Global Hawk
Integrated Risk Management

26 October 2006

NORTHROP GRUMMAN DEFINING THE FUTURE™
Integrated Systems

U.S. AIR FORCE

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Introduction

Dominant Air Power: Design For Tomorrow…Deliver Today

Objective

- **Overview Lessons Learned for the USAF Global Hawk Program's risk management process.**

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  United States Air Force
- **Kevin Engfer**
  Northrop Grumman Corporation
- **William Buzzell**
  Dayton Aerospace Corporation

Agenda

Dominant Air Power: Design For Tomorrow…Deliver Today

- Introduction
- **Product Background**
- Program Background
- Management Challenge
- Risk Management Improvement Process
- Results
- Then till Now
- Summary

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Global Hawk Integrated System

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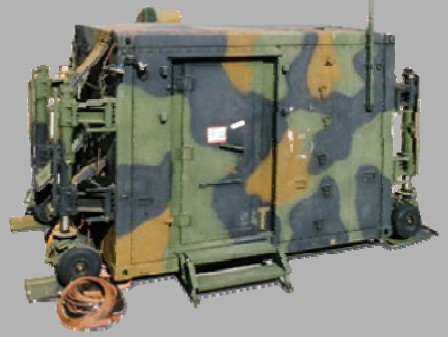
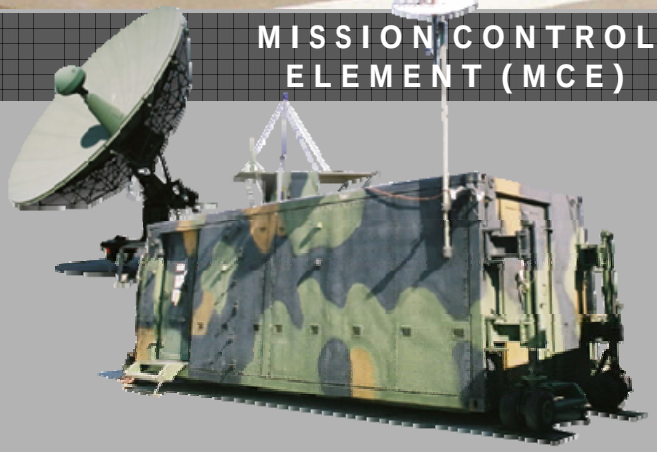
AIR VEHICLE

LAUNCH & RECOVERY ELEMENT (LRE)



Launch and Recovery, Mission Planning and Backup Control

MISSION CONTROL ELEMENT (MCE)



Mission Planning, Command and Control, Communications Monitoring and Image Dissemination

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Global Hawk Size in Perspective

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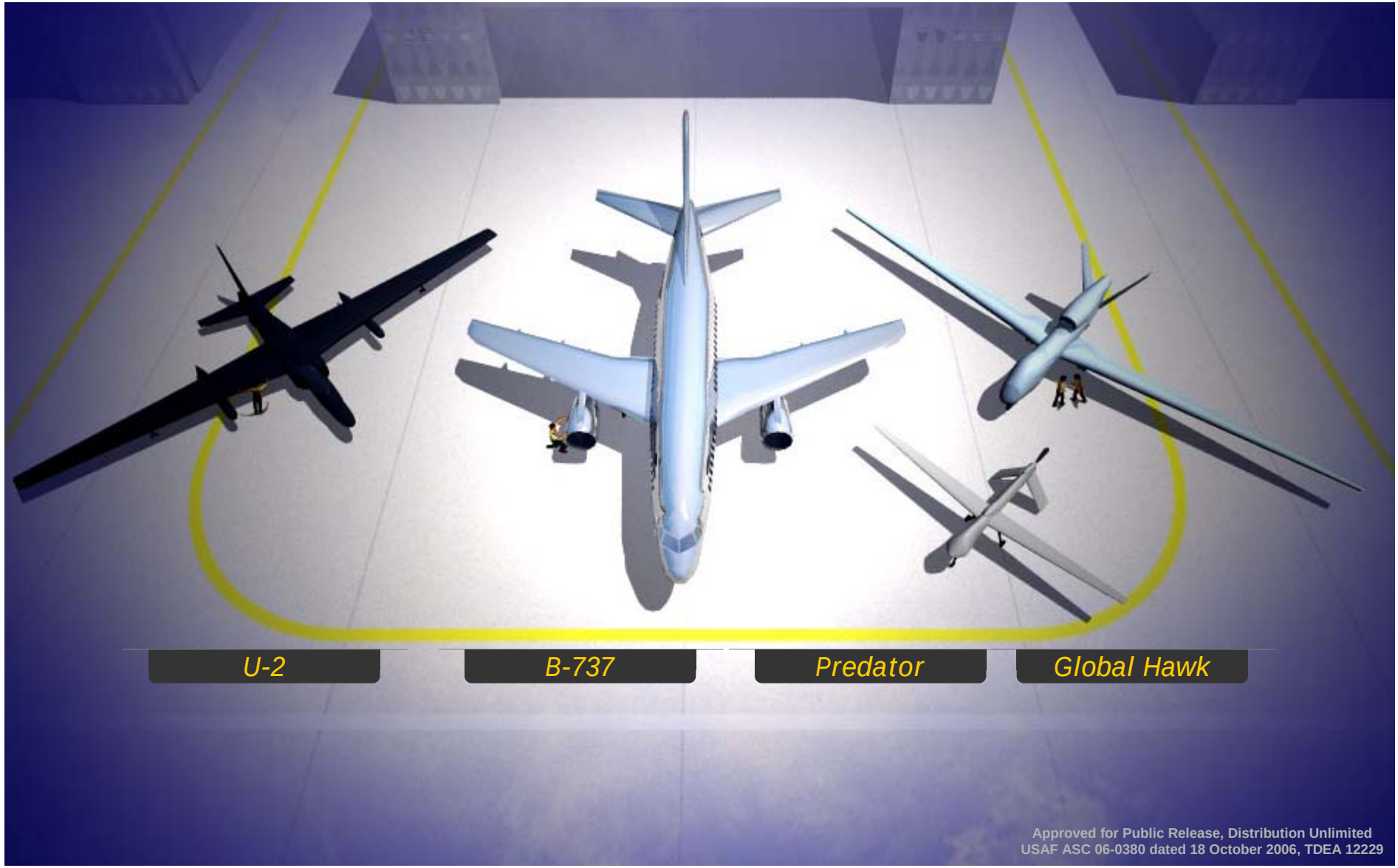

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RQ-4A (Block 10) & RQ-4B (Block 20)

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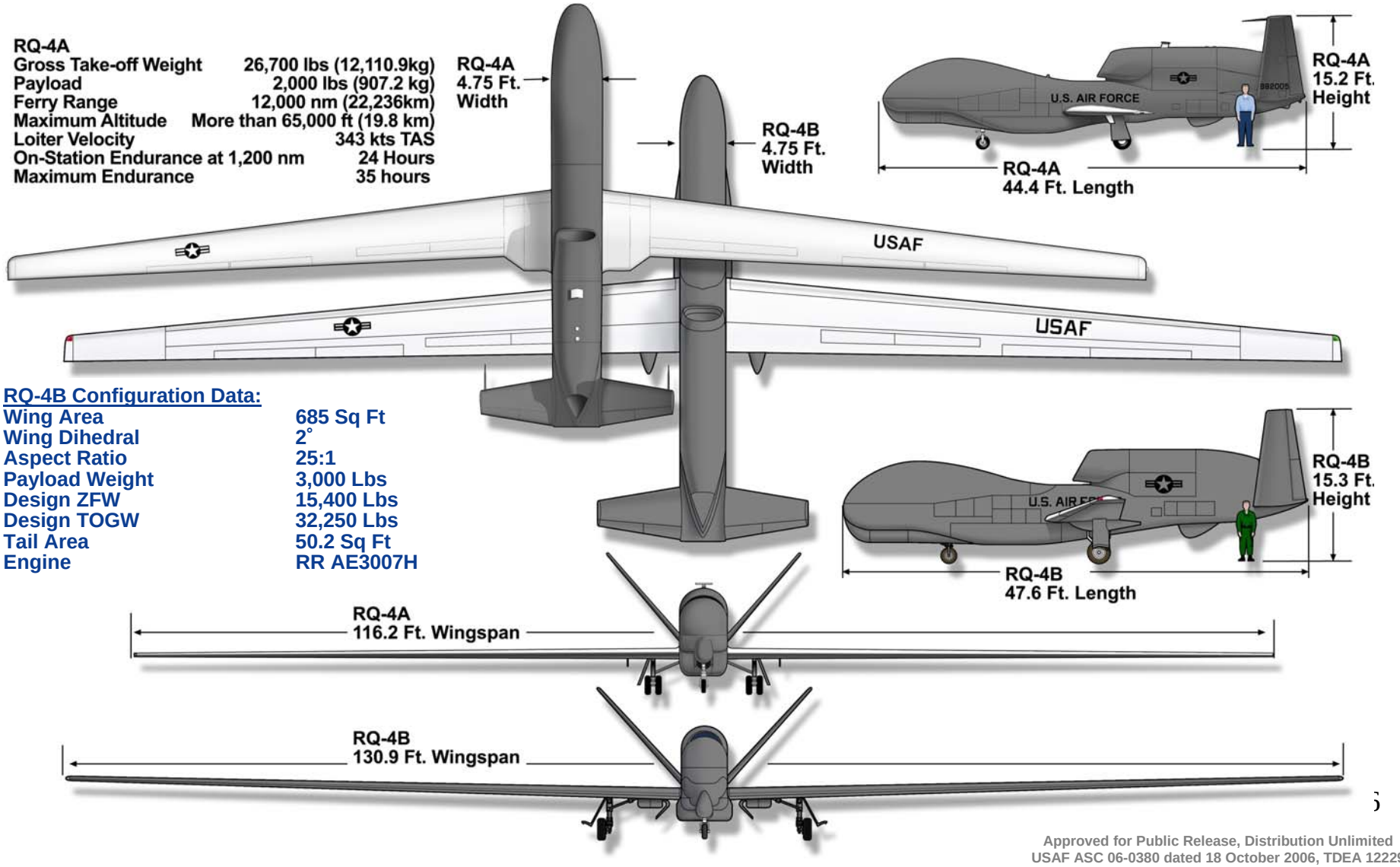
RQ-4A	
Gross Take-off Weight	26,700 lbs (12,110.9kg)
Payload	2,000 lbs (907.2 kg)
Ferry Range	12,000 nm (22,236km)
Maximum Altitude	More than 65,000 ft (19.8 km)
Loiter Velocity	343 kts TAS
On-Station Endurance at 1,200 nm	24 Hours
Maximum Endurance	35 hours



RQ-4B Configuration Data:

Wing Area	685 Sq Ft
Wing Dihedral	2°
Aspect Ratio	25:1
Payload Weight	3,000 Lbs
Design ZFW	15,400 Lbs
Design TOGW	32,250 Lbs
Tail Area	50.2 Sq Ft
Engine	RR AE3007H

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Spiral Development History (2004 era)

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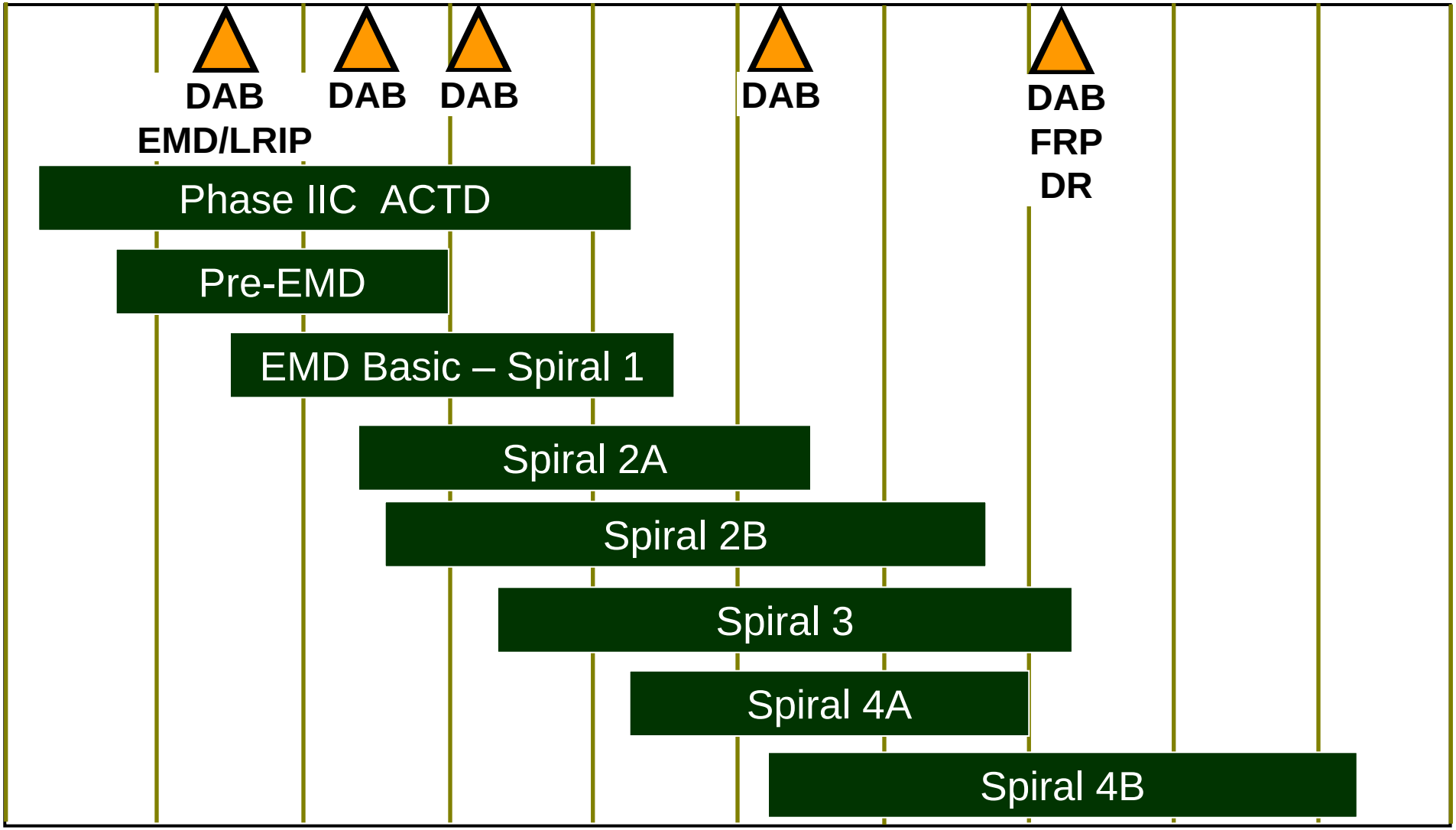

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Background

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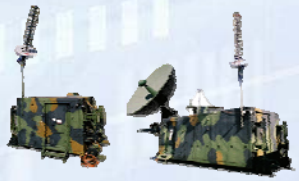
DARPA ACTD Program

7 Demonstrators
Supported Global War On Terrorism

Basic Ground Station (GS)

RQ-4A Block 10

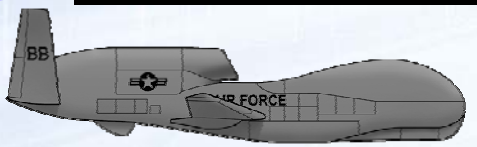
2,000 lb payload
Basic SAR Radar
Basic EO/IR
Plan 63 Systems
Actual: 7 Air Force, 2 Navy



Basic + DAWS
TCDL for Nose Camera
Wide Band Interface Unit

- **Multi-INT**
- **MP-RTIP (Radar) Capable**

RQ-4B Block 20/30/40



3,000 lb payload/volume
Increased Power Generation (x2.5)
Enhanced Radar or MP-RTIP Radar
Enhanced EO/IR sensor
Advanced SIGINT package
Improved Reliability
Open System Architecture
Plan 54 Systems (Includes 7 RQ-4A's)

Basic + Automated Contingency Generator and JUMPS
Open Systems Architecture
Automated Collection Manager

Global Hawk

United States Air Force Unmanned High-Altitude, Long Endurance Reconnaissance System

- *Delivered 7 ACTD and 7 LRIP Block 10 Air Vehicles To Date*
- *Over 8500 Block 10 Fleet Flight Hours ~ Over 5250 Combat ~ 592 Flights-To-Date*
- *Navy 1 First Flight to Edwards AFB October 2004, Navy 2 First Flight to Edwards June 2005*
- *First Production Block 20 Entered Flight Testing September 2006*
- *Six Block 20's Currently in Production*

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Management Challenges

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- **Continuous ACTD deployments supporting GWOT**
- **Spiral Development**
- **Requirements growth**
- **Accelerated Block 10 fielding to support GWOT**
- **Cost growth**

Multiple Competing Program Priorities Challenged the Global Hawk Team's Ability to Effectively Integrate Management Process

Independent Review Team (IRT)

- **The Global Hawk IRT and internal assessments of Program health/executability established requirement for Program management process, system and tool evaluation and improvement.**
- **Specific process improvements identified as key for successful program execution:**
  - **Improved Systems Engineering**
  - **Improved Subcontracts Management**
  - **Integrated Master Schedule (IMS)**
  - **Risk Management**

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Risk Management Improvement Plan

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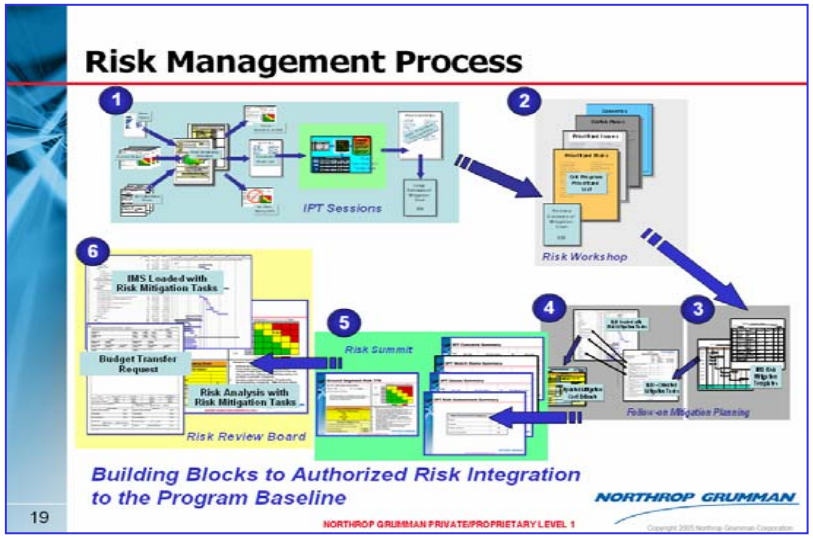
- **Integrated Risk Management**
  - ✓ **Jointly Assessed Program Risks Leveraging Dayton Aerospace As Independent Facilitators**
  - ✓ **Held Risk Review Board And Risk Summits To Baseline Program Risks**
  - ✓ **Integrated Risk Mitigation Plans Into Our IMS For Program Visibility**
  - ✓ **Integrated Updates Into Risk Management Processes**



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Risk Management

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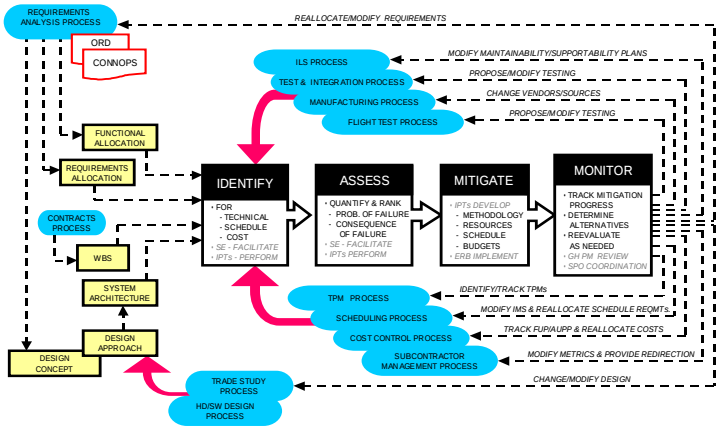
Overview

- Risk Management Improvement Plan



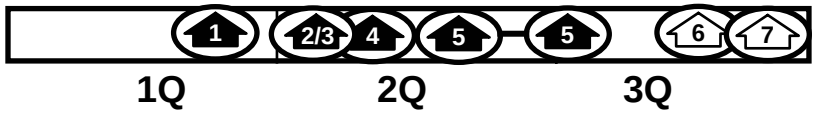
Issue

- GH Program Risk Management Process must be established such that the probability/consequence definitions for performance, schedule, and cost risk assessments are clearly defined
- Identified risks must be mapped to the appropriate WBS elements and/or schedule activities

Approach / Tasks

- Establish Joint Risk Management Improvement Plan
- Develop Revised Process Flow and Clear Definition of RAA
- Conduct Training (Revised Process Flow)
- Conduct Joint Risk Reassessment
- Develop Updated Risk Mitigation Plans (in IMS Format) & Link Risk Plans to IMS
- Institutionalize Process
- Evaluate Options for System / Tool Improvements

Corrective Action Plan



1) Develop Joint RMIP
2) Establish Clear Process / RAA
3) Conduct Training
4) Joint Risk Reassessment
5) Risk Summit & Risk Review Board
6) Institutionalize Process
7) Conduct System / Tool Gap Analysis and Implement Results

Risk Management Improvement Scope

…Hit the Reset Button

Short Term Tasks (includes internal preparation for the IRA)

1. **Risk Training – get everyone on the same page**
2. **Re-assess Program Risks – current, IRT identified, new**
3. **Risk Mitigation Planning – focus on IMS–oriented tasks**

Long Term Tasks (includes long term process improvements)

4. **Evaluation of Risk Management Tools – current & new**
5. **Review/Update Risk Management Process**
   - **Seamless integration of risk mitigation tasks with IMS**
   - **Integrated management tool(s) to monitor risk database and interface with program IMS, program metrics**

Risk Management Process Elements

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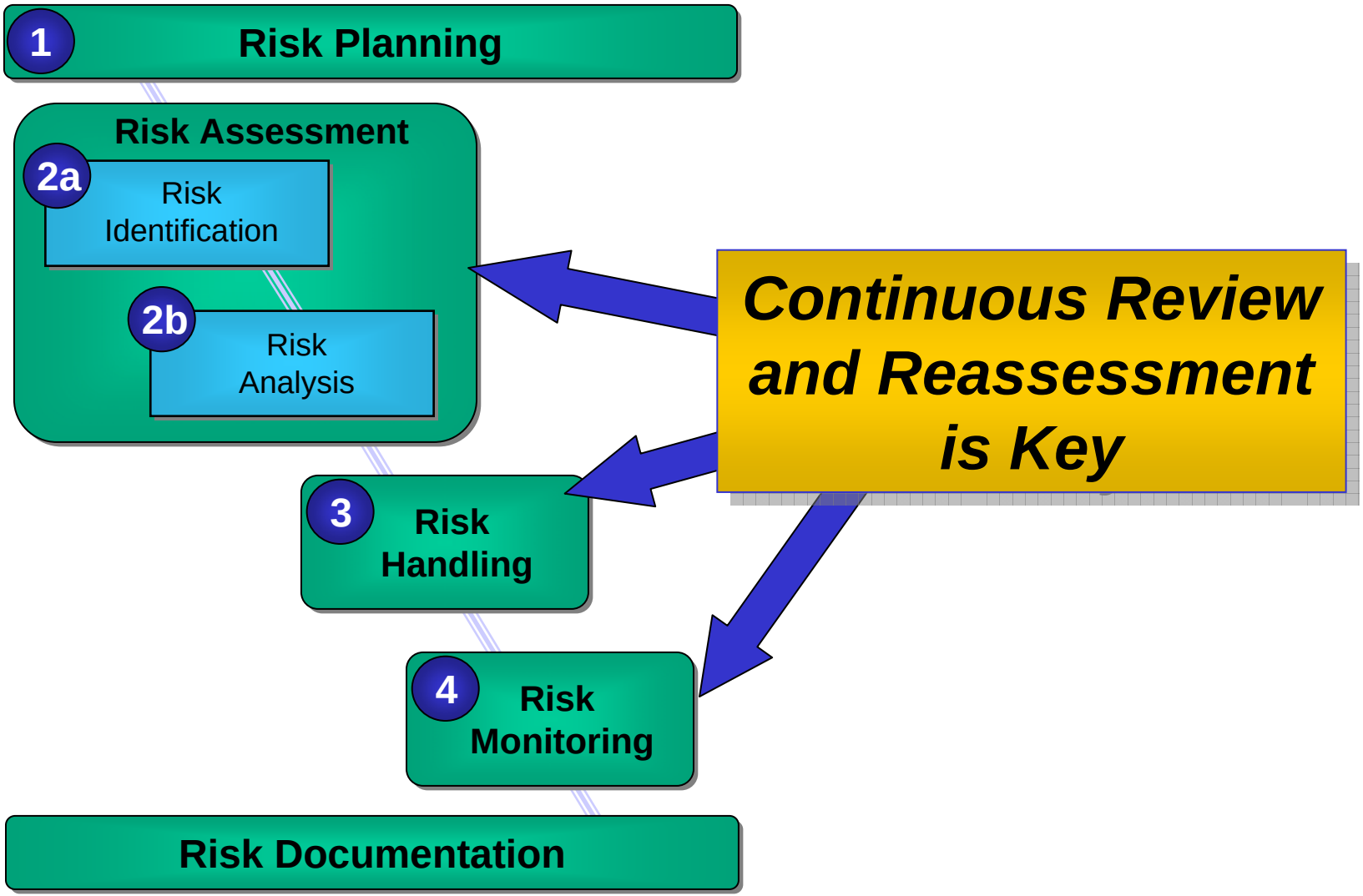

Risk Management Planning

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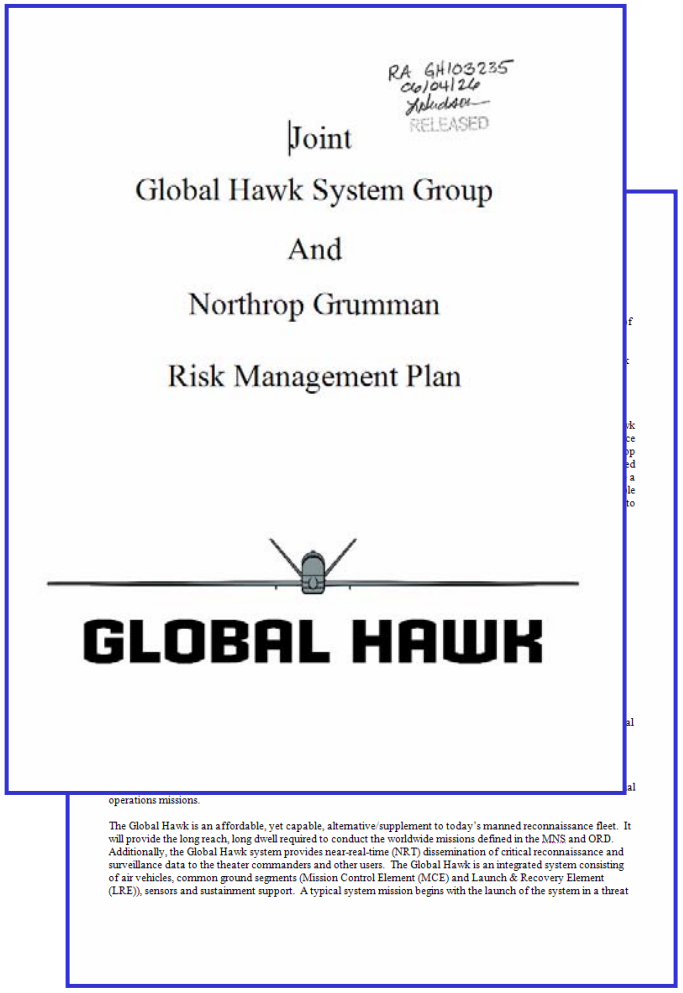
1

- **Define the Risk Management Strategy**
- **Document in a Risk Management Plan (RMP)**
  - **Process**
  - **Responsibilities – Clearly defined Accountability and Authority**
- **Define Templates and Tool**
- **Include Mitigation Cost Estimates and Plans in the Program Baseline**



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Joint

Global Hawk System Group

And

Northrop Grumman

Risk Management Plan

GLOBAL HAWK

operations missions.

The Global Hawk is an affordable, yet capable, alternative/supplement to today's manned reconnaissance fleet. It will provide the long reach, long dwell required to conduct the worldwide missions defined in the MNS and ORD. Additionally, the Global Hawk system provides near-real-time (NRT) dissemination of critical reconnaissance and surveillance data to the theater commanders and other users. The Global Hawk is an integrated system consisting of air vehicles, common ground segments (Mission Control Element (MCE) and Launch & Recovery Element (LRE)), sensors and sustainment support. A typical system mission begins with the launch of the system in a threat

Risk Identification - Risk Screening

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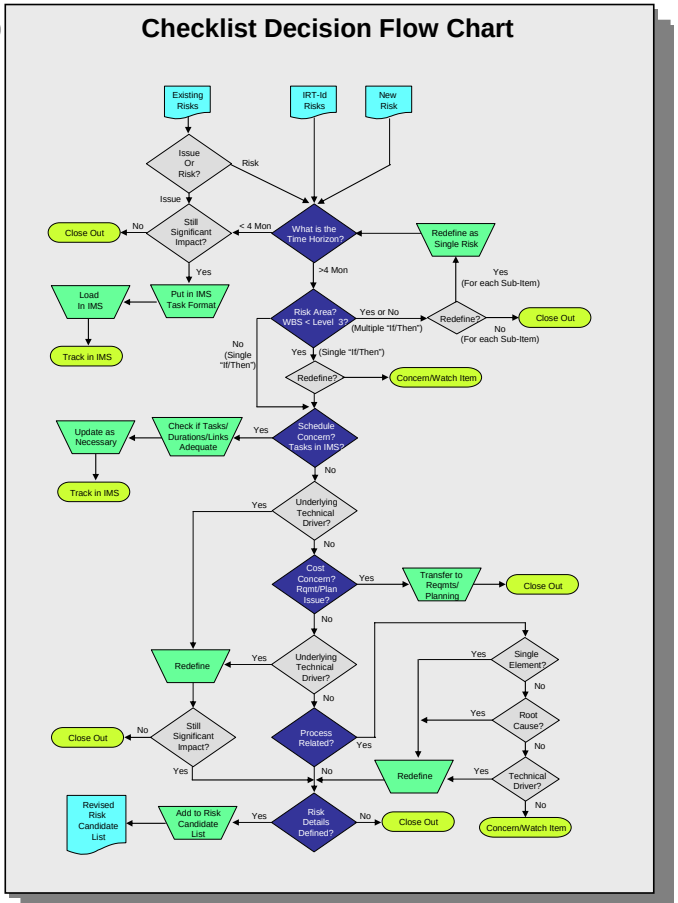
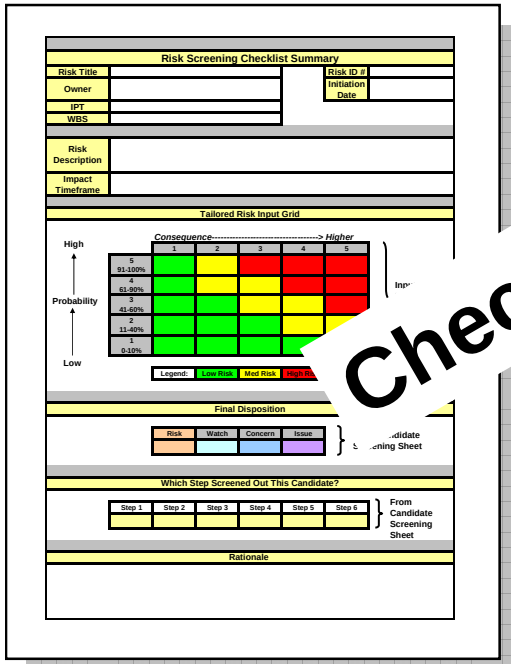
2a

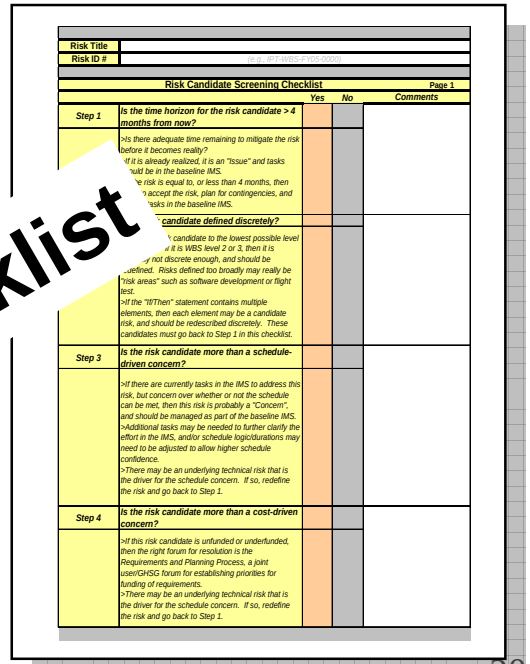
Checklist Decision Flow Chart



Basic Questions

1. What is the "Time Horizon"?
2. Is the risk defined too broadly (really a "Risk Area")?
3. Is the risk really a "Schedule Driven Concern"?
4. Is the risk really a "Cost Driven Concern"?
5. Is the risk "Process Driven"?
6. Can the "Risk Details" be defined?





Checklist

Risk Identification - Risk Areas

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2a

Risk Area	Potential Risk Indicator
Requirements Maturity	**Changing or poorly stated requirements increases the introduction of performance, cost, and schedule problems.**
Design Maturity/Complexity	**The degree of new technology or new design that is required directly increases the risk level of the program. This also includes the complexity and quantity of new software required.**
Process Maturity/Experience	**Until new processes are validated and the people who implement them have been trained and gain experience in successfully using the process, there is always risk associated with early implementation. Also, the further that a program deviates from best practices, the higher the potential risk.**
Resources/Facilities	**People, funds, schedule, and facilities (including tools) are necessary ingredients for successfully implementing a program. There is increased risk if any are inadequate or will take time to ramp up (to include training/recruiting qualified people).**
Testing	**The amount and complexity of testing required is a source of risk. This also includes the reliance on (availability) of government test equipment/facilities or test assets (e.g., aircraft).**
Integration	**The amount of integration required, both hardware and software drives potential risk. In addition, integration between subsystems and prime systems (including the working relationship between contractors) is a source of risk.**
Support	**New technology may require significant new supportability considerations or concept changes which can drive additional risk.**
Subcontractor Maturity	**A subcontractor not experienced with the processes for designing and producing a specific product is a source of risk.**
Concurrency	**Uncertainty resulting from the combining of overlapping phases or activities.**
Production	**The ability to achieve the program's production objectives based on the system design, manufacturing processes chosen, and availability of manufacturing resources (facilities and personnel).**

Risk Analysis - Risk Prioritization

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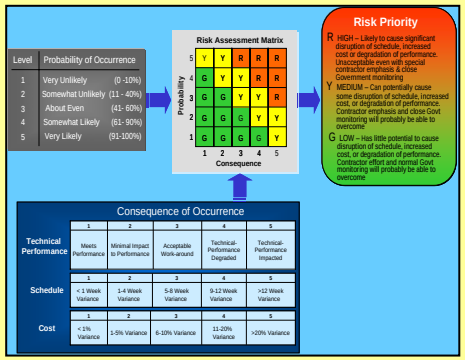
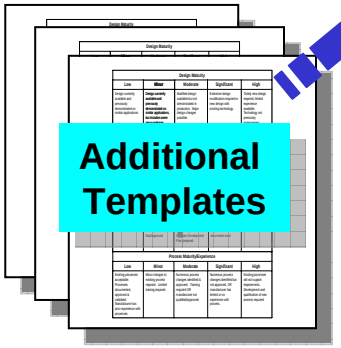
2b

Candidate Risks

- Critical Performance
- External Interfaces
- Internal Interfaces
- Complexity/Dependency
- Integration Requirements
- Qualification Testing
- Test Requirements
- Ability to Modify
- Design Errors
- Maintenance
- Omissions
- Threat
- GFI/GFE/GFP
- Concurrency
- Security
- Hardness Levels
- System Elements
- Customer (User) Uncertainty
- Requirements
- Changing Requirements
- Modifications
- Technology Demonstrations
- Operational Environment
- System Environment
- Environmental Effects
- Environmental Impact
- Maturity
- Software Language
- Computation Reserves
- Through Put
- Configuration Management
- Parts Quality

Risk Assessment Templates





Additional Templates

Prioritized Risks

- Critical Performance
- External Interfaces
- Internal Interfaces
- Complexity/Dependency
- Integration Requirements
- Qualification Testing
- Test Requirements
- Ability to Modify
- Design Errors
- Maintenance
- Omissions
- Threat
- GFI/GFE/GFP
- Concurrency
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- Through Put
- Configuration Management
- Parts Quality

Note: Prioritized Only as R/Y/G

Initial Mitigation Cost Estimate $$$

Risk Prioritization Methodology

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2b

Level	Probability of Occurrence	
1	Very Unlikely	(0 -10%)
2	Somewhat Unlikely	(11 - 40%)
3	About Even	(41- 60%)
4	Somewhat Likely	(61- 90%)
5	Very Likely	(91-100%)

Risk Assessment Matrix

Probability	1	2	3	4	5
5	Y	Y	R	R	R
4	G	Y	Y	R	R
3	G	G	Y	Y	R
2	G	G	G	Y	Y
1	G	G	G	G	Y

Consequence

Risk Priority

R HIGH – Likely to cause significant disruption of schedule, increased cost or degradation of performance. Unacceptable even with special contractor emphasis & close Government monitoring

Y MEDIUM – Can potentially cause some disruption of schedule, increased cost, or degradation of performance. Contractor emphasis and close Govt monitoring will probably be able to overcome

G LOW – Has little potential to cause disruption of schedule, increased cost, or degradation of performance. Contractor effort and normal Govt monitoring will probably be able to overcome

Consequence of Occurrence

	1	2	3	4	5
Technical Performance	Meets Performance	Minimal Impact to Performance	Acceptable Work-around	Technical-Performance Degraded	Technical-Performance Impacted
Schedule	< 1 Week Variance	1-4 Week Variance	5-8 Week Variance	9-12 Week Variance	>12 Week Variance
Cost	< 1% Variance	1-5% Variance	6-10% Variance	11-20% Variance	>20% Variance

Each Risk Candidate is prioritized using the Probability and Consequence Templates

Risk Handling - Option Decision Tree

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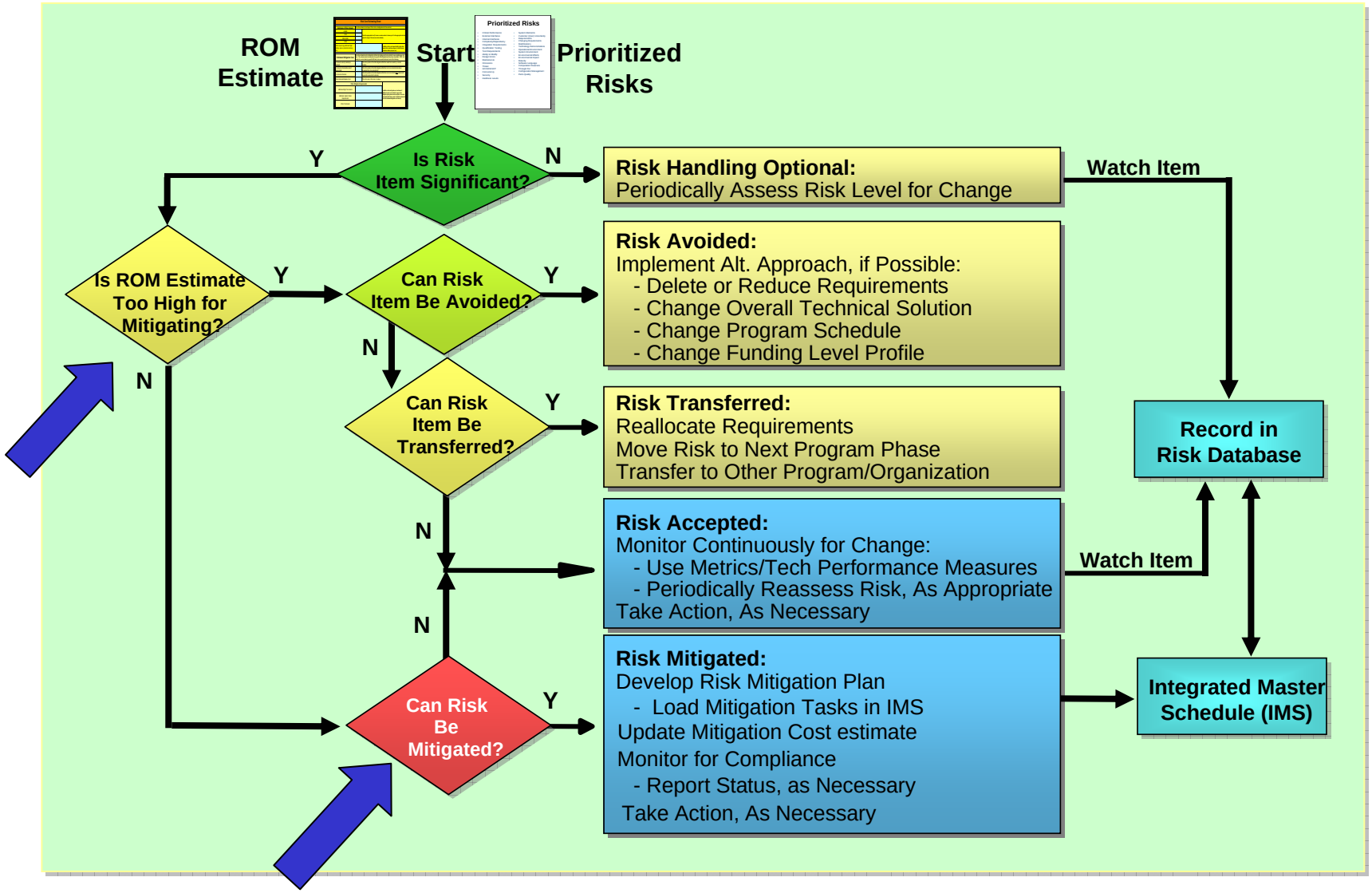

Risk Mitigation Planning Process

3

- Mitigation planning that is an integral and traceable part of the IMS
- Supports the proper calculation of risk mitigation costs
- Necessary to properly support the Government Schedule Risk Assessment
- Disciplined planning process
  - Objective to layout logical IMS-based mitigation tasks
  - Forms the input to create the “Risk Waterfall” metric

Risk Handling - Mitigation/Integration

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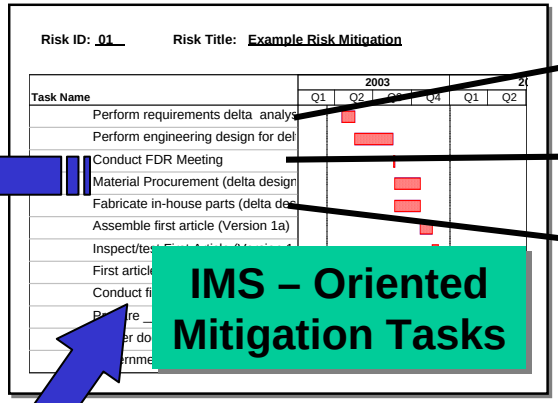
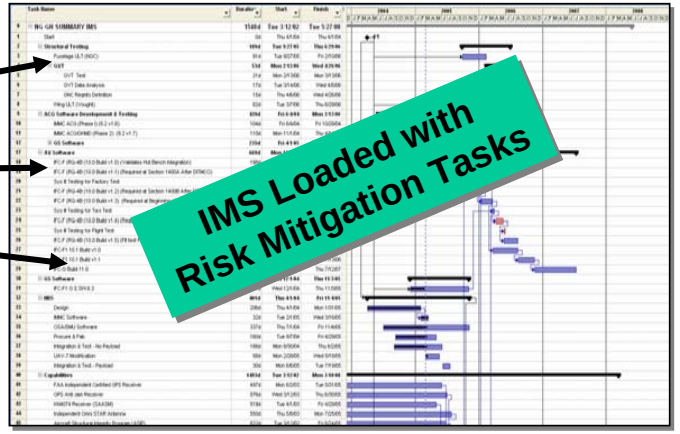
3

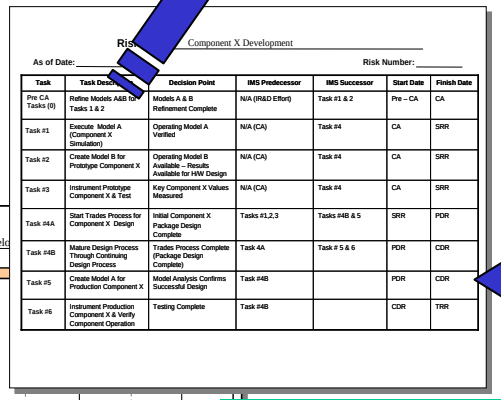
Updated Mitigation Cost Estimate $$$

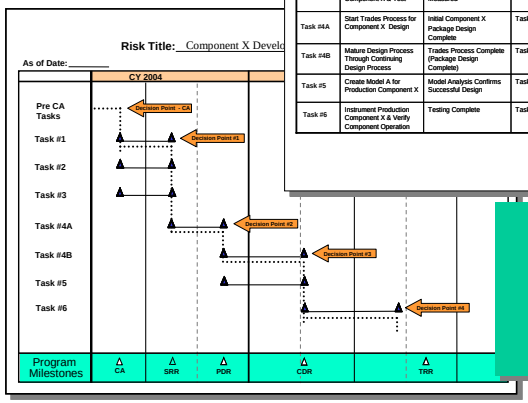


IMS – Oriented Mitigation Tasks

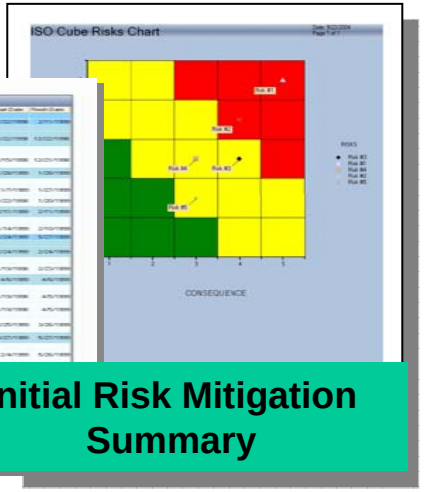


IMS Loaded with Risk Mitigation Tasks





IMS Risk Mitigation Templates



Initial Risk Mitigation Summary

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Risk Mitigation Task Planning Template

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3

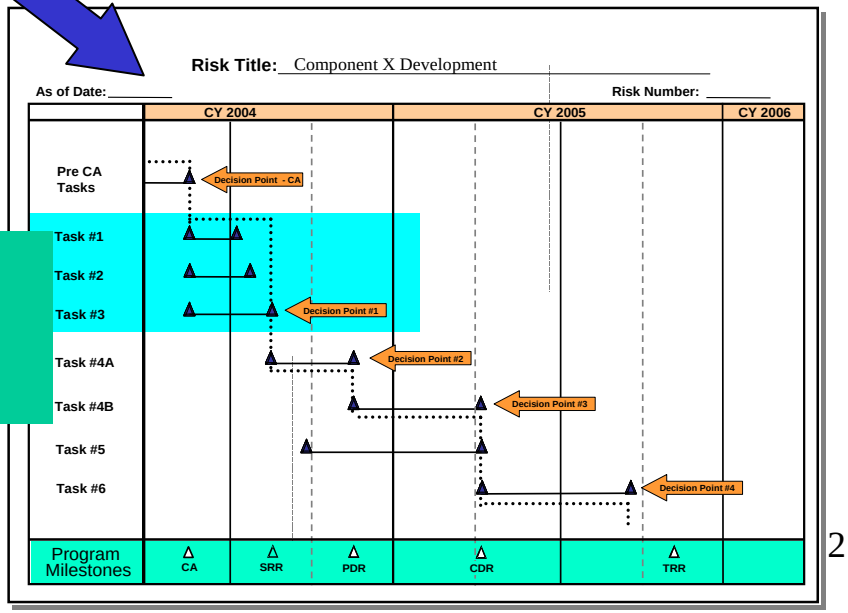
Risk Title: Component X Development

As of Date: _____ **Risk Number:** _____

Task	Task Description	Decision Point	IMS Predecessor	IMS Successor	Start Date	Finis
Pre CA Tasks (0)	Refine Models A&B for Tasks 1 & 2	Models A & B Refinement Complete	N/A (IR&D Effort)	Task #1 & 2	Pre – CA	CA
Task #1	Execute Model A (Component X Simulation)	Operating Model A Verified	N/A (CA)	Task #4	CA	SRR
Task #2	Create Model B for Prototype Component X	Operating Model B Available – Results Available for H/W Design	N/A (CA)	Task #4	CA	SRR
Task #3	Instrument Prototype Component X & Test	Key Component X Values Measured	N/A (CA)	Task #4	CA	SRR
Task #4A	Start Trades Process for Component X Design	Initial Component X Package Design Complete	Tasks #1,2,3	Tasks #4B & 5	SRR	PDR
Task #4B	Mature Design Process Through Continuing Design Process	Trades Process Complete (Package Design Complete)	Task 4A	Task # 5 & 6	PDR	CDR
Task #5	Create Model A for Production Component X	Model Analysis Confirms Successful Design	Task #4B		PDR	CDR
Task #6	Instrument Production Component X & Verify Component Operation	Testing Complete	Task #4B		CDR	TRR

Risk mitigation tasks developed in an IMS, linked format

Mitigation tasks are grouped to form "waterfall" logic



Risk Mitigation Task Planning Template

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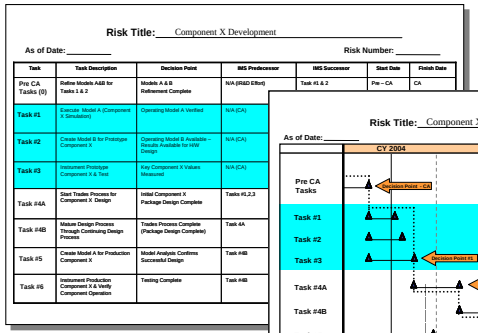

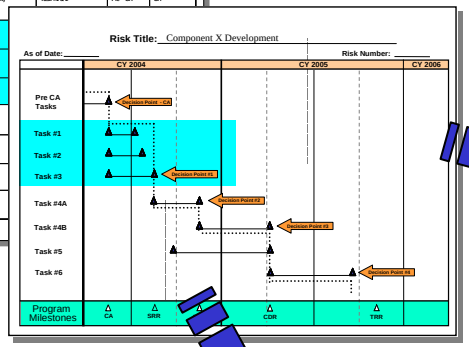

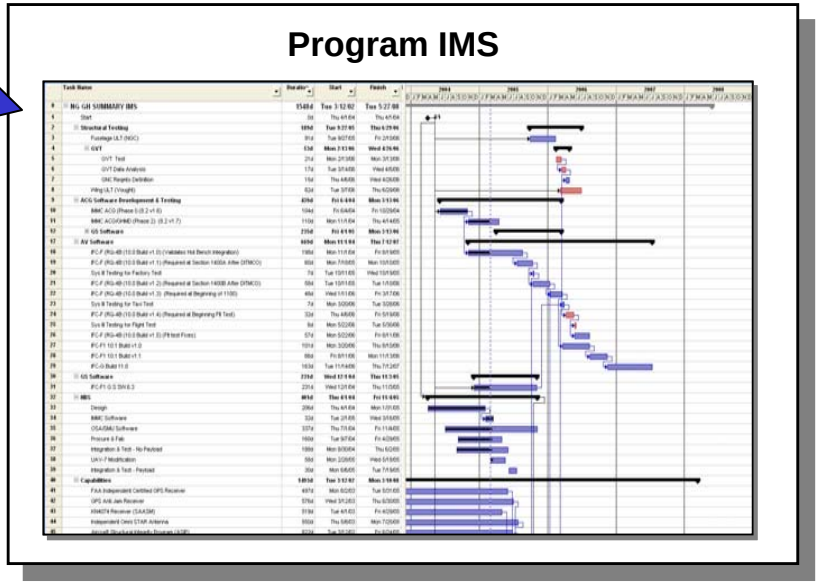

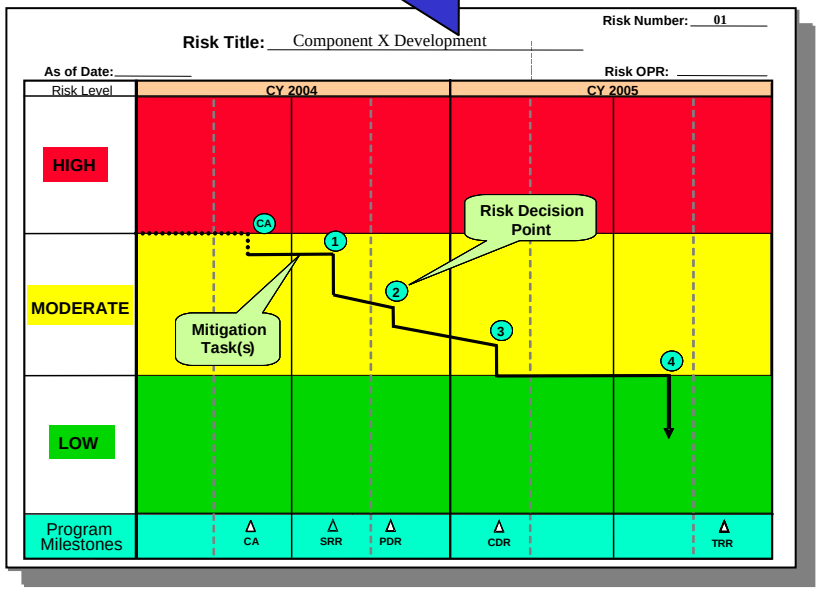

Risk Mitigation – Concept of "Risk ROI"

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- Determining risk mitigation costs are a key part of the Risk Handling step
- Risk "Return on Investment (ROI)" can be used to help prioritize which risks to mitigate
- ROI is the ratio of the risk impact cost to the risk mitigation cost
- The higher the ROI, the better the investment
- ROI assumes that the risk will be mitigated from an unacceptable level (red or yellow) to an acceptable level (green)

Risk Cost Estimating Sheet		
Estimate of Risk Impact	**This is the estimate of cost impact if the risk is not mitigated and is then realized.**	
< $500K		**Check the appropriate box (if a more accurate number is known, put it in the appropriate box that spans the range of the more accurate estimate).**
< $1M		
$1M to $5M		
> $5M		
Other Impacts (eg additional flight testing, spares, production delivery, etc)		**In addition to the cost impact briefly highly other impacts that could have impact to critical assets, production delivery impact, etc).**
Estimated Mitigation Cost	**This is the estimated cost to mitigate the risk from its starting point (red or yellow) to an acceptable green risk point. This estimate should be made after the specific IMS mitigation tasks have been formulated. *NOTE: Not looking for a cost estimate by specific IMS tasks, but an overall estimate of each of the following.***	
1. Amount currently funded (on contract)	$	This is the portion of the IMS mitigation effort that would be covered by a current contract.
2. Amount not funded but part of revised EAC	$	This is the portion of the IMS mitigation effort that is not on contract but has been accounted for in the revised EAC.
3. Amount not funded	$	This is the portion of the IMS mitigation effort that is not on contract **and** is above and beyond the revised EAC estimate.
Total Estimated Mitgation Cost	$	This is the sum of the lines 1-3 above.
Other Mitigation Requirements		**In addition to the mitigation cost estimate, if additional assets are needed to execute the mitigation plan, please note here *(Note: the costs associated with these assets should be included in the total estimated mitigation cost above).***
Additional Flight Test Assets		
Additional System Center Requirements		
Other Test Assets		

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Risk Monitoring - Quad Chart

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4

Risk Title: _____

Risk #: _____ IPT: _____

Risk Description (If/Then):

Consequence----------> Higher

Probability	1	2	3	4	5
5 91-100%					
4 61-90%					
3 41-60%					
2 11-40%					
1 0-10%					

High ↑ Probability ↑ Low

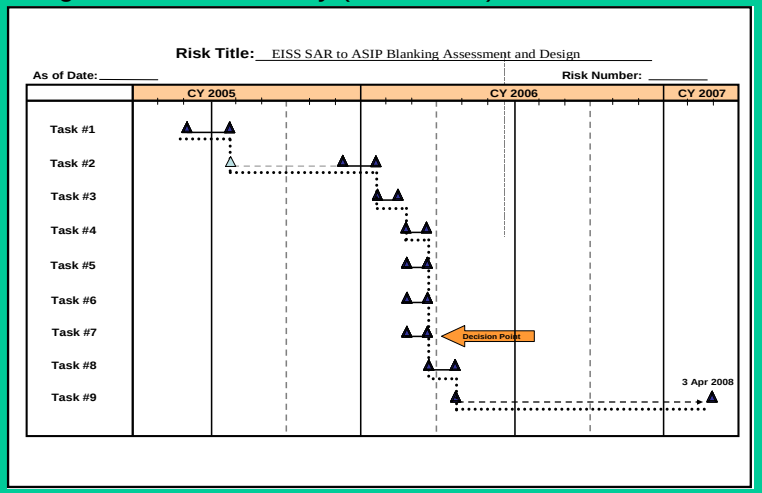
Legend: Low Risk | Med Risk | High Risk

Risk Cost Estimating Sheet

Estimate of Risk Impact	
< $500K	
< $1M	
$1M to $5M	
> $5M	

Estimated Mitigation Cost	
1. Amount currently funded (on contract)	$
2. Amount not funded but part of revised EAC	$
3. Amount not funded	$
Total Estimated Mitgation Cost	$

Mitigation Plan Summary (IMS Tasks):



Agenda

Dominant Air Power: Design For Tomorrow…Deliver Today

- Introduction
- Product Background
- Program Background
- Management Challenge
- Risk Management Improvement Process
- **Results**
- Then till Now
- Summary

Process Improvement - Results

- ✓ **Conducted Joint Leadership Team RM Training**
  - **Facilitated by DAI**
  - **Established Baseline for IPT Training and Risk Review & Reassessment Process**
- ✓ **Conducted Initial DAI & GHSG IPT Review**
  - **DAI & IPT Risk Managers Prescreening Risks**
  - **DAI addressing additional prescreening for entire database**
    - **Evaluating Risks vs. Issues vs. Watch Items**
- ✓ **Conducted Risk Training Session with DAI & NGC**
  - **Addressing Potential to Tie-In Subs for Training**
- ✓ **Conducted Joint Risk Reviews in Accord with our Roadmap**
  - **Incorporated into plan for IMS Mid Point and Risk reviews**
  - **Includes NGC/GHSG/Subs**

Process Improvement - Results

- ✓ **Conducted Risk Workshop**
  - **Included NGC/GHSG/Subs**
  - **Established agreement on IPT level Risks/Issues/Concerns**
- ✓ **Developed Detail Risk Mitigation Plans**
  - **IPTs Addressing Risks / Issues / Watch Items / Concerns**
  - **Developed Mitigation Plans and Incorporated into IMS**
- ✓ **Conducted Risk Summit**
  - **Integrate Updates to Risk Database and Updated IMS**
- ✓ **Institutionalized Risk Management Process Across the Global Hawk Enterprise**

Global Hawk Business Rhythm

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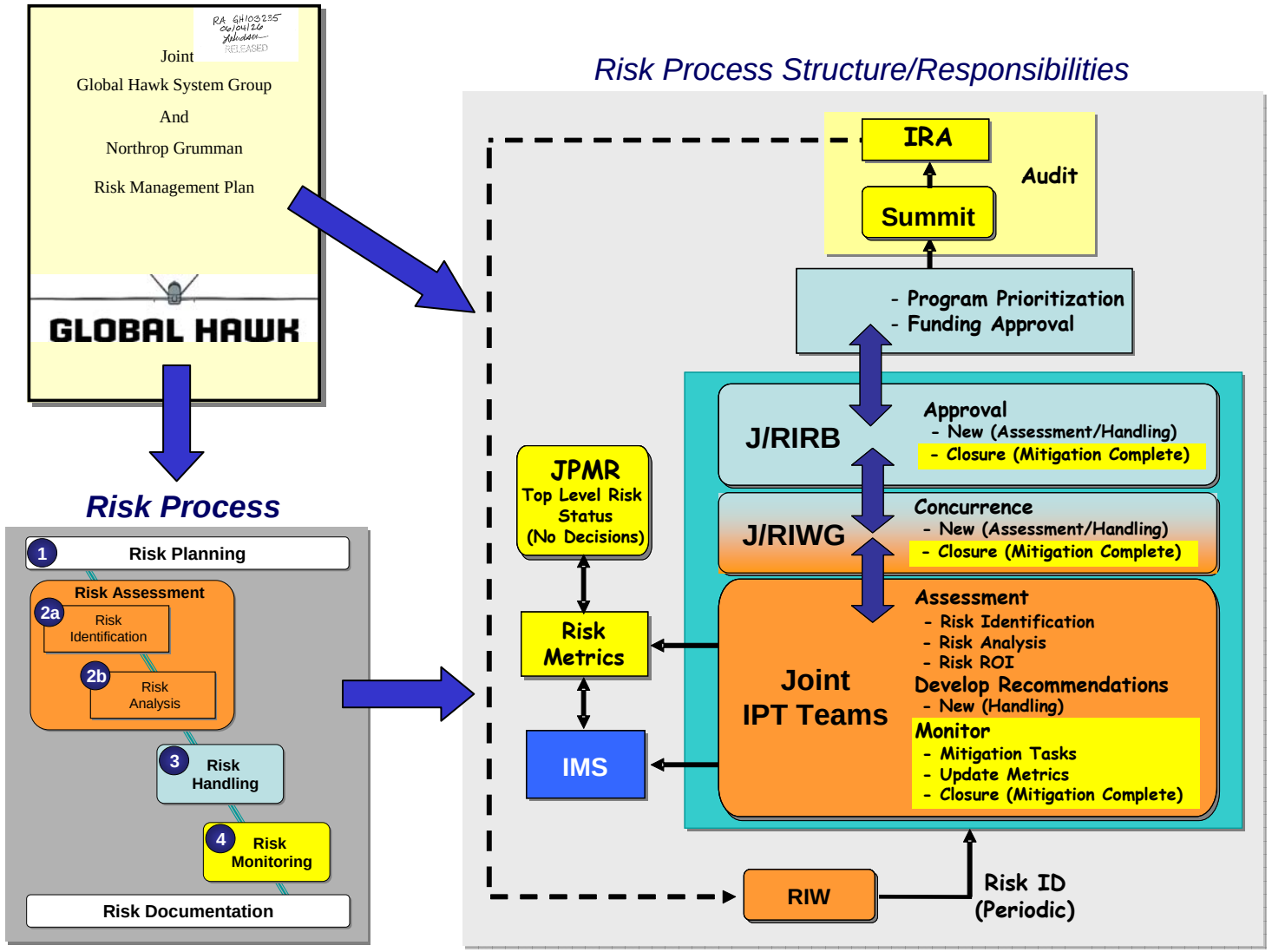

First Block 20 and Last Block 10

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Agenda

Dominant Air Power: Design For Tomorrow…Deliver Today

- Introduction
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Then Until Now

- Risk Management Institutionalized within Global Hawk Program
- Program strategic rhythm includes biweekly risk identification and monitoring and monthly risk reporting
- Continual process improvement / refinement enabling a higher level of confidence for Program cost and schedule executability
- Preparing for annual Integrated Risk Assessment

Agenda

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Summary

- Spiral Development of Global Hawk extremely successful at responding to rapidly changing Warfighter needs for Global War on Terrorism
- However, fast moving program put significant strain on traditional acquisition management
- Systems Engineering processes such as Risk Management critical for long term success of program
- Key is integrating tools and processes together for seamless program execution

Global Hawk
Integrated Risk Management

Questions?

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•Backup

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Baseline Program Plan

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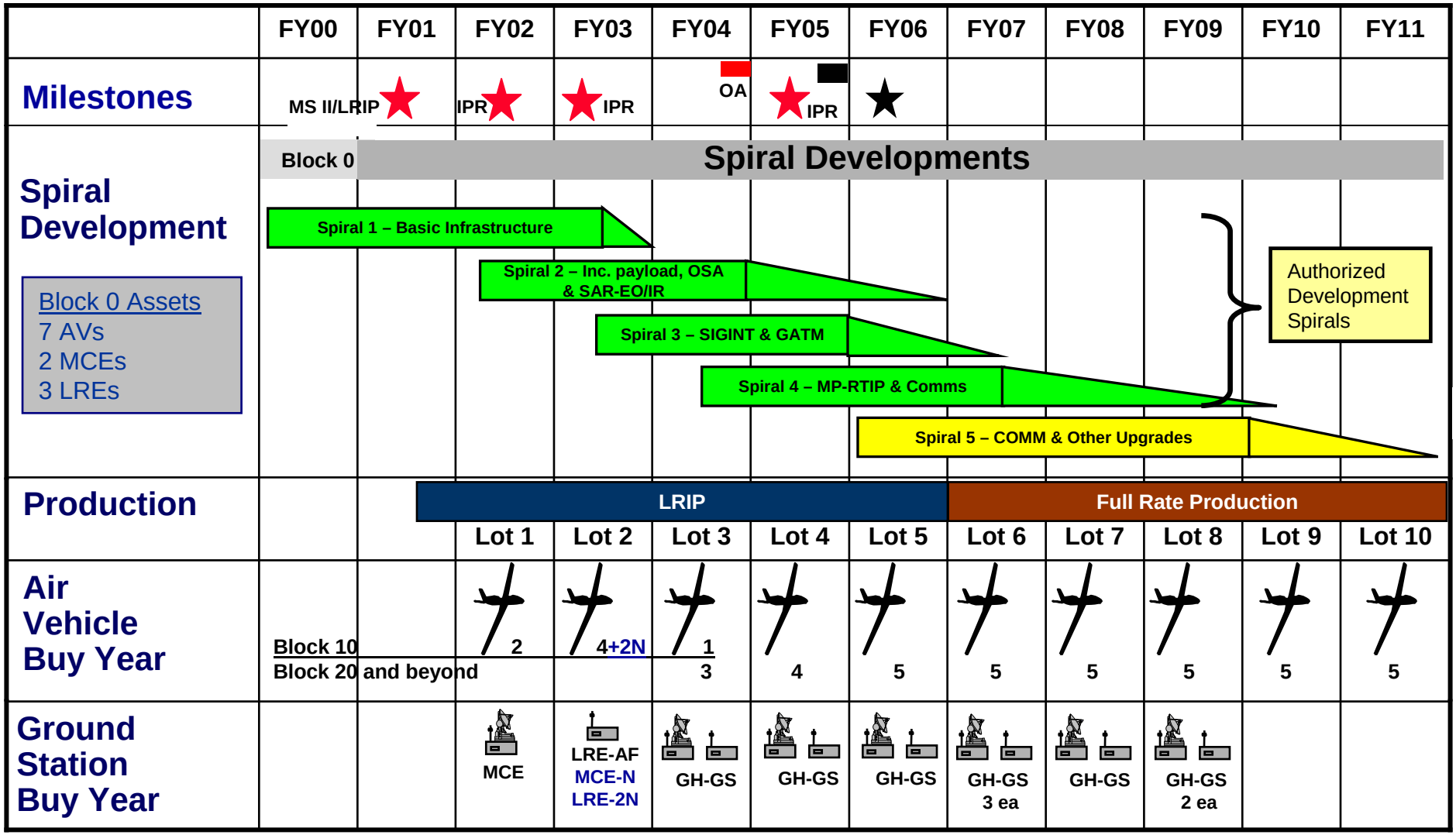

Risk Identification

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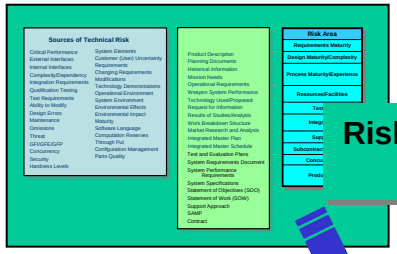
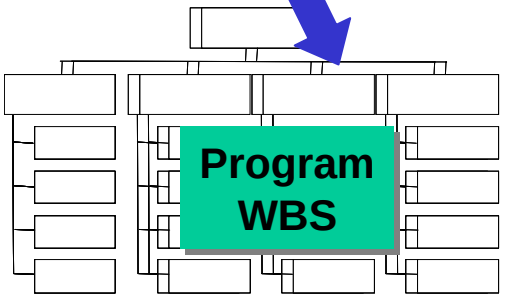
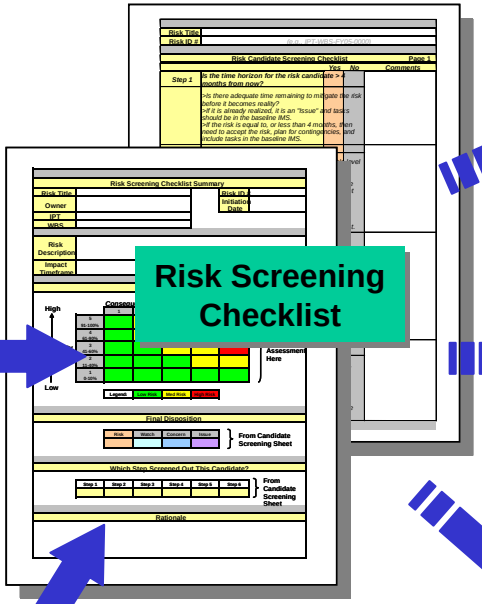
2a



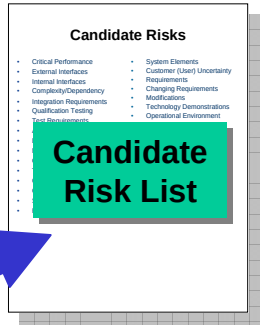
Risk Source Lists



Program WBS



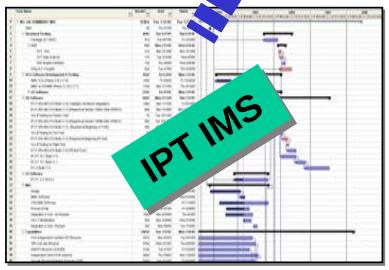
Risk Screening Checklist



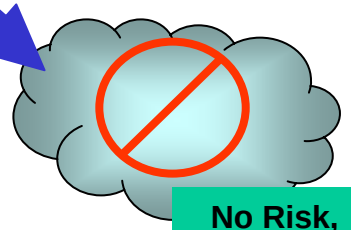
Candidate Risk List

Issue – Baseline in IMS

Subject Matter Experts/Interviews

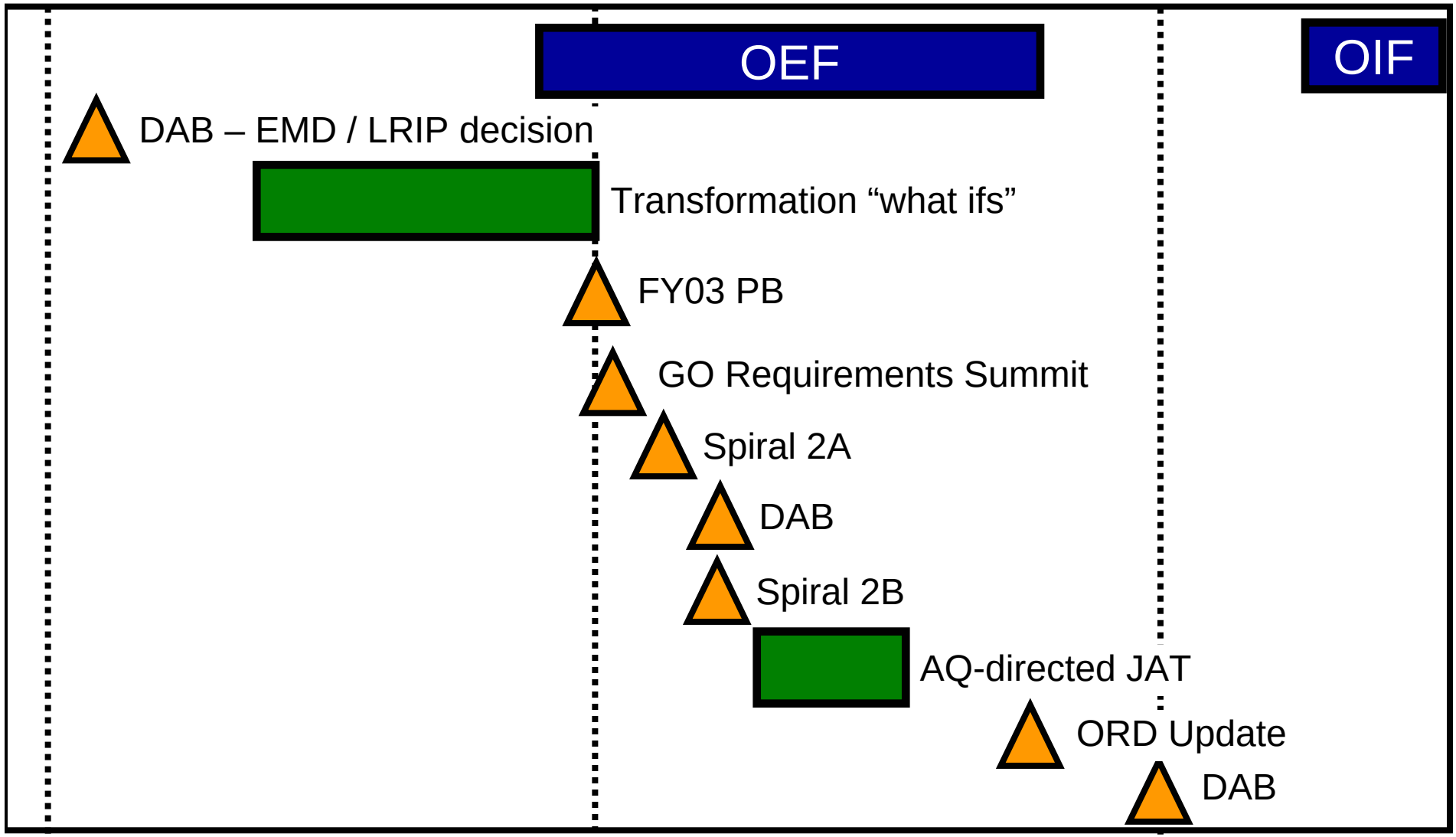


IPT IMS



No Risk, Worry Item

Global Hawk History (2004 era)



Risk Identification - Program Focus

2a

- Technical Risk
  - ***Level of confidence*** **in technical solution to meet performance requirements**
  - **Design/Process maturity**
  - **Level of Complexity**
  - **Integration/Test**

  } ***Focus on Both H/W & S/W***
- Cost Risk
  - ***Level of confidence*** **in cost estimates**
  - **Focus on ability to meet program EAC**
- Schedule Risk
  - ***Level of confidence*** **in tasks durations**
  - **Focus on durations of Critical Path tasks**
  - **Also applies to Subcontractor's schedules, with focus on integration points**