• What are the important features of a PRA?	• A PRA is a systematic and comprehensive methodology that uses system modeling techniques (e.g., logic diagrams like event trees, fault trees, and Failure Modes and Effects Analysis (FMEA)), probabilistic, statistical and logic (Boolean) concepts and mathematics, as well as phenomenological and engineering analyses (e.g., structural, mechanical, nuclear, chemical) whose selection depends on the nature of the adverse consequences being modeled. A very important strength of PRA is that it recognizes uncertainty as being inherent, i.e., a fact of life. Uncertainties are generally things that "we know we don't know and those that we don't know that we don't know" (to quote a recent statement of Secretary Rumsfeld). There are uncertainties of many types that one deals with in performing a PRA. These are intended to account for such things as the variability of data and measured quantities that are input to PRA. There are also uncertainties due to modeling methodology, its assumptions, and lack of information or knowledge. These uncertainties are used in a PRA in the form of mathematical distributions. PRA results generally quote risk values, which are also given in terms of distributions. Risk can be expressed in terms of quantities such as the probability of adverse consequences of a given type (e.g., the probability of a catastrophic failure of the Space Shuttle). In contrast with individual failures and their associated consequences, which are observed or measured quantities, these probabilities are calculated quantities. They reflect the knowledge (and lack of) quantitative risk, the likelihood of given adverse consequence. The distributions are provided because exact values of these probabilities are never known in view of the above-mentioned inherent uncertainties. Probabilities are expressed in terms of distribution parameters, such as "mean" and "median" values and in terms high or low confidence values such as the "5th percentile" or the "95th percentile" values, respectively. For convenience, single-valued probability measures of risk, the mean or the median, that are parameters of the risk distribution (e.g., 1/250 or $4X10^{-3}$) are often quoted and are only useful to place the quantitative measure of risk in the proper perspective. The most useful single-valued quantities generated in a PRA are therefore not the mean or the median of the distribution but the relative risk contributions of the various systems and components to the overall risk value. These are the quantities that help decision makers to make decisions on enhancements in the context of cost-benefit trade-offs. [redacted]

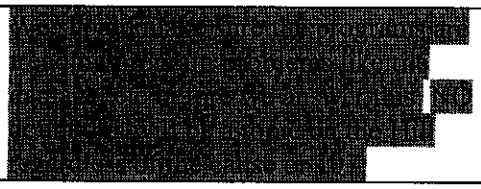
• Is Probabilistic Risk Assessment (PRA) being used by NASA?	• Since the Challenger accident, PRA has been increasingly used at NASA to improve safety, performance and mission success. Over the past three years, the use of PRA at NASA has been accelerated especially for human space missions, e.g., the Space Shuttle and the International Space Station. NASA also has used PRA in missions involving nuclear payloads and is now beginning to apply it early in the product life cycle to improve design. Extensive awareness and practitioner training has been conducted at NASA Headquarters and NASA Centers. NASA currently possesses state-of-the-art computer tools to perform PRA. NASA recently developed, with the help of world-recognized experts in the field, a PRA procedures guide, and a fault tree handbook, both for aerospace applications. NASA also has a number of on-going projects aimed at advancing PRA technology.
• What kinds of NASA PRA efforts have been performed for the Space Shuttle?	• The important Shuttle related PRA efforts have been: ✓ "Independent Assessment of Shuttle Accident Scenario Probabilities for the Galileo Mission" performed in connection with the PRA for the Galileo mission, was published in 1989. ✓ "Probabilistic Risk Assessment of the Space Shuttle, A Study of the Potential of Losing the Vehicle During Normal Operation" published in 1995. ✓ A PRA effort performed in the 1997-1999 time frame by using NASA-developed QRAS (Quantitative Risk Assessment System), an integrated PRA computer program. ✓ Currently, the Space Shuttle Program is near completion of an effort to perform a new Space Shuttle PRA to assist in decisions about shuttle updates. This effort was started several years ago.

• Explain the discrepancy between the PRA-estimated probability of a catastrophic shuttle accident and the demonstrated probability of the same catastrophic accident.	• The probability of a frequent event can be reasonably well estimated from available statistics as the number of outcomes of interest divided by the total number of trials. Fore rare events such as the catastrophic failure of the Space Shuttle, this approach does not yield meaningful results. The catastrophic failure of the Space Shuttle cannot be accurately calculated by dividing the number of such accidents by the total number of flights because the total number of flights is small. Therefore, one needs to construct a mathematical model based on a methodology called probabilistic risk assessment. This model will yield a probability distribution whose mean, or average, typically describes the probability of interest. As more Shuttle flights occur and the experience database increases, the calculated distribution can be updated using statistical techniques yielding a new distribution, which generally tends to have a narrower uncertainty range than the previous distribution.
• Was the potential of Foreign Object Debris impact damage considered in the existing PRA model?	• The most recent NASA Shuttle PRA effort considered the probability of Foreign Object Debris hits to the Orbiter Thermal Protection System (TPS), but it made no distinction regarding the origin of the debris. The debris could come from anywhere on the vehicle during ascent, micrometeoroid and orbital debris (MMOD) on orbit, and debris from the runway during Landing/Deceleration.
• How is the Shuttle PRA being used in the investigation?	• The Shuttle PRA is being used to evaluate potential scenarios that could have happened to Columbia. Each scenario consists of possible events that could have occurred and would have resulted in the loss of the Columbia. Information that is being retrieved is being used to screen out unlikely scenarios and to retain candidate scenarios. The information is also being used to update probabilities of events that could have happened. This helps to focus and prioritize the investigations.
• Did the Shuttle PRA include the loss of External Tank (ET) insulation as one of its scenarios?	• The shuttle PRA does include scenarios of debris impacting the orbiter that will result in loss of crew and vehicle (LOCV). This debris includes loss of insulation from the External Tank (ET) and Solid Rocket Booster (SRB), as well as from micrometeoroid impacts. A detailed mapping of the tiles is used to identify the risk contributions from tile damage and tile loss. The individual tiles and tile areas are prioritized for their risk importance with regard to LOCV.

• Can the Shuttle PRA evaluate the risk after observing the loss of insulation?	• The Shuttle PRA can be used to evaluate the resulting risk after observing such an incident. These types of evaluations are standard and are called precursor evaluations or conditional risk calculations. The Shuttle PRA is being used to evaluate the resulting risk implications from the observed incident of the insulation hitting the underside of the left wing. In this evaluation, the likelihood of tile damage is estimated along with the amount of possible damage sustained. The likelihood of overheating and LOCV is then also estimated. To date, this effect is not appear to be a large risk contribution by itself.
• Will the Shuttle PRA be modified as a result of the Columbia failure?	• A PRA should always updated as new information is obtained. This is what makes the PRA a "living risk assessment tool." The current Shuttle PRA includes the faults and failures that have occurred to the past shuttles as well as the corrections and fixes that have been implemented. As information is obtained from the Columbia disaster, the PRA will be modified to update the assessed risks. This will help provide a tool for focusing corrections and fixes. Any performed corrections and fixes will then also be incorporated into the PRA.
• How will the Shuttle PRA be used to help guide NASA in the future?	• The Shuttle PRA will be used to help guide upgrades of the Space Shuttle. It will also be used to identify how to better re-allocate resources to focus on high-risk contributors. The Shuttle PRA will show the risk benefits from proposed upgrades, which can then be weighed against their costs. It will also identify those low risk contributors from which current resources can be directed to more effectively focus on high-risk contributors. The Shuttle PRA will also be used to track the risk implications of defects and trends such as aging so that corrective measures can be taken before the risks become significant. Furthermore, the Shuttle PRA insights will serve as input to benefit designs of future generations of space transport vehicles.
• Is NASA planning to institute numerical risk criteria for future missions?	• One application of a PRA is to compare the numerical risk that is obtained with an acceptable risk value. Uncertainties in the PRA risk values need to be taken into account in this comparison. NASA is evaluating the use of numerical risk criteria as input to requirements for new designs and missions. NASA is also evaluating the use of numerical risk criteria to assist in the decisions about the Space Shuttle. However, this is only one type of information to be used in any decision-making process along with all relevant engineering information and expert judgment.

• Did the Shuttle PRA specifically model the event of the External Tank (ET) insulation hitting the Orbiter?	• The Shuttle PRA did not specifically model this event. The Shuttle PRA did model the more general event of debris from any source hitting the Orbiter. The likelihood of any debris hitting the Orbiter was determined by analyzing past debris hits on the Orbiter. There were enough hits to make reasonably good estimates of this likelihood. The hits were generally small and of little consequence. The Shuttle PRA extended these data and predicted the likelihood of more severe hits causing damage and LOCV.
• Did the Shuttle PRA model the event of insulation coming off the External Tank (ET)?	• The Shuttle PRA did model the event of debonding that results in insulation coming off the ET. The likelihood of different sizes of debonding occurrences was estimated along with the consequences in terms of aero heating of the tank resulting in LOCV.
• Does the Shuttle PRA include human errors in its risk modeling?	• The Shuttle PRA includes human error contributions. It includes the contributions from human errors that could be committed by the crew. It also includes contributions from possible human errors committed in installation, testing, maintenance, and other ground processing. Since the Shuttle involves extensive processing between missions, it is important to include these processing contributions that can be important risk contributors.
• Dose the Shuttle PRA include autopilot failures and Reentry Control System (RCS) failures?	• The Shuttle PRA includes autopilot failures in its model of failures of the deceleration and landing system. The Shuttle PRA also includes failures of the Orbital Maneuvering System (OMS) and the Reentry Control System (RCS) for the reentry of the orbiter. These system models are being examined to identify candidate scenarios that are relevant to the Columbia disaster.

Trend Analysis

• 	• Data use is evident in continual improvement of Safety and Mission Assurance/Success safety and mission assurance/success.

NASA Safety Reporting System (NSRS)

• What is the NASA Safety Reporting System (NSRS)?	• An anonymous, voluntary, and responsive reporting channel to notify NASA's upper management of employee concerns about hazards. Reports are guaranteed to receive prompt attention of senior personnel..

• What is the NSRS?	• An anonymous, voluntary, and responsive reporting channel to notify NASA's upper management of employee concerns about hazards. Reports are guaranteed to receive prompt attention.
• When was the NSRS established?	• By the NASA Administrator in 1987 after the Challenger accident. The NSRS has since supported all flights and has been expanded to cover all NASA operations.
• Who can send reports to the NSRS?	• Any NASA or contractor employee working in support of NASA.
• When is the NSRS to be used?	• The NSRS is designed to supplement local hazard reporting channels. Personnel are instructed to first report any hazard or safety concern using local established safety reporting procedures. They are to use the NSRS if – ✓ They have reported a hazard locally and have seen no action taken; ✓ They are not satisfied with the response to a reported hazard They fear reprisal if they were to report the hazard through local reporting channels.
• What may be reported to the NSRS?	• Any hazard presented by a NASA operation that can affect the public, the NASA workforce or NASA assets. ✓ On the reporting form, we ask that the hazard be described in detail and when possible, reports should include: ✓ The scope of the hazard (does the hazard affect NASA assets, and/or the NASA workforce, and/or the general public?) ✓ Manufacturing sources and/or part numbers (if hardware is involved) ✓ The physical location of the hazard ✓ Whether or not the hazard has been reported elsewhere ✓ Whether the hazard relates to a single event or recurring process ✓ What the reporter believes may have caused the hazard ✓ What the reporter thinks can be done to correct the hazard and prevent a recurrence ✓ What the reporter believes the consequences may be if the hazard remains unresolved

• How are reporter's anonymity protected?	• An NSRS contractor receives and processes reports at its office located in the Washington, DC metropolitan area. The NSRS contractor removes a reporter's identifying information from the form (known as the identification strip) and forwards only a summary of the concerns to the NASA Headquarters Office of Safety and Mission Assurance for immediate analysis and investigation. The identification strip is mailed back to the reporter by the NSRS contractor so they know their report has been received.
• How are reports handled by NASA Headquarters?	• The NSRS Chairperson at NASA Headquarters, Office of Safety and Mission Assurance, reviews the report summary received from the NSRS Contractor and assigns action to a Technical Advisory Group (TAG) member at the appropriate NASA facility.
• How does a reporter know that their report has been addressed?	• After forwarding a summary of your report to NASA Headquarters, the NSRS contractor returns the report's identification strip to the reporter. Once the identification strip is returned, there is no direct way to inform the reporter of how the report was handled. The best way for reporters to determine if their report had any effect is to observe if there are any changes in the problems that they have reported.
• How many NSRS reports have been received since the inception of the program?	• Over 500
• How many NSRS reports have been received regarding the shuttle program?	• The answer to this question is being researched.
• Were any NSRS reports received that pertained specifically to STS-107?	• None as of Friday, February 7, 2003.

Problem, Failure, [redacted], Mishap Reporting, And Root Cause Investigation

• Does NASA's policy require that problem reporting is included incontinency plans? I d0on;t understand this question. [redacted]	• Yes. Problem reporting is included in operations and contingency plans.
• When a problem is discovered in a shuttle operation or process, how is the problem analyzed and resolved?	• Problem reviews are being investigated to determine root cause and results are documented in LLIS and promptly addressed for recurrence prevention.

• What follow up and lesson learned have has been accomplished since the failure of programs such as Mar's Observer ($1 Billion) caused by a suspected valve, Mar's Rover, and other programs under "faster, better, cheaper" management philosophy.	• [redacted]
• Do you have the Mishap Reports on each of these, and can you comment on the efficacy of their corrective actions?	•
• What is root cause?	• The root cause one of multiple organizational factors that contributed to / created the proximate cause (immediate cause) of the accident and the subsequent undesirable outcome. • Typically, each accident has multiple root causes. • The proximate cause is the event(s) and conditions that occurred immediately before the undesired outcome, directly caused its occurrence, and if eliminated or modified would have prevented the undesirable outcome. • NPG definition: ✓ Contributing Root Cause. A factor, event, or circumstance which led, directly or indirectly, to the dominant root cause, or which contributed to the severity of the mishap or close call.
• How will the CAIB determine the root causes? [redacted].	• First, the CAIB will form a time line of events. Second, the CAIB will create fault trees that illustrate every possible failure that could have occurred. With facts in hand, the CAIB will eliminate elements from the fault tree that have been proven not to have occurred. The resultant diagram is call an Event & Causal Factor Tree. For each failure that remains on the tree, and is known to have existed, the question "why" will be asked. The team will ask why multiple times, until the root organizational factors (such as resource management, policy, and Agency culture) are identified.
• Does NASA collect data on near misses and close calls?	• It is NASA's policy to collect data on near misses. This data is placed in the Incident
• What is root cause analysis	• Root Cause Analysis. The root cause analysis is a structured process for identifying the basic factors, reasons, and causes for conditions that result in mishaps or close calls. Once identified, the conditions can be corrected and future mishaps or close calls prevented. • A structured method that identifies the root causes for an undesired outcome and the actions adequate to prevent recurrence.

• Can the CAIB determine criminal intent or culpability?	• No. The purpose of the NASA mishap investigation process is solely to determine the 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.
• Can we view witness statements?	• No. Witness statements are [redacted] and non-releasable. However, NASA recognizes that the ultimate decision on release of witness statements may reside in the court of law.
• What does NASA do with the information that it learns after an accident?	• First, NASA takes the steps to prevent recurrence by developing and implementing a corrective action plan. • Next, NASA places "lessons learned" in a database to improve the safety of other NASA operations.
• Do NASA Center's only report and investigate major accidents	• No. It is NASA's policy to report, investigate and document mishaps including mission failures, incidents and close calls. • NASA has immediate reporting requirements, that allows management to react to an accident, preserve life, prevent further damage, secure and safeguard evidence so that a proper investigation can occur.

Product/Service Assurance Analysis And Product Protection

Product Assurance Goals

• How is product assurance protection achieved?	• Goals are established, promulgated and reinforced for product and service.
• How does the Space Shuttle program know the products and services will meet their performance requirements?	• Goals are measurable and performance measures are provided to program/project.
• When are product and service assurance analysis goals developed and integrated into NASA's programs?	• Goals are integrated early in the life cycle into NASA's programs and operations covering all of SRM&QA disciplines.
• When are product analysis and service goals reviewed?	• Goals are reviewed with program milestones.
• What does a worker do if he detects an unsafe operation?	• Policy for workers to terminate of unsafe operations policy is in place and evident. • ** They call a STOP. **
• When are product assurance goals incorporated into the development process?	• Goals are incorporated into maintenance concept early in the development process.

Identification Of Customer Requirements

• How do you verify that the customer's requirements have been identified?	• Customer needs are reviewed with the customer and documented.

Requirement/Product Control

• How does a program know what to accomplish?	• Approved requirements are available to the program.
• How is this assured?	• Verification and Validation is performed to ensure that products (both hardware and software) have been built (and maintained) to the applicable specifications and drawings.
•	• Products (both hardware and software) have been built (and maintained) to the applicable specifications and drawings.
•	•
• Is there a policy on backup systems?	• Ensure that safety-critical functions have appropriate functional redundancy.
• Who is responsible if requirements are not met?	• Any exceptions and waivers to the design and use requirements have been approved and documented.
• *Pass to Tom*	• All safety discipliners are covered in product controls and reviewed as a part of safety Surveillance Plans
• What has been the affect of the "greening" of NASA manufacturing processes with meeting EPA requirements to the reliability and maintainability of NASA flight hardware?	•

Development, Manufacturing, and Operational Surveillance

• How does NASA effectively assure that products are being produced to specifications?	• Safety and Mission Assurance Development Surveillance plan is approved at appropriate level for each program/project. • NASA safety organization performs and leads ongoing surveillance. • Assessments are done to identify and mitigate/eliminate hazards and build appropriate safety measures, such as failsafe features, into programs and projects beginning early in the life cycle. • Improve the reliability and robustness of aerospace hardware and software. • The probability and severity of human error to minimize effects/results are overtly considered. • Safety and Mission Assurance Operational Surveillance plan is approved at appropriate level for each program/project. • NASA safety organization performs ongoing surveillance. • Documentation is maintained by NASA safety of the surveillance, oversight, and independent assurance activities in a controlled manner.
• In the past 5 years, how has the NASA surveillance process changed? Did a change in government surveillance of contractor activity cause a decrease in safety?	• NASA's surveillance of major contracts such as the Space Shuttle SFOC contract has been consistently strong over the years. When critical hardware is at stake NASA surveillance involves significant on-site government participation and an extensive contractor performance review process. Personnel (contractor and government) work side-by-side throughout the processing activity. For human space flight, our experiences have demonstrated a high level of contractor commitment when it comes to the safety and quality. Furthermore, significant award and incentive fee are associated with quality and safety performance. In rare instances where expectations have not been met NASA has been vigorous in correcting the problem and impacting the performance award.

Assessment Reviews

• What role does safety and mission assurance/success play in the launch readiness process? How does the safety community assess and confirm satisfactory completion of all of the safety activities necessary to provide an acceptable level of confidence in mission success prior to launch? • What reviews are performed by the safety	• safety overtly reviews products (hardware and software) prior to flight or usage. This includes Preflight Assessment Reviews (PAR), Flight Readiness Reviews (FRR), Integrated Mission Assessment Review (IMAR), and other like reviews.

community to demonstrate a complete understanding of the individual element and integrated mission risks?	
• Does NASA have a formal risk management system?	• Formal risk management practices are used to drive prudent program/project decisions.

Independent Activities And Assessments

Program Evaluation

• As the Senior NASA official, do you review NASA's Annual Occupational Safety and Health Report to the Department of Labor?	• Annual safety and health program evaluations are prepared with written narrative reports, recommendations for program changes, action plans, and verification procedures.
• How are risks identified and managed?	• Formal risk management practices are employed to drive prudent program/project decisions throughout the program/project life-cycle and documented in controlled data packages..
• How do NASA's Safety Organizations ensure that they are providing the products and services that NASA's programs and projects need to keep them safe and successful?	• Safety organizations overtly solicit customer needs and satisfaction with safety and health activities throughout the design, assembly, test, operations and post-operations periods. • Customer satisfaction comments are incorporated into ongoing activities to include correction of noted problems.

Program Oversight

• Does safety limit its involvement in Programs?	• Safety is involved in all facets of programs and projects.
• Does safety assess government contractor activities?	• Adequacy of program/project and contractor safety activities and records is reviewed periodically.
• Contrast the roles of oversight and insight and the relationship of safety?	• Safety Oversight is done with the attitude of improvement of the efficiency, effectiveness and completeness of safety processes.
• ADD?? *** In-line vs. oversight??? ***	•
• **Tom**	• Documentation is maintained by NASA safety of the surveillance, oversight, and independent assurance activities in a controlled manner.
• **John Lemke**	• Termination of unsafe operations policy in place and evident
•	• Certification of Flight Readiness process in place and evident

Process Verification

• How does NASA Headquarters (Office of Safety and Mission Assurance) ensure that NASA Center, Programs and Projects are implementing safety policies?	• NASA Headquarters Office of Safety and Mission Assurance safety performs periodic Process Verification (PV) reviews of NASA Centers and Headquarters Offices (once every 2 years). Center safety organizations perform like reviews of

	programs, projects and contractors on a periodic basis.
• How does NASA Headquarters (Office of Safety and Mission Assurance) encourage NASA Center safety Organizations to be proactive in self-improvement?	• PV self-assessments are completed periodically.
• Does NASA Headquarters Office of Safety and Mission Assurance follow-up on PV findings?	• Observations from PV activities are recorded, tracked and corrected in a timely manner. PV self-assessments reflect the actual state of the organization and are not 'spun' for management.
• What are PVs based on?	• PVs trace to valid implementing requirements and processes. PVs include safety and health functions.

Independent Verification and Validation

•	• Independent Verification and Validation requirements and capabilities are defined, documented and controlled.
•	• Independent Verification and Validation is conducted to a level appropriate to the risk and mission success criticality.
•	• Independent Verification and Validation process is controlled and monitored by appropriate level of management.
•	• Improve cost effectiveness of programs/projects/

Special Assessment Reviews

• Following reviews/review groups are supported as appropriate:	
• How is the Associate Administrator for Safety and Mission Assurance made aware of NASA-wide concerns affecting the safety of aviation operations at the operational level?	• ASP (Aviation Safety Panel). ✓ Panel is comprised of each Center's Aviation Safety Officer, the Headquarters Office of Safety and Mission Assurance Aviation Safety Officer, the NASA Aviation Safety Assurance Manager and the Associate Administrator for Safety and Mission Assurance.
• How do NASA aircraft operators provide advice, counsel, and recommendations for consideration by senior management in all aspects of aircraft operations?	• IAOP (Intercenter Aircraft Operations Panel). ✓ Panel is comprised of senior aircraft operations representatives, aviation advisors, and safety personnel. • IAOP review team inspects the implementation of aviation safety regulations and practices are being done to maintain a safe and efficient aircraft operations environment.
• How does NASA review the launches of radioactive materials into space?	• Per Presidential Directive (PD/NSC-25), NASA convenes an Interagency Nuclear Safety Review Panel (INSRP) (DoD, DOE, EPA, NRC, NASA) to review the risk associated with the launching of the radioactive materials. Results are reported to OSTP.
• What reviews does Office of Safety and Mission Assurance and Center	• PAR/IMAR/FCR/FRR (Preflight Assessment Review, Integrated Mission Assurance Review, Flight

safety lead in or participate in preparing for a launch of the Space Shuttle?	Readiness Review).
• **Mike Card**	• SFSP/PSRP/GSRP (Space Flight Safety Panel, Payload Safety Review Panel, Ground Safety Review Panel)
• **Martha**	• Software Advisory Group (SG)
• **Pete**	• HAB (HEDS [Human Exploration and Development of Space] Assurance Board)
• How does NASA ensure the safety of their facilities and infrastructure, including operations?	• OEP (Operations and Engineering Panel) ✓ Panel of facility safety personnel from across NASA review the following: facility safety, operations & maintenance, fire protection, operational safety, emergency preparedness, occupational health, environmental compliance, energy conservation, et al.
• The Michoud Assembly Facility contract with NASA has not been updated with current requirements of safety and quality programs. Could this have contributed to the mishap?	• This has been under investigation. In December 2002 the Operational Engineering Panel identified a need by MSFC to update contracts. The [redacted] did not directly review the production of the external tanks. [redacted]

Shuttle Payload Safety

• How does the NASA payload safety process ensure payloads are safe?	• All Shuttle payloads must pass a 3-phase safety review process to ensure safety, hazard identification and hazard mitigation. The Ground Safety Review Panel reviews all payloads for safety of ground processing and integration into the Shuttle.
• How are payloads certified for flight?	• After completion of the 3-phase safety review process the Payload Safety Review Process (PSRP) Chairmen approves all hazard reports. The payload experimenter must also sign all hazard reports. The PSRP Chairmen also sign a Certificate of Flight Readiness attesting to the fact that the PSRP has completed its safety review and that all risks are identified. The experimenter signs a Certificate of Flight Readiness of the hardware for which the safety reviews have been conducted.
• Could a payload have contributed to the accident?	• Following the accident, all payloads were again reviewed to identify 1) possible hazards resulting from the payload destruction that could be harmful to search teams and 2) once again check payload safety data to determine if a payload could be a possible cause of the accident. The reviewed showed that no payload is suspect.
• Are payloads reviewed outside of the Payload Safety Review Panel?	• Yes, the Office of Safety and Mission Assurance conducts a Pre-flight Assessment Review (PAR) as preparation for participation in the Shuttle Flight

	Readiness Review. In this review PAR participants independently assess all payloads and any associated hazards.
• Who makes up the Payload Safety Review Panel?	• PSRP membership is a full time job for panel members with expertise from all engineering directorates at the Johnson Space Center. When necessary additional expertise may be called in to support the panel. USA is also represented on the panel.
• Whatever happened to the Space Flight Safety Panel? (Suggest drop this reference per Rich. JSC MOD Director had never heard of this panel, also.)	• The astronaut safety representative may convene The Space Flight Safety Panel on as needed basis. Understand that it is currently inactive.

X-Sender: jmullin@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Mon, 03 Feb 2003 10:57:26 -0500
To: prutledg@hq.nasa.gov
From: "Jonathan B. Mullin" <jmullin@hq.nasa.gov>
Subject: OSMA Support to Bryan O'Connor as
Ex-Officio member of Space Shuttle Mishap Investigation Board (SSMIB)
Cc: Matthew Gaier <mgaier@hq.nasa.gov>, wharkins@hq.nasa.gov,
eraynor@hq.nasa.gov, jlemke@hq.nasa.gov

Pete, some recommendations in to the assignments are indicated in Yellow. I think we need to add some Flight (Aviation Safety) into the tasked areas. I would recommend that we do a priority listing of the enclosed topics. Perhaps there is a need to coordinate some of our areas with Code AM as they may overlap, such as Human Factors.

Regards, Jon

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"Mission Success Starts with Safety"


OSMA Support to Bryan O11.doc

As of: February 2, 2003

SMA Support to Bryan O'Connor as Ex-Officio member of Space Shuttle Mishap Investigation Board (SSMIB)

SMA-Related Investigative Area	Remarks	OSMA Lead
Hazard reports, Fault Trees, FMEA	Relates to work of Space Shuttle System Safety Review Panel (SSRP); especially pertaining to ET foam; e.g., impact on Orbiter	Mark K., Bill B.
Risk	Accepted risks for this mission?	Mark K., Bill B.
Payload safety (as cause of mishap)	Relates to work of Payload Safety Review Panel (PSRP). Interest includes potential for hazardous payloads to have caused catastrophe..	Mike Card, John Castellano
Payload safety (safety of recovery)	Includes radiological and other hazardous payload contents	John Lyver/Gil White
Problem trends (HW/SW)	Relates to Problem Reporting and Corrective Action (PRACA); initially PRs dealing with ET foam problems may be of most interest?	Paul Boldon (SW PRs), Mark K., Bill B. (HW PRs)
Quality	Material Review Board actions, repairs, etc., initially especially in regard to foam and tile installation and repair; contractor/supplier surveillance	Tom Whitmeyer
Probabilistic Risk Assessment (PRA)	Initial interest includes 1990 Pate-Cornell PRA of Shuttle tile installation process, as well as current Shuttle PRA	Michael Stamatelatos
Pre-launch reviews	Includes Pre-launch Assessment Reviews, Mission Safety Evaluations, waivers, deviations, rules changes, limited life items, etc.	Mark K., Bill B.
Expected casualty, Ec (post-mishap)	Includes collecting/using data from this mishap to calculate Ec for Shuttle re-entry	Pat Martin (with Maria Tobin)

Software hazards	Includes software changes, software hazard analysis	Paul Boldon, Sharyl Butler (JSC), Martha Wetherholt, IV&V Ctr
SMA Policy	Emergency Preparedness, system safety, R&M, mishap investigation, etc.	Wil Harkins, Jon Mullin, [redacted]
Contingency Planning	A post-mishap look at correctness/effectiveness of our contingency plans; do we need updates/changes?	Gill White, [redacted]
NASA Safety Reporting System (NSRS), Alerts	Includes any NSRS reports or alerts pertaining to foam, tile, ingredients, etc., as well as any current Shuttle-related reports	Eric Raynor
Lessons Learned	Are there any pertinent LL in the database? Ensuring that these new lessons get into the LLIS in the long run.	Eric Raynor
SMA Reviews and Assessments	OEP, PV, FMR spot checks, staff assistance visits, other periodic center visits (including MAF)	Steve Newman, Art Lee, John Lyver, [redacted]
Aerospace Advisory Panel	Includes any pertinent findings	Len Sirota
Training	Of workers on the floor—certification and training for insulation application, repair, etc.	Eric Raynor [redacted]
Life extension program	We were about to benchmark what USAF does for aging aircraft. Any implications for what NASA does?	Tom Whitmeyer, SLEP Panel (Obs.& Sustainment), Bill Bihner, John Castellano, [redacted]
Mishap Investigation protocol and methodology	Supporting with info on NPDs, NPGs, root cause methods, training for MIB members, briefing packages, etc.	Wayne Frazier, Faith Chandler, [redacted]
Human Factors	What opportunities were there for human factors	Faith Chandler, [redacted]

	to contribute to the mishap?	

Post-mishap implications for ISS	Keeping up-to-date information on affect of this mishap on ISS supportability, etc.	Rich Patrican, Gil White
MIB Web-based work group area	PBMA work group to support information and communication needs of the MIB, including IT security of the posted/transmitted information	Steve Newman, Steve Wander
DoD data	Data that DoD might have that could be useful	Mike Card
Space Shuttle Manufacture	Background and details of the manufacturing process.	Len Sirota

X-Authentication-Warning: spinoza.public.hq.nasa.gov: majordom set sender to owner-code-qs using -f
X-Sender: jlemke@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Tue, 04 Feb 2003 16:49:03 -0500
To: code-qe@lists.hq.nasa.gov, code-qs@lists.hq.nasa.gov
From: jlemke <jlemke@hq.nasa.gov>
Subject: Re: Supporting Bryan on the Columbia Accident Investigation Board (CAIB)
Sender: owner-code-qs@lists.hq.nasa.gov

At 07:49 PM 2/2/2003 -0500, Pete wrote:

> Attached is a rough list we prepared today of investigative areas--for the most part these are areas in which the SMA community has some special expertise. For each area we have tentatively named an OSMA lead (and in some cases more than one person to work together). If you can think of other areas that we have not captured, and should, let me know. If we've associated you with the wrong area(s) or failed to associate you with the right area(s), let me know. We don't want to disrupt the investigation--we want to be prudent; we want to help Bryan. Think about whether and how you might be able to be helpful in these areas; then, before you take any action, write down your plan in a clear, concise manner, and send it to me--state what you might be able to do and how you would propose to do it. Then wait for a go-ahead from Jim or me. Keep in mind that we have asked the SMA directors at JSC, MSFC, KSC, LaRC, ARC, and SSC to work with us as needed, so this can be part of your plan, if appropriate.

There have been some questions about the attachment to the above email. Therefore I'd like to parse and restate Pete's direction. The specific **action** asked of us is:

1. "Think about whether and how you might be able to be helpful in these areas." If your name is next to the item, this means we are asking YOU if you think there is something to be done that would be helpful. If the answer is NO--so advise your boss.

2. If the answer is YES: "then, before you take any action, write down your plan in a clear, concise manner, and send it to me--state what you might be able to do and how you would propose to do it." Do not work the action--explain how it could be worked--including who, what, etc. (For QS--please run the plan by me before you send to Pete.)

3. "Then wait for a go-ahead from Jim or me (Pete)." (Pete--please run the QS go-aheads through me with a copy to Sylvia for tracking purposes.)

Easy as 1-2-3. (QS: can we do ours by COB Thursday? Thanks.)

johnl

John Lemke
Manager, System Safety Engineering
NASA HQ, Code QS
202-358-0567 FAX 358-3104

jlemke@hq.nasa.gov
"Mission success stands on the foundation of our unwavering commitment to safety"
Administrator Sean O'Keefe January 2003

From: "NAKAMURA, STACEY T. (JSC-NS) (NASA)" <stacey.t.nakamura@nasa.gov>
To: "'James Lloyd'" <jlloyd@hq.nasa.gov>,
"'Mullin, Jon (Code QS)'"
<Jonathan.B.Mullin@hq.nasa.gov>,
"'Lemke, John (HQ)'"
<jlemke@hq.nasa.gov>, tom.whitmeyer@hq.nasa.gov,
"HOLSOMBACK, JERRY B. (JSC-OE) (NASA)" <jerry.b.holsomback@nasa.gov>,
"ERMINGER, MARK D. (JSC-NC) (NASA)" <mark.d.erminger@nasa.gov>,
"MARSHALL, YOLANDA Y. (JSC-NA) (NASA)" <yolanda.y.marshall@nasa.gov>,
"JOHNSON, GARY W. (JSC-NA) (NASA)" <gary.w.johnson@nasa.gov>,
GarriH@kscems.ksc.nasa.gov, Lorraine.K.Raby@msfc.nasa.gov,
David.Barker-1@nasa.gov, Amanda.H.Goodson@nasa.gov
Subject: RE: FW: IRIS Data Request
Date: Wed, 19 Feb 2003 10:41:23 -0600
X-Mailer: Internet Mail Service (5.5.2653.19)

My office has offered to help Bill Harris out with integrating the package and we plan to do that.

USA Houston contacted me yesterday about this and we gave them several brainstorming concepts to work with as well as suggested data sources (i.e. for "mishaps", use the official Agency "IRIS" database).

We will work will Bill Harris to get you a copy of the final product.

We will keep the S&MA community in the loop on this project as it progresses....

Regards,
Stacey

-
Stacey T. Nakamura
Phone: (281) 483-4345
Fax: (281) 483-6275
-----Original Message-----
From: James Lloyd [mailto:jlloyd@hq.nasa.gov]
Sent: Wednesday, February 19, 2003 10:32 AM
To: NAKAMURA, STACEY T. (JSC-NS) (NASA)
Cc: 'Mullin, Jon (Code QS)'; 'Lemke, John (HQ)'; tom.whitmeyer@hq.nasa.gov; HOLSOMBACK, JERRY B. (JSC-OE) (NASA); ERMINGER, MARK D. (JSC-NC) (NASA); MARSHALL, YOLANDA Y. (JSC-NA) (NASA); JOHNSON, GARY W. (JSC-NA) (NASA); GarriH@kscems.ksc.nasa.gov; Lorraine.K.Raby@msfc.nasa.gov; David.Barker-1@nasa.gov; Amanda.H.Goodson@nasa.gov
Subject: Re: FW: IRIS Data Request

Stacey,
Is JSC (Are you) integrating the information that has also been requested from MSFC and KSC?
I am interested in the outcome of this data search and would like a copy sent to Headquarters of what results.
I'd also like a brief assessment as to how well the data was documented, how easy it was compiled, and how complete it seems to be.

Thanks,

At 09:34 AM 2/19/2003 -0600, NAKAMURA, STACEY T. (JSC-NS) (NASA) wrote:

Hi Jon, et al,

Here is the request I received (Sharla works for United Space Alliance and has been tasked by Bill Harris, Shuttle Program Office - Bill has been assigned this task by the Task Force through the MRT).

Bill Harris, is the Govt "official" associated with this task. I will help out with sanity checks where I can.

Yes, we discussed the "below $1000" threshold. If we do that, it will be a second order sweep. For now, we will do the "first order, one layer deep" sweep.

will keep you posted.

Regards,
Stacey

-

Stacey T. Nakamura
Phone: (281) 483-4345
Fax: (281) 483-6275

-----Original Message-----
From:
Sent: Wednesday, February 19, 2003 8:59 AM
To: NAKAMURA, STACEY T. (JSC-NS) (NASA); 'Lorraine.K.Raby@msfc.nasa.gov'; 'David.Barker-1@nasa.gov'
Cc: Green, Mark D; Beagley, Richard C; Lovell, Craig L; HARRIS, WILLIAM J. (JSC-MA) (NASA)
Subject: IRIS Data Request

Per Bill Harris' request, we need the following information pulled from the IRIS database for Space Shuttle Program mishaps:

Scope:

- All Type A, B, C mishaps (people and property)
- Space Shuttle Program only (if possible)
- Timeframe: 1993 - 2003 at a minimum, back to Challenger if possible

Requested Fields:

- Center / Site
- Fiscal Year
- Case #
- Case Category (A, B, C) – or is this the same as Impact Summary?

- Contract #
- Description of Event
- Impact Summary – or is this the same as Case Category?
- Class of Equipment Damaged (Flight Hardware, GSE, Facility, Pressure Vessel, Motor Vehicle, Aircraft, Other)
- Final Damage Amount
- Actions Taken

We would prefer the data be dumped into Excel so that we can expeditiously manipulate the data. We also need the data as soon as you can provide it. If I have misrepresented any of the data fields or have asked for something that is not in the system, please let me know. Feel free to call me if you have any questions. Thank you for your willingness to support this important action.

United Space Alliance
Corporate Environmental, Safety, & Health

Jim

X-Sender: jmullin@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Sat, 08 Feb 2003 10:47:07 -0500
To: jlemke@hq.nasa.gov
From: "Jonathan B. Mullin" <jmullin@hq.nasa.gov>
Subject: Questions to Consider
Cc: prichard@hq.nasa.gov, prutledg@hq.nasa.gov, sbrookov@hq.nasa.gov

More potentials for Congress??
Jon

Jonathan B. Mullin
Manager Operational Safety
Emergency Preparedness Coordinator
Headquarters National Aeronautics and Space Administration
Phone (202) 358-0589
FAX (202) 358-3104
"Mission Success Starts with Safety"


107 Questions.1.doc

X-Sender: jlemke@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Thu, 06 Feb 2003 16:21:45 -0500
To: '
From: jlemke <jlemke@hq.nasa.gov>
Subject: Re: Smart Questions:
Cc: "Jonathan B. Mullin" <jmullin@hq.nasa.gov>, tom.whitmeyer@hq.nasa.gov

John:

It seems that at the mtg, Pete said to also submit unanswered ones--if they were outside of the matrix. They would be kept "on the side" until we completed the matrix.

johnl

At 04:00 PM 2/6/2003 -0500, John W. Lyver, IV wrote:
Jon,

Thanks, but, I need the answers as well. Please add them to your file or tell me which answers they go to on my listing.

John

At 03:46 PM 2/6/2003 -0500, Jonathan B. Mullin wrote:
First round of Smart Questions, copy in your envelope. Regards, Jon

Jonathan B. Mullin
Manager Operational Safety
Emergency Preparedness Coordinator
Headquarters National Aeronautics and Space Administration
Phone (202) 358-0589
FAX (202) 358-3104
"Mission Success Starts with Safety"
John W. Lyver, IV

Safety means staying a step ahead of the grim reaper

John Lemke
Manager, System Safety Engineering
NASA HQ, Code QS
202-358-0567 FAX 358-3104
jlemke@hq.nasa.gov
"Mission success stands on the foundation of our unwavering commitment to safety"
Administrator Sean O'Keefe January 2003

X-Sender: jmullin@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Thu, 06 Feb 2003 15:46:26 -0500
To: jlemke@hq.nasa.gov
From: "Jonathan B. Mullin" <jmullin@hq.nasa.gov>
Subject: Smart Questions:
Cc: jlyver@hq.nasa.gov, tom.whitmeyer@hq.nasa.gov

First round of Smart Questions, copy in your envelope. Regards, Jon

Jonathan B. Mullin
Manager Operational Safety
Emergency Preparedness Coordinator
Headquarters National Aeronautics and Space Administration
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FAX (202) 358-3104
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Smart Questions1.doc

Smart Questions:

1. Was RBAM ever totally integrated into all of the Agency's contracts?

2. Code Q did not have a Quality Assurance person assigned to Code Q for a lengthy period of time. When did this function return to Code Q and what was the program or project impact to mission success?

3. The Michoud Assembly Facility contract with NASA has not been updated with current requirements of safety and quality programs. Could this have contributed to the mishap?

4. When did NASA stop "mandatory inspection reports" of all critical processes and what has been the effect to mission success?

5. Risk Based Mission Assurance has been a contract requirement of the NASA FARs since 2000. Have all contracts been reviewed and updated as requested by the NASA Administrator Dan Goldin in November 2000?

6. What has been the affect of the "greening" of NASA manufacturing processes with meeting EPA requirements to the reliability and maintainability of NASA flight hardware?

7. What follow up and lesson learned have has been accomplished since the failure of programs such as Mar's Observer ($1 Billion) caused by a suspected valve, Mar's Rover, and other programs under "faster, better, cheaper" management philosophy.
Do you have the Mishap Reports on each of these, and can you comment on the efficacy of their corrective actions?

Jon Mullin

X-Info: This message was accepted for relay by
smtp02.mrf.mail.rcn.net as the sender used SMTP authentication
X-Trace: UmFuZG9tSVZ8l/woTgvxGs5brXqzq/5RhRX3ub7sEQVDanwClQOPPCpV0ztA594o
X-Sender: jlyver@pop.erols.com
X-Mailer: QUALCOMM Windows Eudora Version 5.2.0.9
Date: Thu, 06 Feb 2003 16:00:40 -0500
To: "Jonathan B. Mullin" <jmullin@hq.nasa.gov>
From:
Subject: Re: Smart Questions:
Cc: jlemke@hq.nasa.gov, tom.whitmeyer@hq.nasa.gov .

Jon,

Thanks, but, I need the answers as well. Please add them to your file or tell me which answers they go to on my listing.

John

At 03:46 PM 2/6/2003 -0500, Jonathan B. Mullin wrote:
First round of Smart Questions, copy in your envelope. Regards, Jon

Jonathan B. Mullin
Manager Operational Safety
Emergency Preparedness Coordinator
Headquarters National Aeronautics and Space Administration
Phone (202) 358-0589
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"Mission Success Starts with Safety"

Safety means staying a step ahead of the grim reaper

X-Sender: jmullin@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Thu, 06 Feb 2003 16:44:18 -0500
To: wfrazier@HQ.NASA.GOV
From: "Jonathan B. Mullin" <jmullin@HQ.NASA.GOV>
Subject: Smart Questions-1
Cc: jlemke@HQ.NASA.GOV

Wayne, I think I have a mix of Smart Questions for the Board, and also for Congress? See if you have any notion of the answers that I have failed to address. Tom Whitmeyer think I am straying into his domain with my questions. I was following Jim Lloyd's guidance to address any open areas.
Regards, Jon

Jonathan B. Mullin
Manager Operational Safety
Emergency Preparedness Coordinator
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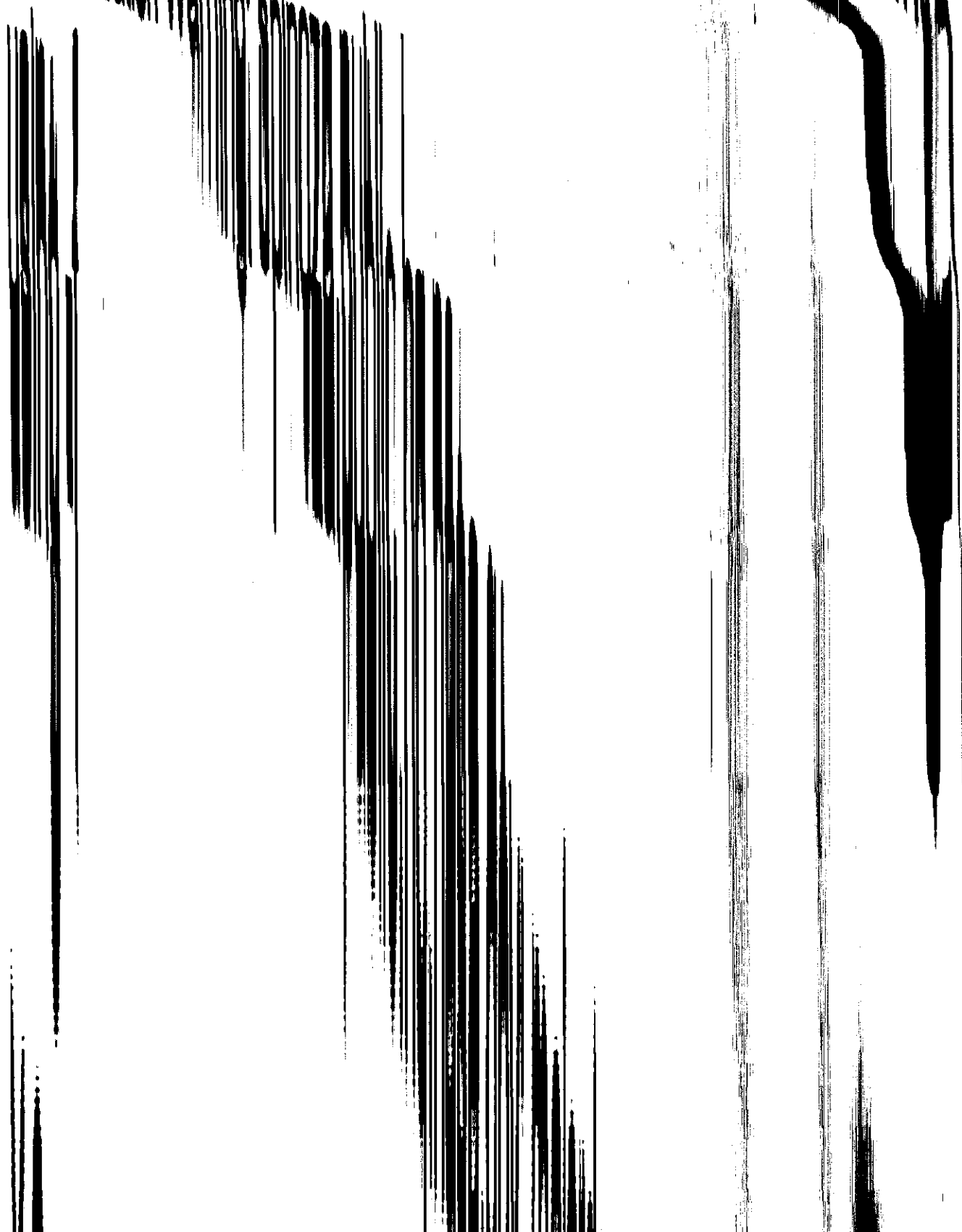
Smart Questions21.doc

John W. Lyver, IV, 12:04 PM 2/6/2003 -0500, **HOT** OSMA ALL HANDS MEETING THURSDAY



X-Authentication-Warning: spinoza.public.hq.nasa.gov: majordom set sender to owner-code-q using -f
X-Sender: jlyver@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Thu, 06 Feb 2003 12:04:34 -0500
To: Code-Q@Lists.HQ.NASA.GOV
From: "John W. Lyver, IV" <jlyver@hq.nasa.gov>
Subject: **HOT** OSMA ALL HANDS MEETING THURSDAY: Topic Areas for Safety and Mission Success/Assurance Questions and Answers
Sender: owner-code-q@Lists.HQ.NASA.GOV

*** HOT HOT HOT ***

**From Pete and Jim **

1) There will be an OSMA ALL HANDS meeting IMMEDIATELY following the 1pm SMA Directors telecon in the QMIC, today, Thursday, 2/6/03.

2) Attached is the second cut at the Questions/Answers crib sheet for helping Mr O'Keefe prepare for SMA portion of the Congressional testimony next week. PRINT OUT the file BEFORE the meeting if you can.

3) Pete will instruct all hands on what is needed to fill in the charts on the attachment. Basically here's a summary of what Pete's going to tell you:

- **Bolded** headings are the areas to concentrate on.
- The tables for each SMA topical area are presented like JEOPARDY. We've listed the answers in the right hand column. Your job is to come up with the questions for the left hand column. Mr. O'Keefe will be playing Double Jeopardy with them next week on the Hill.
- The answers are a first cut from the DRAFT SMA Requirements Model. Do NOT consider this list as complete and final. It may be appropriate to expand, combine, delete, add, fix, ... some of the answers. Your comments will also be considered for incorporation into the SMA Requirements Model.
- If your name is next to a heading, then you are the JEOPARDY Player who has been asked to to fill in the questions for the table below that heading. If your name is next to a line on a table, then you only need to 'Question' that item.
- Here's what we need you to turn in:
  = **All questions are due by COB Thursday, 2/6/03**. If you can't get it done today, see Pete. (We're worried about getting snowed in and meeting Michael Greenfield's Friday suspense for a completed response.)
  = Handwritten filling in the tables is preferred. Please use something other than black ink. You are welcome to write the questions in the left hand column, line out where items are deleted, add yellow sticky notes where you want to add stuff, ... (Beauty does NOT count, just as long as I can read them!)
  = Please put your name on the top of the first page so we know whose comments are whose.
  = Your welcome to develop any questions for any of the other answers beyond what you were assigned, if you have time.

*** PLEASE put the completed Question Sheets in the envelope on my door.***

If you have any questions, ask Pete.

THANKS!!
Pete and John

030206 noon - Topic Areas for Safety and Mission Success.doc

****

John W. Lyver, IV - C.S.P.
NASA Headquarters - Code QV
Office of Safety and Mission Assurance
Washington, DC 20546-0001
(w) 202/358-1155 (fax) 202/358-3104

"Safety vigilance is not negotiable, lives are at stake"

****

To: Phil Napala <pnapala@hq.nasa.gov>
From: "Jonathan B. Mullin" <jmullin@hq.nasa.gov>
Subject: Re: Orbital Debris Information
Cc:
Bcc:
Attached:

Phil, good idea, the plots need to be GPS related. NTSB should have a program. I am sure they are available, I would suggest that any product be readied and provided to the investigation team. Who has the lead to do this, and has the Board President been advised?
Regards, Jon
At 12:12 PM 2/3/2003 +0000, you wrote:

> Wayne,
>
> The amount of debris from Shuttle and the collection effort is an opportunity to update our survive/demise models.
>
> We need to think about what data we need to ask for in order to create a standard data sheet for all debris found.
>
> Perhaps, we could get JSC and KSC to develop a palm pilot data collection checksheet to be passed out to all collection teams.
>
> This information could be use to help determine STS107 failure mode and also aid in developing better ways to protect the public on future NASA missions both in estimating debris field and better design for minimal damage.
>
> Phil

Jonathan B. Mullin
Manager Operational Safety
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X-Sender: jlloyd@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Fri, 07 Feb 2003 18:04:36 -0500
To: hcat@hq.nasa.gov
From: James Lloyd <jlloyd@hq.nasa.gov>
Subject: Fwd: Columbia's Debris Field
Cc: boconnor@mail.hq.nasa.gov, prichard@hq.nasa.gov

Some thoughts on the potential size and location of debris field. For your consideration.

From: Ron Baalke <baalke@zagami.jpl.nasa.gov>
Subject: Columbia's Debris Field
To: nasamitimages@jsc.nasa.gov, columbiaimages@nasa.gov
Date: Fri, 7 Feb 2003 13:33:42 -0800 (PST)
Cc: baalke@zagami.jpl.nasa.gov (Ron Baalke), matt.landano@jpl.nasa.gov, jlloyd@mail.hq.nasa.gov, timothy.howell@jpl.nasa.gov
X-Mailer: ELM [version 2.5 PL1]

Hi,

My name is Ron Baalke and I work at JPL. I've done some calculations on the Shuttle debris field, and would like to pass on some information that I've uncovered that indicates the shuttle debris field is a little larger than anyone had originally anticipated.

I was also particularly interested in the report of possible debris found in Joshua Tree, California. At first glance, it would appear that Joshua Tree is too far from Columbia's ground track (about 300 miles) to be considered a feasible location for shuttle debris. However, I've made an important observation that may explain how debris may have landed in Joshua Tree, due to the effects of the shuttle S-bank maneuvers.

The main debris field in Texas/Lousiana has been reported in the news as being 380x230 miles. Any debris field will form an ellipse, with the longest axis in the direction of the fall. The short end, in this case 230 miles, is roughly the deviation from the flight path. So, the debris was deviated +/- 115 miles off the flight path. I've then calculated that the dispersion angle from when the shuttle broke up is +/- 10.8 degrees.

I then took this angle and applied it to Joshua Tree. If a fragment was to land in Joshua Tree with a 10.8 degree dispersion angle, it would have to have separated from the shuttle about 1,400 miles to the west of Joshua Tree. In other words, over the Pacific Ocean. Also, the time of separation would have been at around 8:50 am EST.

However, it seems unlikely that debris would have this high of a separation angle at such a high altitude, as it would tend to travel along the flight path. Was there anything that could divert debris away from the flight path? There was. The S-bank turns.

It turns out that the shuttle had just performed its first S-bank maneuver at around this time:

- 8:49 am: Columbia begins a series of gentle side-to-side turns designed to lower its speed. The first of these is to the right.

Note the bank was to the right. If any debris were to fall off during the bank turn, it would tend to be thrown off in a southwards direction from the flight path. And Joshua Tree is south of the shuttle's flight path and lines up with an 10.8 degree dispersion angle. We now know from Air Force imagery that the the shuttle had suffered large damage to the left wing. Debris from the damaged wing may have been falling off just as soon as the shuttle entered the atmosphere over the Pacific Ocean. I think this increases the probability that the metallic object found in Joshua Tree is a piece of shuttle debris, probably from the left wing.

Also, I should point that that is has become rather obvious to me that due to the shuttle's hypervelocity speed, any shuttle debris found in California would have almost have definitely separated from the shuttle over the Pacific Ocean.

Taking this a stop further, if a right turn bank would throw debris in a southward direction, I would expect a similar effect, but in the opposite direction, when the shuttle banked to the left:

- 8:57 am: Over New Mexico, the shuttle -- still on autopilot -- begins a left turn to reduce its speed. Mission control in Houston loses transmissions from the left wing temperature sensors.

Any debris that falls off during the left turn bank maneuver would tend to be thrown northward of the flight path.
This opens up the possibility that debris due to the left bank turn could have fallen in Oklahoma, northern Texas and Arkansas.
There has been one report of shuttle debris (unconfirmed) in Arkansas.

I just wanted to pass this information on to you, and I hope it helps.

Ron Baalke
baalke@zagami.jpl.nasa.gov
818-354-5912

Jim

X-Sender: jlloyd@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Fri, 07 Feb 2003 11:47:26 -0500
To: hcat@hq.nasa.gov
From: James Lloyd <jlloyd@hq.nasa.gov>
Subject: Fwd: Analysis for the CAIB's Consideration
Cc: boconnor <boconnor@hq.nasa.gov>, prichard@hq.nasa.gov,
pete Rutledge <prutledg@hq.nasa.gov>, jlemke <jlemke@hq.nasa.gov>,
a.h.phillips@larc.nasa.gov

Please read soon this very interesting analysis that should provoke some thinking. It has been passed forward from Langley.

X-Sender: a.h.phillips@pop.larc.nasa.gov
Date: Fri, 7 Feb 2003 11:06:30 -0500
To: Pete Rutledge <prutledg@hq.nasa.gov>
From: "Alan H. Phillips" <a.h.phillips@larc.nasa.gov>
Subject: Analysis for the CAIB's Consideration
Cc: Jim Lloyd <Jlloyd@hq.nasa.gov>, Faith Chandler <fchandle@hq.nasa.gov>

Enclosed is an observational analysis that one of our employees has offered for consideration. Please forward to the responsible parties for their use.

Thanks.

Alan

--
****
Alan H. Phillips
Director, Office of Safety and Mission Assurance
NASA Langley Research Center
5A Hunsaker Loop
Building 1162, Room 112C
Mail Stop 421
Hampton, VA 23681

(757)864-3361 Voice
(757)864-6327 Fax
****

MazanekMemo1.pdf

Jim

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)

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

[redacted]

To: Cindy Lee <C.C.LEE@larc.nasa.gov>

Hi Cindy,

I would like to offer several observations regarding the theory that debris damaged Columbia's left wing during launch on January 16, 2003. I would like to be able to discuss these ideas during an appropriate Columbia accident investigation meeting here at LaRC.

1. The video footage (apparently provided by the KSC Ice & Debris Team) appears to show that the debris, assumed to be polyisocyanurate foam from the external tank (ET), may not have originated from the ET. In the first few frames of the video sequence, the debris appears to come from a location obscured by the orbiter and ricochets off the ET. The origin of debris still could be from the ET, or possibly the underside of the orbiter. After contacting the ET, the debris fragments into two visible pieces. The first, apparently smaller, debris fragment produces a small shower of particles that can be seen at the trailing edge of the left wing. The second, larger piece of debris appears to result in a much larger impact on the trailing edge of the left wing. The debris may have been made of ice or some other material(s) and could be much more massive than the calculated 1.211 kg (2.67 lb.). If the photogrammetric measurements accurately measured the debris to be 0.508 x 0.406 x 0.152 meters (20 x 16 x 6 inches), and it was made of solid ice, the mass could be approximately 28.7 kg (63.4 lb). The energy released from this impact could be almost 25 times greater than estimated. Other dense materials, such as aluminum, would make this impact even more damaging. I would like to suggest a re-examination of the debris impact video footage to determine if the fragment(s) could have originated from another location, possibly an ice buildup somewhere under the orbiter. As a reference, if the debris was 1.211 kg. and assuming a conservative relative impact velocity of 457.2 m/s (2 x 750 fps used in the JSC analysis), the kinetic energy would have equivalent to a 500 lb safe impacting at 75 mph. If the debris was 28.7 kg, that would be the equivalent of a 500 lb safe hitting the wing at 365 mph.

2. If the observation in #1 above can proven to be incorrect, and it can be definitively determined that the debris was foam insulation from the ET, there still appears to be an issue regarding its thickness. It has been estimated that the debris was 0.152 meters (6 inches) thick. Several sources that I have found indicate that the insulation is sprayed on the ET to a thickness of 1-2 inches. It is certainly possible that certain locations on the ET may have insulation that is 6 inches in depth, but how thick was the insulation at the point where it is believed to have separated? How accurately is this location known? I assumed that the volume of ET insulation can be approximated by a thin walled cylindrical body with flat, circular plates on each end. I assumed that the ET was 46.8 meters (153.8 ft) in length, 8.412 meter (27.6 ft) in diameter. I used a density of 38.63 kg/m^3 (calculated from the mass and size of the foam debris assumed in #1 above).

Using a uniform thickness of 0.152 meters (6 inches), I estimate the total mass of the insulation to be 8080 kg (17,813 lb). This is 3.7 times greater than the 2187 kg (4823 lb) that is stated on the NASA Human Space Flight Shuttle Reference web page. A 0.0254 meter (1 inch) thickness results in a total mass of 1328 kg (2928 lb), and a 0.0508 meter (2 inch) thickness results in a total mass of 2664 kg (5873 lb). These totals are consistent with a thickness of 1-2 inches. It is possible that the numbers stated on the Space Flight web page are not very accurate, but I would not expect them to be that much off. I have not heard any discussion about variations in the insulation thickness, and I would like to understand how certain we can be that the debris was entirely made of foam.

3. Even if the damage to the tiles was not obviously visible, could this type of impact carve out a significant channel in the protective tiles? This channel

would then allow extreme heating to occur down the length of the wing. How many re-entries had the tiles in the area of the suspected damage been through? Is it possible that this area could have had "older" tiles that could be more easily loosened from the wing during impact, but only separated during re-entry or later during ascent? Could the impact result in a significant increase in the surface roughness of the tiles around the impact area, and could this result in a high turbulent heating that caused tiles to be shed during re-entry? Finally, it is reasonable that the impact could have multiple effects on the orbiter, such as damage to control surfaces.

Thanks very much for your attention to these observations. I hope that they are helpful in the investigation of this terrible loss for the astronauts and their families, NASA, and our country.

Dan

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To: prichard@hq.nasa.gov
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Subject: Fwd: senior level charts

for the log
From: "W Frazier" <wr.frazier@verizon.net>
To: <boconnor@hq.nasa.gov>
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Subject: senior level charts
Date: Tue, 4 Feb 2003 21:18:06 -0500
X-Mailer: Microsoft Outlook Express 6.00.2720.3000
X-Authentication-Info: Submitted using SMTP AUTH at out005.verizon.net from [4.42.97.8] at Tue, 4 Feb 2003 20:18:20 -0600

Bryan,

Here are the charts. They were delayed slightly since Legal wanted to review them in case they get outside. Legal recommended we use the current definitions for the AA briefing rather than the proposed for some of the new changesbut siad its OK for the CAIB. Faith has reviewed and provided input. Hope this helps. Hope all is going well and we stand ready to support.

Wayne


Senior managers briefing 02.04.ppt

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"Mission success starts with safety"

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Overview of NASA Mishap Investigation Policy and Process and Contingency Planning

February 4, 2003

Jim Lloyd
NASA Headquarters
Office of Safety and Mission Assurance

Purpose

- To provide a top level overview of NASA Mishap Policies and Procedures and their connection to the ongoing contingency efforts for the STS-107 mishap

NASA Policy and Procedures

- **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

NPD 8621.1G Mishap Reporting, Investigating, and Recordkeeping Policy"

Office of Prime Responsibility : Office of Safety and Mission Assurance (Code Q)

Bryan O'Connor,
Associate Administrator

- Establishes NASA-wide policy for mishap reporting and investigating—signed by the Administrator.
- Describes purposes of mishap investigation, board appointment authorities, roles of responsible officials, and responsibilities for final report acceptance and approval.
- Requires all levels to have mishap response plans; e.g., pre-mishap plans, contingency plans, for response to emergencies.

NPG 8621.1G, "NASA Procedures and Guidelines for Mishap Reporting, Investigating and Recordkeeping"

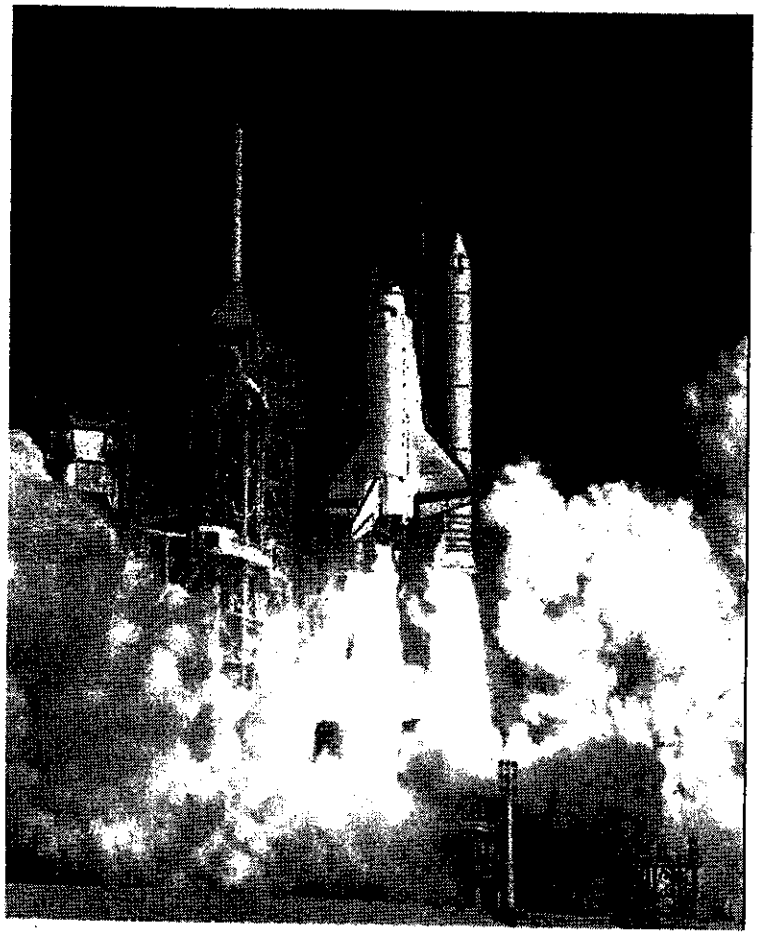
Office of Prime Responsibility : Office of Safety and Mission Assurance (Code Q)

Bryan O'Connor,
Associate Administrator

- Establishes NASA-wide procedures and guidelines for mishap reporting, investigating and recordkeeping
- Provides definitions of types of mishaps, descriptions of reporting procedures, investigative techniques, report format, report timelines, report approval process, corrective action process, and lessons learned process.

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 process.



Office of Space Flight
Contingency Planning

Special Considerations –OSF Contingency Planning

- NPD requires each level of organization to "develop mishap response plans, (e.g. pre-mishap plans,contingency plans, emergency response plans) to ensure effective response to...emergencies....and mission failures."
- Shuttle Program in NSTS 07700 details:
  - A pre-designated, rapid response team trained in agency investigation policies, and supporting working groups with expertise in specific Shuttle systems and operations. (Called Mishap Investigation Team or "MIT"- chaired by Dave Whittle of JSC)
- Office of Space Flight-Agency Contingency Plan for Spaceflight Operations, Jan 2003 details:
  - A standing interagency board of senior personnel independent of NASA for Administrator-level boards in the event of major mission failures or high visibility events in Space Flight Operations.

Mishap Investigation Team (MIT) aka "go team"

- 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, and addresses.