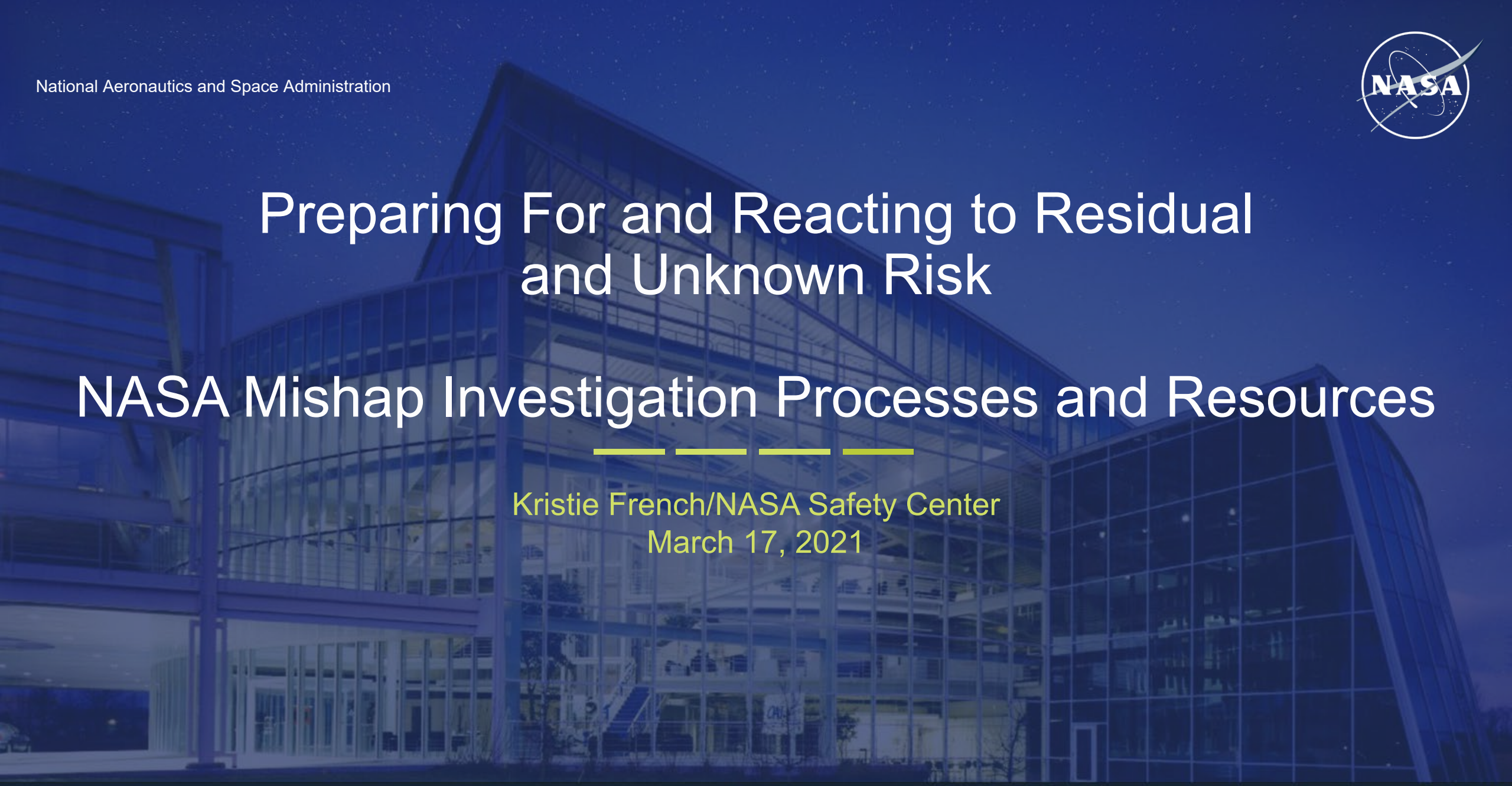


Preparing For and Reacting to Residual and Unknown Risk

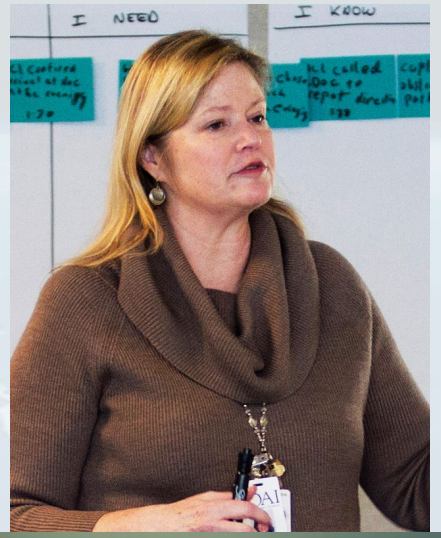
NASA Mishap Investigation Processes and Resources

Kristie French/NASA Safety Center

March 17, 2021

Introduction and Agenda

- NASA Safety Center
- Preparation
- Reporting
- RCA Process
- Resources
- Questions

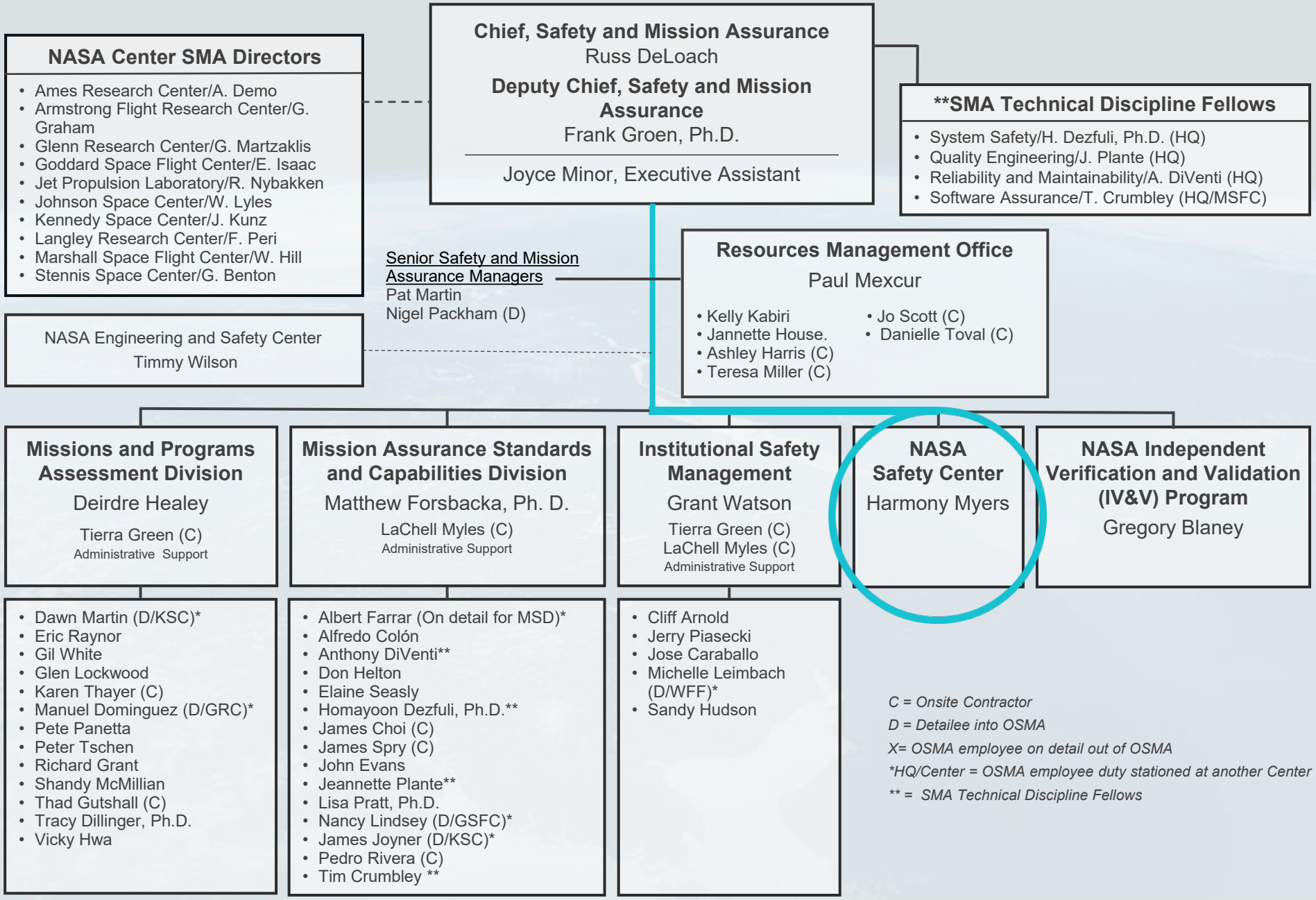


The NASA Safety Center

- Established in October 2006 in response to the Columbia Accident Investigation Board (CAIB) to support the Safety and Mission Assurance (SMA) requirements of NASA's portfolio of programs and projects
- Three offices which focus on improving the development of tools, processes and personnel needed for the safe and successful achievement of NASA's strategic goals
  - *Technical Excellence*
  - *Knowledge Sharing and Analysis*
  - *Assessments and Investigations*
- Located in the Ohio Aerospace Institute in Brook Park, Ohio
- Tenant of NASA Glenn Research Center (GRC)

Debris from the fallen space shuttle Columbia as seen in May 2003 during a reconstruction effort as part of the accident investigation. The debris was later moved into the preservation office. (NASA)

All of the pieces received and collected in the Columbia Reconstruction Hangar have been catalogued and moved to a permanent site in the VAB. Credit: NASA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• Goddard Space Flight Center/E. Isaac
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• Homayoon Dezfuli, Ph.D.**
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• James Spry (C)
• John Evans
• Jeannette Plante**
• Lisa Pratt, Ph.D.
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• James Joyner (D/KSC)*
• Pedro Rivera (C)
• Tim Crumbley **
• Cliff Arnold
• Jerry Piasecki
• Jose Caraballo
• Michelle Leimbach (D/WFF)*
• Sandy Hudson
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D = Detailee into OSMA
X= OSMA employee on detail out of OSMA
*HQ/Center = OSMA employee duty stationed at another Center
** = SMA Technical Discipline Fellows

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NASA SAFETY CENTER

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Administrative Officer


HEATHER LINDEN
Business Manager


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DIRECTOR
Harmony Myers


DEPUTY DIRECTOR
Robert Conway


DENNIE GONIA
Executive Assistant


MARK KOWALESKI
Chief Engineer


KEN O'CONNOR
Mishap Investigation Program Executive

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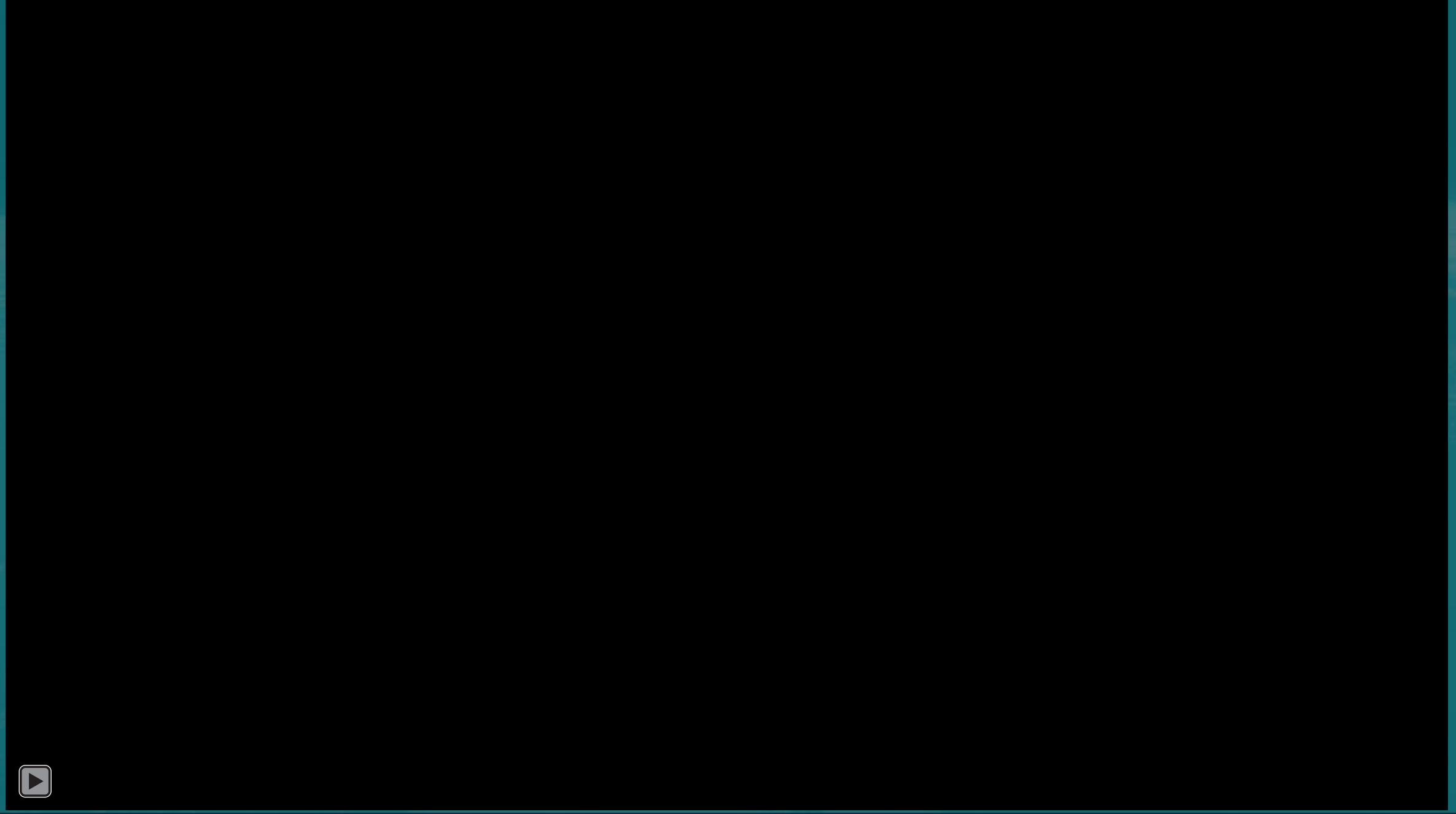
Preparation



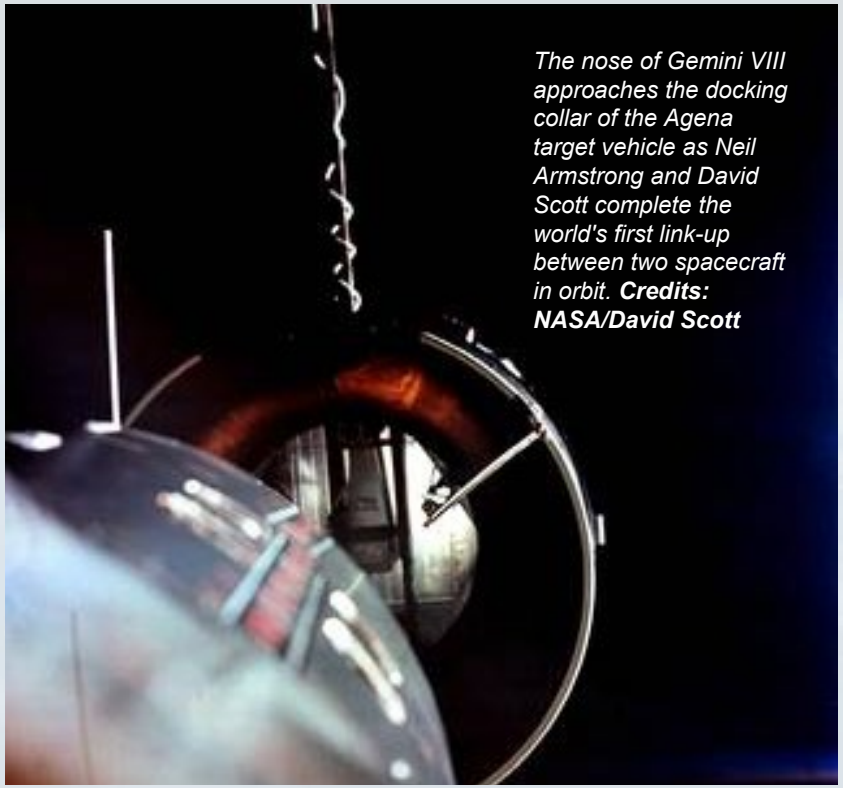
Is NASA Ready to Respond?

Preparation

NASA does everything we can to reach success. But we must also prepare for failure to limit the impact of our bad days. After loss, we must plan the moves ahead to continue our mission.

- NPR 8621.1
  - *Baselined in 1966 after the Gemini VIII mishap*
  - *Applies to all NASA employees*
  - *Contains Mishap Program Definitions, Roles & Responsibilities, Training, Processes*
- NASA Mishap Investigation Handbook – aid for the investigation process
- Mishap Preparedness and Contingency Plans (MPCPs)
- Trifolds

https://www.nasa.gov/feature/geminis-first-docking-turns-to-wild-ride-in-orbit



The nose of Gemini VIII approaches the docking collar of the Agena target vehicle as Neil Armstrong and David Scott complete the world's first link-up between two spacecraft in orbit. ***Credits: NASA/David Scott***

Spacecraft communicator Jim Lovell, foreground, and fellow astronaut Bill Anders, follow reports from Gemini VIII during the in-space emergency. A spacecraft maneuvering thruster malfunctioned causing Neil Armstrong and David Scott's capsule to tumble out of control. ***Credits: NASA***

NASA Mishap Definitions

Mishap Is an Unplanned Event Leading to	Mishap Isn't
Occupational Injury or illness caused by NASA funded operations	Test-Induced (accepted risk)
	Normal Wear and Tear
Destruction or Damage to NASA, public, private property caused by NASA-funded operations	Weather
	Vandalism
NASA mission failure	Illness or Fatality from Natural Causes, Self-Inflicted

Mishap Type	Definition – Damage	Definition – Injury/Illness
Type A	Direct Cost of $2M or more, LOV, OCF	Fatality or Permanent Total Disability
Type B	Direct Cost of at least $500K but < $2M	Three or more Hospitalized or PPD
Type C	Direct Cost of at least $50K but < $500K	Restricted or Days away, Hospitalization
Type D	Direct Cost of at least $20K but <$50K	OSHA Recordable
Close Call	Direct Cost of <$20K, Mishap Potential	First Aid, Mishap Potential

Direct Cost – Replacement Cost; LOV – Loss of Vehicle; OCF – Out of Control Flight; PPD – Permanent Partial Disability

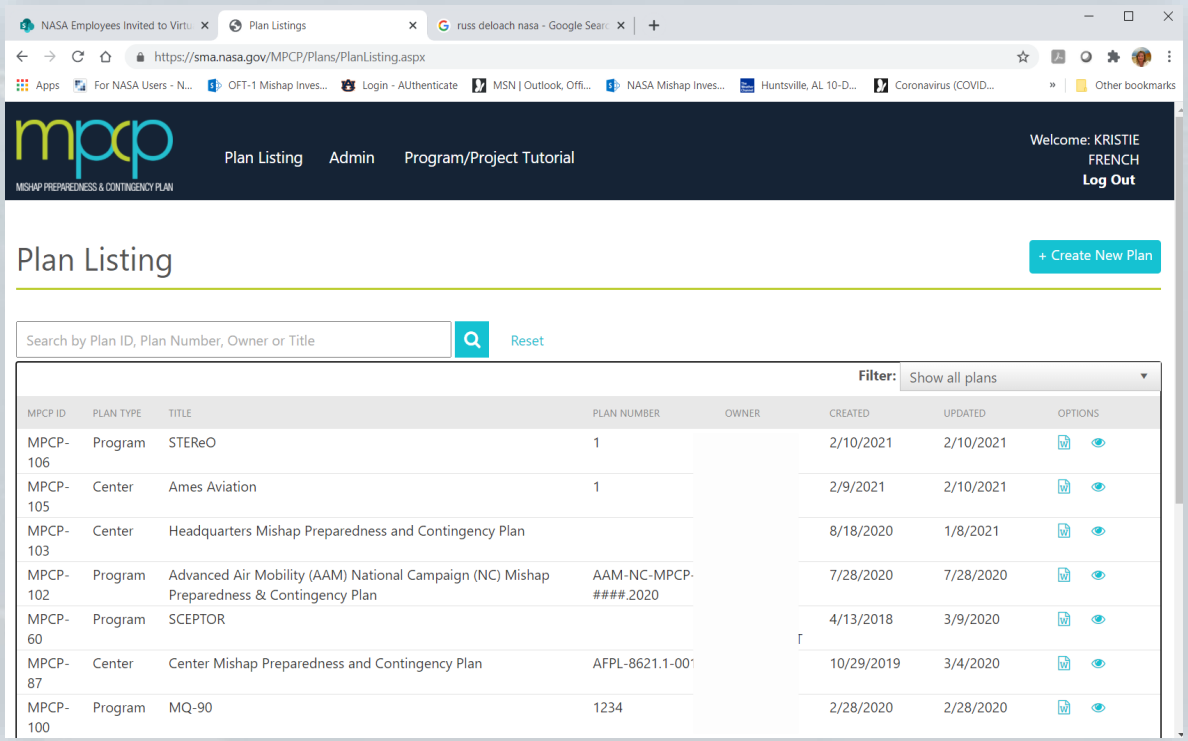
Note – Not a compete list

Mishap Training Requirements

Role	Definition	Training
Interim Response Team (IRT)	Team that responds after the mishap scene has declared the scene safe. Not Emergency Response.	Mishap Process IRT Program or Project Specific
Investigating Authority	NASA Mishap Investigator, Mishap Investigation Team, Mishap Investigation Board	Mishap Process (recommended) Chair Training > 1 member have SM training
IA Safety Member (SM)	Federal Employee w/Safety Skill	Mishap and Root Cause Analysis
IA Human Factors Member (HF)	Federal Employee with HF Skill	Human Factors Investigation
Ex Officio	Federal Employee, non-voting, ensures process per NPR 8621.1	SM, HF and Chair
Advisors	Fed Employee, non-voting	Mishap Process (recommended)
Consultants	Non Federal, non-voting	Mishap Process (recommended)

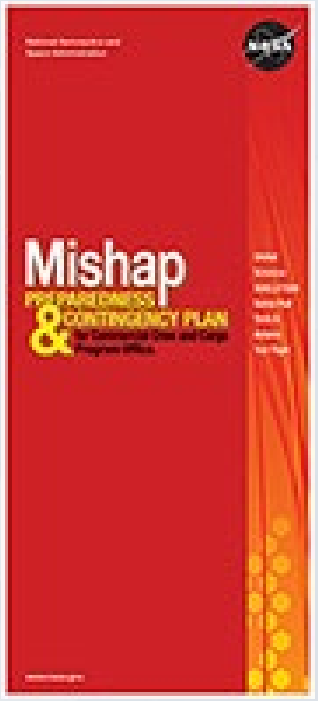
Mishap Preparedness and Contingency Plan (MPCP)

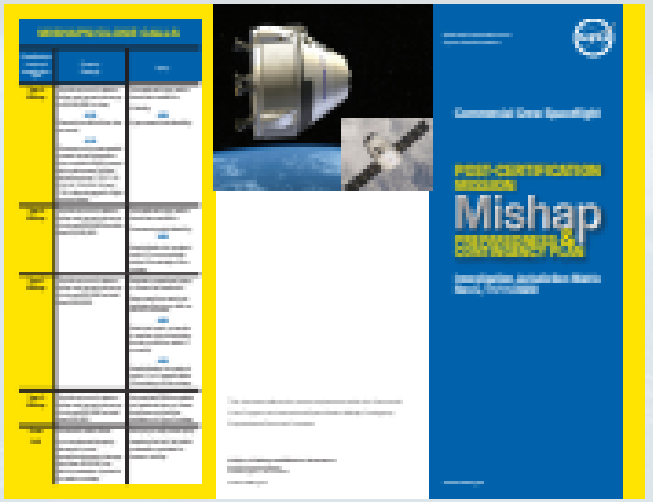
- Each center and Program/Project manager must have an MPCP outlining organizational activities and responsibilities to be accomplished in the event of a mishap.
- **MPCP's** include, but are not limited to
  - *Hazards*
  - *Responsible Organizations and Call List*
  - *Relation to other Plans, International Agreements*
  - *Simulations*
  - *Impoundment Details*
  - *Mishap Investigation*
  - *Funding*
  - *Precedence*

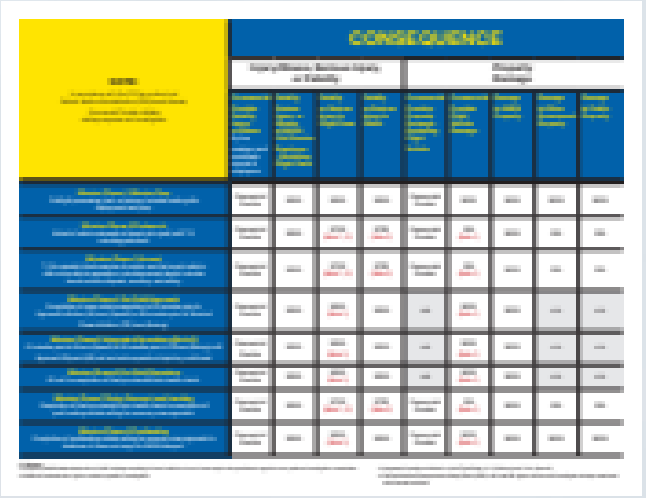


Trifolds

- Provide **agreement** of mishap criteria, definitions of Type A-D and Close Calls
- Responsibility for the investigation dependent on mission phase and severity
  - *NASA*
  - *Commercial Provider*
  - *Launch Site*
  - *FAA*
  - *NTSB*
  - *Other Government Agency*
  - *Salvage Contractor*







Reporting

Reporting Options

- Center Processes – Safety Concerns Reporting System, SHETrak
- IFAs, Process Escapes
- Security issues, IG
- Test or mission investigations not defined as a mishap but NASA has **high interest** or do not accept the depth or results of the responsible org
- News – least desirable – **High Visibility**

NMIS

- The NASA Mishap Information System (NMIS) - custom-developed system required for capturing NASA mishaps, close calls and hazards
- Any civil servant or contractor working in support of any NASA activity may use NMIS - If a NASA employee is injured or involved in an incident that results in damage, it is his or her **personal responsibility** to tell the supervisor what happened, it is the supervisor's job to report it in NMIS
- You do **not** need a NMIS account to report the event
- **What should be reported in NMIS?**
  - *NASA civil servants and contractors should always report a **close call, mishap or hazard** to their supervisor. The supervisor will document the incident in NMIS*
  - *Depending on the severity of the incident, there may be a heightened level of investigation so that the agency can ensure Corrective Actions are put in place to prevent it from happening again. If this happens, employees may be asked some additional questions beyond what was additionally reported*
- **How do you submit a NMIS report?**
  - *If you're a supervisor and an employee reports an incident to you, go to **NMIS** and click "Report an Event." Fill out the fields with as much detail as possible. Record when the event occurred, where it occurred and what happened. There is also an option to provide a photo. To respect privacy and accurately depict the incident, photos should not include the injured person and should not be staged*

NSRS

- The NASA Safety Reporting System (NSRS) is an **anonymous**, voluntary and responsive reporting channel to notify NASA's upper management of concerns about hazards and mission assurance concerns
- Any civil servant or contractor working in support of any NASA activity may use the NSRS to report safety and health concerns.
- **What should be reported to the NSRS?**
  - *Anyone who **fears restraint, interference, coercion, discrimination or reprisal** for filing a report of an unsafe or unhealthful working condition can use the NSRS to submit concerns anonymously. If an employee reports a mishap, but doesn't approve of how the investigation was handled, he or she can submit a report to the NSRS to attain resolution and exposure.*
  - *Though some organizations offer anonymous reporting options, it's important to note that personnel, regardless of affiliation, can choose to voluntarily bypass local reporting channels and report directly to the NSRS at any time.*
- **How do you submit a NSRS report?**
  - *To submit a **report to the NSRS**, print the downloadable NSRS report form, complete it and mail it to: NSRS, P.O. Box 5826, Bethesda, MD 20824-9913. The report form, or a personal letter if preferred, should include as much detail as possible, though sharing one's identity is optional*
  - *Submitted NSRS reports go to a postal mailbox controlled by an independent NASA contractor, who sends only a redacted version to NASA Headquarters. Any identifying information is removed — **identities are NEVER shared with NASA***

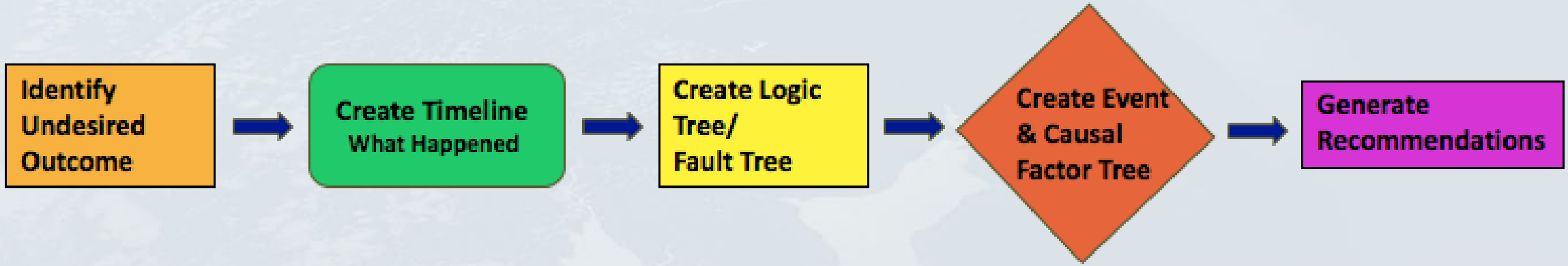
Process

Response

- **First Responders** (Paramedics, Fire Fighters, Hazmat) arrive to the scene
  - *Treat injured personnel*
  - *Ensure both personnel and property are **safe***
- **Interim Response Team** (IRT) (First Hours Until Investigating Authority Arrives)
  - *Document the scene using photography, video, and debris mapping*
  - *Preserve perishable evidence*
  - *Identify the witnesses and collect written statements*
  - *Implement the chain-of-custody process.*
  - *Impound evidence*
  - *Collect debris*
  - *Advise the supervisor if drug testing should be requested*
- **Investigating Authority** (IA) MIB, MIT, MI, JIRT
  - *Receive the evidence collected by the IRT*
  - *Collect additional evidence*
  - *Analyze data, identify causes of mishap*
  - *Generate report describing **findings and recommendations***

NASA Root Cause Analysis Process

- Does NASA investigate all NASA Mishaps? – Yes
- Does NASA investigate incidents that are not a NASA mishap? – Yes
- Do all mishaps require the same effort? – No – depends on severity
- **NASA 5-Step Method for Root Cause Analysis** – Type A, B, High Vis CC and anyone else who wants to



Root Cause Analysis: NASA's History

- The NASA Root Cause Analysis (RCA) method was developed to provide a **systematic and thorough evaluation** of NASA mishaps and incidents
- The intent was to eliminate **investigation pitfalls** such as Confirmation Bias, Single String Logic, and Hardware-Only analysis
- RCA can be used to evaluate **any** situation where there is a **gap between the desired performance and the actual performance**
- The process was formalized and documented in **NPR 8621.1**, the NASA Mishap Investigation, Reporting and Recordkeeping Procedure.
- **Software** was developed to support the method

RCA is an effective tool to evaluate
— *A chain of events*
— *Process problems*
— *Complex problems that are made up of several events and conditions*

How Do We Find Root Cause?

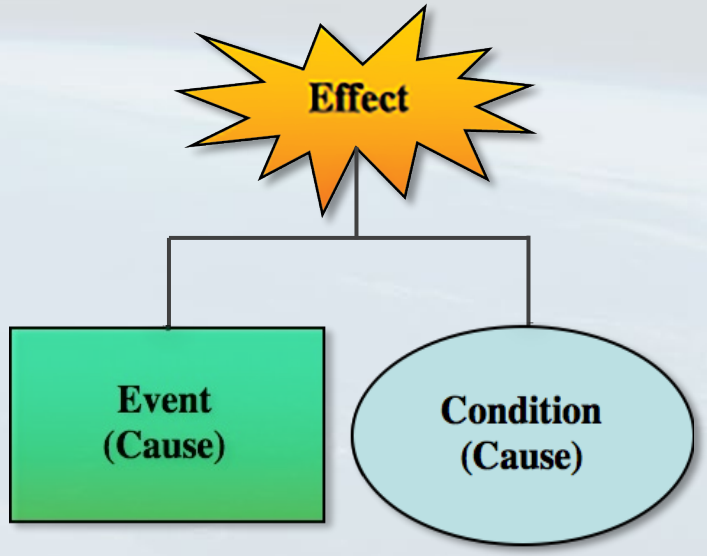
RCA

- RCA is a systematic and structured evaluation method that identifies the proximate, intermediate, and root causes for a **Defined Undesired Outcome**
- RCA is an event-based **5-step method** that helps determine
  - ***What*** *happened?*
  - ***How*** *it happened?*
  - ***Why*** *it happened?*

The purpose of RCA is to identify the "root causes" so that these systemic problems can be eliminated or modified. Future occurrences of similar and related problems may then be prevented

Cause–Effect Relationships

- A **Cause** is something or somebody that makes something happen or is responsible for a certain result or action. A cause can be thought of as the **reason** that somebody does something or the reason that something happens
- **Effect** - a change or changed state that occurs as a direct result of an
  - **Event – one discreet action**, direct action by somebody or something
  - **Condition - as found state**
- **Undesired Outcome (RCA Step 1)** - an unwanted effect (A-V-D, Quantified)
- Effects in a causal chain can be positive or negative

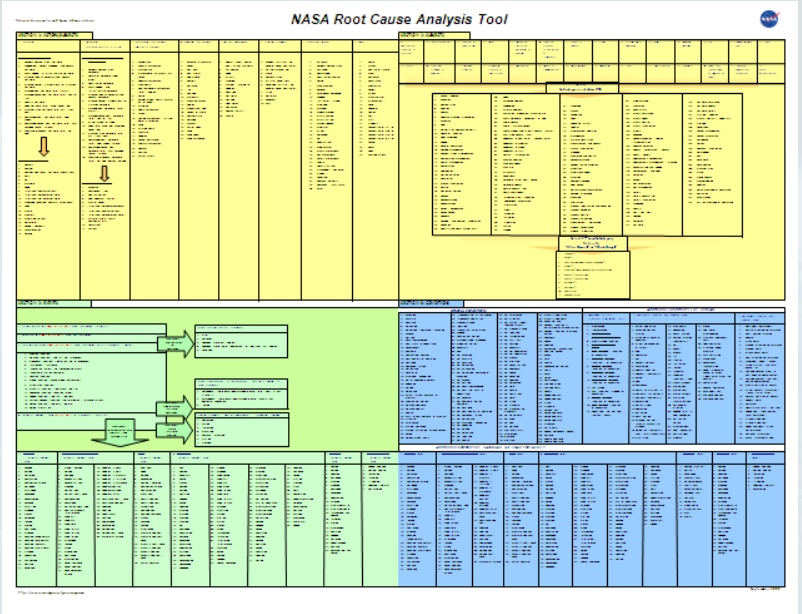


One cause can lead to one effect, multiple effects. Multiple causes can lead to one effect.

RCA Tools

- Gathering **data** (evidence) supports all steps of RCA
- For each cause or contributing factor, the evidence must be known.
- Sources of data = **SHELL-D**
  - *Hardware*
  - *Environment*
  - *Liveware (individual)*
  - *Liveware (e.g., team, company)*
  - *Documents*

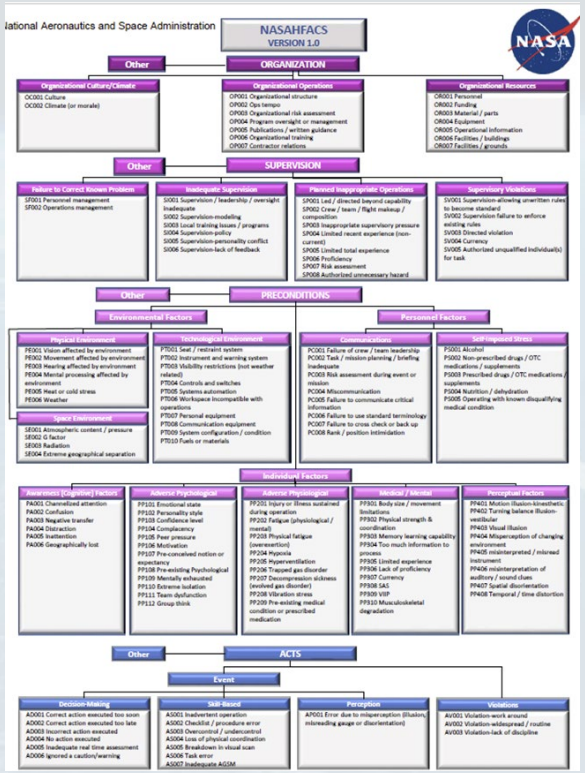
Big Sheet



Four-Column List to organize information in the analysis.

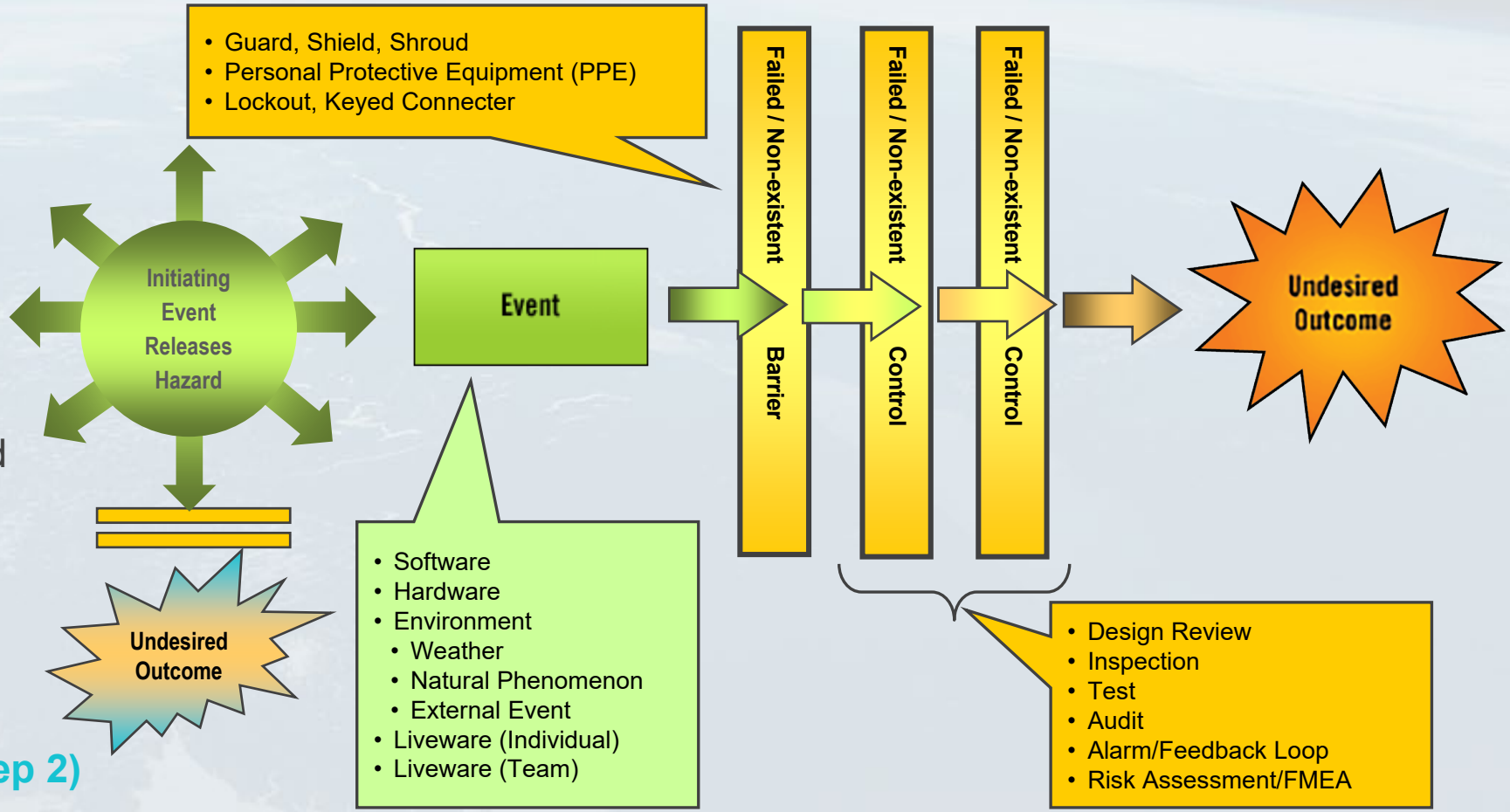
NASAHFACs

- Based on James Reason's "Swiss Cheese" model
- Four "slices," or tiers, of **human performance**
- The NASAHFACS tool views the event with an eye towards the **entire system**.
- Understanding factors beyond the operator are critical for getting to embedded factors that can reoccur in the future.



Anatomy of an Accident (AoA)

- Identify
  - Initiating Event
  - Hazard
  - Barriers/Controls
  - Target
- Order of events, conditions failed barriers/controls is
  - ***Situation Specific***
  - ***Does not show causation***
- Becomes the **Timeline (RCA Step 2)**



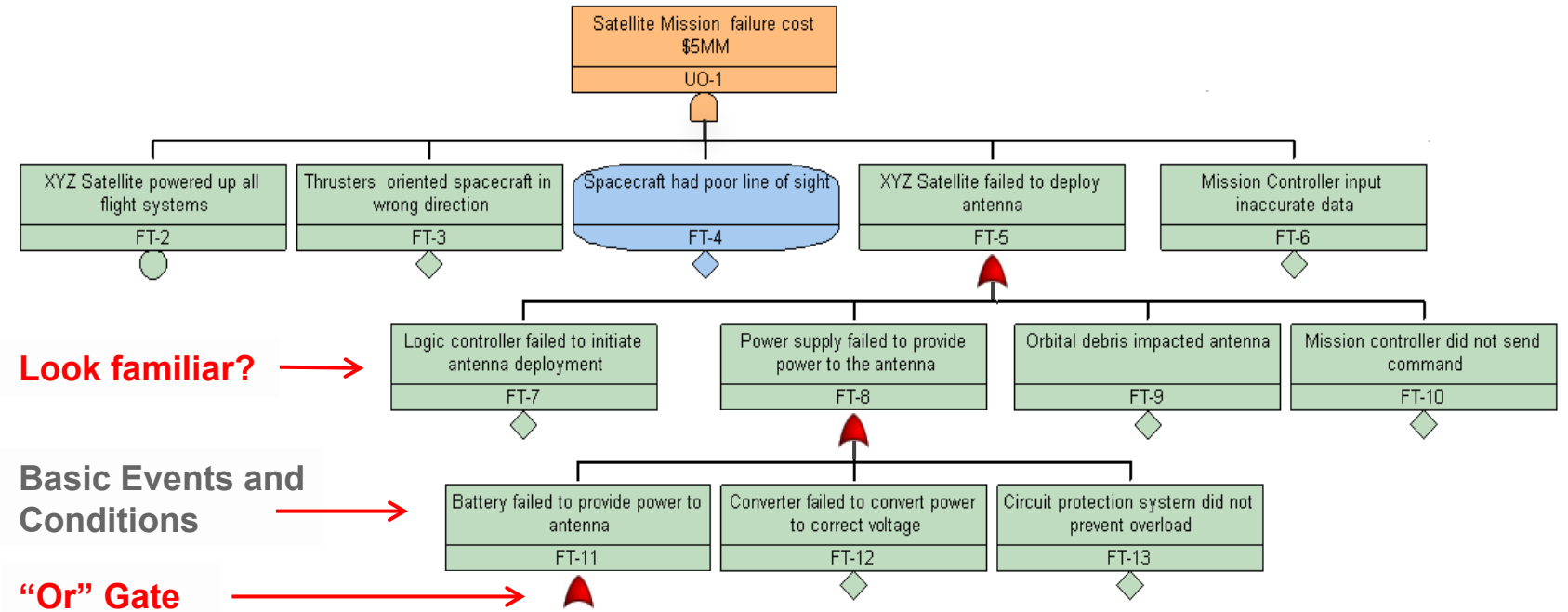
Root Cause Analysis Fault Tree

An **RCA Fault Tree (RCA Step 3)** is a logic diagram that has the potential causes and contributing factors that could have created the undesired outcome. It is different from a traditional Fault Tree.

Identify	For RCA, the top event is the **Undesired Outcome.**
Place potential event and conditions that could have caused the top event below.	**For RCA, the first tier identifies the proximate causes and usually comes from the timeline.** RCA Fault Trees can also include normal events. Use the cause test to identify missing causes.
Decompose	For RCA, answer why the proximates occurred, may initially contain compound events and conditions. Then break down to graphically illustrate each compound as a potential individual contributor. Events with multiple system elements must show each element separately.
Resolve	For RCA, further define the circumstances and type of failure for each of the system elements so that each box displays one discreet action or a single as found state and answers why for above.

RCA Fault Tree

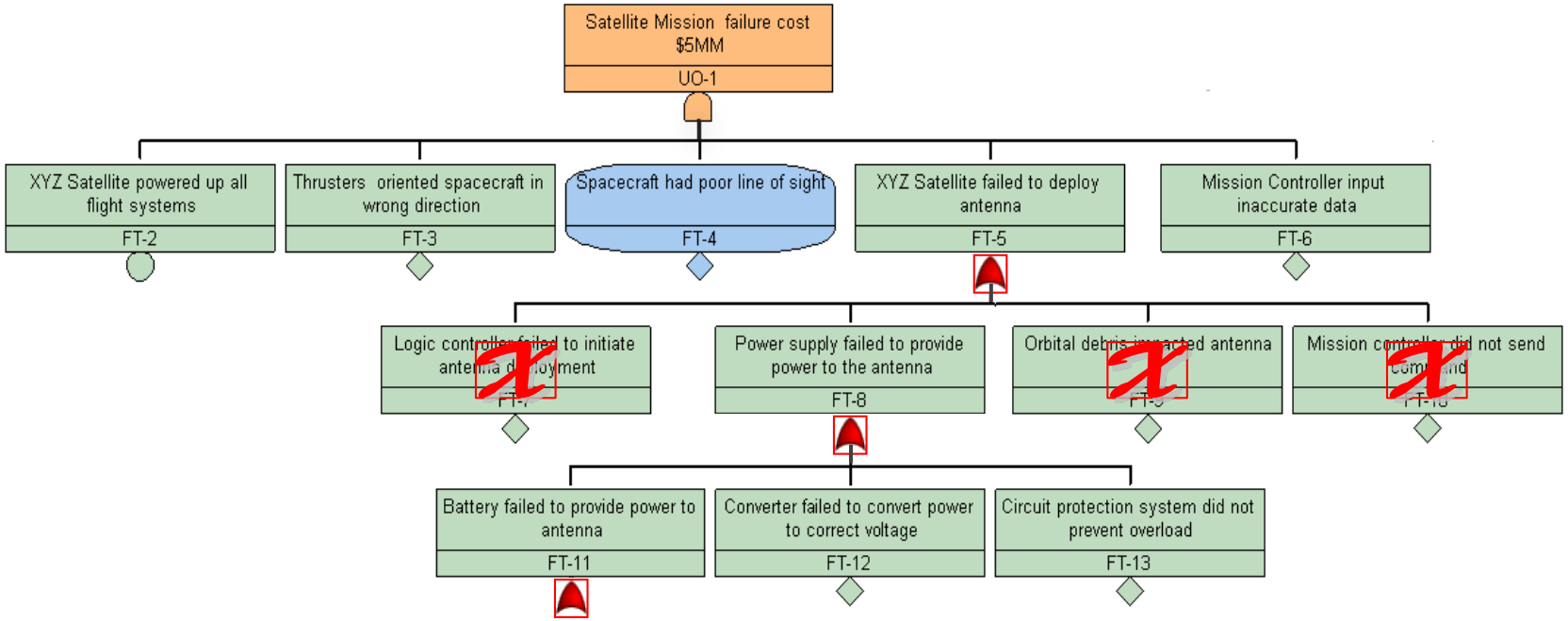
- Identify **all potential causes** (failure modes) that may have occurred and caused each event and condition
- Brainstorm to ensure that all possible causes are included, NOT just those that you are sure are involved – **Use SHELL-D, the Big Sheet, NASAHFACS, existing FTAs**
- Decompose down to basic events/conditions to be ruled in/out



RCA Cause Test

When determining if you have a cause-effect (causal) relationship, Ask the following 3 inter-related questions:

1. Did the cause **precede** the effect or occur at **exactly the same** time and in the same place?
2. Is the cause **necessary** for the effect to occur?
3. Is the cause **sufficient** **by itself** for the effect to occur?

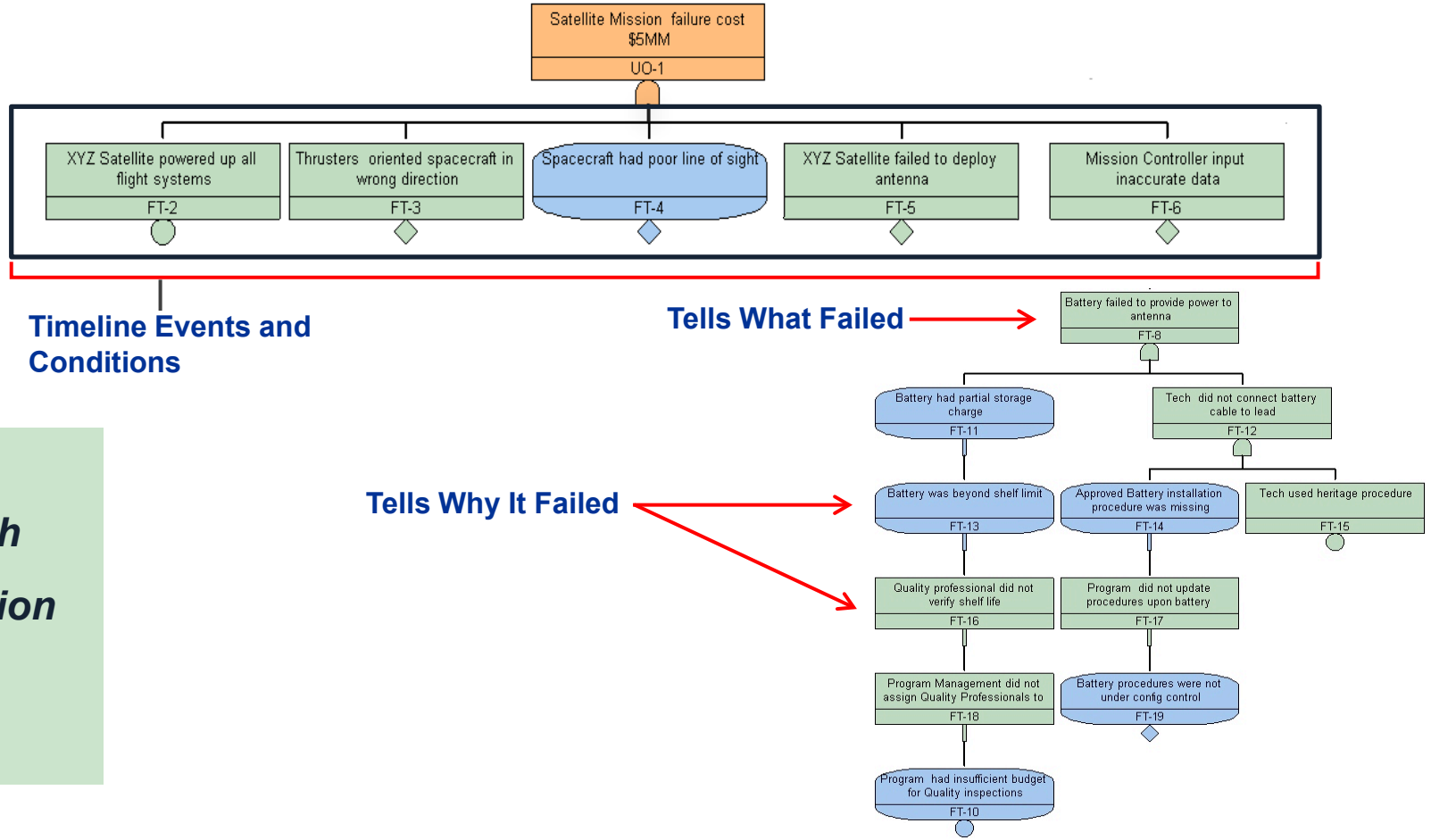


Event and Causal Factor Tree

Similarities and Differences between the Fault Tree and Event & Causal Fault Tree (ECFT) (RCA Step 4)

	Fault Tree	Event and Causal Factor Tree
Same	Deductive Logic Tree	Deductive Logic Tree
Same	Standard Symbols	Standard Symbols
Same	Undesired Outcome (Fault) Top Event	Undesired Outcome Top Event
Different	Predominantly describes “what” failed	Describes “what” failed and “why”
Different	Focuses on failures that contributed to fault	Focus on “why” each event/condition occurred. May include things that are not “failures” or “anomalies”
Different	May include compound events and conditions in tree	Does **NOT** include compound events and conditions in tree
Different	Includes ALL potential causes and contributing factors	Includes **ONLY** events and conditions that occurred and caused or contributed to the undesired outcome

RCA Step 4: Create Event and Causal Factor Tree



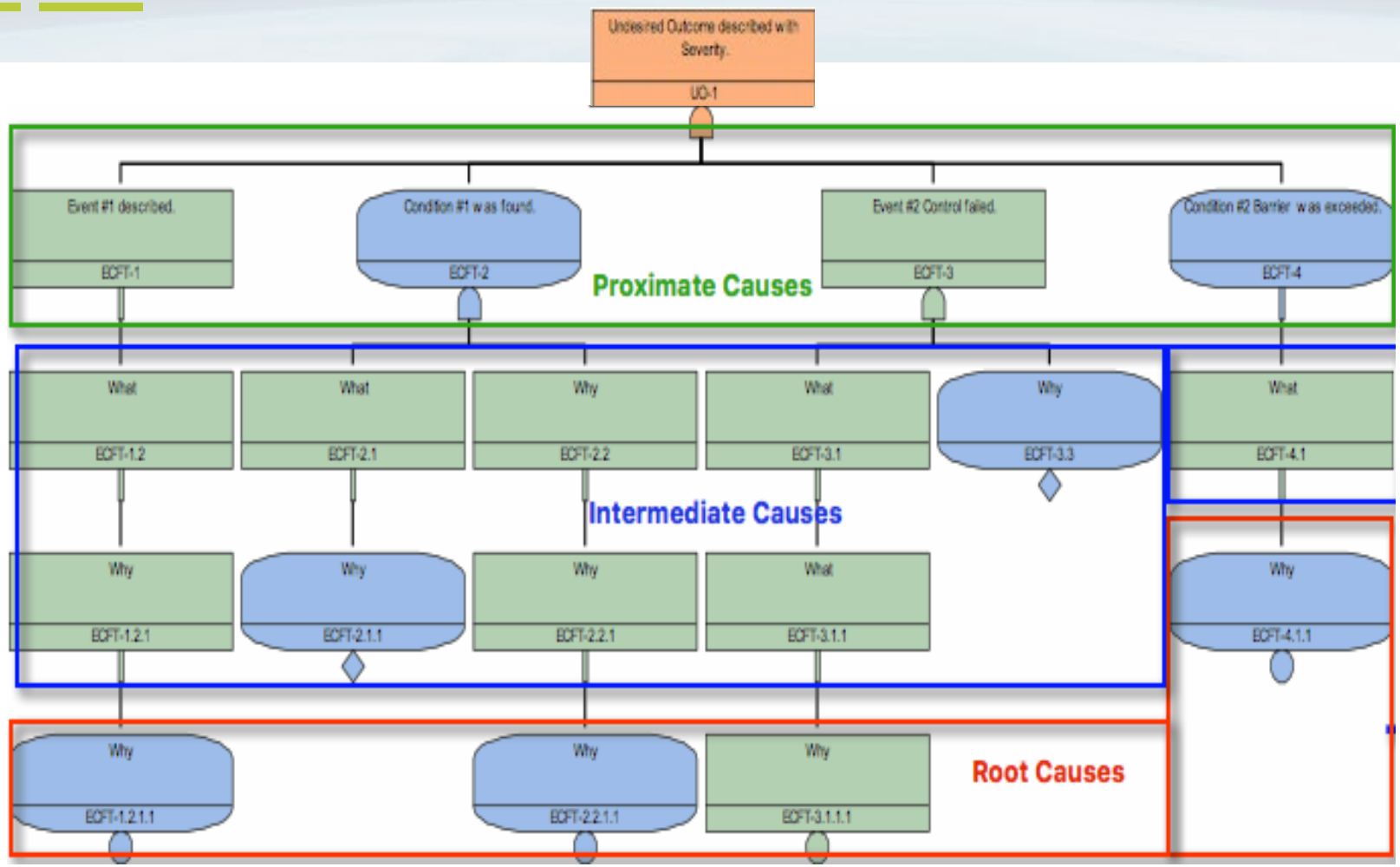
Ask WHY each event or condition occurred.

Stopping Rules

Continue to ask “Why” until you have reached any of the following:

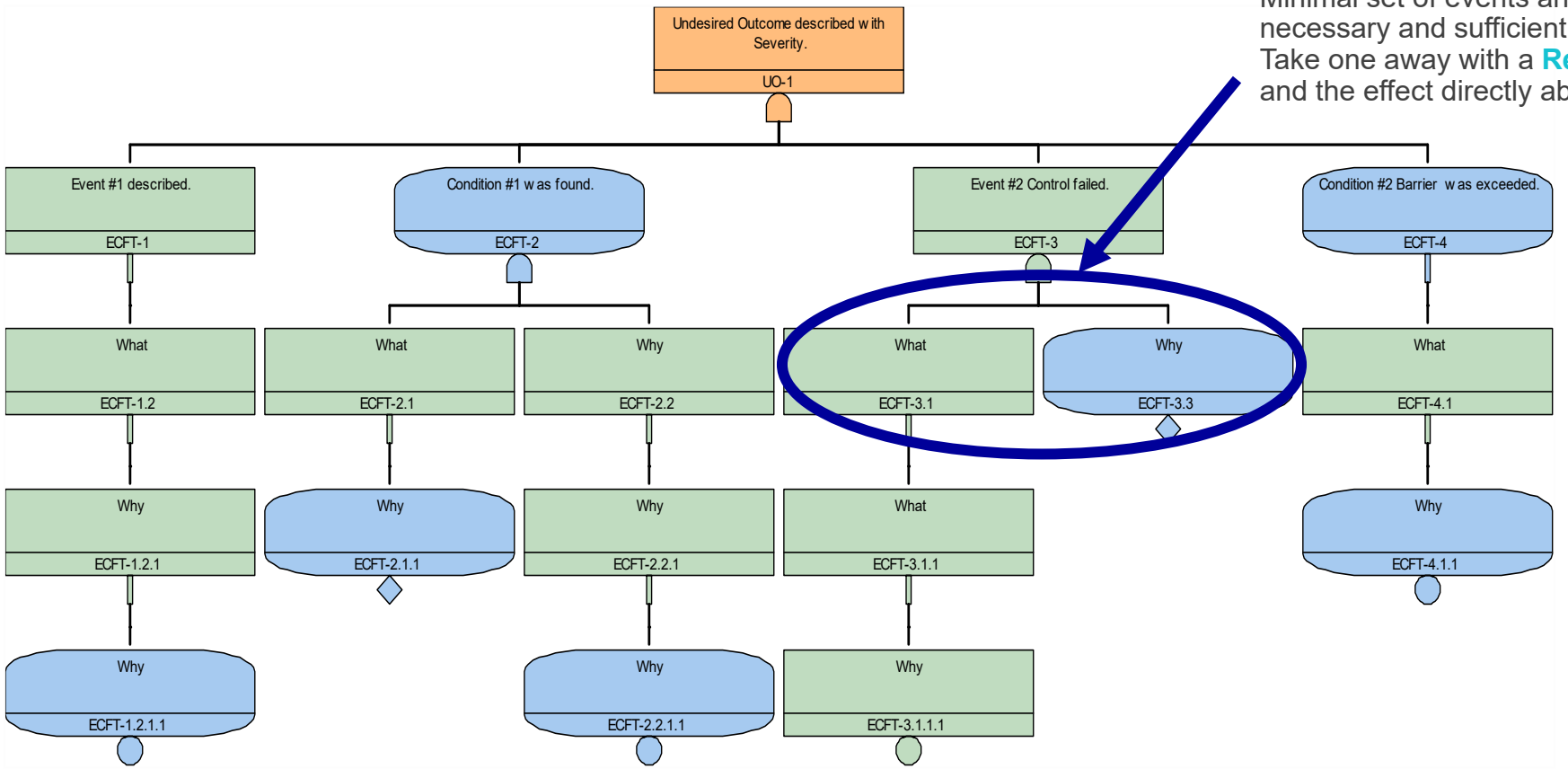
1. Root causes, including all organizational factors that exert control over the design, fabrication, development, maintenance, operation and disposal of the system.
2. A problem that is not correctable by NASA or NASA contractor.
3. An event or condition that is not an anomaly.
4. Insufficient data to continue.

Event and Causal Factor Tree



Recommendations

Event and Causal Factor Tree



Minimal Cut Set

Minimal set of events and conditions that are necessary and sufficient to produce the effect. Take one away with a **Recommendation (Step 5)** and the effect directly above should not occur

Step 5: Generate Recommendations

Types of Recommendations in Order of Effectiveness

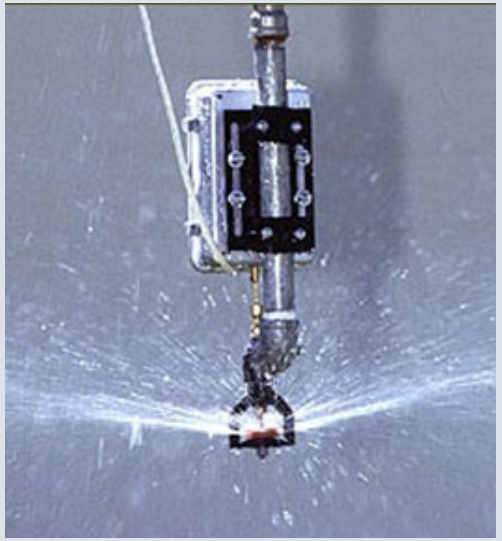
1. Eliminate hazards.

2. Minimize likelihood hazard will reach the target.
   a. Create a passive mechanism (barrier) to prevent contact between hazard and target; strengthen a barrier or fix an existing barrier.
   b. Create an active mechanism to detect and correct hazardous release (control) prior to undesired outcome. Create a control, strengthen a control, or fix an existing control.

3. Minimize the worst-case effect.
   c. Improve amelioration.
   d. Strengthen the target to minimize the damage (e.g. tougher structures).

4. Provide warnings when residual risk still exists.

Source: *Concepts and Techniques of Machine Safeguarding*, OSHA



Tips to Writing a Good Recommendation

Tips for Writing a Good Recommendation – clear, verifiable and achievable, must address a Finding

1. Describe the specific action that must be taken using an action verb **(What).**
2. Describe when the action should be taken **(When).**
3. Describe where the action should be taken **(Where).**
4. Describe the specific steps necessary to take the action. Detail may vary.
5. Describe **Who** should take it (i.e., who in general, not specific person; this is assigned later).
6. Describe the **measurable results** of the action. (measurable or verifiable product, object, data, or result)
7. Describe method to verify that action is completed. (Optional).
8. If a recommendation is to implement an **existing requirement** – **have not found all the Causes!**

Recommendations for Human Factors

Possible Solutions to Human Causes

PERCEPTION ERROR • Failure to perceive or detect	• **Improve perception: make more visible, louder, feel different...**
INTERPRETATION ERROR • Failure to recognize data as hazardous • Failure to understand severity of the hazard	• **Train to recognize and provide understanding**
DECISION-MAKING • Failure to consider alternative behaviors • Failure when applying "If-Then" logic • Failure to select correct/appropriate action • Failure of memory-forgetfulness	• **Train to understand alternatives and make correct selection** • **Reinforce good decision** • **Provide memory aids**
ACTION EXECUTION ERROR • Physical inability to make response • Response is out of sequence • Response timing is incorrect	• **Modify design** • **Change process** • **Slow down system**
VIOLATION • Intentional departure from known rule-no intent to harm	• **Behavior-based safety** • **Change reinforcement**

Root Cause Analysis

- Useful for all types of anomalies and incidents.
- Provides an unbiased, independent, and thorough investigation of the facts.
- Identifies proximate causes, intermediate causes, and root causes.
- Allows identification of systemic–organizational factors so that related problems can be prevented.

Our task now is not to fix the blame for the past, but to fix the course for the future."

-John F. Kennedy

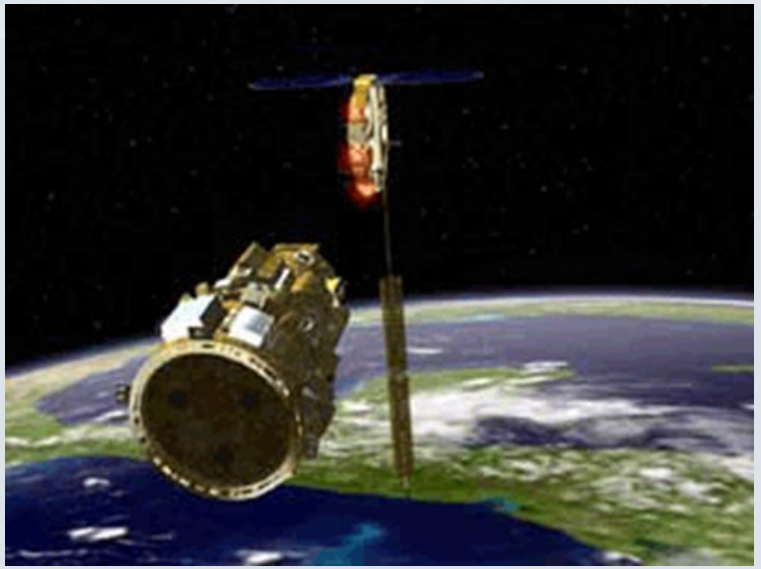
Recurrent Causes (IMHO)

- **Schedule Slip**
  - *WB-57 Runway Departure, 3/5/19*
    - *Major Inspection – two years vs. eight months*
  - *Commercial Crew Program*
    - *SW development – years vs. months*

Allows for personal changes, loss of program knowledge, leadership changes, changes in priorities

- **Schedule Pressure**
  - *Apollo 1*
  - *DART, 4/15/2005*
    - *Testing skipped*
    - *Accept less than adequate quality*
  - *Shuttle*

Allows for decisions made without account for Unknown Risk



Recurrent Causes (IMHO)

- **Systems Engineering Issues**
  - *DART – system functions not understood*
  - *Genesis*

Must understand the Whole System and Functions

- **Heritage Hardware**
  - *DART – Pegasus*
  - *Genesis (2004) – Stardust*

Must understand the assumptions, uses, risks

- Mis-Matc**h of Talent**
  - *Genesis – crucial test skipped*

Must ensure our employees are prepared for the job.

We have excellent team but don't set them up for failure, use NESC's SMEs.

Genesis landing site

Stardust landing site

Recurrent Causes (IMHO)

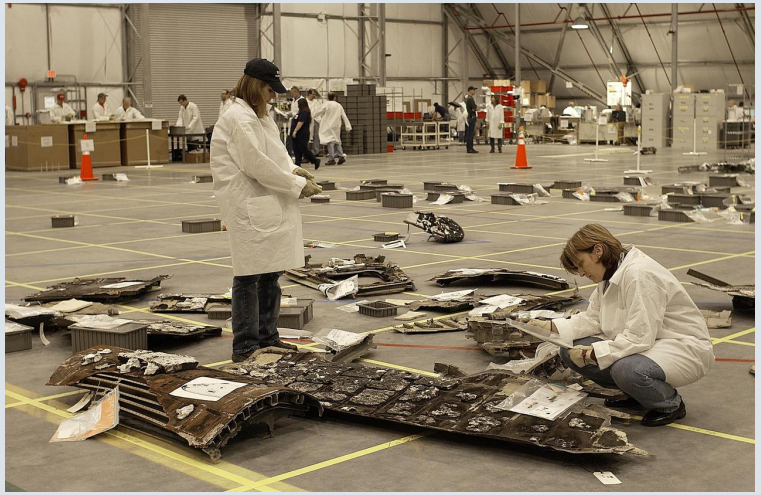
- **Insight/Oversight**
  - *Balloon Mishap (2010)*
    - *Flow Down of requirements, implementation of safety requirements*
    - *Follow through of Corrective actions*

Must understand technical risks and clearly define responsibilities, nature of NASA's role, how do we identify the right allocation of resources, base on Hazard Levels, but must not be complacent and be bit by the Unknown Unknowns

NASA Balloon crash, au news

- **Silent Safety Program**
  - *Shuttle*
  - *DART*
    - *Assumed communications ITAR*
    - *Assumed Resources more limited than they were*

Columbia, NASA



- NASA is success oriented, we do more with less if we have to

- Speak Up, test the assumed limits and boundaries, allow decisions to be made, risk accepted, at the **right level of management**.

Human Factors Recurrent Causes

- Decision making
- Communication
- Technical Environment
- Inadequate Supervision
- Psychological Condition
- Organizational Operations
- Organizational resources
- Skill-Based
- Violation
- Supervision Planned
  Inappropriate Operation
- Supervisory Violation
- Organizational Culture/Climate

Thoughts on RCA

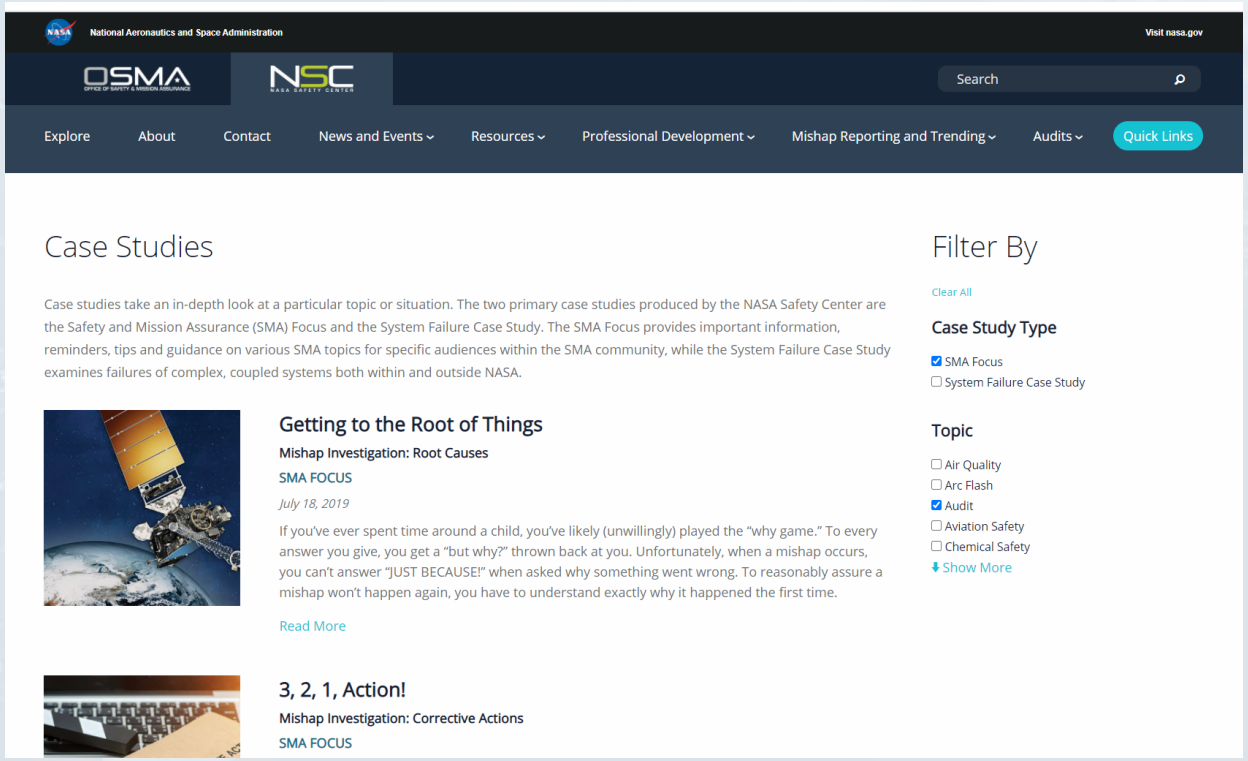
- RCA identifies what, how and why systemic problems occur.
- Organizational root causes historically include senior leader decisions, based on
  - *Cost and/or schedule over safety and/or quality to a highly risky degree.*
  - *Normalization of Deviance*
  - *Overconfidence in analysis and reviews*
- Without identifying and fixing the systemic organizational problems, the chance of repeat is significant .

Underlying organizational causes (Root Causes)
are more difficult to identify.
If not corrected, they will continue to create similar types of problems.

Resources

Websites

- **NASA Safety Center**
  - *Center SMA Content*
  - *SMA Tool Box*
- **Office of Safety and Mission Assurance**
- **NASA Engineering and Safety Center**
- **Other Government Agencies**



Lessons Learned

Lessons learned are brief summaries of mishaps or success stories that are likely to be of interest to other projects.

Unlike a "best practice," they:

1. *Describe a specific "driving event" that occurred; and*
2. *Provide recommendations for avoiding a repetition (or obtaining a repeat of a success), the recommendations merely provide pointers to subject matter experts on measures that have worked in the past.*

- Lesson Learned Data bases – LLIS, NEN, appel
- Case Studies – NASA and Non-Nasa Lessons
- Forums, Webinars, Videos, Podcasts

David Oberhettinger,
Chief Knowledge Officer Emeritus,
NASA Jet Propulsion Laboratory

We are never too Smart to learn, only Ego or Lack of Imagination can deter us.

https://sma.nasa.gov/docs/default-source/step/cohort-2020/2020-cohort-june-lessons-learned96b9a069d2a865b9a1a0ff0f003ca228.pdf?sfvrsn=bb11c5f8_0

Audits

- NASA
  - *IFOSA*
  - *QAAR*
  - *ICA*
- Center Internal Audits
- OSHA Voluntary Protection Program (VPP)
- International Organization for Standardization (ISO)

Training

- **Online**
  - *SMA-002-11 NASA Interim Response Team Training (5hrs)*
  - *SMA-002-07 Overview of Mishap Investigation* (1.5 hrs)*
  - *SMA-002-08 Mishap Investigation Roles and Responsibilities* (1 hr)*
  - *SMA-002-09 Completing the Investigation and Mishap Report* (1hr)*
  - *SMA-002-10 Introduction to Root Cause Analysis* (1.5 hr)*
  - *SMA-001-07 Human Factors* (3 hrs)*
  - *SMA-002-12 Root Cause Analysis Tool (16 hrs)*
  - *SMA-002-13 Mishap Investigation Board (MIB) Chair Training (4 hrs)*
  - *SMA-002-14 NASA Root Cause Analysis (may substitute for classroom training SMA-SAFE-OSMA-4003) (16 hrs)*
  - *SMA-002-15 NASA Human Factors in Mishap Investigation (may substitute for SMA-SAFE-OSMA-4004) (15 hrs)*

- **Classroom (Must attend all of class to receive credit)**
  - *SMA-SAFE-OSMA 4003 NASA Root Cause Analysis (19 hrs)*
  - *SMA-SAFE-OSMA 4004 Human Factors in Mishap Investigation (4 hrs)*
  - *SMA-SAFE-OSMA 4009 NASAHFACS Training and Certification (24 hrs)*
  - *SMA-JSC-WBT-300 FAULT TREE-BASED FAILURE INVESTIGATION PROCESS AND ROOT CAUSE ANALYSIS (4.5 hrs)*

- **Alternate RCA and Human Factors professional training may be submitted for substitution consideration.**

Required per NPR 8621.1 by investigating authority role			
Safety Member Training	**Human Factors**	**MIB Chair**	**Ex-Officio**
SMA-002-07	SMA-SAFE-OSMA-4009 or SMA-SAFE-OSMA-4004 or SMA-002-15	SMA-002-13	Safety Member Training
SMA-002-08			Human Factors Training
SMA-002-09			
SMA-002-10			SMA-SAFE-OSMA-4003
SMA-002-11			SMA-SAFE-OSMA-4004
SMA-SAFE-OSMA-4003			**OR**
OR			SMA-002-14
SMA-002-14			SMA-002-15

*** prerequisites for classroom training**

Final Thoughts

Final Thoughts

- Think about the what ifs
- Be clear and descriptive
- Find the Evidence (for and against)
- Challenge yourself and others
- Speak Up - Don’t stifle yourself
- Ask the experts, retirees, any level of management – they enjoy sharing in our success

NASA is an exceptional place to work, we are all here for a reason, not to know everything as individuals but to collaborate to do things not even imagined yet

Thank You!

RCA Definitions

- **Undesired Outcome** - Any event or result that is unwanted and different from the desired and expected outcome. Most UO are event-based. They usually do not occur because of one single event, but rather from a series of events and actions, with specific conditions present. When describing the undesired outcome, do the following:
  - *Use a complete sentence (**A**ctor-**V**erb-**D**escriptor).*
  - *Identify when and where it occurred.*
  - *Describe the severity of the problem.*
- **Proximate Causes** - The events that occurred, including any conditions that **existed immediately before the undesired outcome,** directly resulted in its occurrence and, if eliminated or modified, would have prevented the undesired outcome.
- **Intermediate Cause** - An event or condition that created the proximate cause and, if eliminated or modified, would have prevented the proximate cause from occurring.
- **Root Cause** - An event or condition that is an organizational factor that existed **before the intermediate** cause and directly resulted in its occurrence (thus, it indirectly caused or contributed to the proximate cause and subsequent undesired outcome) and; if eliminated or modified, would have **prevented the intermediate cause from occurring,** and the undesired outcome.