
The ABC's of Risk Management
Goddard Space Flight Center
NASA

Risk Management Course Objectives

This course is intended to help you understand:

Section 1: What is Risk Management (RM)?

Section 2: The Continuous Risk Management (CRM) process

Section 3: The Risk-Informed Decision-Making (RIDM) process

Note: When you see this symbol  , this topic is explained in depth in the RM Processes at GSFC Course

Agenda

❑ Introduction	15 Minutes
❑ What is Risk Management?	40 Minutes
❑ IBEX Case Study	15 Minutes
❑ Break	10 Minutes
❑ CRM Process	60 Minutes
❑ Break	10 Minutes
❑ NFIRE Case Study	20 Minutes
❑ RIDM Process	20 Minutes
❑ Atlas Centaur-67 Case Study	30 Minutes
❑ Wrap-Up	10 Minutes

1. What is Risk Management?

- NASA Risk Management
- Why GSFC implements Risk Management

NASA Missions Are Inherently Risky

- We must take risks to achieve mission success

- At the same time, we must reduce the likelihood and consequence of these risks to the extent possible within our constraints

- To minimize risks, we must use an organized approach to determine uncertainties, consider all alternatives, and make risk-informed decisions

GSFC Risk Management Sponsors

"NASA Risk Management is fundamental to the way we do business."
by Chris Scolese, Director, Goddard Space Flight Center, Greenbelt, MD

Project Management at NASA is a real challenge and one that deserves our special attention. A significant component of project management is Risk Management (RM).

"NASA Risk Management (RM) as an SMA function."
by Judy Bruner,
Safety & Mission Assurance Director, Goddard Space Flight Center, Greenbelt, MD

As part of the Safety Mission Assurance (SMA) role at GSFC, we support all programs and projects. We recognize that their successful execution is equally important to the overall NASA mission. Each effort has a certain amount of inherent risks to it's successful completion. Identifying, tracking, mitigating and documenting all risks will aid the program/project managers and technical leads in a more successful completion of all programs and projects.

RM training & implementation techniques as well as project risk facilitation and assessment services are available through the Code 300 , the office of Risk Management. For further information or details concerning Risk Management contact Mr. Anthony DiVenti at the Goddard email: anthony.j.diventi@nasa.gov

Purpose Of GSFC Risk Management

- Facilitate mission success by identifying and managing risks

- Facilitate communication of risks horizontally and vertically throughout Goddard (reported at the Center Management Council [CMC])

- Ensure compliance with all governing rules, regulations, and requirements for risk management (e.g., NPDs, NPRs, GPRs, Directorate / Program / Project risk management plans)

RM Policy and Guidance Documents

Version 1.0 - NASA/SP-2010-576 – APRIL 2010

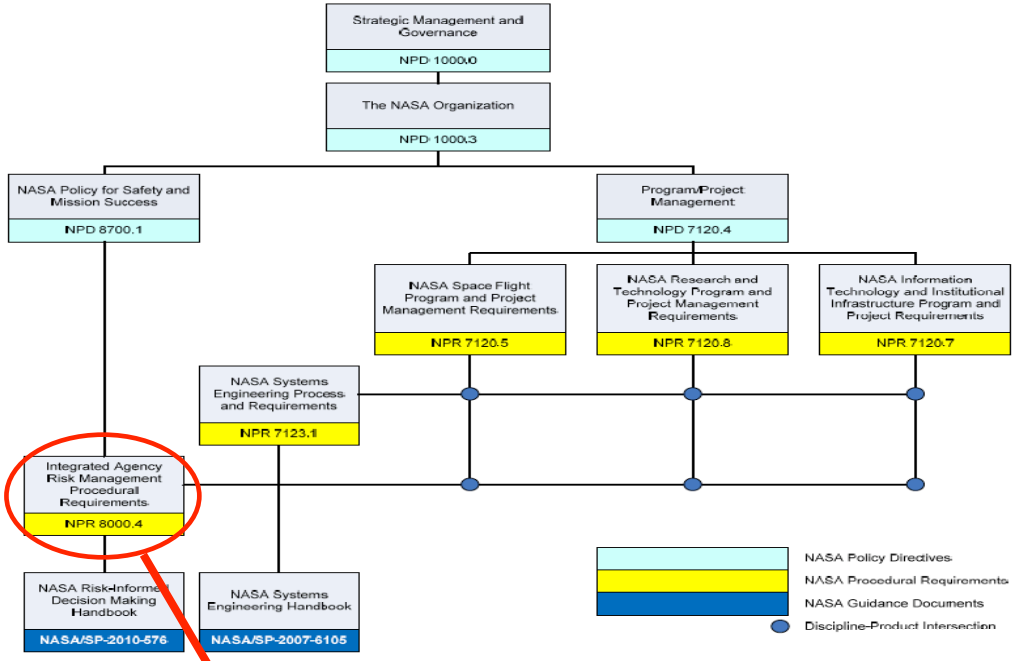


Figure 1. Intersection of Discipline Oriented and Product Oriented NPRs and their Associated Guidance Documents

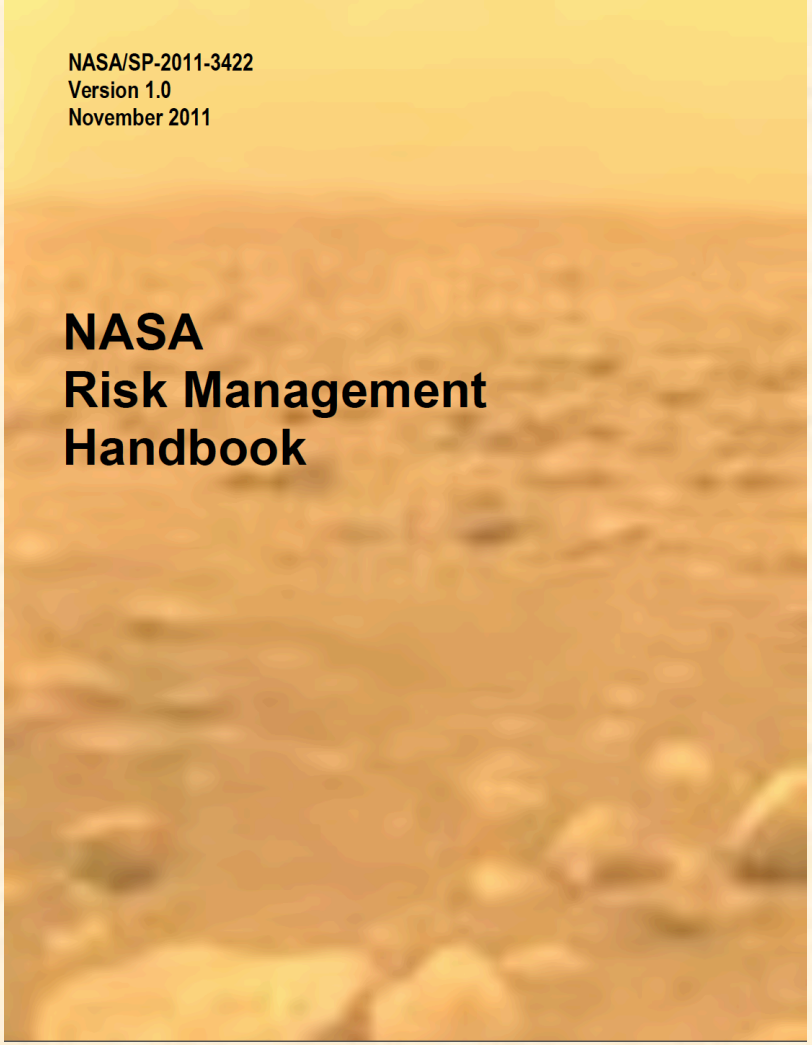
- Light Blue – NASA Policy Directives
- Yellow – NASA Procedural Requirements
- Dark Blue – NASA Guidance Documents

- GPR 7120.4 – Risk Management

NASA's RM Handbook

In some form, risk management has always been an integral part of virtually every challenging human endeavor.

- A formal and, at that time, qualitative RM process known as Continuous Risk Management was introduced to NASA in the latter half of the 1990s.
- More rigorous quantitative RM processes including Risk-Informed Decision Making and an enhanced version of CRM have only recently been developed for implementation as an integral part of systems engineering at NASA.
- While there will probably always be vigorous debate over the details of what comprises the best approach to managing risk, few will disagree that effective risk management is critical to program and project success and affordability.



http://www.hq.nasa.gov/office/codeq/doctree/NHBK_2011_3422.pdf

Where Are The Risks?

Eliminate your blind spots

Known Knowns	Current knowledge we are confident of and can move forward on (little risk)
Known Unknowns	Things we know exist and carry as risks because we don't know how/what will happen
Unknown Knowns	Things somebody knows we should know but don't. This is a sharing and knowledge search risk; can we find it in time?
Unknown Unknowns	Risks we aren't even aware of (only mitigation is to stay away from the edge); causes us to be cautious on the knowledge that there are always things lurking out there

Credit: Dr. Edward W. Rogers, GSFC Chief Knowledge Officer

We Do It Every Day

- You are planning a drive to Atlantic City this weekend. What might you do to ensure your vehicle is ready (reduce risk)?
  - Check tire pressure and inflate to manufacturer's spec
  - Check fluid levels and top-off
  - Check for a working flashlight, basic tools, and First Aid Kit
  - Check spare tire pressure (where is that spare, anyway?)
  - Replace those worn-out wiper blades
  - Check Registration and have proof of insurance

RM's Intention Is To Prevent Surprises

- Risk Management is *Forward-Thinking*
  - *What* could go wrong?
  - *How will we know* that something has gone wrong?
  - *When* will we know that something has gone wrong?
  - What could we *do* about it?
  - What *will* we do about it?

Brainstorming Atlantic City Trip

- Now that our vehicle is ready for our Atlantic City trip, what else could impact our goal of a great weekend?
  - Bad weather? Check the forecast: hurricane coming?
  - Driving during daylight or night time? Night driving is more dangerous (limited sight distance, impaired drivers). Plan for day time drive whenever it's feasible.
  - Will a truck tire blow-out in front of us? Manage distance to potential hazards and pay attention to nearby traffic.
  - What might we forget to bring? Beach umbrella? Boogie board? Medication? Laptop? Make a list.
  - What other unknowns could affect our trip?

Risks vs. Issues

- Risks are *anticipated* Issues
- Issues are events that *have occurred*
- 100% probability of occurrence means the Risk is really an Issue, NOT a Risk
- Issues require decisions; since decisions have a degree of uncertainty, explore the associated candidate Risks associated with each Issue
- Concern are the seed of a risk, however, not enough is know about it to become a risk

Risk Defined

- Things that *might* happen that could prevent you from meeting your objectives

- The expression of the potential for performance shortfalls, which may be realized in the future, with respect to achieving explicitly established and stated performance requirements

- The performance shortfalls may be related to any one or more of the following mission execution domains:
  - Safety
  - Technical performance
  - Cost
  - Schedule

Credit: NASA Agency Risk Management Procedural Requirements – NPR 8000.4

Program/Project Risk Defined

- Safety Risk - a potential problem that includes the possibility of personnel injury and / or damage to facilities

- Technical Risk - a potential problem that includes the possibility of impact to Flight / Ground segments during operations (i.e., "end products" performing their desired functions in their operational environments)

- Cost / Schedule (Programmatic) Risk - a potential problem that includes the possibility of impact to development activities and / or the ability to deliver the required product within the allocated budget, schedule, and resources

Types Of Risks

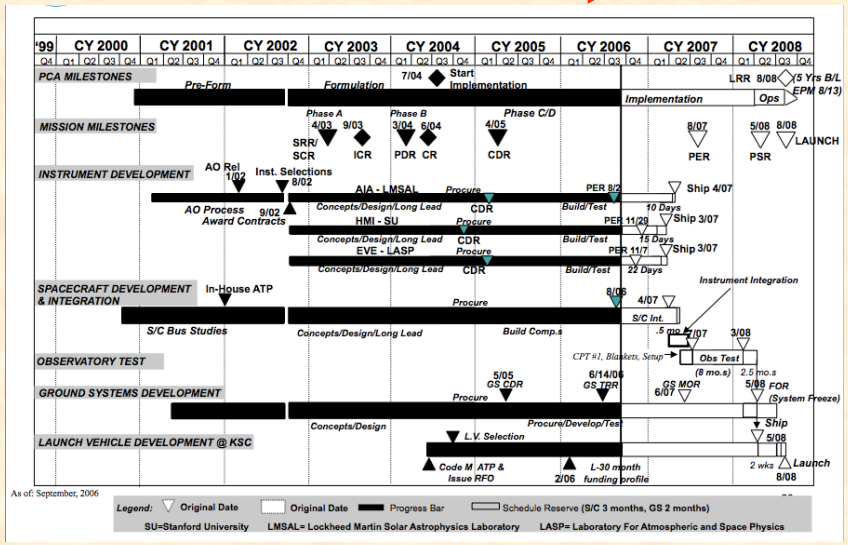
NASA GSFC Risk Management Training

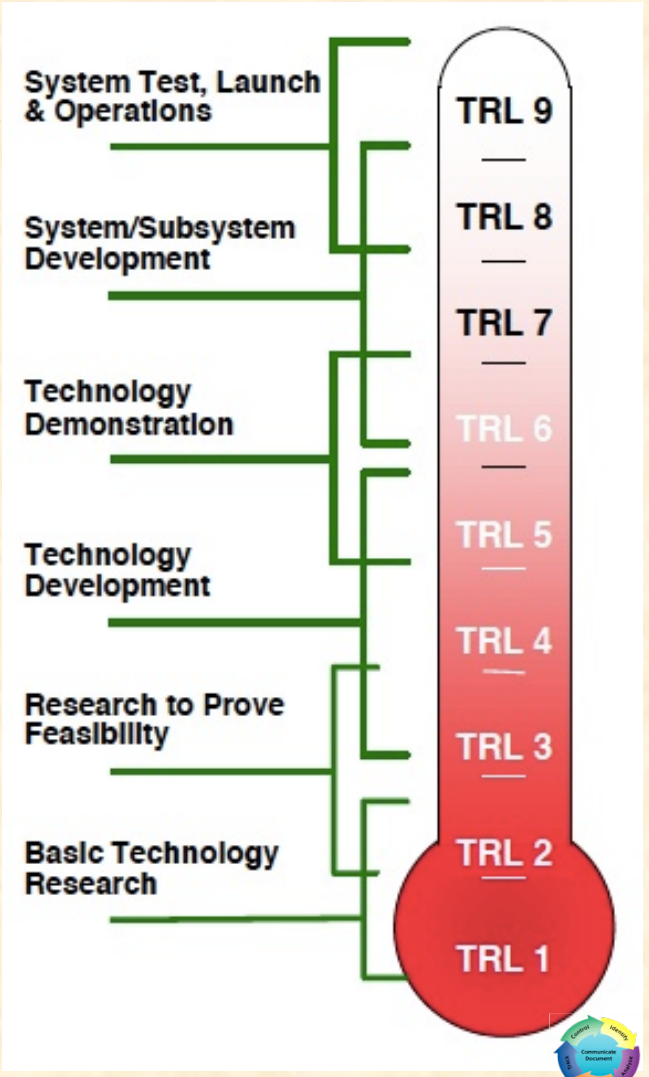
NASA encounters risks in all of its activities and the project risk manager works in identifying risks in the following project areas:

Technical

Safety

Cost / Schedule





Opportunity Defined

- Opportunities are the opposite of risks

- An opportunity is an uncertain event or condition that, if it occurs, will have a *positive* effect on one or more of the project objectives, such as safety, cost, schedule, or technical performance objectives.

Credit: Dave Lengyel – HEOMD Risk & Knowledge Management Officer

Case Study

Interstellar Boundary Explorer (IBEX)

Break Time

10 Minutes

2. CRM

- The Five Continuous Risk Management Steps
- How risks are escalated / reported at GSFC

5 Steps Of CRM

Assess the risk status and redirect risk activities as needed

Identify risks to program / project success

Collect and analyze data on risk status and report per the governing Risk Management Plan

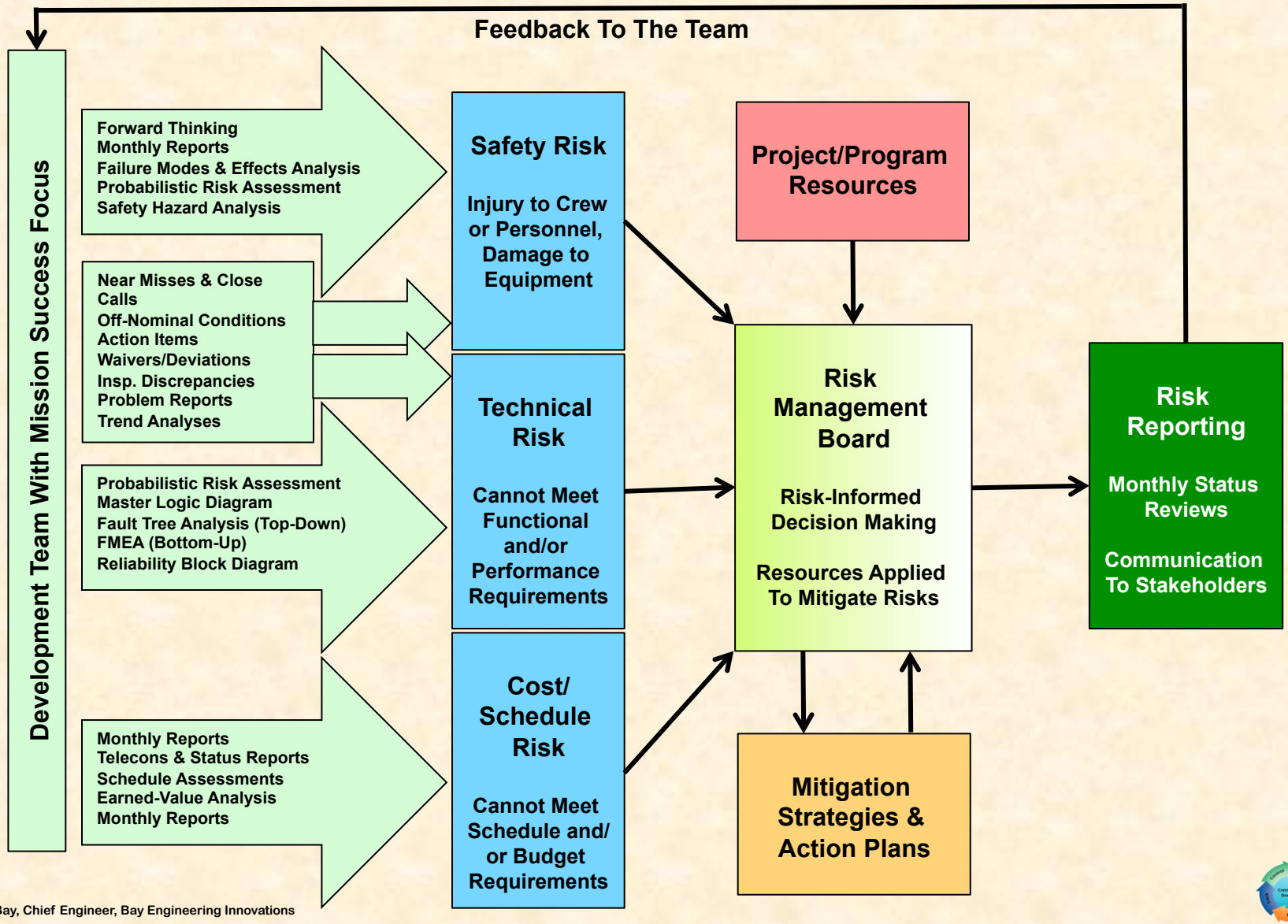
Conduct analyses to determine the probability and potential impact of the risk on the program / project

Develop approach to address risk (accept, watch, mitigate). Develop mitigation plans as needed

Credit: Dave Lengyel – HEOMD Risk & Knowledge Management Officer

NASA CRM Process Flow

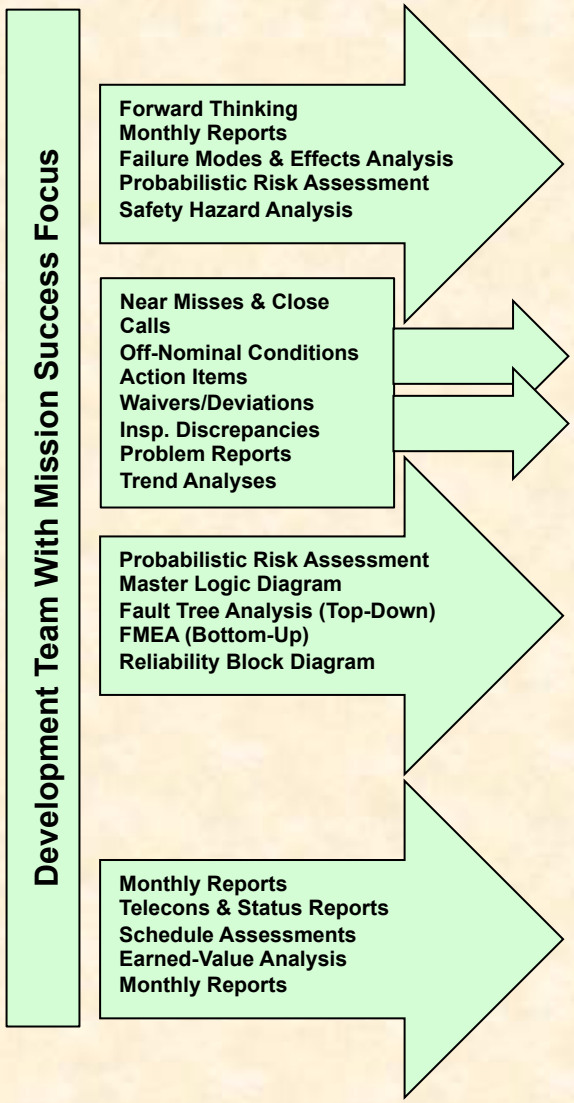
NASA GSFC Risk Management Training



Credit: Michael Bay, Chief Engineer, Bay Engineering Innovations

Step 1: Identify

Risks Come From Many Sources



- ❑ Forward thinking mindset
- ❑ Trade studies
- ❑ Safety/Hazard analyses
- ❑ Independent project reviews
- ❑ Reliability analyses
- ❑ Problem / Failure Reports
- ❑ Monthly status reports
- ❑ Meeting discussions
- ❑ Budget Estimates
- ❑ Schedule Reviews
- ❑ Technical Peer Reviews
- ❑ Brainstorming sessions

Credit: Dave Lengyel – HEOMD Risk & Knowledge Management Officer

What Makes Up A Risk Statement?

- ❑ Must be a Fact or perceived to be Fact
- ❑ Must be Reality Based
- ❑ Can have NO uncertainty attached

- ❑ Must be a very specific outcome
- ❑ Determines Risk Category (e.g., Safety, Cost, Schedule, Technical)

GIVEN → CONDITION → there is a POSSIBILITY that, → CONSEQUENCE → RESULTING IN → IMPACT

- ❑ Must have a Negative impact to the Condition
- ❑ Must focus on the long term impact of the risk to the project

A good risk statement must be ACTIONABLE and have ONE condition and ONE consequence per statement

Risk Context Statement

- The Risk Context statement complements the Risk Statement by providing additional detail (who, what, when, where, and how) essential to understanding the entire set of risk circumstances

- The Risk Context is a "snap shot" of the situation at the time the risk was written. It should complete, clear, and concise

Risk We May Write

- While planning your drive to Atlantic City this weekend, what are some example risks?
  - Given that: the spare tire pressure hasn't been checked in the last year and may be flat; There is a possibility that: I may get a flat tire during the trip and need the spare, Resulting in: my family being stranded by the side of the road.
  - Given that: the fluid levels have not been checked in the last year and may be low; There is a possibility that: the car could overheat, Resulting in: my family being stranded by the side of the road.
  - Given that: the car Proof Of Insurance is in my desk drawer; There is a possibility that: I may be pulled-over for a routine traffic stop, Resulting in: a ticket for no proof of insurance.

Some Other Risks To Consider

- The possible risks on our drive to Atlantic City is almost endless. What are some risks that are less likely?
  - Given that: a meteorite could strike the car; There is a possibility that: it would destroy the car and everyone in it, Resulting in: total loss of mission.
  - Given that: an earthquake could occur on the East Coast near Atlantic City; There is a possibility that: Atlantic City would be destroyed, Resulting in: no place to spend the weekend.
  - Given that: the price of gasoline has increased dramatically over the last year; There is a possibility that: the price could get so high that we could not afford to drive to Atlantic City, Resulting in: cancellation of our trip.

Continuous Risk Identification

- An initial set of risks is identified prior to project initiation (based on past experience)
- Risk identification sessions should be scheduled on a regular basis (typically monthly)
- Risk Coordinator assigned to your Program / Project is there to facilitate the Goddard risk process so seek them out and talk about possible risks

Credit: Dave Lengyel – HEOMD Risk & Knowledge Management Officer

Example Goddard Risks

- Some risks you may see at Goddard:
  - Given that: a pyro valve failed to fire during qualification testing; There is a possibility that: another valve procured from this vendor may not fire on-orbit, Resulting in: total loss of mission.
  - Given that: a recent failure of thin small outline package parts due to a coefficient of thermal expansion mismatch; There is a possibility that: a similar failure may occur in our C&DH board, Resulting in: a significant cost and schedule increase to replace the parts and retest.
  - Given that: Engineering Test Unit (ETU) development typically encounters unforeseen delays; There is a possibility that: one or more ETUs will be delivered late, Resulting in: impact to the Project Schedule Critical Path.

Capturing Risk Data

❑ Risk repositories are used to contain risk data and generate reports

- Risk List Worksheet (Word Table)
- Risk Spreadsheet (Excel Spreadsheet)
- Commercial-Off-The-Shelf (COTS) database software
- Risk Management-specific database software

Trend	Rank	Risk ID	Approach	Risk Title
➡	1	210	M	System Optical Testing
➡	2	177	M	Region 1 Power Dissipation
⬆	3	347	M	OTE/ISIM Thermal Balance Test Failure
➡	4	317	M	No OTE Alone Test Workmanship Risk
NEW	5	183	M	Cryocooler Thermal Load Growth
⬇	6	287	M	Backplane Cryo Alignment
➡	7	351	W	Sunshield Deployment
➡	8	390	R	OTE SMA Actuator

Step 2: Analyze

New Risk Analysis

- **Validating New Risks** - Is the candidate risk legitimate, and is it appropriate to enter it into the Program / Project database?
  - Is the new Risk Statement complete, concise, accurate, and understandable?
  - Between the Risk Statement and Context information, is the new risk self-explanatory?
  - Is the new risk a Safety, Technical, or Cost / Schedule risk, or more than one risk?
  - Does the initial Risk Ranking need adjustment?
  - What is the next decision point (Trigger Event)?
  - Who should be the Risk Owner?
  - Is the initial Mitigation Strategy appropriate and complete?

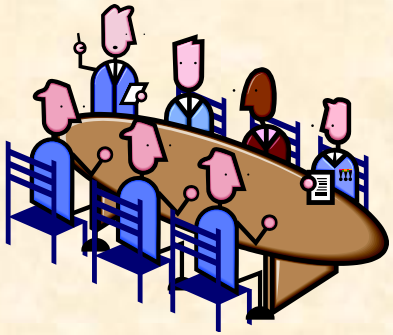
Risk Board Analysis – New Risks

- After preliminary analysis, new and existing risks are reviewed by the Risk Management Board

"Is this a *legitimate* risk, or just someone's concern?"

"Has the *root risk* been identified, or just a symptom?"

"What are the *cost and schedule impacts* associated with mitigating this risk vs. *doing nothing* (accepting the risk)?"



"Have *all possible outcomes* been considered and addressed in the Mitigation Strategy steps?"

"Who is the *appropriate* person to manage this risk (Risk Owner)?"

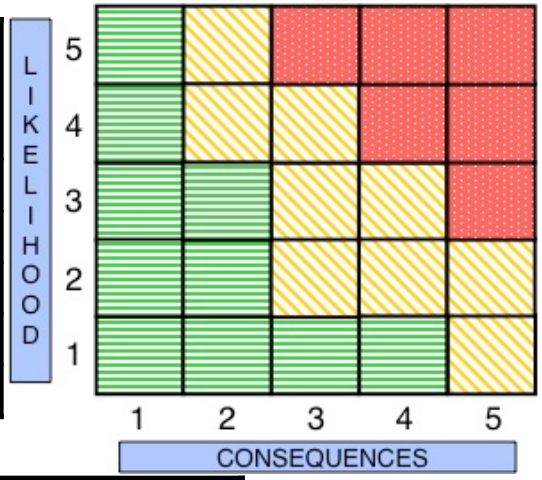
"Does each Mitigation Strategy step have a *clear objective* and *success criteria*?"

"If this potential problem occurs (worst case), what impact would it have *to overall mission objectives*?"

Credit: Dave Lengyel – HEOMD Risk & Knowledge Management Officer

GSFC Risk Matrix Standard Scale

Likelihood	Safety (Estimated likelihood of safety event occurrence)	Technical (Estimated likelihood of not meeting performance requirements)	Cost/Schedule (Estimated likelihood of not meeting cost or schedule commitment)
5 Very High	($P_{SE} > 10^{-1}$)	($P_T > 50\%$)	($P_{CS} > 75\%$)
4 High	($10^{-2} < P_{SE} \leq 10^{-1}$)	($25\% < P_T \leq 50\%$)	($50\% < P_{CS} \leq 75\%$)
3 Moderate	($10^{-3} < P_{SE} \leq 10^{-2}$)	($15\% < P_T \leq 25\%$)	($25\% < P_{CS} \leq 50\%$)
2 Low	($10^{-5} < P_{SE} \leq 10^{-3}$)	($2\% < P_T \leq 15\%$)	($10\% < P_{CS} \leq 25\%$)
1 Very Low	($10^{-6} < P_{SE} \leq 10^{-5}$)	($0.1\% < P_T \leq 2\%$)	($2\% < P_{CS} \leq 10\%$)



Consequence Categories					
Risk	**1 Very Low**	**2 Low**	**3 Moderate**	**4 High**	**5 Very High**
Safety	Negligible or No impact.	Could cause the need for only minor first aid treatment .	May cause minor injury or occupational illness or minor property damage.	May cause severe injury or occupational illness or major property damage.	May cause death or permanently disabling injury or destruction of property.
Technical	No impact to full mission success criteria	Minor impact to full mission success criteria	Moderate impact to full mission success criteria. Minimum mission success criteria is achievable with margin	Major impact to full mission success criteria. Minimum mission success criteria is achievable	Minimum mission success criteria is not achievable
Schedule	Negligible or no schedule impact	Minor impact to schedule milestones; accommodates within reserves; no impact to critical path	Impact to schedule milestones; accommodates within reserves; moderate impact to critical path	Major impact to schedule milestones; major impact to critical path	Cannot meet schedule and program milestones
Cost	<2% increase over allocated and negligible impact on reserve	Between 2% and 5% increase over allocated and can handle with reserve	Between 5% and 7% increase over allocated and can not handle with reserve	Between 7% and 10% increase over allocated, and/or exceeds proper reserves	>10% increase over allocated, and/or can't handle with reserves

HIGH RISK

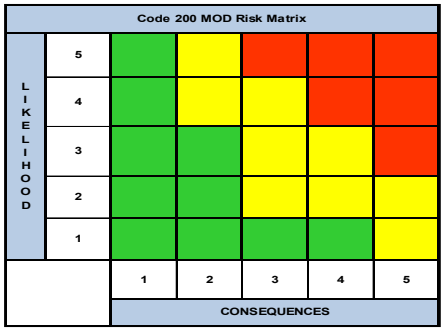
MODERATE RISK

LOW RISK

GSFC Institutional 5x5 Risk Matrix

APPENDIX C. Code 200 RISK SCORECARD

Likelihood Rating			
LIKELIHOOD	5	Very Likely	Expected to happen. Controls have mimimum to no effect.
	4	Likely	Likely to happen. Controls have significant limitations or uncertainties.
	3	Possible	Could happen. Controls exist, with some limitations or uncertainties.
	2	Unlikely	Not expected to happen. Controls have minor limitations or uncertainties.
	1	Highly Unlikely	Extermely remote possibility that it will happen. Strong controls in place.



SEVERITY

- **High** - Mitigate; implement new processes, charge requirements, or re-baseline
- **Moderate** - Manage/consider alternative processes, or Accept
- **Low** - Manage within normal processes; or close

CONSEQUENCES	*Subcategories*	1	2	3	4	5
HE (Health, Environment)	*System, Facility*	Minor damage to asset	Moderate impact or degraded performance	Loss of non-critical asset	Damage to critical asset	Loss of critical asset or emergency evacuation
	Environment	Minor or non-reportable hazard or incident	Moderate hazard or reportable violation	Significant violation; event requires immediate remediation	Major violation; event causes temporary work stoppage	Catastrophic hazard
Technical	*Performance*	Minor impact to mission objectives or requirements	Incomplete compliance with a key mission objective	Non-compliance; significant impact to mission	Noncompliance; Major impact on Center or Spaceflight mission	Failure to meet mission objectives
Center Capabilities	*Infrastructure*	Minor impact or reduced effectiveness	Moderate impact or damage to infrastructure	Significant damage to infrastructure or reduced support	Mission delays or major impact to Center operations	Extended loss of critical capabilities
	Workforce	Minor impact to human capital	Moderate impact to human capital	Significant impact; loss of critical skill	Major impact; loss of skill set	Loss of Core Competency
Cost	*Organizational or CMO Impact*	<2% Budget increase or <$1M CMO threat	2 - 5 % Budget increase or $1M - $5M CMO threat	5 - 10% Budget increase or $5M - $10M CMO threat	10 - 15% Budget increase or$10M - $60M CMO threat	>15% Budget increase or >$60M CMO threat
Schedule	--	Minor milestone slip	Moderate milestone slip; Schedule margin available	Project milestone slip; no impact to a critical path	Major milestone slip; impact to a critical path	Failure to meet critical milestones

Step 3: Plan

Risk Planning

- **Evaluating Existing Risks** – Since Goddard Programs / Projects are inherently dynamic, risk circumstances change month-to-month and require re-evaluation to stay on track
  - What new information is available since the last update?
  - Have requirements associated with this risk changed?
  - Has the risk Category changed: Safety, Technical, or Cost / Schedule?
  - Does the initial Risk Ranking need adjustment (Likelihood or Consequence)?
  - Do we need to change our risk Approach (Watch, Research, Mitigate, or Accept)?
  - What changes do we need to make regarding Mitigation Strategy (adjust budget, schedule, or resources)?

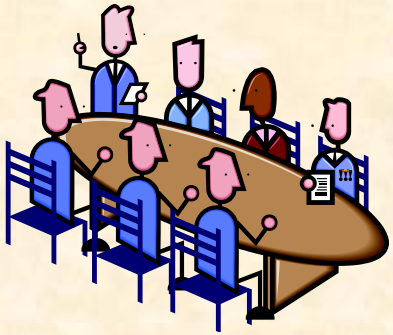
Risk Board Planning

❑ Each month, existing risks are reassessed at the Risk Management Board Meeting

"Is the Risk Statement *still valid* as written?"

"Are we approaching a *Trigger* Date / Event (decision point)?"

"Does the latest cost / benefit analysis still support *mitigating* this risk or should we *accept* it?"



"Have any *new* possible outcomes been considered and addressed in the Mitigation Strategy steps?"

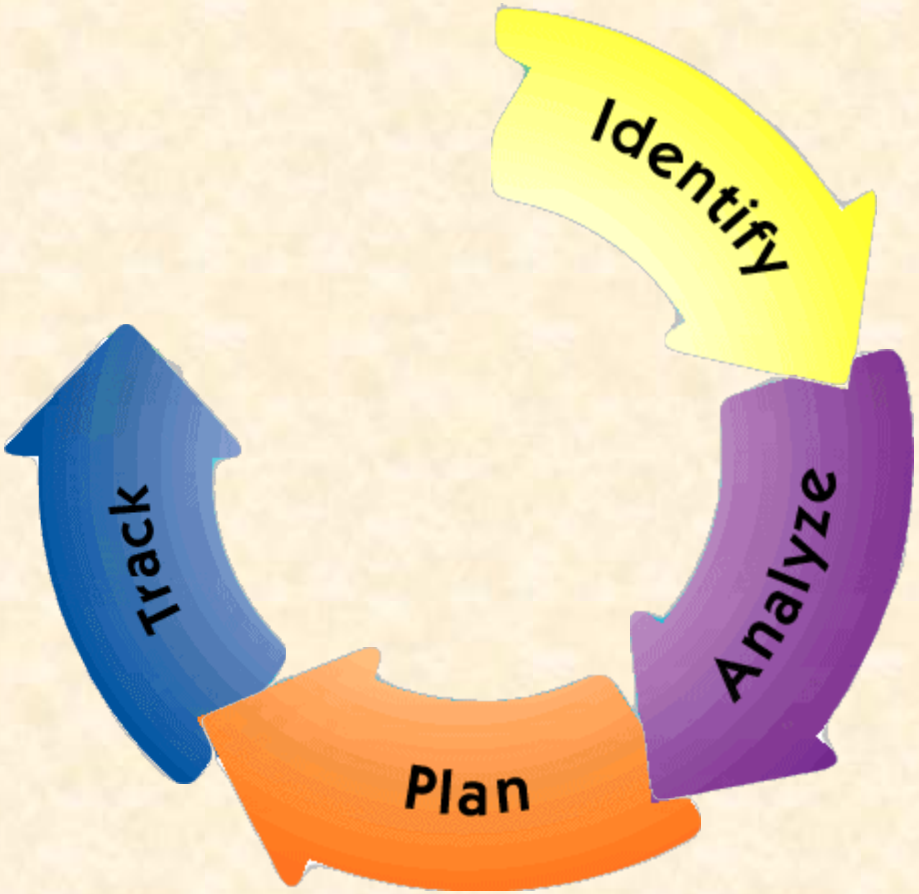
"Does the risk status include all necessary information needed to make *informed* Mitigation Strategy *decisions*?"

"What will it take to bring this risk to closure?"

"Has the potential impact (worst case) increased or decreased; *now* what impact would it have *to overall mission objectives*?"

Credit: Dave Lengyel – HEOMD Risk & Knowledge Management Officer

Step 4: Track



Track Data

- Acquire information / background
  - Determine what information is required
  - Obtain the data (e.g., trade studies, cost analysis)
- Compile information
  - Organize data
  - Review metrics and identify trends
  - Format data consistent with other projects
- Report horizontally and vertically
  - Communicate the compiled data throughout the management chain
  - Recommend action to be taken for each risk and specify any modifications that may be required

Credit: Dave Lengyel – HEOMD Risk & Knowledge Management Officer

Step 5: Control

Control

- **Evaluate Risk Data:**
  - Trends, deviations, anomalies, significant risk changes
  - Assess the effectiveness of mitigation plans, and determine the best courses of action
- **Decide What to Do**
  - Determine the best way to proceed to effectively manage the risk and meet objectives
- **Implement the Decisions**
  - Implement the decisions and ensure that all decisions are appropriately documented for future reference and historical record maintenance

Credit: Dave Lengyel – HEOMD Risk & Knowledge Management Officer

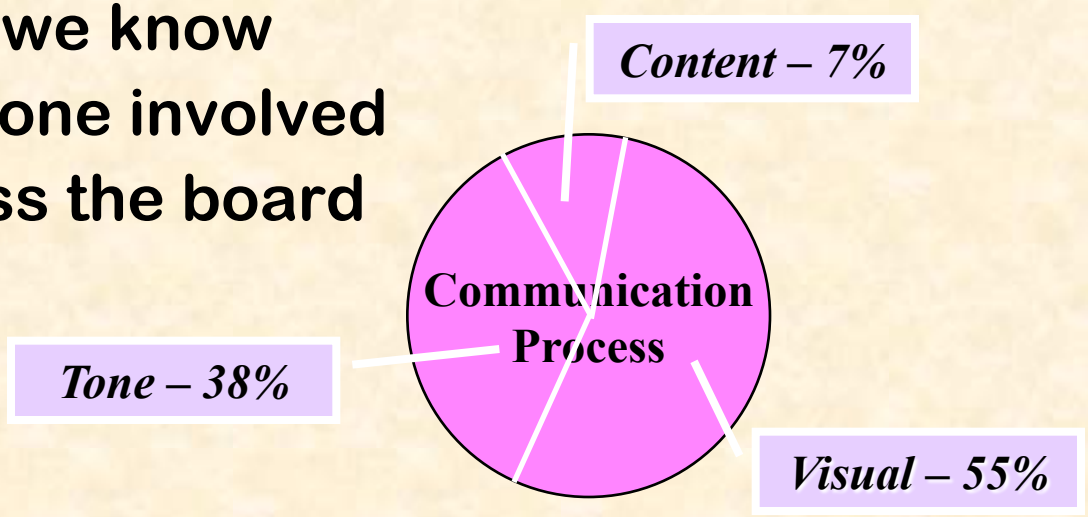
Communicate and Document

- ❑ Risks must be communicated horizontally & vertically throughout the org
- ❑ Risks must be documented to ensure that CRM is being implemented correctly and to serve as lessons learned

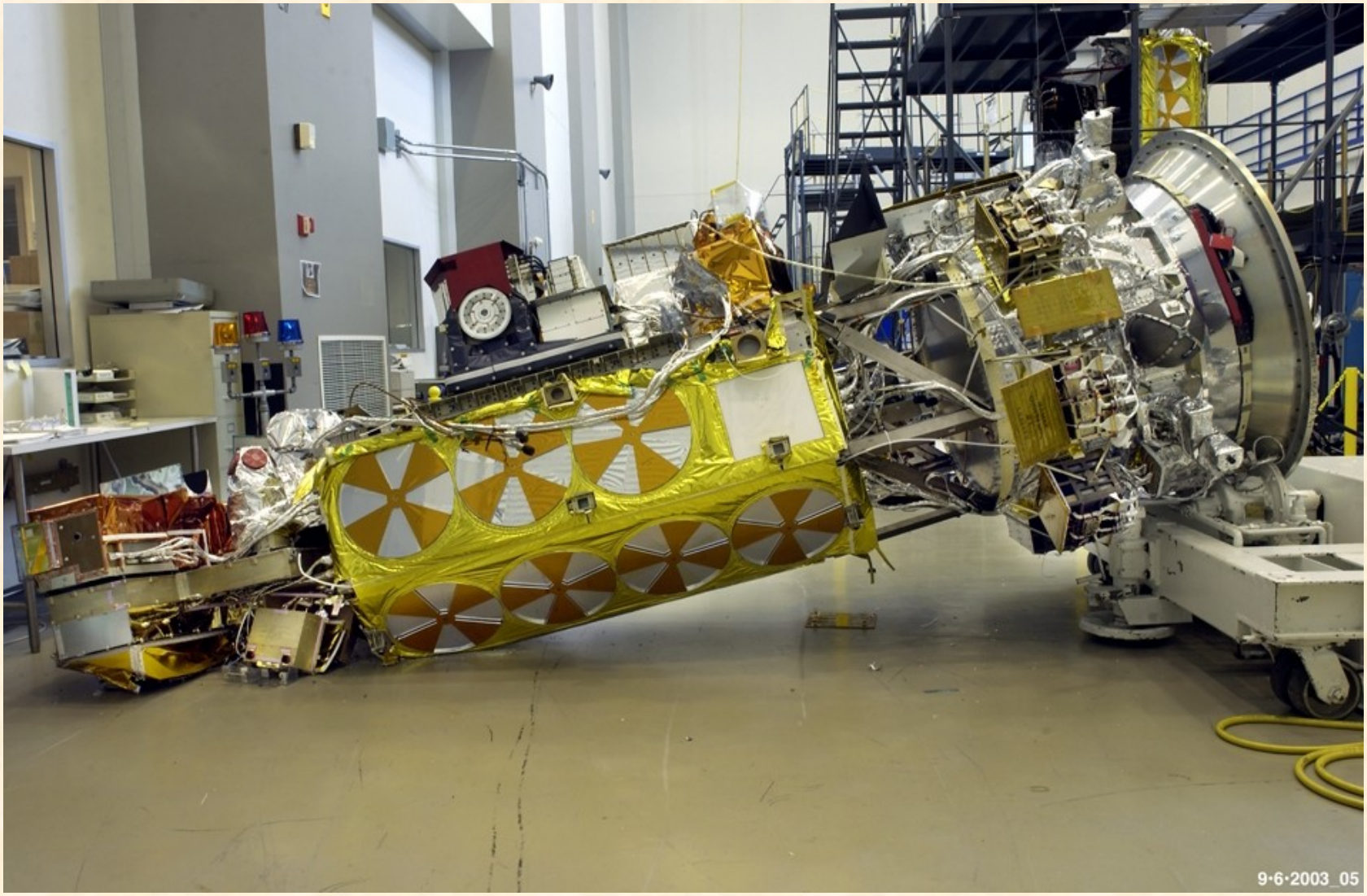
Credit: Dave Lengyel – HEOMD Risk & Knowledge Management Officer

Communication Complexity

- Two parts to communication
  - S*ending* and *receiving*
  - *"What I say" and "What you hear are seldom the same*
- Communication involves
  - Active listening
  - Questioning what we hear
  - Reporting what we know
  - Informing everyone involved
  - Openness across the board



Example of a Lack Of Communication



Comm & Doc Examples

Risk Communication

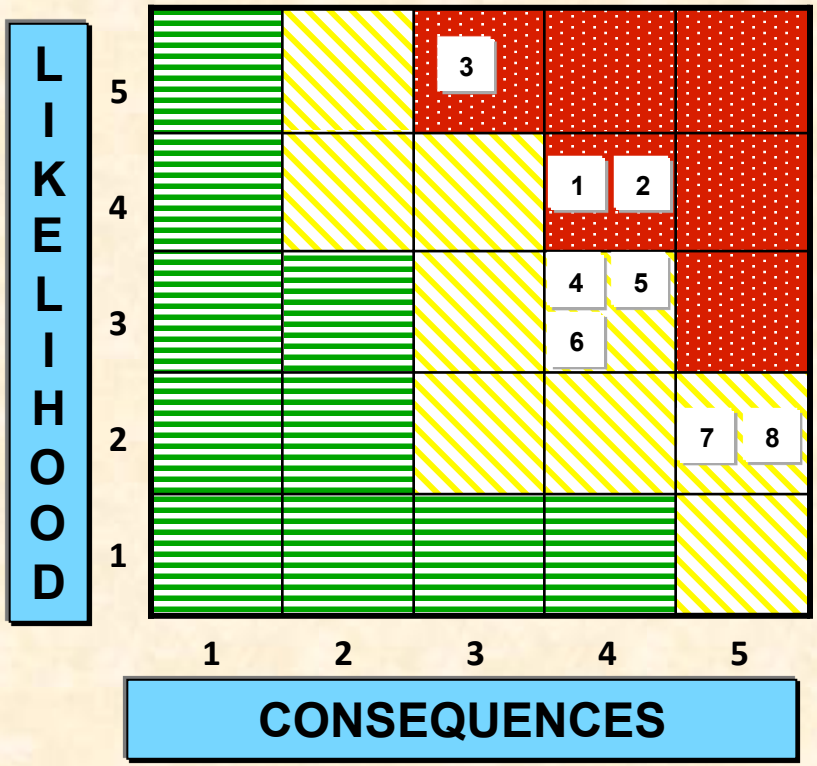
- ❑ Person to person
- ❑ Project meetings
- ❑ Risk meetings
- ❑ Web-X & other Internet Protocols
- ❑ Project documentation
  - ➢ Plans
  - ➢ Schedules
  - ➢ Drawings
  - ➢ Requirements & Specification
  - ➢ Processes & Procedures

Risk Documentation

- ❑ Risk Spreadsheet or Database
- ❑ Risk Metric Reports
- ❑ Program/Project E-mail
- ❑ Program/Project Memos
- ❑ Program/Project Reports:
  - ➢ Cost & Budget
  - ➢ Program/Project Test Results
  - ➢ Contractor & Vendor Status
  - ➢ Integrated Baseline Reviews
  - ➢ Trade Studies

Project Risk Report Example

NASA GSFC Risk Management Training

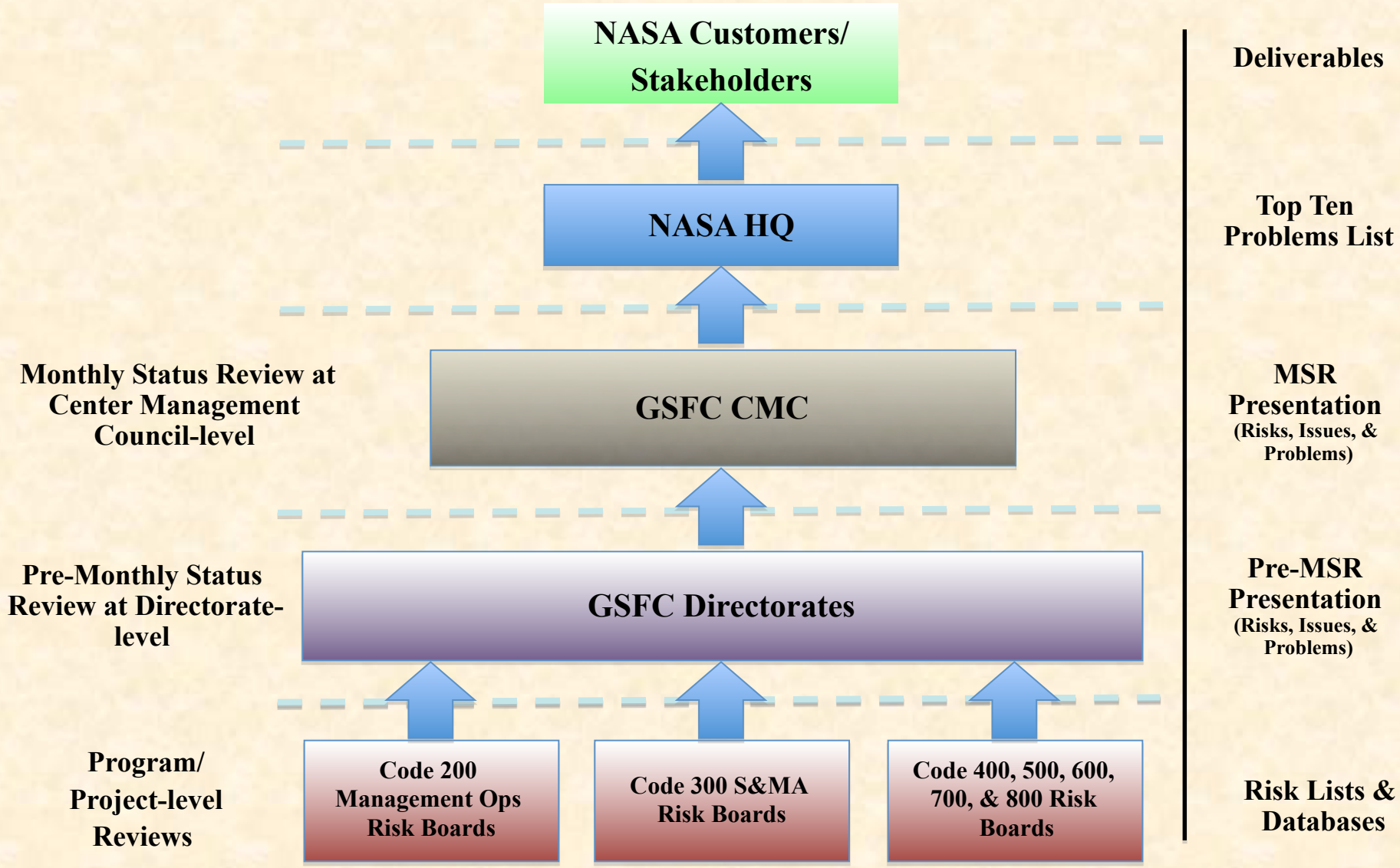


Trend	Rank	Risk ID	Approach	Risk Title
⇨	1	210	M	System Optical Testing
⇨	2	177	M	Region 1 Power Dissipation
⇨	3	347	M	OTE/ISIM Thermal Balance Test Failure
⇨	4	317	M	No OTE Alone Test Workmanship Risk
⇨	5	183	M	Cryocooler Thermal Load Growth
⇨	6	287	M	Backplane Cryo Alignment
⇨	7	351	M	Sunshield Deployment
⇨	8	390	M	OTE SMA Actuator

Criticality	Trend	Approach
High	⇩ Decreasing (Improving)	M - Mitigate
Med	⇧ Increasing (Worsening)	W - Watch
Low	⇨ Unchanged	A - Accept
	□ New Since Last Period	R - Research

Risks are identified and trended from the previous review to the current review

Risk Reporting Flow



Typical Program Reporting Flow

Deliverables

Pre-MSR/MSR Presentation (Risks, Issues, & Problems)

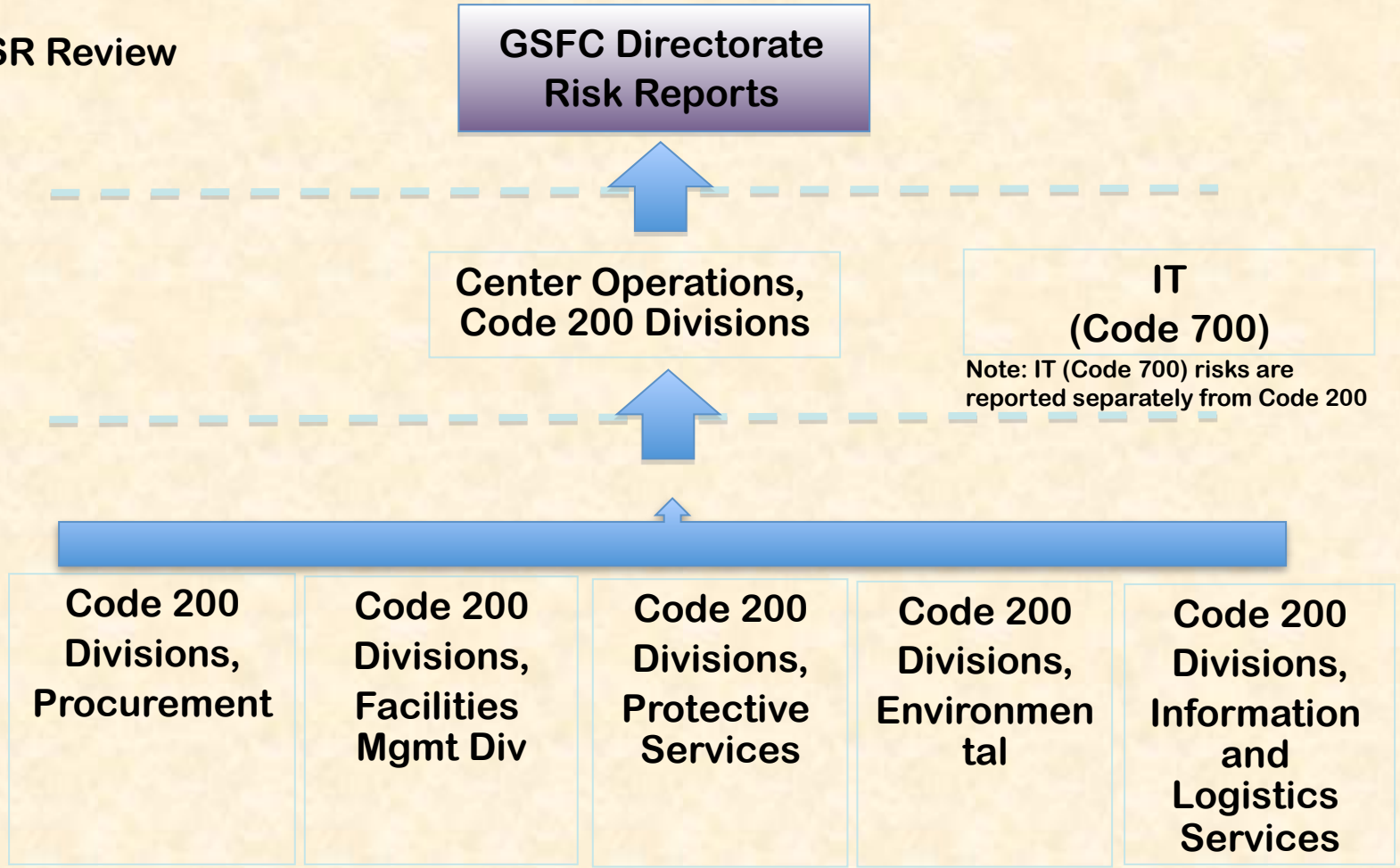
Pre-MSR/MSR Presentation (Risks, Issues, & Problems)

Monthly Status Deliverables (Risks, Issues, & Problems)

Note: No. of Flight Projects and Ground Projects vary from program to program

Operations Reporting Flow

Pre-MSR Review



Case Study

Near-Field Infrared Experiment (NFIRE)

Break Time

10 Minutes

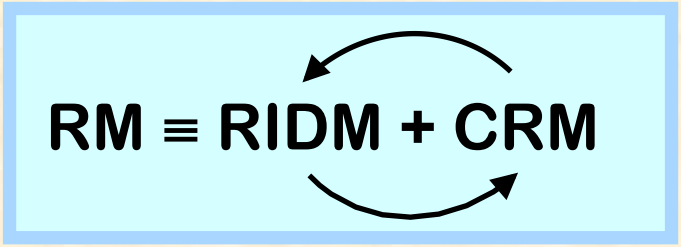
3. RIDM

- Risk-Informed Decision-Making Principles and Process
- *RM = RIDM + CRM*

NASA's Risk Management Policy

- NASA Policy Directive (NPD) 1000.5 (2009) states: "*It is NASA policy to incorporate in the overall Agency risk management strategy a risk-informed acquisition process that includes the identification, analysis, and management of programmatic, infrastructure, technical, environmental, safety, cost, schedule, management, industry, and external policy risks that might jeopardize the success with which the Agency executes its acquisition strategies.*"

- NPR 8000.4A (2009), Agency Risk Management Procedural Requirements, evolves NASA's risk management approach to entail two complementary processes:
  - Continuous Risk Management (CRM)
  - Risk-Informed Decision Making (RIDM)



RIDM Defined

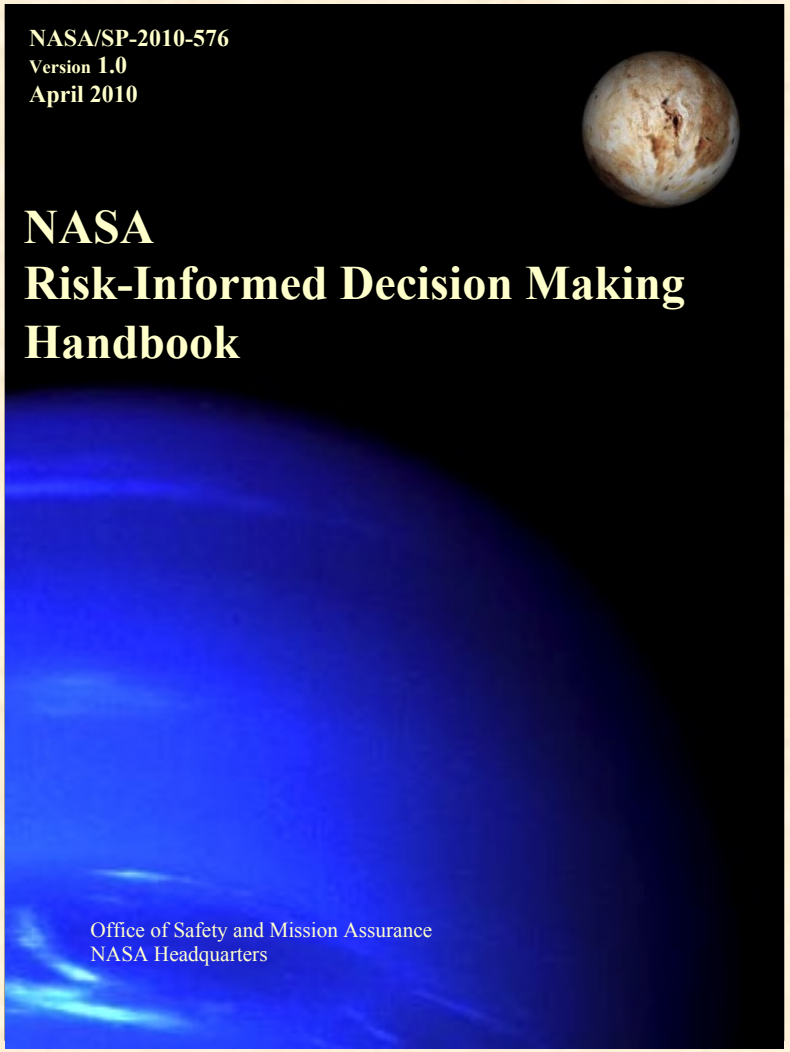
- RIDM is a more effective and comprehensive use of risk assessment to improve the quality and consistency of directorate, program, and project decision making

- A risk-informed decision-making process that uses a diverse set of performance measures along with other considerations within a deliberative process to inform decision making
  - Decisions are informed by an integrated risk perspective rather than being informed by a set of individual "risk" contributions
  - A decision-making process relying primarily on a narrow set of model-based risk metrics would miss the "big picture"

NASA's RIDM Handbook

Risk-Informed Decision Making (RIDM) is a complementary process to CRM that is concerned with analysis of important and/or direction-setting decisions.

- Prior to the development & implementation of RIDM, Risk Management (RM) was considered equivalent to CRM. Now RM is defined as comprising both processes CRM and RIDM.
- The RIDM handbook is for systems engineers, risk managers, and risk analysts. It is to be used in conjunction with NPR 8000.4A and emphasizes the proper use of risk analysis aid in the development of risk-informed decisions.
- RIDM impacts all project execution domains, including safety, technical, cost, and schedule.



http://www.hq.nasa.gov/office/codeq/doctree/SP2010576.htm

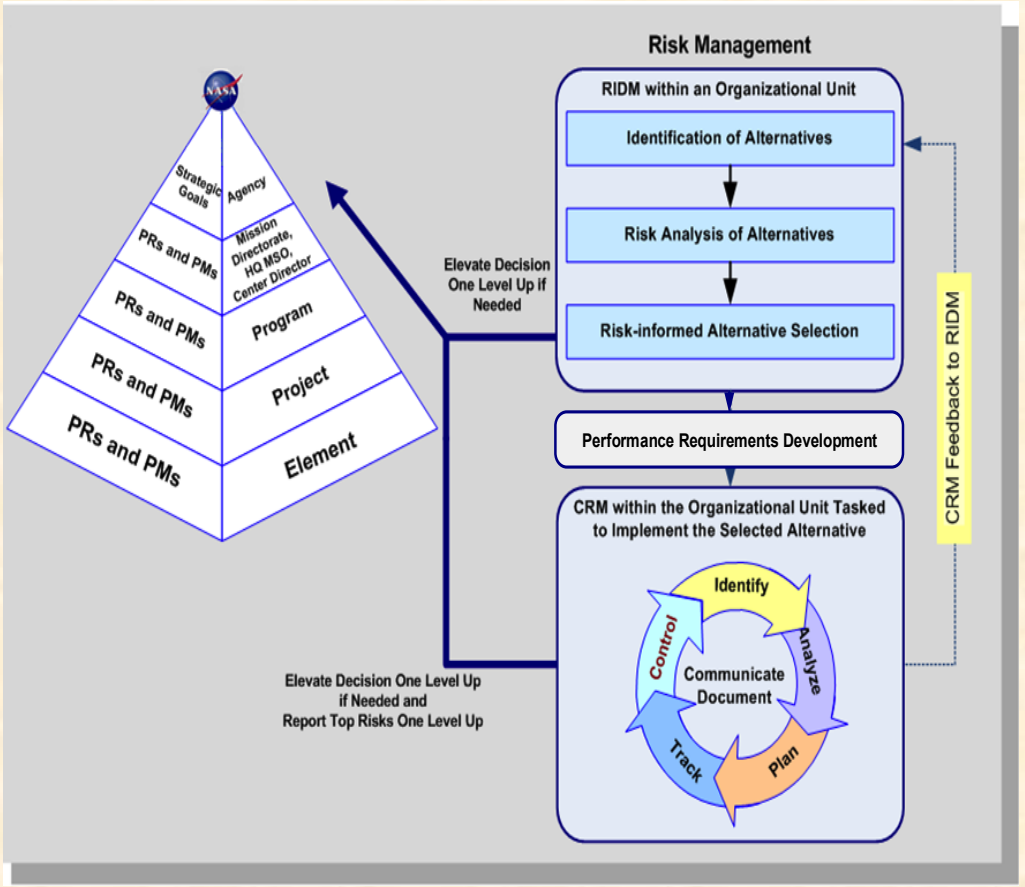
When Is RIDM Invoked?

- RIDM is invoked for key decisions such as:
  - Architecture & design decisions
  - Make-buy decisions
  - Budget reallocation to include allocation of reserves
  - Supplier not meeting requirements
  - Parts failures due to quality issues or inappropriate design
  - Other project Key Decision Points (KDP)

- These decisions typically involve requirements-setting, re-evaluation or re-baselining of requirements

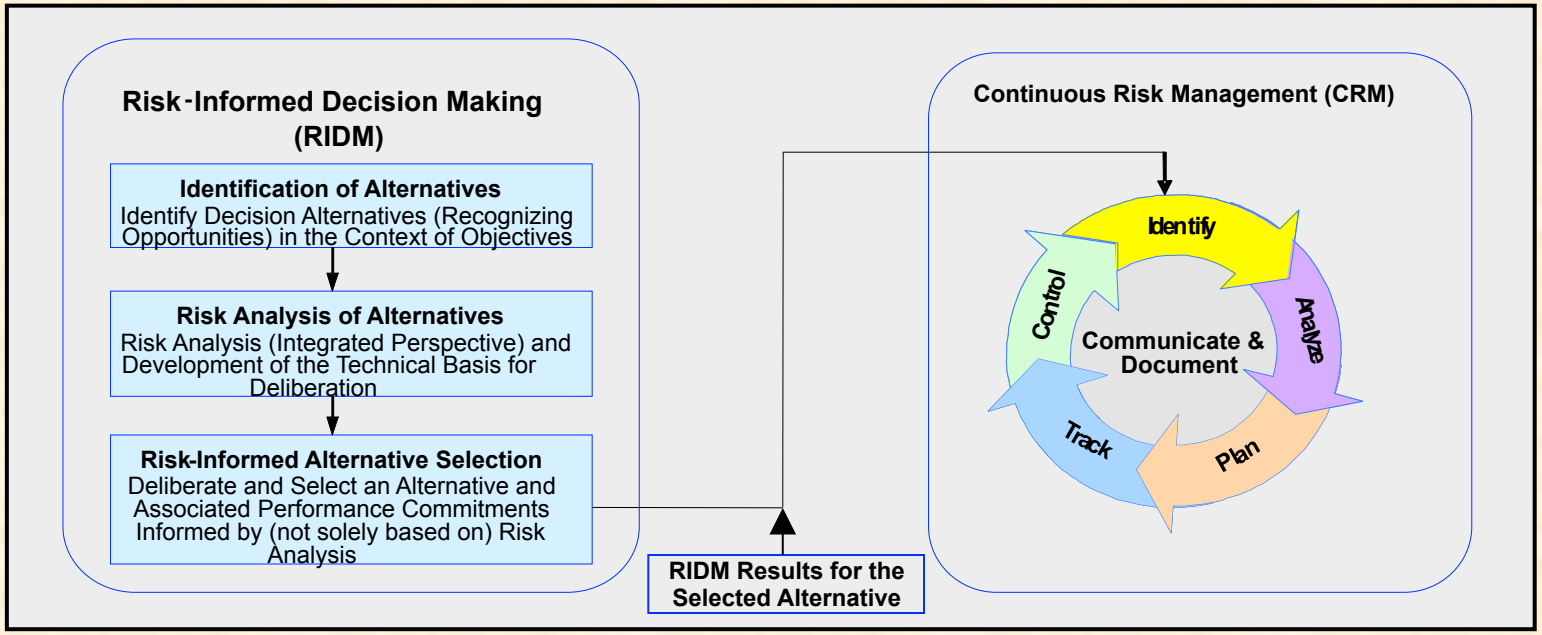
RM Begins With High-Level Objectives

- NASA's high-level Objectives/Themes flow down in the form of progressively more detailed performance requirements, whose satisfaction assures that objectives are met in the following areas:
  - Integrated perspective of risk analysis
  - Scenario-based modeling of risk
  - Better treatment of uncertainties



Integration of RIDM/CRM Process

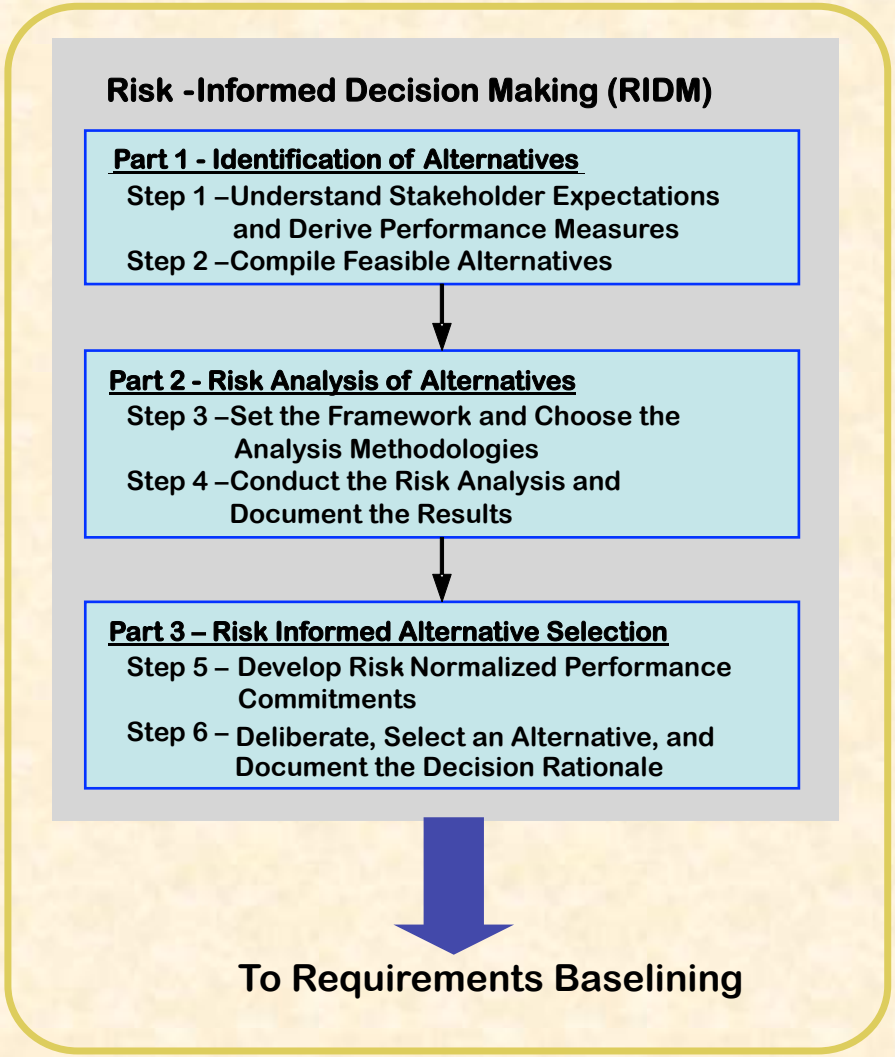
- CRM is initiated by the results of the RIDM process:
  - The risk analysis for the selected alternative
  - An initial risk list
- CRM focuses on meeting performance requirements by:
  - Managing performance margins over time so that associated performance requirements are not violated
  - "Burning down" (over time) the risk of violating performance requirements
  - Means of mitigation actions



The RIDM Process

The RIDM Process as defined the RIDM Handbook, NASA/SP-2010-576 & NASA's Risk Management Requirements - NPR 8000.4A.

- Part -1: Identification of alternatives (decision context) and considering a sufficient number and diversity of performance measures to constitute a comprehensive set for decision-making purposes
- Part – 2: Risk analysis is defined broadly in NPR 8000.4A as uncertainty analysis of performance associated with the alternative
- Part – 3: Selection of a decision alternative informed by (not solely based on) Risk Analysis results



Case Study

Atlas Centaur-67

Risk Management Course Summary

You now have a better understanding of:

- What NASA Risk Management consists of, and why GSFC implements Risk Management (RM)
- The Continuous Risk Management (CRM) process and the 5 CRM steps
- The Risk-Informed Decision-Making (RIDM) Principles and Processes
- How Risk Management is applied to a Programs/Projects

Backup

Why Standardize NASA's RM Approach?

- To manage risk in a complete and coherent manner across the entire Agency
- To institutionalize "what if…" forward-thinking and identify potential problems at the earliest opportunity
- To enhance communication of potential problems across "stovepipe" organizational structures
- To more effectively apply resources required to address risks while meeting stakeholder expectations
- To ensure consideration of alternative approaches is thorough, documented, and communicated throughout the organization

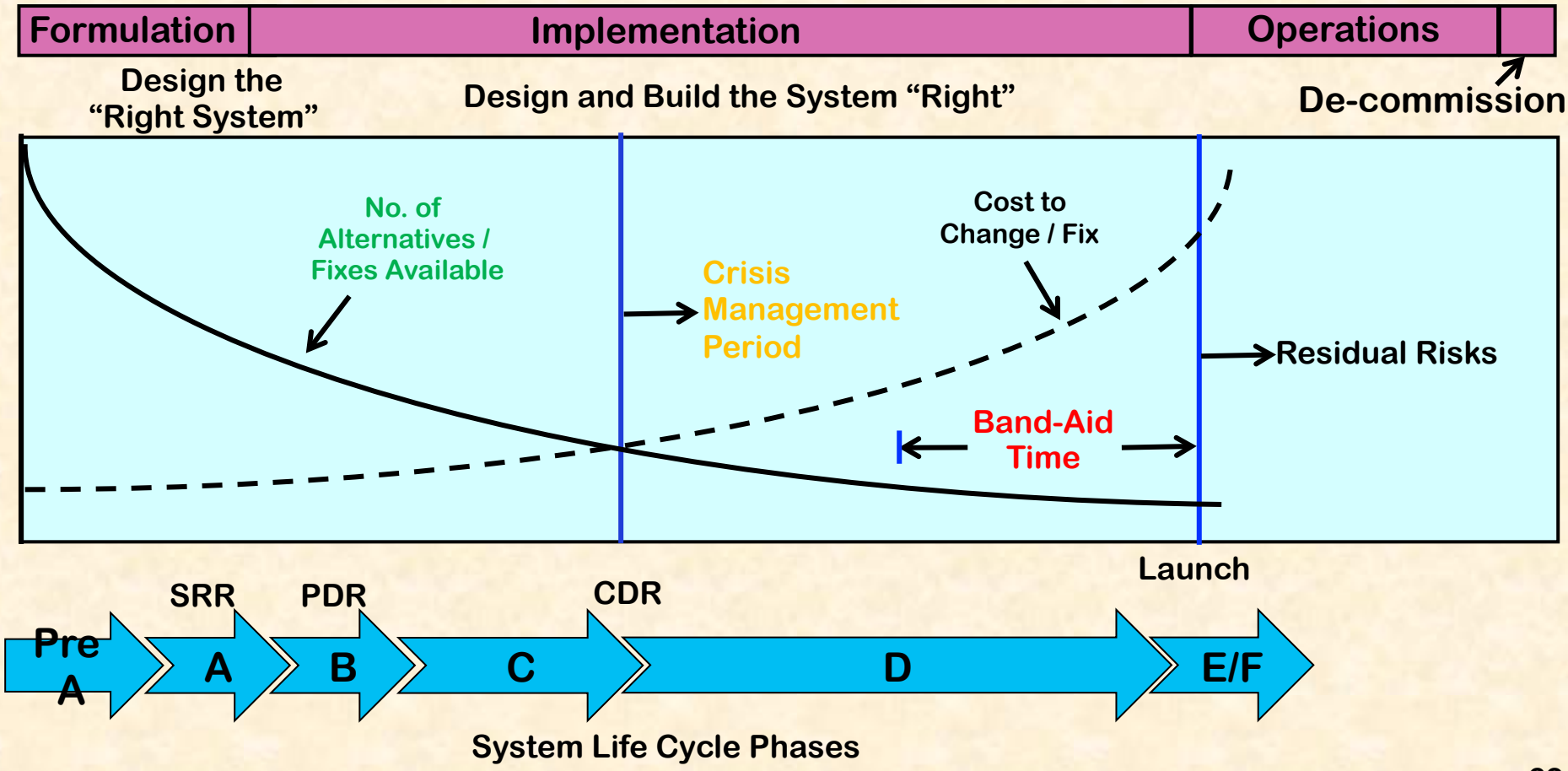
Examples of Standardization Benefits

- Kennedy Space Center and Goddard Space Flight Center carried the same GLORY Project risk, however, the Risk Statements were different and they were ranked differently (different perspectives)
- NASA Projects are not required to standardize risk prioritization and may therefore communicate priorities differently to their management
- When Goddard Projects are completed, the staff are re-assigned to various different projects and may not be familiar with the new project practices and procedures

4R Model For Mission Success

Risk Management & Project Life Cycle

- Risk management is done throughout project life cycle
- Performing risk management during the early phases has high-payoff



Section Review & Questions

Which statement is true?

1. The four types of risk include:

a) Social, Technical, Cost, and Schedule

b) Safety, Technical, Problems, and Schedule

c) Safety, Technical, Cost, and Schedule

d) Safety, Technical, Cost, and Staffing

Section Review & Questions

Which statement is false?

2. NASA standardized its approach to Risk Management:

a) To institutionalize "what if…" forward-thinking and identify potential problems at the earliest opportunity

b) To enhance communication of potential problems across "stovepipe" organizational structures

c) To more effectively apply resources required to address risks while meeting stakeholder expectations

d) To ensure consideration of alternative approaches is thorough, documented, and communicated throughout the organization

e) To more accurately place blame related to mission failures

Writing A Good Risk Statement

Condition + Consequence = Risk Statement

- **Condition –** a single, factual, phrase briefly describing the current key circumstances, situations, etc., is based in reality and have no uncertainty attached.

- **Consequence –** a single phrase or sentence that describes the key, negative outcome of the current condition.

- **Risk Statement –** a descriptive statement of a clear condition, that is concise, followed by a single consequence and will be understood by a majority of program/project stakeholders.

Ex: *Given that:* the new high-speed modem does not meet performance requirements;
There is a possibility that: the vendor will not deliver the modem on schedule and within budget,
Resulting in: increased cost and impact to the Project Schedule Critical Path.

Risk Statement Consistency

- **Consistency builds Credibility**
- **Consider these questions when writing a risk statement:**
  - **Is it fact-based?**
  - **Is it clear and concise?**
  - **Does it capture the "……..."?**
  - **Is there only ONE condition followed by ONE consequence?**
  - **Does it have a "resulting in" statement?**

Risk Analysis "Fine-Tunes" The Risk

- Analysis provides information to the decision makers
  - Validate risk for sufficient information to move forward
  - Evaluate importance of the risk to meeting program/project objectives
  - Classify/organize risk to gain leverage in making decisions, determine significance and develop multiple perspectives
  - Prioritize all risks to determine importance to the program/ project

Risk Planning Steps

- **Assign Risk Owner**
  - **Requires authority and resources to manage**
- **Determine risk handling action**
  - **Watch, Research, Mitigate, or Accept**
- **Develop risk mitigation plan**
  - **Step-by-step plan to reduce risk likelihood and/or consequence**
- **Apply resources to mitigate**
  - **Personnel, additional funding, and/or additional time**

Risk Tracking Steps

- **Acquire tracking data**
  - **Determine what information is required to track/trend risks**
  - **Interview Risk Owners monthly (minimum) to obtain status data**
- **Compile tracking data**
  - **Organize data for each risk**
  - **Format information to be consistent with other risks**
  - **Develop & monitor trends**

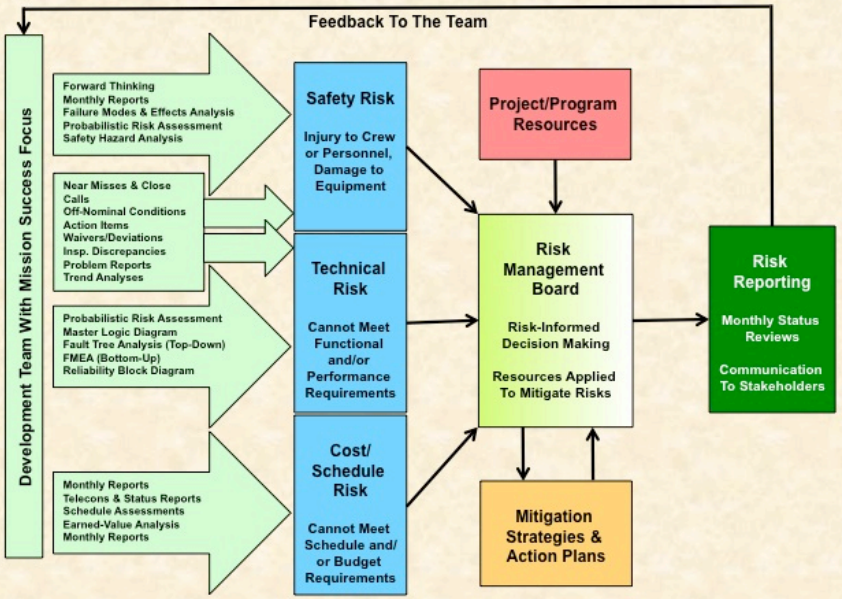
Risk Control Steps

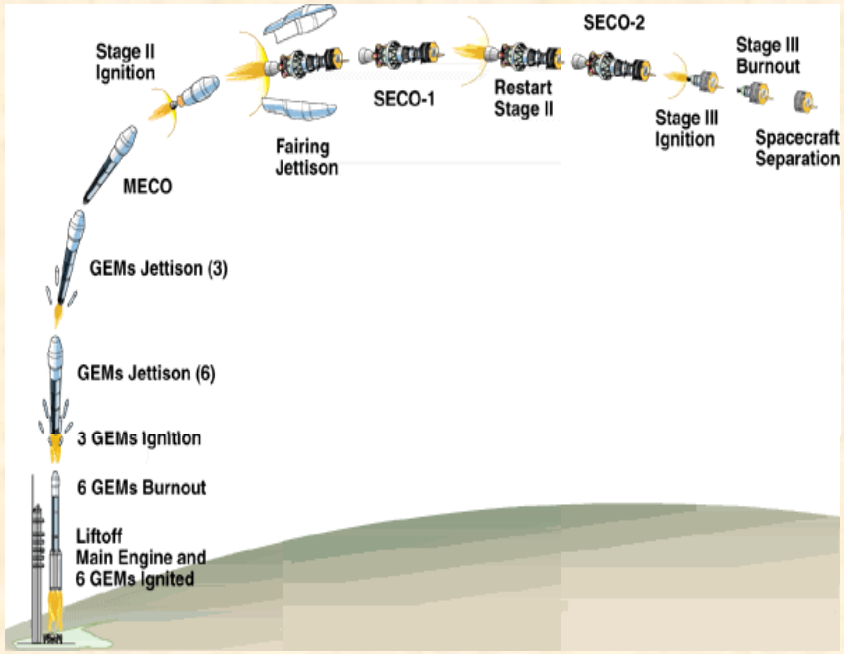
- **Evaluate**
  - **Trends, deviations, anomalies, significant changes in risks**
  - **Assess mitigation action effectiveness**
- **Decide**
  - **Determine best course of action**
- **Execute**
  - **Implement mitigation action and document decisions**

Risk Management & Project Success

Risk Management helps us better identify the risks, manage the uncertainty, and understand our decisions

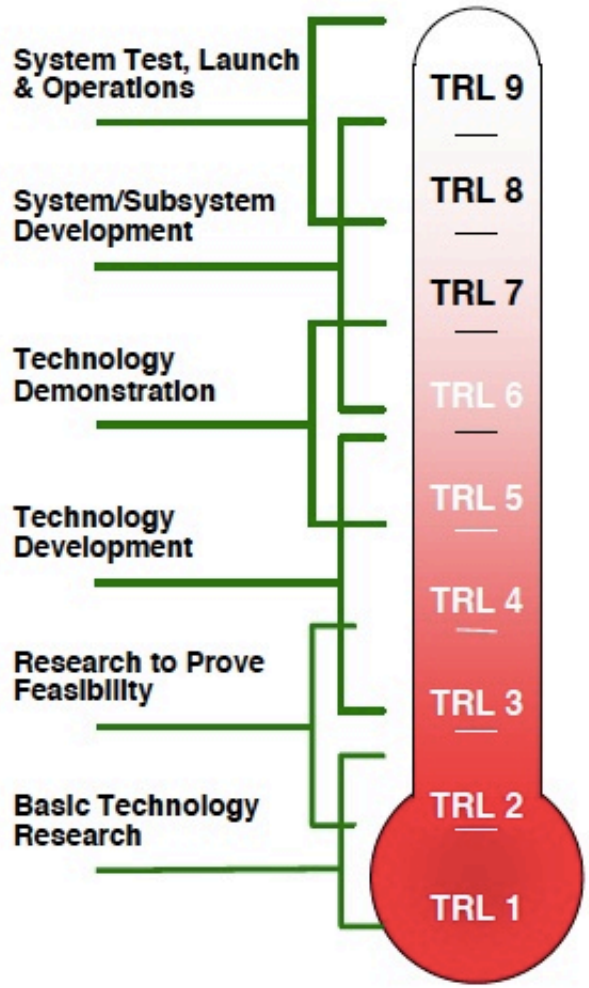
NASA CRM Process Flow





Implementing a Risk Management Process increases the likelihood of Project Success

Technology Readiness Levels



Actual system "flight proven" through successful mission operations

Actual system completed and "flight qualified" through test and demonstration (Ground or Flight)

System prototype demonstration in a space environment

System/subsystem model or prototype demonstration in a relevant environment (Ground or Space)

Component and/or breadboard validation in relevant environment

Component and/or breadboard validation in laboratory environment

Analytical and experimental critical function and/or characteristic proof-of-concept

Technology concept and/or application formulated

Basic principles observed and reported

Credit: John C. Mankins – Technology Readiness Levels White Paper, 4/6/95

Risk Management Course Summary

While attending this course, the student learned:

- ❑ **NASA's Risk Management Strategic Goals and Policy**
- ❑ **Continuous Risk Management Principles and Process**
- ❑ **Risk-Informed Decision Making Principles and Process**
- ❑ **How Risk Management Could Have Been Applied in 1626 on the Swedish VASA Project**

Terms and Definitions

TERM	DEFINITION
Acceptable Risk	Acceptable risk is the risk that is understood and agreed to by the program/project, Governing Program Management Council (GPMC), Enterprise and other customer(s) sufficient to achieve the defined success criteria within the approved level of resources.
Failure Modes and Effects Analysis (FMEA)	A Failure Modes and Effects Analysis is a procedure by which each potential failure mode of each element of a system is analyzed to determine the effects of the failure mode on the system and to classify each potential failure mode according to the severity of the effects.
Fault Tree Analysis (FTA)	A Fault Tree Analysis is a qualitative technique to uncover credible ways that a top event (undesired) can occur. The results of the FTA are documented in a fault tree, which is a graphical representation of the combination of faults that will result in the occurrence of an undesired top event.
Concern	A candidate risk with insufficient or immature information to analyze or define mitigation options.
Goddard Space Flight Center Council	The body of GSFC center management, Program Management representatives, and Directors which serves as a governing body over activities at GSFC.
Primary Risk	A Primary Risk is a risk that is assessed as both a high probability and high impact/severity.
Probabilistic Risk Assessment (PRA)	Probabilistic Risk Assessment is a rigorous technical discipline used in complex technological applications to reveal design, operation and maintenance vulnerabilities, to enhance safety and to reduce costs.
Risk	The combination of a) the probability (qualitative or quantitative) that an organization will experience an undesired event such as cost overrun, schedule slippage, safety mishap, or failure to achieve a needed technological breakthrough; and b) the consequences, impact, or severity of the undesired event were it to occur.
Risk Acceptance	Determination that the consequences of an identified risk, should they occur, are acceptable without further mitigation. No further resources are expended in managing this risk except periodic review (every six months) to ensure assumptions or circumstances have not changed.
Risk Analysis	An evaluation of all identified risks either qualitatively and/or quantitatively to estimate the likelihood of occurrence, consequence of occurrence, timeframe when mitigation actions are needed, classification into sets of related risks, and priority ranking.
Risk-Based Acquisition Management	Risk-Based Acquisition Management (RBAM) is a management initiative to apply CRM earlier and throughout the acquisition process (i.e., requirements development, acquisition planning, RFP development/solicitation, source selection, and post-award acquisition management).
Risk Elevation	The process of increasing the visibility of a concern to a risk.
Risk Escalation	The process of raising risk visibility by reporting the risk to a higher level in the organization. This is done either to raise the awareness and visibility of a risk, calling attention to adverse changes in consequence, likelihood of occurrence or timeframe, or to request resources that are not available to handle the risk at the lower level. Risks are escalated to one or more levels above the level at which it is owned and mitigated.
Risk Identification	A continuous effort to capture, acknowledge and document risks as they are found.
Risk List	The Risk List is the listing of all identified risks in priority order from highest to lowest risk, together with the information that is needed to manage each risk and document its evolution over the course of the project.
Risk Management (RM)	RM is an organized, systematic decision making process that efficiently identifies, analyzes, plans, tracks, controls, communicates, and documents risk to increase the likelihood of achieving goals. RM is performed continuously which is an essential element and an integral part of NASA project management and system engineering.

Risk Management Definitions cont.

TERM	DEFINITION
Risk Mitigation	The elimination or reduction of an identified risk by reducing the consequences, likelihood, or by delaying the projected time of occurrence (i.e. to allow time to mitigate, or beyond time which impacts the tasks being performed).
Risk Owner	Identifies, implements, and tracks the risk mitigation approach and actions (the focal point for integrating all the risk information and ensuring adequate management and closure). The risk owner has the necessary resources (budget and workforce) required to mitigate the risk, either by delegation or routine operations.
Risk Planning (Handling Strategy)	Establishes the proper course of action for dealing with a particular risk. Resulting actions are to watch, accept, research, or mitigate.
Risk Tracking	An activity to capture, compile, and report risk attributes and metrics which determine whether or not risks are being mitigated effectively and whether risk mitigation plans are being implemented correctly.
Success Criteria	The minimum set of measures that establish the accomplishment of predefined goals and objectives for a given activity or undertaking. Within the practice of risk management it usually refers to the establishment of goals and objectives for risk mitigation activities.
Validate Risk	The process of examining an identified concern to verify that it has been written in such a way as to allow further analysis and that mitigation actions are within the scope of the program or initiative in question.
Watch	The monitoring of an identified risk and its attributes for early warning of critical changes in consequences, likelihood, timeframe, or other indications that might reveal a risk event is imminent.

Risk Management Acronyms

Acronym	Full Term
ACD	Actual Completion Date
CMO	Center Management and Operations
CRM	Continuous Risk Management
DLO	Directorate Level Organization
ECD	Estimated Completion Date
HQ	Headquarters
EPA	Environmental Protection Agency
HSE	Health, Safety and Environment
IRMA	Integrated Risk Management Application
GPD	Goddard Space Flight Center (GSFC) Policy Directive
GMC	GSFC Management Council
GPR	GSFC Procedural Requirements
GSFC	Goddard Space Flight Center
L x C	Likelihood versus Consequence
NASA	National Aeronautics and Space Administration
NESC	NASA Engineering and Safety Center
NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
POC	Point of Contact
PPBE	Planning, Programming, Budgeting, and Execution (annual budget cycle)
RIDM	Risk Informed Decision Making
RM	Risk Management
RMB	Risk Management Board
RMWG	Risk Management Working Group
TCR	Top Center Risk
TDR	Top Directorate Risk
TOR	Top Organizational Risk
TPR	Top Program Risk