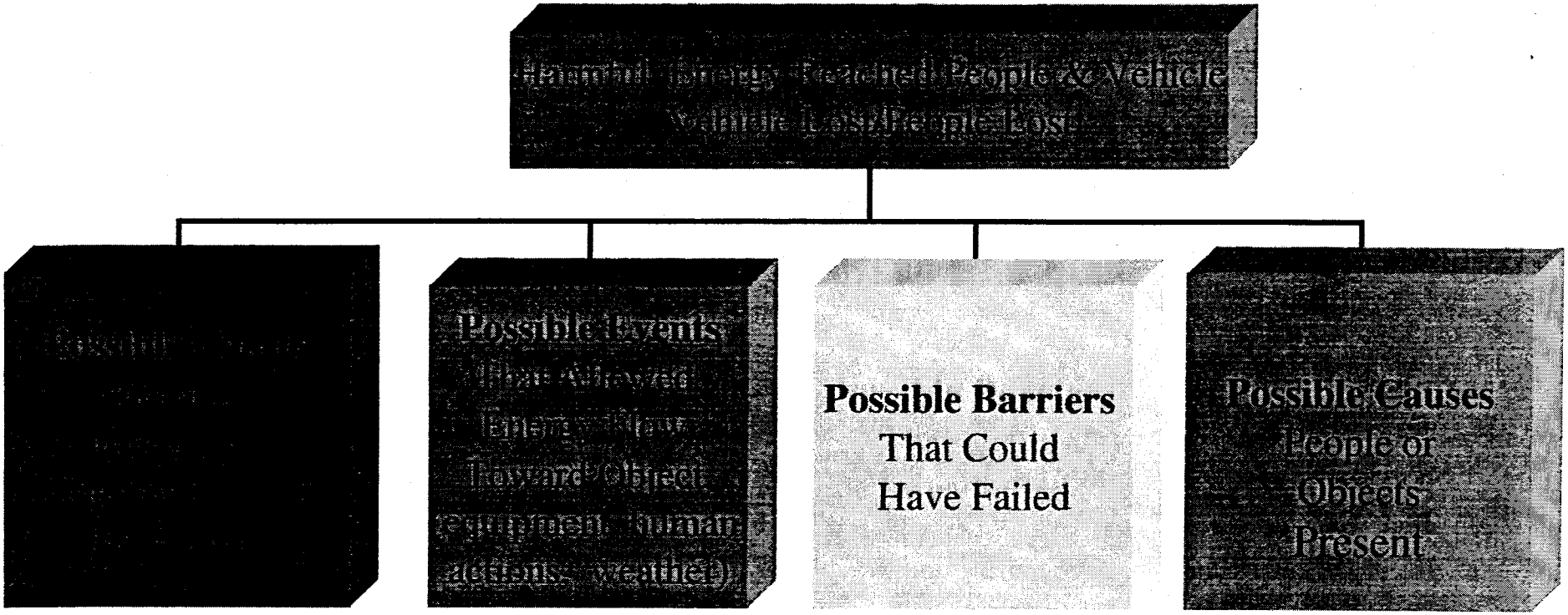
- **Intimidating or interrogating the witness.**
- **Leading the witness by answering your own questions.**
- **Jumping to conclusions.**
- **"Sharing" Information provided in other interviews or by other data sources.**

# Create Time Line of Events



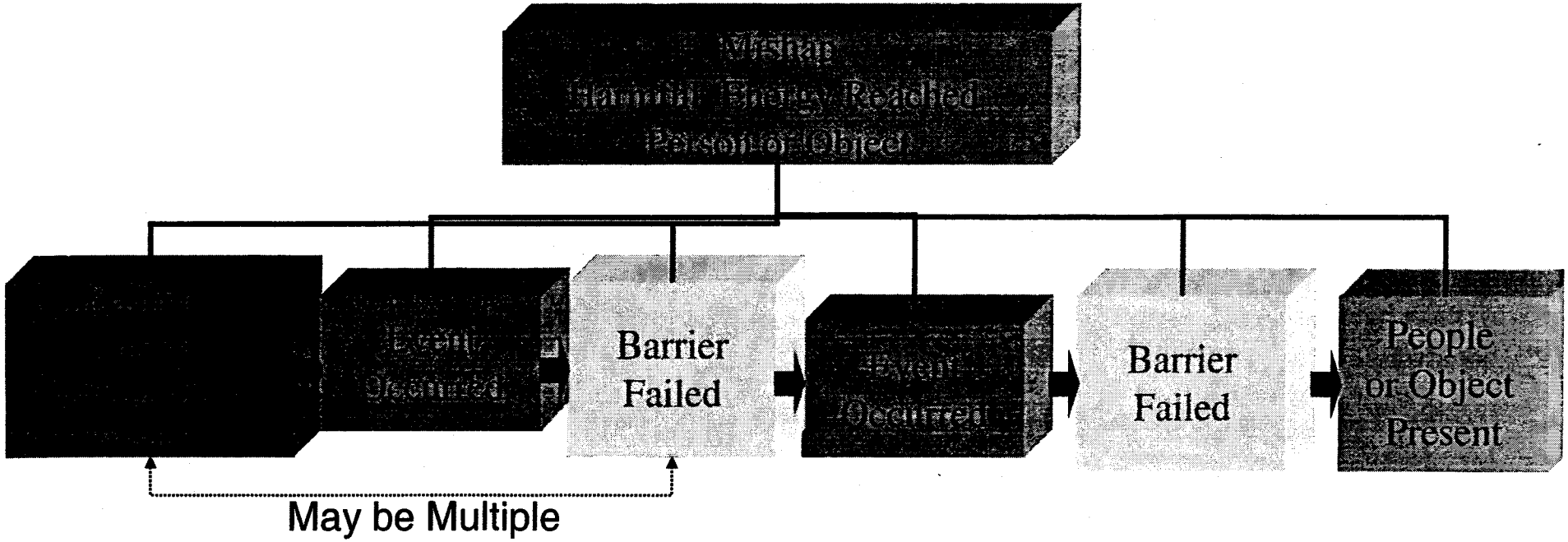

- **Documents mishap scenario in chronological order.**
- **Begin well before the accident – e.g., Shuttle Processing or Launch.**

# Create Fault Tree of Event




- **The resultant tree should lead to a comprehensive picture of all *POTENTIAL* causes of the accident (including conditions and events).**

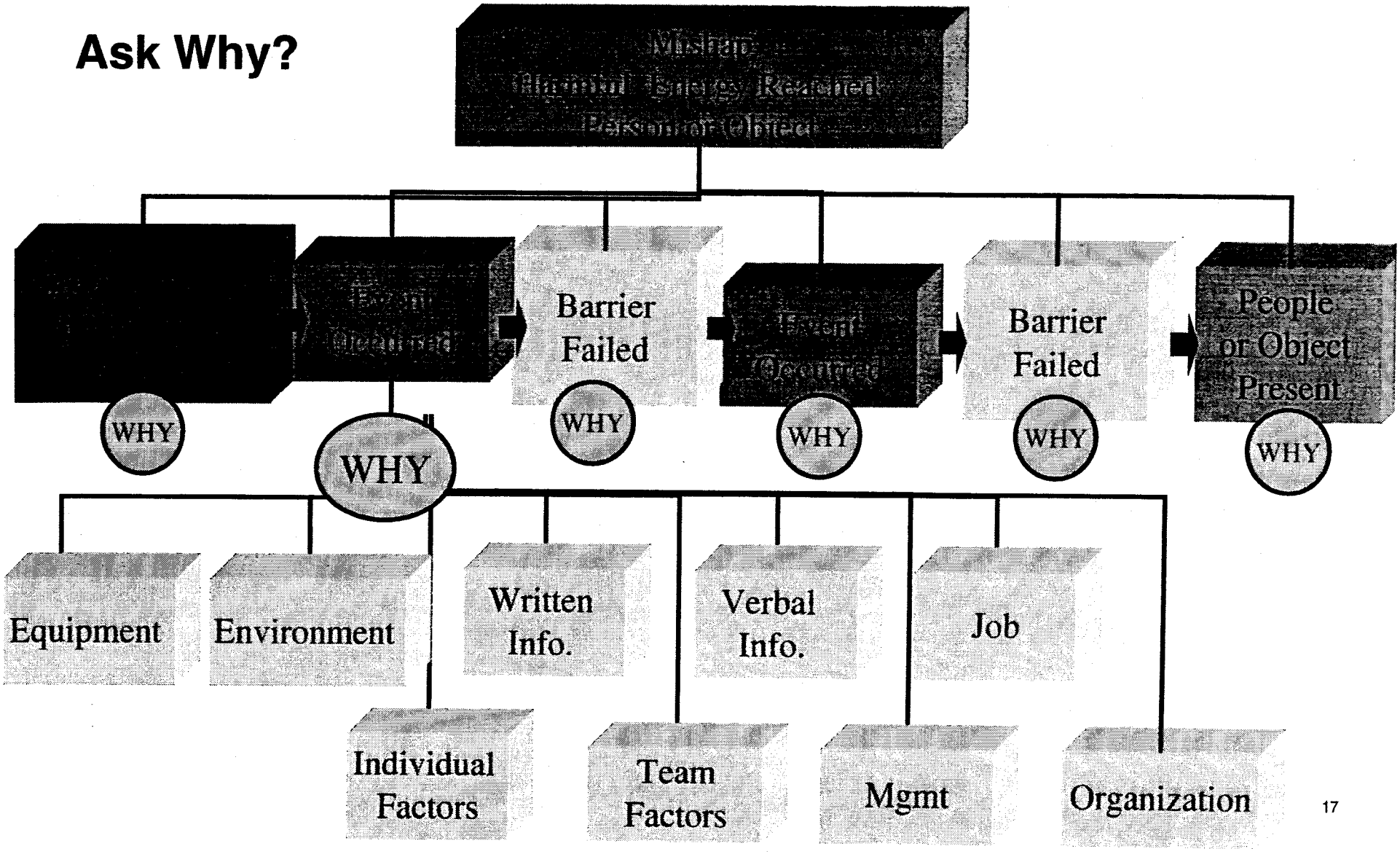
# Form Event & Causal Factor Tree




- **Merge fault tree and event data to document actual events of and failed barriers.**
- **If possible, show events in chronological order.**

# Event & Causal Factor Tree (Root Cause)

## Ask Why?



# Root Cause Analysis

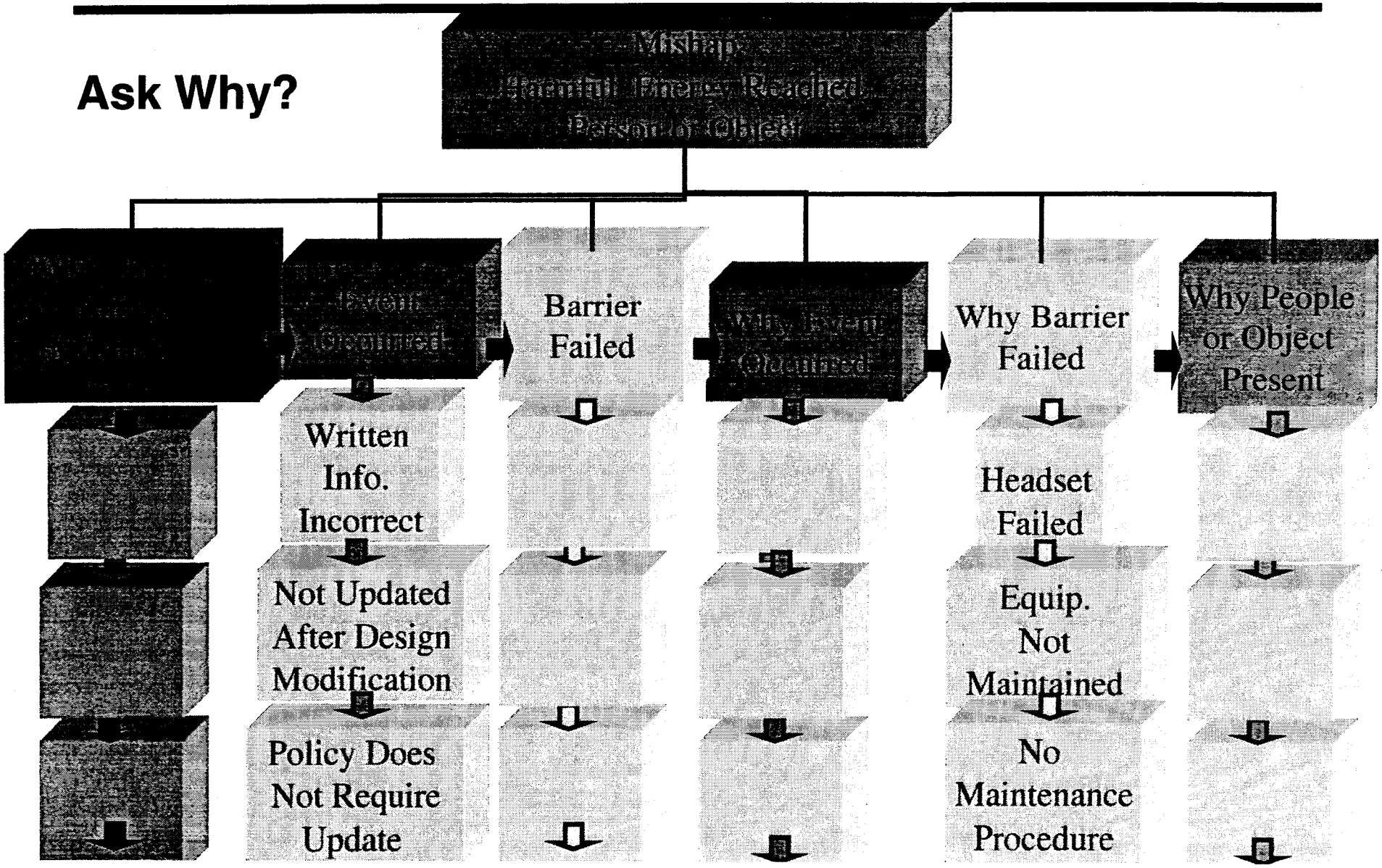
- Each lower box should answer the question "why" from the box above. (Be sure to keep the logic – questions should be in line with the original issue.)
- Should continue asking "why" until the analysis identifies "organizational" root causes.
- Tools such as the Incident Analysis Tool – Modified can be used to ensure that all possible areas of cause are considered.

# Analysis – Human Factors

- Cause of human error(s) should be analyzed.
- Cause of of unsafe act(s), violations and/or undesired action(s) should be analyzed.
- Can be done through many analysis techniques (e.g., root cause, MORT, barrier analysis, Incident Analysis Tool – Modified, etc).
  - Must define the type of human action before cause is identified. For example:
    - perceptual error
    - interpretation error
    - decision making error
    - action execution error, violation

# Root Cause Analysis

## Ask Why?



# Root Cause Analysis

## Apply the cause test

- If the deficiency or decision in question were corrected, eliminated or avoided, would the problem be prevented or avoided?

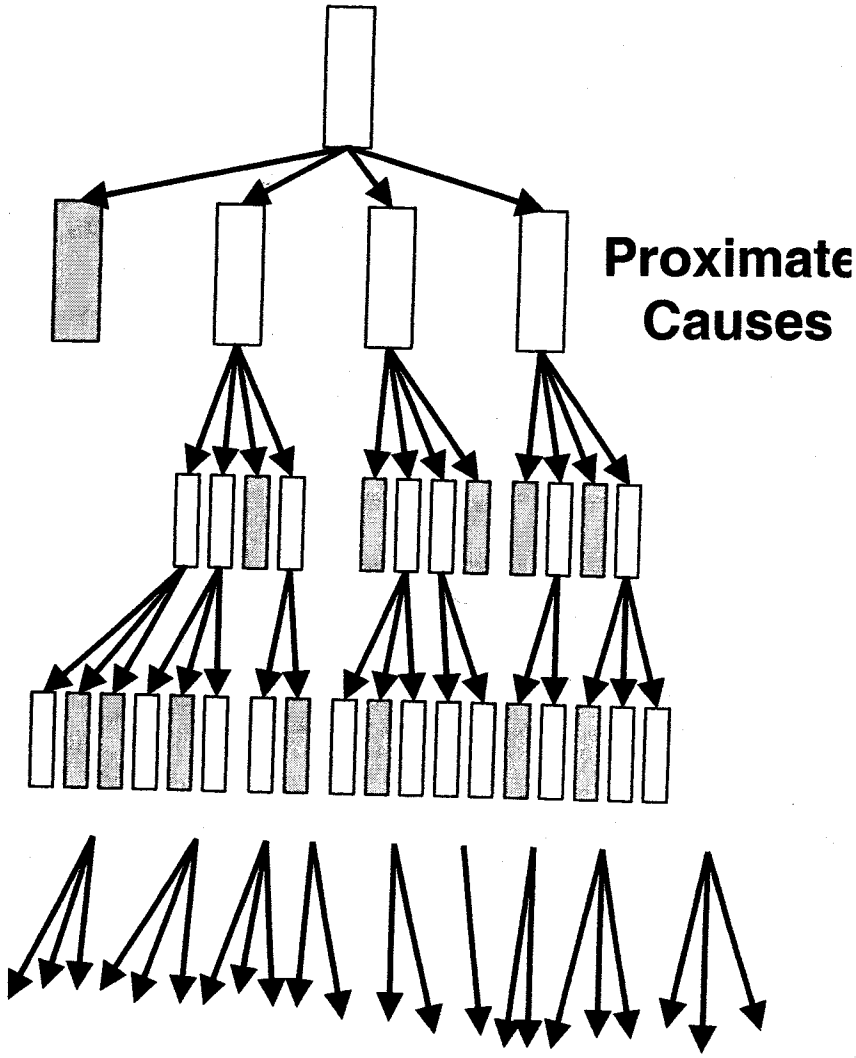
  If yes, then it is a cause.

  If no, then eliminate from the tree.

- Some choose to leave contributing factors on the tree… if done, illustrate them differently (e.g., different shape).

# Root Cause Analysis

- There may be more than one root cause and many contributing factors.
- Don't be surprised if more than one paths leads to similar causes.
- Once the tree is complete, perform a detailed review of each cause, verifying logic and that facts support causes.



# Analysis Pitfalls

**There is a great temptation to grasp the first plausible "WHY", cease investigating and start writing.**

**If the first "why" is grabbed three things happen:**

1. **Communications are made that steer the investigation in a narrow direction… which may be the wrong direction.**
2. **It becomes difficult for the Investigation Team to change its mind/direction even when new solid contradictory evidence is discovered.**
3. **The Investigation Team becomes discouraged and frustrated when new facts surface.**

# Analysis

**There is a great temptation to eliminate possibilities too quickly.**

- **There should be sound reasoning to indicate that it doesn't apply. Better to leave it, and eliminate it later than fail to consider it completely.**

# Report

- NPG: Appendix H-3 Sample Table of Contents

- Demonstrated tie from the
  - Facts to…
  - Findings (causes, contributing factors & observations) to …
  - Recommendations.

- Recommendations
  - Address both proximate and root causes.
  - Eliminate or decreases risk (probability and/or severity).
  - Clearly state intended action.

# Summary

- NASA philosophy:
  - Identify root cause and contributing factors to prevent mishap recurrence using structured and proven investigation methodology.
  - Non-punitive system.
- NASA needs quick and thorough investigation to ensure safety of process and return to flight to support Agency mission objectives.
- Policy and guidelines:
  - Ensures an unbiased, independent, and thorough investigation of the facts.
  - Provides description of data collection, analysis, and reporting methods.

# Overview Backup

# Definitions

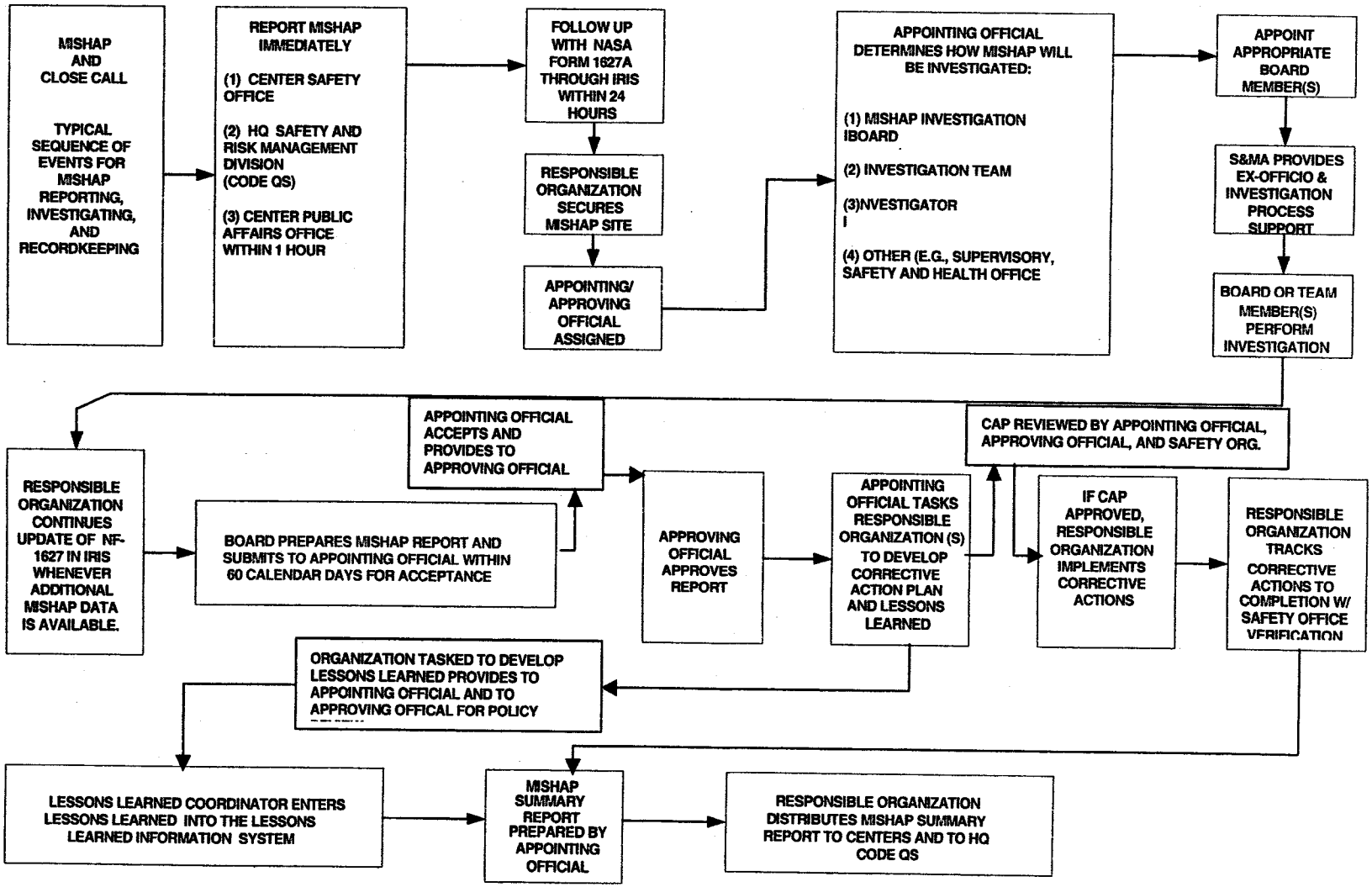
- Proximate Cause(s) – The event(s) and condition that occurred immediately before the undesired outcome, directly caused its occurrence, and if eliminated, or modified, would have prevented the undesirable outcome.

- Root Cause(s) – One of multiple organizational factors that contributed to / created the proximate cause and subsequent undesirable outcome, and if eliminated or modified would have prevented the undesirable outcome.

- Contributing Factor – A condition or event that may have contributed to the occurrence of an undesired outcome but if eliminated or modified would NOT by itself prevent the recurrence.

- Significant Observation – A factor, event, or circumstance identified during the investigation that did not contribute to the mishap or close call, but if left uncorrected has the potential to cause a mishap, injury, or increase the severity should a mishap occur.

# Sequence of Events for the MI Process – NPG 8621.1, Page 169



**MARY E KICZA, 03:39 PM 2/5/2003 -0500, Mishap Investigation briefing**

To: MARY E KICZA <mkicza@mail.hq.nasa.gov>
From: Faith Chandler <fchandle@hq.nasa.gov>
Subject: Mishap Investigation briefing
Cc: pahlf <pahlf@mail.hq.nasa.gov>, prichard@hq.nasa.gov
Bcc:
Attached: C:\Documents and Settings\fchandle\My Documents\Columbia\Mary K - Investigation Overview.ppt;

Mary,

Attached, please find the briefing package for tomorrow.
This was developed with input from Peter Ahlf.

Mr. Ahlf has set a 2:00 meeting time for this presentation.

I request some additional information:
1) Room location?
2) Will this be a power point presentation on a screen or a round table discussion (no projection equipment)?
3) Should I bring copies of the presentation (if yes, how many) or while someone on your staff produce the handouts?

# Overview of NASA Mishap Investigation Policy and Process

**February 6, 2003**

**NASA Headquarters**
**Office of Safety and Mission Assurance**

# Agenda

- NASA Policy & Guidelines
- Purpose of Investigation
- Mishap Investigation Team (MIT) - "Rapid Response Team"
- Columbia Accident Investigation Board (CAIB)
- Teams Supporting CAIB
- Investigation Techniques & Methods
- Data Collection
- Analysis (Time Line, Fault Tree, Root Cause)
- Summary

# NASA Policy and Guidelines

- NASA has policy and contingency planning in place to assure the proper investigation of all mishaps (including Space Shuttle).
  - NASA Policy Document (NPD) 8621.1, "NASA Mishap Reporting, Recordkeeping and Investigating Policy," October 02, 2002.
  - NASA Procedures and Guidelines (NPG) 8621.1, "Procedures and Guidelines for Mishap Reporting, Investigating, and Recordkeeping," June 2, 2000.
- Policy may be downloaded from: http://www.hq.nasa.gov/office/codeq/doctree/doctreec.htm

# NASA Mishap Investigation Policy

- The objective of a NASA mishap investigation is to:
  - Gather information from the mishap investigation process and use as a key element of NASA's mishap prevention program.
  - That is, understand what happened (root cause) and prevent recurrence.
- The results of mishap investigations are not to be used in matters related to civil, criminal, or administrative culpability or liability, or for disciplinary actions.
- Witness statements given in the course of a NASA mishap investigation are treated as privileged and non-releasable (to the extent allowed by law).
- Mishap reporting and investigating process is overseen by Code Q to assure independence of the process.

# Mishap Investigation Team (MIT)

- A trained, rapid response team that the Space Shuttle Program may deploy to any Shuttle incident site in a contingency situation.
- The team consists of the following personnel:
  - -- Chairman
  - -- Flight-trained crew representative
  - -- Flight Surgeon
  - -- Orbiter engineer
  - -- Main propulsion system engineer
  - -- Photographer
  - -- DDMS * representative
  - -- Payload representative
  - -- Safety representative
  - -- Administrative manager
  - -- Ground Operations manager

  *(DDMS: Department of Defense Manager's Space Shuttle Support)

  (Note: All of the above must have attended either the Shuttle Crash Investigation or an Aircraft Mishap Investigation Course.)

- The MIT travels to the incident site on a rapid response aircraft and they are the initial Accident Investigation Board. Their primary responsibilities are to:
  - -- Secure the site and control access.
  - -- Document the original state of the evidence.
  - -- Locate witnesses and obtain initial statements, names, & addresses.

# MIT Supporting Teams

- Can be named from any supporting center or project organization as needed, examples are payloads/cargo, solid rocket booster, flight operations and networks, etc.
- For STS-107 a Rapid Response Team is supporting the MIT in the field.

# Columbia Accident Investigation Board

**The independent board (named by Mr. O'Keefe as the Columbia Accident Investigation Board - CAIB) consists of a chair and seven members, supported by Headquarters, NASA Field Centers, and technical consultants, as required. Board Membership is as follows:**

**Chair: Adm (ret) Harold Gehman Jr. (Washington D.C.)**

1. **Maj. Gen. Kenneth W. Hess, USAF Chief of Safety (Kirtland AFB, NM)**
2. **Mr. Steven B. Wallace, FAA Director of Accident Investigation (Washington, DC)**
3. **Maj. Gen. John L. Barry, Director Plans and Programs, Air Force Materiel Command, (Wright-Patterson AFB, CA)**
4. **Rear Adm. Stephen Turcotte, Commander, Naval Safety Center (Norfolk, VA)**
5. **Dr. James N. Hallock, DOT Chief of Aviation Safety Division (Cambridge, MA)**
6. **Brig-Gen Duane Deal, Commander 21st Space Wing (Peterson AFB, CO)**
7. **Mr. G. Scott Hubbard, Director, Ames Research Center (Moffett Field, CA)**

- **Executive Secretary: NASA Chief Engineer, Mr. Theron M. Bradley Jr. (NASA Headquarters, Washington, DC)**
- **Ex-officio member: Mr. Bryan O'Connor NASA Associate Administrator, Office of Safety and Mission Assurance (NASA Headquarters, Washington, DC)**
- **Oversight : Mr.** Bruce Cobb, **U.S. Inspector General (TBA).**

# Columbia Accident Investigation Board's Responsibilities

- Conduct activities in accordance with direction from NASA Administrator.
- Use established NASA support structure for working groups.
- Activate the working groups as appropriate to the mishap.
- Impound property, equipment, and records as necessary.
- Obtain and analyze relevant facts, evidence, and opinions.
- Determine facts (what happened), as well as probable causes.
- Identify & document findings: causes, contributing causes, potential causes, and pertinent observations. (Evaluate ALL possible reasons "why" it happened.)
- Develop recommendations to preclude recurrence of a similar mishap and other appropriate actions.
- Provide a final written report.

*Per letter to Admiral Gehman 2-2-03*

# Other Supporting teams to the CAIB

Independently assesses data and may conduct their own inquiries, tests, and actions.

**Columbia Accident Investigation Board**

**(CAIB)**

Independent Board

Coordination

NASA Led

FEMA
Homeland Securit
EPA
DDMS
NTSB
FBI
FAA
Texas National Guard
Local Law Enforcement
U. S. Forest Service
Other agencies

Task Force to be added soon

Headquarters Contingency Action Team

Mishap Response Team

Membership: Mission Management Team (MMT)

Flight Crew Operations
Mission Operations
Engineering
System Integration
Payloads & Cargo
MSFC Projects
Space & Life Sciences
Prime Contractors

Mishap Investigation Team

Orbiter

Emergency Operations Center

Data & Record Handling Team

External Tank
Solid Rocket Booster
Reusable Solid Rocket Motor
Space Shuttle Main Engine

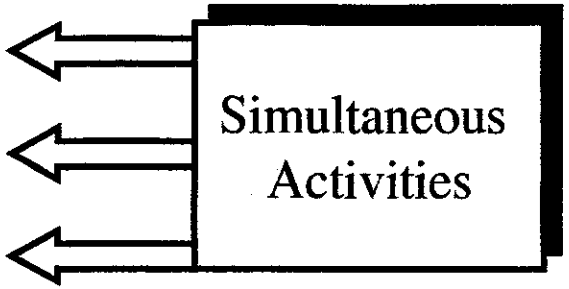
Rapid Response Team

KSC Ground Operations

# Investigation Techniques and Methods

**Comprehensive systematic method (a suggested NASA practice).**

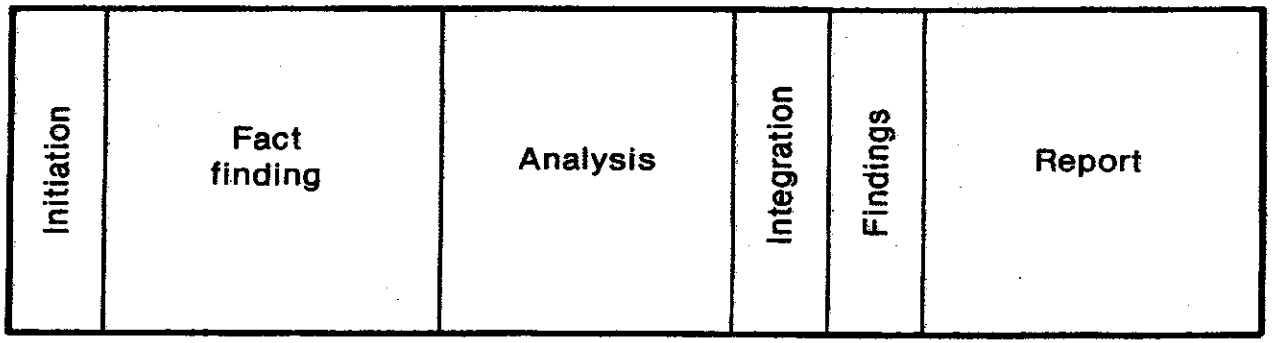
- **Gather data.**
- **Create time line.**
- **Create fault tree.**



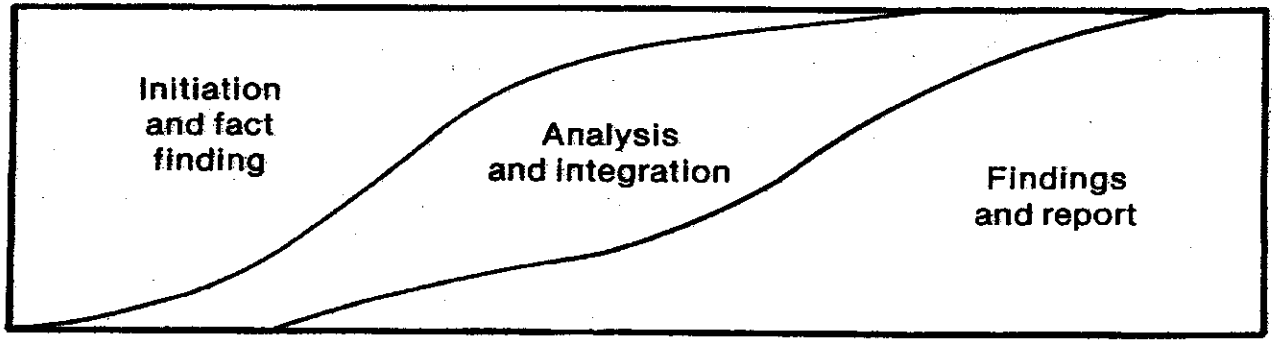

- **Merge fault tree and time line to create events and causal factor tree.**
- **Further investigate root cause.**
- **Perform cause test.**
- **Document root cause, contributing factor(s) and other significant observations.**
- **Each finding (cause, contributing factor, or observation) should have a recommendation in the final report.**

# Implementing the Process

Classic phase sequence (step-by-step)




Real-life phase sequence (overlapping and combined)



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  - Change analysis

# Data Collection

**Initially Focus on "WHAT HAPPENED"**

- **NOT "Why It Happened."**
  **Should Not Fixate on Causes.**

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**Investigating an Incident and Fixing the Problem are Two Separate Things... Should Be Kept Separate.**