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Acquisition

RISK MANAGEMENT

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This pamphlet does not apply to the Air National Guard or US Air Force Reserve units and members. This pamphlet is intended to provide program managers and their program management team a basic understanding of the terms, definitions and processes associated with effective risk management.

Current acquisition reform initiatives embrace closer government/industry relationships and greater reliance on commercial technologies—both designed to provide reliable, lower cost weapon systems. Hand-in-hand with these initiatives is an accompanying focus on risk management.

The risk management concepts and ideas presented in this pamphlet are focused on encouraging the use of risk-based management practices and suggesting ways to address the program risk without prescribing the use of specific methods or tools. Rather, this pamphlet was prepared as a guide, with the expectation that program risk management processes will be developed to meet the intent of this document.

The terms and definitions in this guide have been standardized with the current DoD terminology as a result of the activities of the 1996 DoD Risk Management Working Group. Additionally, this document served as a primary source of the DoD level risk management material for the December 96 version of the DoD online acquisition model, "Deskbook."

SUMMARY OF REVISIONS

This pamphlet was rewritten in its entirety.

Chapter 1

INTRODUCTION

1.1. Pamphlet Roadmap. This risk management pamphlet applies to acquisition risks and is organized into three general segments. Chapters 1 and 2 provide an executive-level overview of risk management. Chapters 3 and 4 provide high level concepts related to application of risk management on new programs and to implementation of sample approaches and techniques. Chapter 5 contains a selected list of references for additional information.

1.2. Overview. Risk management is an integral part of the overall acquisition process. When a disciplined, comprehensive risk management program is implemented throughout a program's life cycle, critical program risks are properly identified and suitable handling plans are developed and implemented. A well-managed risk management program is an invaluable tool for balancing cost, schedule, and performance goals, especially on programs with designs which approach or exceed the state-of-the-art.

1.2.1. Risk management is not a separate program function but an integral part of the overall program planning and management process. In order to be effective, the risk management process must be recognized as a program management activity, and not something limited to the engineering function. Any program element associated with cost, schedule, and performance has a direct interface with the risk management process.

1.2.2. It is important to remember that risk management is employed throughout the program's life cycle. A risk management strategy should be developed early in the program (as early as Phase 0) and addressed continually throughout the program. This process does not change fundamentally as the program progresses, although refinement will occur as program unknowns become knowns and its design matures.

1.2.3. Recent emphasis on risk management coincides with overall DoD efforts to reduce life-cycle costs (LCC) of system acquisitions. New processes, reforms, and initiatives are being implemented within the acquisition communities with risk management as a key component. It is essential that programs define and implement appropriate risk management and contingency plans. Risk management should be designed to enhance program management effectiveness and provide program managers a key tool to reduce LCCs.

1.2.4. An effective risk management process requires a commitment on the part of the program manager and the program office to be successful. Many impediments exist to risk management implementation. One good example is the natural reluctance to identify real program risks early for fear of jeopardizing the program's support or even continuation. Another example is the lack of sufficient funds to properly implement the risk handling process. However, when properly implemented, the risk management program supports setting realistic cost, schedule, and performance objectives and identifies areas that require special attention.

1.2.5. Planning a good risk management program integral to the management process ensures that risks are handled at the appropriate management level.

1.3. Major DoD References.

1.3.1. DoD Directive 5000.1, *Defense Acquisition*.

1.3.2. DoD 5000.2-R, Mandatory Procedures for Major Defense Acquisition Programs and Major Automated Information System Acquisition Programs.

1.3.3. DoD 4245.7-M, *Transition from Development to Production.*

1.3.4. DoD Directive 5000.4, OSD Cost Analysis Improvement Group (CAIG).

1.4. Purpose. This pamphlet:

- Provides guidance to help establish a risk management framework for planning, assessing, handling and monitoring risks for all acquisition programs.
- Serves as a source of general guidance which can be tailored to fit within the program and statutory requirements.
- Includes discretionary acquisition guidance and information, expert wisdom, best practices and lessons learned.
- Applies to all elements of a program (system, subsystem, hardware and software).
- Should be used in conjunction with related directives, instructions, policy memoranda, or regulations issued to implement the mandatory procedures contained in DoD directives and instructions.
- Can be tailored into a single management process to provide an efficient, integrated acquisition process supporting the orderly flow of program decisions, milestones, and other essential activities.
- Discusses performance within the context of the following areas of technical risks: threat; requirements; technology; engineering; manufacturing; environmental, safety, and health; logistics and supportability; test and evaluation; operational support; demilitarization and disposal.

Note. This pamphlet uses the term “acquisition” generically to apply to all programs, regardless of life-cycle phase-from laboratory research programs to major weapon or information system development programs-through sustainment and disposal.

1.5. Risk Management Definitions.

1.5.1. Risk. Risk is a measure of the inability to achieve program objectives within defined cost and schedule constraints. Risk has two components.

- The probability (or likelihood) of failing to achieve particular performance, schedule, or cost objectives.
- The consequence of failing to achieve those objectives.

1.5.2. Failure to account for the severity of the consequences means that risks may be misstated. For example, if a particular event has a high probability of failure (PF), but only a small impact, then it is unrealistic to call it a high risk. On the other hand, a number of risks can have a low probability of occurrence but have consequences so serious that they are treated as significant risks. A classic case is safety issues, which typically have been handled as moderate or high risks, despite their relatively low probability of occurrence.

1.5.3. Risk Management Process.

1.5.3.1. Risk management is the act or practice of controlling risk. This process includes identifying and tracking risk areas, developing risk mitigation plans as part of risk handling, monitoring

risks and performing risk assessments to determine how risks have changed. Risk management process activities fall into the following four broad elements and are performed with many iterative feedback loops.

1.5.3.2. Risk planning is the process of developing and documenting organized, comprehensive and interactive strategy and methods for identifying and tracking risk areas, developing risk mitigation plans, performing risk assessments to determine how risks have changed, and planning adequate resources.

1.5.3.3. Risk Assessment is the process of identifying and analyzing program area and critical technical process risks to increase the likelihood of meeting performance, schedule and cost objectives. It includes risk identification and risk analysis. *Risk identification* is the process of examining the program and each critical technical process to identify and document risk areas. *Risk analysis* is the process of examining each identified program and process risk, isolating the cause, and determining the impact. Risk impact is defined in terms of its probability of occurrences, its consequences, and its relationship to other risk areas or processes.

1.5.3.4. Risk handling is the process that identifies, evaluates, selects and implements options in order to set risk at acceptable levels given program constraints and objectives. This includes the specifics on what should be done, when it should be accomplished, who is responsible, and the cost impact. The most appropriate strategy is selected from these handling options and documented in a risk handling plan.

1.5.3.5. Risk monitoring is the process that systematically tracks and evaluates the performance of risk handling actions against established metrics throughout the acquisition process and develops further risk handling options or executes risk mitigation plans, as appropriate.

1.6. The Risk Management Participants.

1.6.1. Involve Everyone In Risk Management. Effective risk management requires early and continual involvement of all of the program team as well as outside help from subject-matter experts, as appropriate. Participants include the customer, laboratories, acquisition, contract management, test, logistics, and sustainment communities and, above all, industry.

1.6.2. Develop Close Partnership With Industry. Effective management of a program's risk requires a close partnership between the government, industry, and later, the selected contractor(s). The program manager should understand the differences in the government's view of risk versus industry's view and ensure all risk management approaches are consistent with program objectives. Both the government and industry need to understand their respective roles and authority while developing and executing the risk management effort.

1.7. Effective Risk Management. Acquisition programs run the gamut from simple, straightforward procurements of mature technologies which cost a few thousand dollars to state-of-the-art and beyond programs valued in the multibillions of dollars. Effective risk management programs generally follow consistent characteristics and guidelines across all programs despite these vast differences in program size and technologies. Some characteristics of effective risk management programs follow.

1.7.1. Characteristics Of Successful Risk Management. Successful programs will have the following risk management characteristics.

- Feasible, stable, and well-understood user requirements.

- A close partnership with user, industry, and other appropriate participants.
- A planned risk management process integral to the acquisition process.
- A program assessment performed early to help define a program which satisfies the user's needs within acceptable risk.
- Identification of risk areas, risk analysis and development of risk handling strategies.
- Acquisition strategy consistent with risk level and risk handling strategies.
- Continuous reassessment of program and associated risks.
- A defined set of success criteria that covers all performance, schedule, and cost elements.
- Metrics used to monitor effectiveness of risk handling strategies.
- Formally documented.

Table 1.1. Top-Level Guidelines for Effective Risk Management.

Assess program risks and develop strategies to manage these risks during each phase.	
-	Identify early and intensively manage those design parameters which critically affect capability, readiness, design cost, or LCC.
-	Use technology demonstrations/modeling/simulation and aggressive prototyping to reduce risks.
-	Include test and evaluation as part of the risk management process.
Include industry participation in risk management. Offerors must identify risks and develop plans to manage those risks as part of their proposals.	
Use proactive, structured risk assessment and analysis process to identify and analyze risks.	
-	Identify, assess and track technical, schedule, and cost risk areas.
-	Establish risk mitigation plans.
-	Provide for periodic risk assessments throughout each program phase.
Establish a series of "risk assessment events," where the effectiveness of risk reduction conducted to date is reviewed. These events are to be tied to the integrated master plan (IMP) at each level and have clearly defined entry and exit criteria.	
Include processes as part of risk assessment. This would include the contractor's managerial, development, and manufacturing processes.	
Clearly define a set of evaluation criteria for assigning risk ratings (low, moderate, high) for identified risk areas.	

Chapter 2

RISK MANAGEMENT PROCESS

2.1. Overview. Chapter 1 broadly defined the four basic elements of the risk management process. In this chapter, we will be described in more depth to illustrate key events, actions, and tasks associated with each of these elements, as well as to provide general guidelines on timetables for implementation.

2.2. Risk Management Elements. Recall from the previous chapter that risk management involves activities from four different elements: risk planning, risk assessment, risk handling and risk monitoring. Although this chapter will address each element as a separate phase, these four elements are often integrated and performed using many feedback loops.

2.2.1. Risk Planning. Risk planning is the process of developing and documenting organized, comprehensive and interactive strategy and methods for identifying and tracking risk areas, developing risk mitigation plans, performing risk assessments to determine how risks have changed, and planning for adequate resources.

2.2.1.1. Risk planning consists of the up-front activities needed for a successful risk management program. At the end of one program phase, risk planning is the heart of the preparation for the next program phase.

2.2.1.2. Effective management of a program's risks requires a close working relationship between the program office and the potential contractor(s). The program manager should understand the differences in the government's view of risk versus industry's view and ensure all risk management approaches are consistent with program objectives. This is because the government will focus on managing overall program risks while the contractor is charged with maintaining accountability in design and executing the requirements of the contract. Both the government and potential contractor(s) need to understand the risks clearly, and be involved in planning the risk management effort.

2.2.2. Risk Assessment. Risk assessment is the process of identifying and analyzing program area and critical technical process risks to increase the likelihood of meeting performance, schedule and cost objectives. It includes risk identification and risk analysis. This process of identifying and analyzing program risks increases understanding necessary to setting and meeting performance, schedule and cost objectives. In this context, risk identification is the process of examining each program area and critical technical process to identify risk areas. Risk analysis is the process of examining each identified program risk and critical technical process risk. It refines the description of the risk, isolates the cause, and determines the impact of the program risk in terms of its probability of occurrences, its consequences, and its relationship to other risk areas or processes.

2.2.2.1. Integrating technical, schedule, and cost assessments into a single process provides a final product which:

- Starts with well-defined requirements.
- Builds upon a solid technical foundation.
- Develops a realistic program schedule.
- Documents the resources needed in the program cost estimates.

2.2.2.2. Risk assessments should be performed to support program definition, planning and key events, which can include:

- Acquisition strategy development.
- Request for proposal (RFP) preparation.
- Source selection.
- Sole source proposal evaluation.
- Program reviews and milestone decisions.

Note. Risk assessment during source selection is a self-contained process and should not be part of the prior program risk assessment process.

2.2.2.3. The program- or contract-level risk assessment integrates the technical program assessment, schedule assessment, and cost estimate steps using established risk evaluation techniques. A risk assessment should be done periodically throughout each acquisition phase at both program and supplier level.

2.2.2.4. When the situation demands, a specific team may also perform a risk assessment focused on a lower-level product or specific task. Examples include: 1) projected test cost trades given decreased number of test units, or 2) contract production costs for a particular number of units, or 3) independent cost assessment.

2.2.3. Focus Areas. The risk assessment must integrate the technical, schedule and cost aspects of the program under review. Each of these focus areas has activities of primary responsibility, but is provided inputs and support from the other two focus areas. This helps to keep the process integrated and to ensure the consistency of the final product. The activities are often tailored, but the typical responsibilities on a risk assessment include:

2.2.3.1. Technical Assessment.

- Provides technical foundation.
- Identifies and describes program risks.
- Prioritizes risks with relative or quantified weight for program impact.
- Analyzes risks and relates them to other internal and external risks.
- Quantifies associated program activities with both time duration and resources.
- Uses risk handling to set risk at acceptable levels given program constraints.
- Scopes schedule and cost consequences if risk mitigation fails.
- Quantifies inputs for probabilistic schedule assessment and cost estimate if this method is used for schedule assessment and cost estimating.
- Documents technical basis and risk definition for the risk assessment.

2.2.3.2. Schedule Assessment.

- Evaluates baseline schedule inputs.
- Incorporates technical assessment inputs to program schedule model.
- Evaluates risk impacts to program schedule based on technical team assessment.
- Performs schedule analysis on program Integrated Master Schedule (IMS).

- Quantifies schedule excursions which reflect schedule impacts if risk mitigation fails.
- Provides schedule impacts for risk handling options as part of risk handling.
- Quantifies schedule excursions which reflect impacts of cost risks, including resource constraints.
- Provides government schedule assessment for cost analysis and year planning.
- Reflects technical foundation, activity definition and inputs from technical and cost areas.
- Documents schedule basis and risk impacts for the risk assessment.

2.2.3.3. Cost Estimate.

- Builds on technical and schedule assessment results.
- Translates technical and schedule risks into “dollars and cents.”
- Provides cost estimates for risk handling options.
- Derives cost estimate integrating technical assessment and schedule risk impacts to resources.
- Establishes budgetary requirements consistent with fiscal year planning.
- Provides program cost excursions from.
- Near-term budget execution impacts.
- External budget changes and constraints.
- Documents cost basis and risk impacts.

2.2.3.4. Risk assessment activities combine the above.

- After contract award, use risk monitoring to track actual program indicators against baseline performance, schedule, and cost plans as part of continuous program assessments.
- Repeat the above three assessments when technical performance, schedule, or cost metrics indicate changes are significant enough to warrant updating the risk assessment, or when needed to support program decision process.
- Tie technical, schedule, and cost focus areas together in feedback loops as needed during initial or periodic risk assessment.
- Document the integrated results of the risk assessment.

The scope of each of these focus areas depends on the program and the objective of the risk assessment.

2.2.4. When to Do Risk Assessments. Risk assessments should be applied early and continuously in the acquisition process, from the time performance requirements are developed. The early identification and assessment of critical risks allows for the formulation of risk handling approaches and the streamlining of both the program definition and the RFP processes around those critical product and process risks. Risk assessments should be used for all major contractual actions and milestone decisions. The following general descriptions will help interpret the risk assessment process.

2.2.4.1. All risk management actions begin with the identification and analysis of the program's risks. The caliber and quality of this effort establishes the effectiveness of the risk management effort. A determination of what the system must do is the necessary starting point for risk assessment. The program requirements need to be established before risks can be identified and their significance analyzed.

2.2.4.2. The level of detail needed is dependent upon the program phase and the nature of the need to be addressed. However, there must be enough detail to allow a general scoping of the level of effort required, technological capabilities needed, and system complexity.

2.2.4.3. Five basic activities should be performed to assess a program's risks effectively.

2.2.4.3.1. First, the program office should establish the basic approach it will use to assess the risks. A comprehensive and consistent approach is needed to ensure all aspects of the program are examined for risk.

2.2.4.3.2. Second, the program office should establish the working structure for the risk assessment, and appoint experienced government and industry personnel, as appropriate.

2.2.4.3.3. Third, identify the risks in the program. The program manager should ensure each program area is examined to identify the risks inherent in that area.

2.2.4.3.4. Fourth, each identified risk needs to be analyzed to determine the consequences of each risk, the significance of those consequences to the program, and the likelihood of the risk actually occurring. Risk analysis is the detailed evaluation of each identified risk area. This analysis examines each risk, isolates the cause and determines the impact of the risk area on the program.

2.2.4.3.5. Fifth, the results of the risk assessment (and associated risk mitigation planning) should be formally documented. This documentation is important because:

- Formal documentation tends to ensure a more comprehensive risk assessment.
- It provides the rationale for why program decisions were made.
- It provides program background material for new personnel.
- It provides a good baseline for program assessments and updates as the program progresses.
- It provides a management tool for use during the execution of the program. A listing of the expected program risk areas (sometimes called a watchlist) prompts management on areas to monitor.

2.2.4.4. Risk assessment is not a stand-alone program office task. It is supported by a number of other program office tasks. In turn, the results of the risk assessment are used to finalize those tasks. Important tasks which must be integrated as part of the risk assessment process include the requirements analysis/functional analysis (systems engineering), schedule development, and cost estimating.

2.2.5. Early Risk Assessments. A risk assessment which identifies technical risks and reflects the resultant program uncertainty in the program planning may suffice for programs in the initial planning and budgeting stages. Because detailed historical data is not always available, program office teams must be resourceful in gathering the judgments of experts to support the risk assessment.

2.2.6. Using Program Risk Level to Streamline Source Selection. The content of the RFP requirements determines how the source selection will be conducted. Therefore, a risk assessment must be performed prior to release of the draft RFP if it is going to influence what information is actually needed in the proposals. To be effective, the risk assessment should be a key element of the acquisition strategy process and source selection plan development. Specifically, the risk assessment should identify those areas which must be included in the RFP to ensure appropriate consideration is given in

the source selection evaluation process. These are areas that may very likely affect the source selection decision. Alternatively, the risk assessment can identify areas where risk is very low, and therefore evaluation of the area is NOT needed during source selection. Excluding very low risk areas from source selection can save the offeror time and resources in not having to prepare proposal information, and save the government time and resources in not having to evaluate information that will not affect the source selection decision.

2.2.6.1. The risk assessment process is iterative. Feedback from market surveys and industry comments during presolicitation conferences and draft RFP issuance provide avenues to identify and define those critical risks to be addressed through the preaward process.

2.2.7. Risk Assessment Approaches. For each risk assessment, the program office team must establish how the actual assessment will be conducted. At least four choices are available:

- Conduct the assessment as part of the normal activity of the program office.
- Establish a program office risk assessment team, as either a temporary ad-hoc team or a permanent organization.
- Establish a government/industry team.
- Request an outside team or combined program office/outside team assessment.

2.2.7.1. Each approach has its own merits and costs. However, the choices are not mutually exclusive. Program offices could use two or more of these options in combination or for different aspects of the program. An internal effort should always be conducted so that program office personnel are familiar with the risks. Special teams may be appropriate if the resources needed to do the assessment are beyond those available to the program team.

2.2.7.2. Regardless of the method(s) chosen, the contractor team's input should be solicited and included in the final assessment. If the program is not already on contract, the risk assessment team should also try to gain insight from industry, within the bounds of competitive nondisclosure and protection of proprietary data.

Getting the Team Organized and Trained

2.2.7.3. Getting a team organized and trained to follow a disciplined, repeatable process for conducting a risk assessment is important, since periodic assessments are needed to support major program decisions during the program life cycle. Experienced teams do not necessarily have to be extensively trained each time an assessment is performed, but a quick review of lessons learned from earlier assessments combined with abbreviated versions of these suggested steps can avoid false starts.

2.2.7.4. First, establish a core risk assessment team if the program team is not already following a disciplined program acquisition process which incorporates risk assessment activities. This team is the core group of individuals who will conduct the risk assessment and normally includes individuals with expertise in systems engineering, logistics, manufacturing, test, schedule analysis and cost estimating.

2.2.7.5. The risk assessment team should accomplish the following actions.

- Establish the scope of the risk assessment.
- Identify the specific subject-matter experts Arrange for their participation in the risk assessment. The program office needs to ensure it obtains the services of experts in each

potential risk area within the program. It is important to consider outside government organizations for both inputs and team members. They can provide subject-matter experts and bring different perspectives to the program. Consider such organizations as the using command (both operational and logistics personnel), training organizations, the supporting depot (if identified), test organizations, the laboratories, and the in-plant representative from the Defense Contract Management Command (DCMC). Non-DoD organizations include the National Aeronautics and Space Administration, the Federal Aviation Administration, and the Department of Energy's national laboratories.

- Prepare a risk assessment training package for the full team (core team plus subject matter experts). This package would include the risk assessment process, analysis criteria, documentation requirements, team ground rules, and a program overview. Bring the full team together for risk assessment training in an integrated manner. The use of a facilitator may be useful to support this training.

2.2.8. Risk Handling. Risk handling is the process that identifies, evaluates, selects, and implements risk handling options to set risk at acceptable levels given program constraints and objectives. This includes the specifics on what should be done, when it should be accomplished, who is responsible, and the cost impact. The most appropriate strategy is selected from these handling options and documented in a risk handling plan. Risk handling options can include.

- Changing the program to lower the risk to an acceptable level while still meeting overall user requirements.
- Transfer the higher-level risk by reallocating program requirements to program elements at a lower risk level.
- Mitigate the risk to minimize the impact on the program.
- Assume the risk without engaging in any special efforts to control it.

2.2.8.1. Incorporating Risk Handling Strategies into Program Plans. After the program's risks have been identified and assessed, the approach to handling each significant risk must be developed. The various risk handling options are analyzed and those best fitted to the program's circumstances selected. These are included in the program's acquisition strategy. Once the acquisition strategy—with the appropriate risk handling approaches —has been defined, the schedule and cost impacts to the basic program schedule and cost estimates must be derived.

2.2.9. Risk Monitoring. Risk monitoring is the process that systematically tracks and evaluates the performance of risk handling actions against established metrics throughout the acquisition process and develops further risk handling options or executes risk mitigation plans, as appropriate. The program metrics should track progress in meeting product and process objectives and support early indication of when risk areas should be mitigated.

2.2.9.1. The Monitoring Process. The key to the monitoring process is to establish a management indicator system over the entire program. This indicator system is used by the program director to evaluate the status of the program. It should be designed to provide early warning when problems arise, so management actions to mitigate those problems can be taken.

2.2.9.2. In addition to an indicator system, the program staff should engage in periodic assessments of program risk. The assessments should evaluate both previously identified risks and any new risks to the program. The program office should re-examine the risk handling approaches and

risk assessment concurrently. As the program progresses, additional risk handling options may surface which should be considered for inclusion in the program.

Chapter 3

NEW PROGRAM RISK MANAGEMENT

3.1. Overview .

3.1.1. Administration of a successful program requires effective risk identification, assessment, and management. Each program, to be most effective, should implement risk management processes from the presolicitation period through program execution.

3.1.2. The program office should structure the program plan, develop the acquisition strategy, generate RFP, write the source selection plan, evaluate the proposals, and select the contractor team with program risk as a key consideration. This should be done within an integrated management framework that allows the government to manage program and associated top-level risks while the contractor is responsible for management of product and process risks, and maintenance of accountability in design.

3.1.3. This chapter will briefly discuss initial program planning activities, and then describe how risk management processes can be used through the program acquisition process to promote program success.

3.2. Initial Program Planning.

3.2.1. Acquisition program planning should take place within an integrated management framework which follows the generation of the mission need statement, operational requirements document (ORD), technical performance requirements, work breakdown structure (WBS), IMP,IMS, LCC, and program budget.

- The program office team must understand the mission needs and top-level operational requirements. This would apply to either a new system or a modification to an existing system.
- The program office team then must define the technical performance requirements based on inputs from both industry and government technical stakeholders. Once this is done, a program that fulfills those requirements can be developed.
- When the conceptual program has been developed, an initial WBS can be defined with all follow-on program documents tied to the WBS.
- A planning program IMP should be developed, using as much industry input as practical, to define the program critical events with the appropriate success or exit criteria to satisfy those events.
- After the planning IMP is developed, an IMS can be generated to provide the schedule details. This IMS is based on the IMP events and expands them to the activity level for the entire program. The IMS should include all programmatic activities included in the IMP. The program office team should identify required activities and tasks, and develop a program schedule. These activities must be detailed sufficiently by knowledgeable and experienced people, so that critical and high-risk efforts are identified as realistically as possible even though it is very early in the program's life cycle.
- When the preceding activities are complete, an LCC estimate can be developed to support the initial budget submissions. Both the schedule and cost estimates developed by the team

should address the uncertainty caused by the risks identified. The budget submission should represent the program office's best assessment of an executable program.

3.2.2. The activities listed above should be accomplished as early as feasible, and updated as the program progresses. Risk assessments should be performed to provide the necessary insight needed to support these program planning activities.

3.3. Early Industry Involvement . Since the program's actual risk is greatly affected by the capability of the government and contractor team to develop and manufacture the system, early involvement with industry is critical to program planning. Industry's developmental and manufacturing processes and tools, the availability and skills of personnel, and the previous experience of the government and contractor team all influence their ability to handle the proposed system development and subsequent production. Therefore, an effective risk management process includes an evaluation of the capabilities of potential sources, and getting industry involvement in program planning as early as feasible.

3.3.1. Industry Capabilities Review. A powerful tool for determining general industry capabilities to support identification of potential program risk is to conduct an Industry Capabilities Review. To avoid potential problems in the competitive process and ensure a "level playing field" is maintained, an announcement in the *Commerce Business Daily* should be made to inform all potential future offerors that the government may conduct an Industry Capabilities Review and request responses from all interested parties who may wish to take part. The basic steps in the process are.

- Establish the criteria for the capability review.
- Identify the potential companies who will participate in the review.
- Provide an advance copy of the review material to those contractors.
- Select the review team, ensuring it has the necessary mix of technical talents.
- Provide training to the team on both on the purpose of the review and on how to achieve a common understanding of the review criteria.
- Conduct the review and evaluate the results.
- Provide feedback to each company on the results of their review and assessment.
- Provide the results to the program office.

3.3.1.1. DCMC can be a valuable source of information for industry performance and capabilities. In addition, the Industrial Analysis Support Office within DCMC can perform capability assessments on both industry and industry sectors.

3.3.2. Determining Risk Sharing. One of the key elements of the acquisition strategy is to determine whether a particular risk is to be shared with the contractor or retained exclusively by the government. For example, by directing the use of government-furnished equipment (GFE), the government usually retains the entire risk related to the inherent performance of the GFE. However, a less clear case would be an example derived from the definition of a system's operational environment. If a system's vibration environment is unknown, this could potentially affect the system's performance-including reliability-and should be considered a program risk area. At least two choices are possible for sharing this risk:

- The government makes an engineering estimate of the expected range of vibration environments, and provides a requirement to the contractor that the system meet those environments.

In this case, the government retains the risk; if the environment is worse than specified, the contractor has no responsibility to fix the system (as long as it met the specification).

- The government includes a contract work task to measure the range of environments and to design the system to survive those environments. In this case, the contractor has a responsibility to make the system perform in its operational environment.

3.3.2.1. The key concept here is that the government SHARES the risk with the contractor, not TRANSFERS risk to him or her. The program office always has a responsibility to the system user to develop a capable system, and can never absolve itself of that responsibility. Therefore, all program risks, whether primarily managed by the program office or by the developing contractor, are of interest to the program office and must be assessed and managed by the program office. Once the program office has determined which risks and how much of each risk to share with the contractor, it must assess the total risk assumed by the developing contractor (including subcontractors).

3.3.2.2. A prime program consideration is the equitable allocation of program risk, with its associated cost consequences, between the government and its contractors. Contractors should not be required to accept financial risks which are inconsistent with their ability to control and absorb these risks. These financial risks are largely driven by the underlying technical and programmatic risks inherent in a program. This requires the government contracting officer to select the proper type of contract based on an appropriate risk assessment, in addition to the selection principles set forth in Part 16 of the "Federal Acquisition Regulation." In short, there must be a clear relationship between the selected contract type and the assessed program risk.

3.4. Using Risk Assessments to Support Program Planning.

3.4.1. Systems engineering analysis and risk assessments provide additional information to the program planning team during the program planning. This information allows the program decisions to be made on tradeoffs between alternative acquisition and technical strategies which focus on obtaining the proper balance between technical, schedule and cost program objectives.

3.4.2. After the program's risks have been identified and assessed, the approach to handling each significant risk must be developed. The various risk handling options are analyzed and those best fitted to the program's circumstances selected. These are included in the program's acquisition strategy.

3.4.3. The following actual example is provided to depict how the risk assessment process can be tailored to be an invaluable planning tool in the early stages of a program.

3.4.3.1. Early Risk Assessment Example

3.4.3.1.1. Objective:

- Perform an initial iteration of the risk assessment process to:
- Help define an executable program.
- Establish a baseline for a Risk Management Plan.

3.4.3.1.2. Program Status: The system to be acquired was a state-of-the-art avionics system, which was just entering the flight test efforts for the system. The program office was conducting a technology insertion program to reduce risk to the next phase.

3.4.3.1.3. Methodology:

- Developed an initial baseline networked schedule.
- Divided program activity into five broad areas.
- Requirements Allocation.
- Hardware Development.
- Software Development.
- System Integration.
- System Test.
- Examined areas for major technical risks and uncertainties which could affect cost and schedule.
- Performed schedule excursions on major areas of technical risk and uncertainty.
- Examined effects of excursions on schedule critical paths and program cost.

3.4.3.1.4. Issues Identified:

- Requirements Allocation low risk, no cost or schedule excursions performed.
- Hardware Development:
- Internal schedule impacts, but no overall program impact.
- Two LRU costs up 25-50 percent.
- Overall $8 million cost increase.
- Software Development variations from baseline:
- Best case: 20 percent fewer lines of code, reduced schedule 3 months, saved $45 million.
- Worst case: 30 percent more lines of code, increased schedule 3 months, cost increase of $68 million.
- System Integration assessed as reasonable, no cost or schedule excursions
- System Test only issues found in durability life testing:
- Best case: No schedule impact, cost decrease of $3 million.
- Worst case: Slip from 16 to 24 months, third item delivery extended 6 months, costs increase $7 million.

3.4.4. As can be seen from the example, a risk assessment can be used to identify and quantify the key risk areas in a program. Based on this type of analysis, the program office can modify the program as required to incorporate the selected risk handling approaches into the acquisition strategy.

3.5. Request For Proposal.

3.5.1. As stated above, the RFP should focus primarily on what is essential for the source selection decision. Each program will have unique requirements and risks. The RFP should therefore be tailored to reflect the individual needs and risks of that specific program. This tailoring should eliminate or reduce elements which have no significant influence on the source selection decision and thereby reduce proposal preparation and proposal evaluation efforts. If this is done, the offerors are spared the expense of preparing proposals (plans, etc.) for aspects that will not be significant discriminators in

the source selection decision and the government is spared the expense of conducting an evaluation of these aspects.

3.5.2. Before the draft RFP is developed, a risk analysis may be reaccomplished by the program office with inputs from potential offerors to update program planning. Based on the results of the analysis, a revised IMP and IMS, and an updated LCC estimate can be prepared. Again, the quality of this risk assessment will be significantly improved by as much interaction with industry as possible. The technical, schedule and cost issues identified should be discussed in the presolicitation conference(s) before the draft RFP is released. In this way, the critical risks inherent in the program can be identified and addressed in the RFP.

3.5.3. In the solicitation, offerors may be asked to develop a contract IMP and an IMS for inclusion in their proposals to reflect how they propose to do the work. In addition, the RFP may include a requirement for the offeror to prepare and submit a program risk analysis as part of the proposal. This risk analysis should identify the expected risk areas and the offeror's recommended approaches to minimize the effects of those risk areas. This will support the government's source selection evaluation and the formulation of a most probable cost estimate for each proposal.

3.6. The Offeror's Proposal.

3.6.1. The offeror's program plan must be developed and documented in the proposal at an adequate level to also identify risks in the offeror's approach and define risk management activities to be employed throughout the program. The program plan should provide a WBS, a top-down list of activities and critical tasks starting with the IMP, associated schedules of tasks and milestones rolled up into the IMS, and an estimate of the funds required to execute the program, with a particular focus on the resource requirements for the high-risk areas.

3.6.2. The information required and the level of detail will depend on the acquisition phase, the category and criticality of the program, as well as the contract type and dollar value. However, the detail submitted with the proposal must be at the level necessary to identify possible conflicts in the schedule and support the government's proposal evaluation. The information required to be submitted after contract award should be at the proper level to support the decision process during program execution.

3.7. Source Selection.

3.7.1. Assessing Proposal And Performance Risks. The purpose of a source selection is to select the contractor whose performance can best be expected to meet the government's requirements at an affordable price. To perform this evaluation, the government must assess both proposal risk and performance risk for each proposal. Risk assessment in the source selection MUST be done entirely within the boundaries of the source selection process. Prior assessments of any of the offerors may not be applicable or, if applicable, must be considered and used under very specific procedures set forth in the source selection plan.

3.7.1.1. Proposal Risk refers to the risk associated with the offeror's proposed approach to meet the government requirements. The evaluation of proposal risk includes an assessment of proposed time and resources, and recommended adjustments. Performance Risk is an assessment of each contractor's present and past work record in order to determine the offeror's ability to perform the requested effort. Both areas will be discussed in the following sections.

3.7.2. Proposal Risk Assessment. The source selection evaluation team must evaluate the risks inherent in each offeror's proposal. This analysis of proposal risk should be performed according to the risk definitions and evaluation standards developed for the source selection.

3.7.2.1. The technical and schedule assessments are primary inputs to the cost estimate for each proposal. It is important that the evaluation team estimate the additional resources needed to overcome risk for any factors with "moderate" or "high" risk ratings. These resource requirements may be defined in terms of additional time, manpower loading, hardware, or special actions such as additional tests. However, whatever the type of the resources required, it is essential that the cost estimates derived be fully integrated and consistent with the technical and schedule evaluations, and that the results reflect the time and resources required to execute the program.

3.7.3. Performance Risk Assessment. Performance risk assessment is an assessment of the contractor's past and present performance record to establish a level of confidence in the contractor's ability to perform the requested effort. Performance risk is normally assessed by the Performance Risk Assessment Group, a group of experienced government personnel appointed by the source selection advisory council Chairperson to assess performance risk. Performance risk may be separately assessed for each evaluation factor or may be assessed for the offeror as a whole. The performance risk assessment may be provided directly to the source selection advisory council/authority for final decision or indirectly through the Source Selection Evaluation Board. The assessment relies heavily, but not exclusively, on the contractor performance evaluations and surveys submitted by program offices and DCMC.

3.8. Sole Source Acquisitions.

3.8.1. In sole source situations, the risk assessment can be developed with close contractor participation, although the level of participation will depend on the situation and the status of the sole source approval. To be of greatest benefit, the program office team should perform a risk assessment before the RFP is released to the contractor to identify issues and update the RFP. As noted previously, DCMC may be able to provide key support for this effort. After receipt of the contractor's proposal, a second risk assessment based on the proposal can be an invaluable aid to contract negotiations and program planning.

3.8.2. Before RFP release, a systematic risk assessment is accomplished; the IMP and IMS are updated; the LCC is revised; and a track to any previous risk assessment is prepared. Once this has been completed, the formal RFP should be prepared with this updated information and sent to the contractor.

3.8.3. The RFP may ask the contractor to propose an IMS that has resource loading for the high-risk activities which had been identified. This resource detail should support the contractor's proposal and show the government evaluators that the risk mitigation activities have been planned and included in the price. This will also help the government understand the full scope of the effort. However, whatever the proposal data requirements are, a risk assessment should be performed on the proposal, and the analysis should become a critical ingredient in the fact-finding process and a key input to the negotiation objective.

3.8.4. After the contract has been negotiated, the program IMP, the contract IMP and IMS, and the LCC estimate should be updated, and a track documented from the previous risk assessment. This documentation will serve as an invaluable record for program managers and decision-makers during

program execution. The updated LCC may serve as the basis for the next budget submission. An example of a risk assessment performed on an acquisition program in a sole source environment follows.

3.8.4.1. Sole Source Risk Assessment Example.

3.8.4.1.1. Risk Assessment Process:

- Conducted Pre-RFP and Proposal Receipt Risk Assessments.
- Team Composed of Technical Experts.
- Methodologies utilized:
- Software - Parametric Models Including PRICE, REVIC, COCOMO, SEER, and SASET.
- Schedule Risk Assessment - Microsoft Project and CORAM.
- Sensitivity Analysis - Probabilistic Modeling.

3.8.4.1.2. Scope:

- Software Development and Integration.
- Hardware Development.
- Flight Test Schedules and Support.
- Schedule Relationships and Durations.

3.8.4.1.3. Findings:

- Identified High- and Moderate-risk Areas:
- Simulation Software Schedule.
- Operational Flight Test Software.
- Defined Programmatic Impacts:
- Additional Months of Schedule.
- Impacts to Other Tasks.

3.8.4.1.4. SPO Mitigation Plan:

- Early Testing of Software.
- Lower Percentage of Software Retest.
- Eliminate Low Priority Software Changes.
- Management Indicators in Place to Check Mitigation.
- Contractor has Implemented Risk Reduction Efforts.

3.9. Risk Monitoring. Once the contract has been awarded (or organic development efforts begun), the risk management process shifts to managing the effectiveness of the selected risk handling approaches. During this process, a number of decisions need to be made. Regardless of the comprehensiveness of the up-front risk assessment, unexpected difficulties will occur. Therefore, the risk management system must be prepared to identify those difficulties when they occur, assess the consequences of those difficulties, and devise effective corrective measures.

3.9.1. At this point, tools such as the IMP and IMS can become invaluable program baseline and risk management documents. Because the same or a traceable numbering system was used in the WBS, the contract statement of work and the IMP, a consistent thread links all the items in various program documents. Also, resources can be referenced to the IMS, reporting formats derived from it, and the program office team staffing based on it. When dynamic changes occur in the program, this link will enable the impact of the change to be captured in all program documentation much more easily than it has in the past.

3.9.2. In addition, the program office should include risk assessment and handling activities as key contractual tasks during all acquisition phases to support risk monitoring activities. The contractor(s) must be encouraged to identify program risks and to identify and execute effective handling approaches for each. In conducting these assessments, the contractor(s) should examine the risks to a lower level of detail than the government's assessment. This allows the contractor(s) to identify additional risk areas and promotes better insight into follow-on efforts. The program office should also encourage the prime contractor to establish risk management requirements for its subcontractors and critical vendors. Results of those efforts should be reported during program reviews.

3.10. Management Indicators . The key to risk management is a good management indicator system that covers the entire program. It should be designed to provide early warning when problems arise and may utilize DCMC inputs. As indications of problems or potential problems are raised, management actions to mitigate those problems should be taken. This indicator system provides feedback to program management on the effectiveness of planned actions, and for the need to readjust the program based on design realities.

3.10.1. In addition to an indicator system, the program office should perform periodic reassessments of program risks. The assessment evaluates both the previously identified risks and examines the program for risks not previously identified. The program office should be reexamining the risk handling approaches concurrent with the risk assessment. As the program progresses, additional risk handling options may surface which should be considered for inclusion in the program.

3.11. Program Management Indicator System. The program management indicator system is the consolidated repository for categories of data received by the program office. They are: schedule tracking data, cost performance data, technical performance measures (TPM), and program metrics. They are organized on a hierarchical data collection and analysis system, and follow the program's WBS.

3.11.1. The data is organized into basic categories; engineering, manufacturing, support, cost, and schedule. Examples of the kinds of data for each category are shown below.

Table 3.1. Indicators Data.

ENGINEERING	MANUFACTURING	SUPPORT

Key Design Parameters
  Weight
  Size
  Endurance
  Range
Design Maturity
Drawing Release
Design to Cost
Failure Activity
	Manufacturing Yields
	Incoming Material Yields
	Delinquent Requisitions
	Unit Production Cost
	Process Proofing
		System Reliability
		System Maintainability
		Logistics Related Deliverables
		Manpower Estimates

Table 3.2. Indicators Data Continued.

COST	SCHEDULE
Cost Performance Index Schedule Performance Index Estimate at Completion Management Reserve	Design Schedule Performance Manufacturing Schedule Performance Test Schedule Performance

3.11.2. The indicators consist of the following.

3.11.2.1. Technical Performance Measures (TPM). To be effective, TPMs should be established on key program technical characteristics (as defined in the system specifications). They can provide an effective mechanism to monitor the values of the parameters. When TPMs are applied to areas of known risks, they can be used to assess the effectiveness of the various program risk reduction actions. A planned performance profile- with warning and action thresholds-is normally established for each TPM.

3.11.2.2. Program Metrics. These are formal, periodic performance assessments of the various development processes, used to evaluate how well the system development process is achieving its objectives. For each program, certain processes are critical to the achievement of program objectives. Failure of these processes to achieve their requirements are symptomatic of significant problems. Metrics data can be used to diagnose and aid in the resolution of these problems. Where TPMs are derived from specification requirements, metrics are derived from programmatic requirements. Program metrics are established and used in a manner similar to TPMs.

3.11.2.3. Cost and Schedule Performance. The information provided in cost/schedule control system criteria reports provide valuable data which depict how well the program is progressing toward completion. Careful analysis of these status reports can uncover problem areas not previously flagged by the program team.

3.12. Supporting Tools. In addition to the indicators listed above, there are at least two supporting tools which help in risk management. These tools must be created as part of the up-front risk planning activities. They are demonstration events and watchlists.

3.12.1. Demonstration Events. For many significant risks, demonstration events will be defined to assess what risks remain in the development effort. If the event is successful, then the risk has been abated to some degree. If it fails, then the program must either invoke a backup or take additional time and resources to correct the deficiency. Demonstration events are at the heart of the performance requirement and verification, and the IMP/IMS concepts. These demonstration events are laid out as

part of the program planning during the risk handling stage of the risk management process. Monitoring the satisfactory completion of these events gives the program a buildup of confidence that program risks are being reduced. Early failures provide warning that a problem exists; if the events are properly planned, they give the program a margin of time to recover from the failures.

3.12.2. Watchlists. This is a listing of critical areas that management will pay special attention to during the execution of the program. The watchlist is developed as a product of the risk assessment, and can vary in complexity. It is normally a simple list of the identified risks (see next page). A watchlist is a straightforward, easily prepared document. Items on the watchlist should be reviewed during the various program reviews/meetings, both formal and informal. Items can be added to or deleted from the watchlist as the program unfolds.

Table 3.3. Watchlist Example.

XYZ PROGRAM WATCHLIST (Integrating an electronic warfare suite onto an aircraft system) (Program Pre-EMD)	
RISK AREA	DRIVERS
Threat changes	Capability of XXX threat system (ext. IOC 1993). Also, threat signal density based on DIA report ABC.
Jammer/aircraft avionics electromagnetic compatibility	Jammer and system radar operate in the same band.
Software algorithms	Correlation between radar warning receiver, QQQ inputs and missile warning system. Also, timing requirements between warning and jammer and chaff/flare dispenser.
Cooling for EW suite	Current system marginal. Actual available cooling flow and system duty cycles not firmly established.
Man-machine interface	EW suite integrated information display to operator.
Availability of ZZZ system	ZZZ system currently in development; initial availability mid-1993.
BIT capability of AAA system	Capability forecast less than requirement; affects maintenance and training requirements.
Producibility of TWTs	New manufacturing process required to achieve power density requirements.
System integration	Planned suite never installed on large aircraft system.

3.13. Management Actions. Management indicators and supporting tools provide the information necessary to manage the program. Unfavorable trends and incidents must be analyzed and their significance to the program assessed. For those problem areas judged significant to the program, appropriate management actions must be taken. These can either involve the reallocation of resources (funds and schedule), activation of a planned handling approach (such as a backup approach or on-call use of an expert). Severe cases may require readjustment of the program.

3.13.1. It is important that management emphasizes the need to reassess the identified program risks continually. As the system design matures, more information becomes available to assess the degree

of risk inherent in the effort. If the risk changes significantly, the risk handling approaches should be adjusted accordingly. If the risks are found to be lower than previously assessed, specific risk handling actions may be reduced or canceled and the funds reprogrammed for other uses. If they are higher or new risks are found, the appropriate risk handling efforts should be put into place.

3.13.2. In addition to reassessing risks, the program office should look for new risk handling options. Different technologies may mature, new products become available in the market places, or information found in unexpected places. All of these may be of use to the program office. A periodic review of new developments in the laboratories and time spent examining what is coming on the market are useful actions for any program.

3.14. Risk Management Board . A risk management tool used on some programs is the risk management board. This board is chartered as the senior program group that evaluates all program risks, unfavorable event indications, and planned risk abatements. In concept, it acts similar to a configuration control board. It is an advisory board to the program director, and provides a forum for all affected parties to discuss their issues. Risk management boards can be structured in a variety of ways, but share the following characteristics:

- They should be formally chartered and have a defined area of responsibility and authority. Note that risk management boards may be organized as program office only, program office with other government offices (such as user, DCMC, test organizations), or as combined government-contractor. The structure should be adapted to each program office's needs.
- Working relationships between the board and the program office staff functional support team should be defined.
- The process flow for the risk management board should be defined.
- Boards should have formally-defined interfaces with other program office management elements (such as the various working groups and the configuration control board).

3.14.1. On programs with many significant risk areas, the risk management board provides a sound vehicle to ensure each risk area is properly and completely addressed during the program life cycle. It is important to remember that successful risk monitoring is dependent on the emphasis it receives during the planning process. Further, successful program execution requires the continual monitoring of the effectiveness of the risk handling plans.

Chapter 4

RISK MANAGEMENT IMPLEMENTATION EXAMPLES

4.1. Overview . This chapter provides examples of risk management and illustrates tailoring for use on existing programs. In these examples, some of the more familiar risk management techniques are presented. More detailed information on these and other risk management examples can be found by reviewing risk management information sources listed in Chapter 5, Risk Management: References.

4.2. Risk Management Planning . Planning for risk management or changing existing program management strategy to incorporate improved risk management techniques, can occur at any point in a program.

4.2.1. Planning Before Contract Award. Before a contract is awarded, the integrated product team (IPT), with user and industry involvement, should establish the program management strategy and management activities needed to control risk during program execution. These activities should be described in the program master plan, contract master plan, program participant agreements and, if desired, in a separate risk management plan. However, the risk management planning should clearly define roles, responsibilities, authority, and documentation for program reviews, assessment and monitoring, to track status. The program's master plan should eventually cover the program life cycle and have a sufficient level of detail for the current and next phase.

4.2.1.1. Each cycle of a program during its life-cycle process begins with identification of objectives, alternatives and constraints. The next emphasis is to evaluate alternatives, identify significant sources of project risk and select a cost-effective strategy for resolving the risks. During program execution, each phase develops, verifies and deploys products whether they be early concept studies or operational mission or support equipment. At lead-time from completion of the current phase, the team begins the acquisition strategy, updated program and risk assessments, and other aspects of program planning for the next phase of the life cycle.

4.2.2. Planning for Additional Risk Management After Contract Award. Most of today's government and contractor IPTs practice some form of risk management, whether specifically called that or not. Many effective program management techniques such as simulation and modeling can clearly be categorized as risk handling actions.

4.2.2.1. A more formal, disciplined risk management process with some level of documentation and assessment can be added during contract execution. This may be accomplished by either the contractor, as part of general improvements in key program management and systems engineering processes, or through various resource reallocation actions taken by the program office, the contractor, or both, within contract constraints. Even if not implemented as a contract change, information on identified risks can be provided to the program team through existing program reviews, access to internal data as allowed by the contract, minor changes in prime-to-supplier contractor agreements, or other mechanisms.

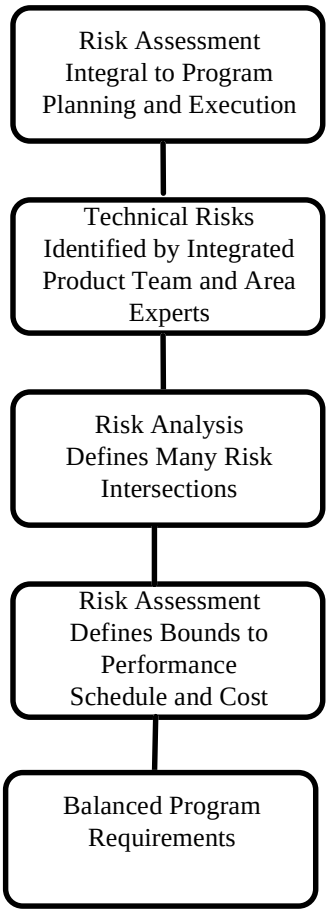
4.3. Assessments In Integrated Product And Process Development.

4.3.1. Methods For Balancing Requirements With The User. The IPTs can use risk management methods to narrow options, help the government and industry refine mission needs, and assess available technology and related programs. During early discussions with the user, the assessment of

available technology and programs should lead to better definition for the acquisition strategy, preliminary program requirements, and schedule and budget estimates. These program assessments may also include assessment of risk inherent in options being analyzed as part of the systems engineering process. One program used *Commerce Business Daily* request for information to obtain industry input on risk drivers; this early involvement of industry proved to be very helpful in the following tasks:

- Identifying risk areas.
- Adjusting requirements to lower risk categories.
- Reducing design options from 23 potential alternatives to 3 viable options.

Figure 4.1.


Risk Assessment Integral to Program Planning and Execution
Technical Risks Identified by Integrated Product Team and Area Experts
Risk Analysis Defines Many Risk Intersections
Risk Assessment Defines Bounds to Performance Schedule and Cost
Balanced Program Requirements

4.3.2. Risk assessment is integral to program planning and execution, as illustrated on Figure 4.1. Some of the risk identification techniques used repeatedly with some success include the following:

- Industry and government surveys and study projects.
- Proof-of-concept projects.
- Early program conferences with potential contractor teams.
- Government or contractor site surveys to identify technology and process capability.

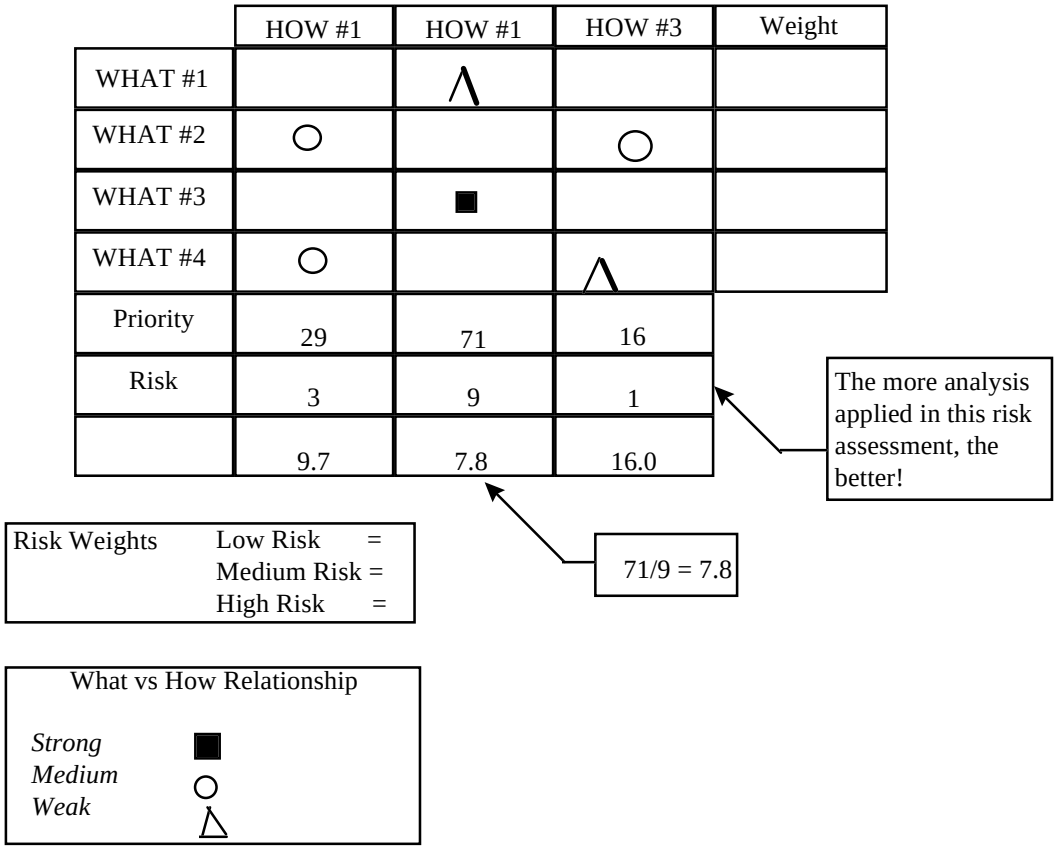
4.3.3. Methods which support analysis of alternative technology and program options include quality function deployment (QFD). The early development planning tied to scoping options which meet mission needs can follow a series of risk assessment phases to narrow options to a manageable, realistic set more likely to satisfy the performance objectives within affordable bounds.

4.3.4. The QFD method is a disciplined technique for product planning and development in which key customer needs and requirements are identified, analyzed, and eventually deployed throughout the program organizations, whether government or contractor. First applied in Japan, this structured discipline introduces a chart that is commonly called The House of Quality, which:

- Provides a structure that ensures the customer needs and wants are carefully considered throughout the life cycle and directly translated into the program's internal product and process requirements from design through production, deployment, and sustainment.
- Provides a great deal of flexibility and can be tailored to individual situations.
- Provides a disciplined technique to help a multifunctional team define a program with a balance of performance, schedule, cost, and risks very early in the process, when a product or service is only an idea.

4.3.5. A very simplified, tailored version of the QFD product is represented in Table 4.1. Table 4.1, an example of a QFD matrix, is used to analyze sensitivity of the results to external factors such as priority or risk for relationships between program technology (HOW) used to satisfy performance requirements (WHAT).

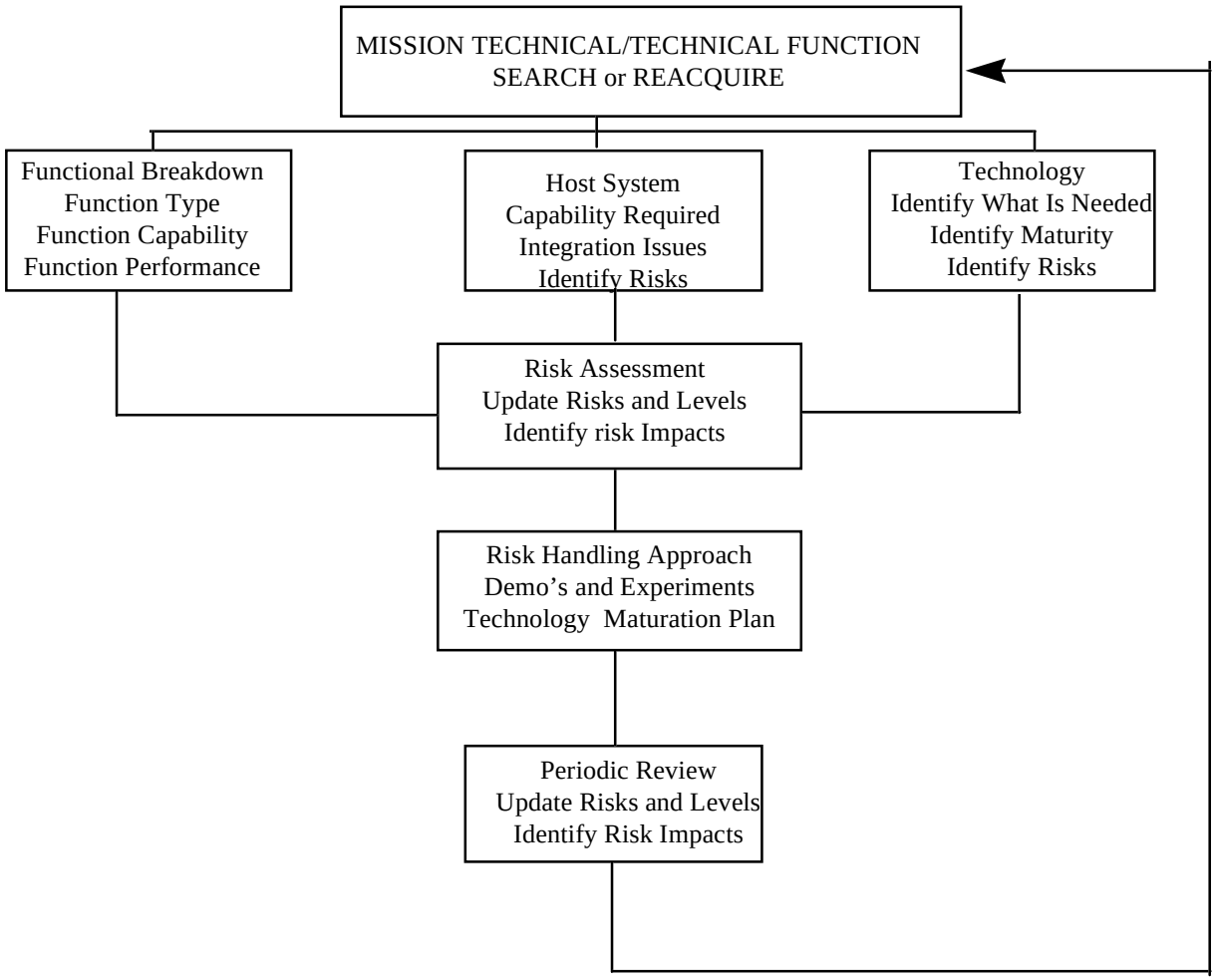
Figure 4.2.


HOW #1
HOW #1
HOW #3
Weight
WHAT #1
WHAT #2
WHAT #3
WHAT #4
Priority
29
71
16
Risk
3
9
1
9.7
7.8
16.0
The more analysis applied in this risk assessment, the better!
71/9 = 7.8
Risk Weights
Low Risk =
Medium Risk =
High Risk =
What vs How Relationship
Strong
Medium
Weak

4.3.6. In other methods, the evaluators of the risk use comparison techniques to determine importance of risks relative to one another. The risks are then ranked and analysis provides a prioritization of risks, where the risk with the highest score is the highest risk factor influencing the portion of the program or system being analyzed by the IPT.

4.4. Risk Analysis Approaches For Defining Risk Levels. The program office needs to establish a disciplined qualitative or quantitative approach for risk analysis. One IPT studied options to meet user needs and created the risk analysis approach described on Figure 4.2.

Figure 4.3.


MISSION TECHNICAL/TECHNICAL FUNCTION
SEARCH or REACQUIRE
Functional Breakdown
Function Type
Function Capability
Function Performance
Host System
Capability Required
Integration Issues
Identify Risks
Technology
Identify What Is Needed
Identify Maturity
Identify Risks
Risk Assessment
Update Risks and Levels
Identify risk Impacts
Risk Handling Approach
Demo's and Experiments
Technology Maturation Plan
Periodic Review
Update Risks and Levels
Identify Risk Impacts

4.4.1. Using the risk analysis approach, this concept study IPT decided to establish six categories for an analysis of identified risks. These six categories include requirements, technology maturity, engineering design and manufacturing, integration and test, support and logistics, and management and process maturity. The IPT established assessment or risk evaluation criteria for each template risk category. A sample risk template is shown in Table 4.2.

Table 4.1. Risk Template No. 1, Requirements Criteria.

LOW (0.1)	MODERATE (0.5)	HIGH (1.0)
Validated ORD submitted by HQ ACC/DR. Performance requirements and operational characteristics are documented and defined. Technical/Engineering requirements well defined and understood by the developers.	Draft ORD available and operational requirements are being refined with the warfighters. A Concept of Operations (CONOPS) is already approved by HQ ACC/DR. Technical performance requirements being evaluated by trade studies and demonstrations. Some hardware and software already participated in Operational Concept Demonstrations .	Minimal to no draft documented operational requirements. No approved CONOPS. HQ ACC staff in nonoccurrence on requirements. Draft performance requirements only analyzed at the top level.
CONSEQUENCE OF FAILURE (CF)		
LOW (1)	MODERATE (5)	HIGH (10)
Performance (Impact on Mission)		
Strong likelihood of meeting all performance and operational characteristics.	May require ORD modification. Marginal impact on mission. May require acceptance of some limited degradation in performance.	Significantly impacts mission performance with strong probability of not meeting specifications.
Schedule (Impact on Program)		
Fully manned by experienced people. Sufficient funding.	Potential schedule slip due to lack of clarification in some areas of operational requirements.	Significant slip in program schedule.
Cost (Impact on Program)		
Potential for any cost overruns is low or minimal.	Marginal cost impact to overall program.	Significant cost impact to overall program, causes major program funding issues.

4.4.2. The IPT used the risk templates, with criteria for PF and CF, to analyze potential identified risks for program options. Risk areas were risk-to-performance, risk-to-schedule, and risk-to-cost. The IPT used the templates in a series of steps which led to a prioritization of risks. Results for each category associated with an identified risk were evaluated as low-, moderate-, or high-risk based on both probability and impact to the system or program mission area. Risk impacts at various work

breakdown levels were then consolidated in a series of matrices and the evaluations summarized in a scaled ranking of the risks. One method for illustrating the results of a quantified risk analysis is the Risk Scales Scoresheet provided as Table 4.2.

Table 4.2. Risk Scales Scoresheet Consolidating Risk Impacts for Risk Categories.

Mission Function: SEARCH or RE-ACQUIRE		Consequences of Risks (Cf)			
Risk Category	Prob. of failure	Performance	Schedule	Cost	Subtotal
Requirements	0.3	1	1	1	2.1
Technology	0.7	5	5	5	14.0
Engineering & Manufacturing	0.7	1	1	1	14.0
Test	0.7	1	1	1	7.7
Support	0.5	1	1	1	8.0
Management	0.3	1	1	1	3.3
					Total
					49.1.

4.4.3. The risk scales scoresheet results for each element of the program can be ranked by the total risk scales rating. Normally the results are rank ordered from the largest to smallest rating. Although the risk score does not provide an estimate of the exact PF or consequence, it does provide a relative measure of "merit" versus the risks in other program elements within the WBS. As a result of this risk analysis approach, an IPT has a common baseline to assess risks which is probably more comprehensive than would otherwise be made. In addition, the approach allows for prioritization of risk while removing personal judgment as much as possible. The IPT's decision on what risk areas require more focus than others can be more easily identified if the results are presented in some ordered fashion.

4.4.4. Not only is the Pareto Analysis Principle (20 percent of the elements account for roughly 80 percent of the impact) handy for separating the "vital few from the trivial many," but the matrix and graphical tools are also helpful. One graphical example is shown on Figure 4.4.

Table 4.3. Graphical Risk Prioritization Example.

HIGH		**X**				**X**	HIGH
P	**X**		**X**		**X**	**X**	
R			**X**	**X49.1**			
O						**X**	
B		**X**		**X**			
	X						
LOW	**X**						
	LOW					**HIGH**	

4.4.5. Low and Moderate Risk Programs. While all programs are required to establish a risk management program, the risk levels in some programs may not be great enough to warrant a complex risk management program. For example, a program team which can leverage a quality defense, commercial, or combined infrastructure may be able to meet program objectives at low and moderate risk. This infrastructure may have already been implemented:

- Good statistical process control where everything is measured and assessed.
- Control of internal and external processes.
- Manufacturing control for quality.
- Integrated product and process development.
- IPTs that are well trained and certified capable to deliver quality products.
- Automation focused on lower process cycle times and higher yields.
- Demonstrated lower development cost and shorter development and production cycles.

4.4.5.1. For these low- and moderate-risk programs, program management may be able to rely on periodic review of government and contractor measurements of product and process completion against planned technical, schedule, and cost objectives. The time between periodic reviews will depend upon the level of risk assessed during that phase of the program acquisition. Problems can be identified for review of status at the next scheduled review, with each problem assigned to be the responsibility of a person or team to ensure the problem is being solved and status assessed and updated at the appropriate management level. The responsible member should describe the problem, define the best solution, plan corrective action, document the status, and periodically assess the status and report results to the appropriate management level.

4.4.5.2. Moderate- and High-Risk Programs. Programs or parts of programs assessed moderate and high risk based on the experience of the program team or a more formal risk assessment will need more formal planning of risk management activities and documentation. More complex risk assessments may be initially performed as part of systems engineering or can be initiated as a separate risk assessment to support a specific decision.

4.4.5.2.1. The sources of the moderate- or high-risk level can be weak key critical processes, leading-edge technology, leap in system performance, complex system architecture, multi-platform integration, weak program development team past performance, and similar risk drivers. A simple but disciplined method for integrating the risk information into a program-level risk level provides a qualitative risk analysis; the program maturity matrix in Table 4.4 is an example of one way to describe part of this evaluation process.

Table 4.4. Qualitative Evaluation Showing Low-, Moderate-, and High-Risk Levels.

Program Risk Level	Maturity Level	Design	Manufacturing	Support
	13	PCA completed	Low rate production successfully done	All ILS elements demonstrate at or above requirements; S/W support facility in place

Low	12	FCA completed	PRR completed. Process proof tests successfully completed	Support equipment demonstrated; tech orders verified
	11	Initial operational testing completed		Key R&M parameters meet requirements
	10	Developmental testing completed	Producibility analysis completed	80% of ILS demonstrated
	9	Detailed design approved	Industrial base capacity and capability verified	Tech orders validated; Spares long-lead on order
	8	Engineering model tested in operational environment		SERDs all approved
Moderate	7	Prototype or engineering model tested in relevant environments		Spares provisioned
	6	Preliminary design approved	Producibility requirements of new technology defined and tested	Support requirements of new technology defined & tested
	5	Component/Breadboard tested in relevant environment	Marginal industrial base capability	Support requirements identified; none exceed state-of-the-art
	4	Critical functions or characterists environment		Support requirements identified; one or more at state-of-the-art
High	3	Conceptual design analysis		
	2	New technology required; state-of-the-art advance	New technology required; state-of-the-art advance	New technology required; state-of-the-art advance
	1	Conceptual design formulate	Inadequate industrial base	

4.4.5.2.2. For these higher risk programs, disciplined risk management efforts may need to be more formalized and can be placed on contract with appropriate schedules and resources committed. The risk management plan should include tailored, specific government and contractor tasks related to risk management, activities, and exit criteria inserted into the IMP; formal, detailed risk assessments at specific milestones; special risk abatement prototypes or studies;

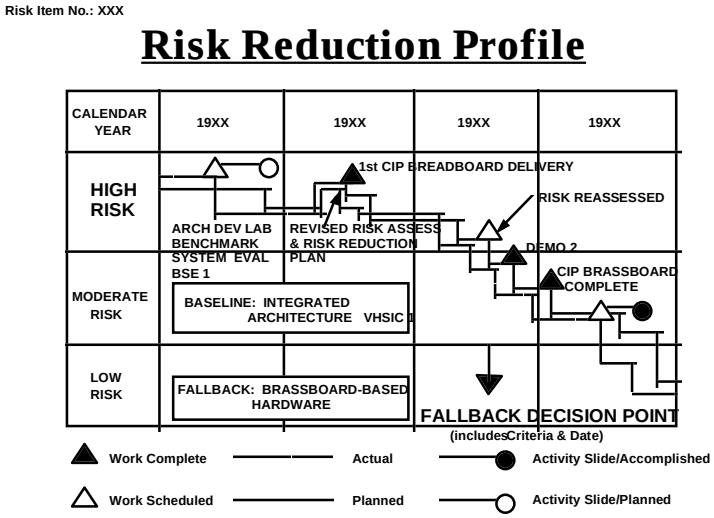
robust statistical process control; required risk management documentation and reviews; and similar efforts.

4.4.5.2.3. The program management team can assign the risk management responsibility to each IPT or a separate risk management team. The risk management plan can be integral to the program IMP or a separate risk management plan, as long as the activities are integral and consistent.

4.5. Risk Handling. Risk Handling Applies To All Levels. Risk handling procedures work at all levels of the program, including subsystems developed by subcontractors. Successful program and risk management efforts result from hard-nosed, persistent, effective risk management. To apply an abatement process requires the committed support of government and contractor management, and all members of the development team. This is performed by:

- Identification of risks to the program elements as early as possible through regular review and analysis of TPMs, metrics, schedule, resource data, cost information, and other program information available to government and contractor team members.
- Determination of cause(s) for each risk and its significance to the program.
- Development and implementation of effective risk handling strategies documented in mitigation or abatement plans.

Figure 4.4.


Risk Item No.: XXX
Risk Reduction Profile
CALENDAR YEAR
19XX
19XX
19XX
19XX
HIGH RISK
MODERATE RISK
LOW RISK
1st CIP BREADBOARD DELIVERY
RISK REASSESSED
ARCH DEV LAB BENCHMARK SYSTEM EVAL BSE 1
REVISED RISK ASSESS & RISK REDUCTION PLAN
DEMO 2
CIP BRASSBOARD COMPLETE
BASELINE: INTEGRATED ARCHITECTURE VHSIC
FALLBACK: BRASSBOARD-BASED HARDWARE
FALLBACK DECISION POINT
(includesCriteria & Date)
Work Complete
Actual
Activity Slide/Accomplished
Work Scheduled
Planned
Activity Slide/Planned

4.5.1. These risk handling strategies can be scoped to change the risk, provide control to minimize adverse effects, or reallocate resources to manage assumed risks. Sometimes a series of risk handling activities are needed, with events for checking work completed against level of risk and time presented as part of risk status reviews or periodic program management reviews. Figure 4.5 shows one program's method for presenting risk status for a specific watchlist item.

4.5.2. Program metrics for monitoring should be linked to identified or potential risk areas. Requirements stability and the control of requirements growth can be a particular problem on a program if it is complex and contains many computer subsystems. Specifically, large commercial aircraft development programs have reported that disciplined management of interfaces from prime contractor through the subcontractor levels have been instrumental in controlling program growth. This also improves communication between IPTs at all levels of the WBS, and provides an early indication of problems which may warrant the application of risk abatement measures to reestablish control.

4.6. Risk Handling Plans. Risk handling involves selection of the option that best provides the balance between performance and cost. Once the alternatives have been analyzed, the selected option should be incorporated into program planning. This may be into existing program plans or documented separately as a risk mitigation or risk abatement plan, depending on the IPT's preference for the word "mitigation" or "abatement." The risk handling plan documentation usually includes:

- A descriptive title for the identified risk.
- Date of the plan.
- Point of contact responsible for controlling the identified risk.
- A short description of the risk (including a summary of the technical, schedule, and resource impacts, likelihood of occurrence, whether the risk is within internal scope).
- Why the risk exists (causes leading to the risk).
- Options for abatement (possible alternatives to alleviate the risk).
- Status (discuss briefly).
- Fallback approach (describe the approach and expected decision date for considering implementation).
- Management recommendation (state whether budget or time is to be allocated, risk incorporated in estimate at completion (EAC), or other).
- Approvals (IPT manager, higher-level product manager, program manager).

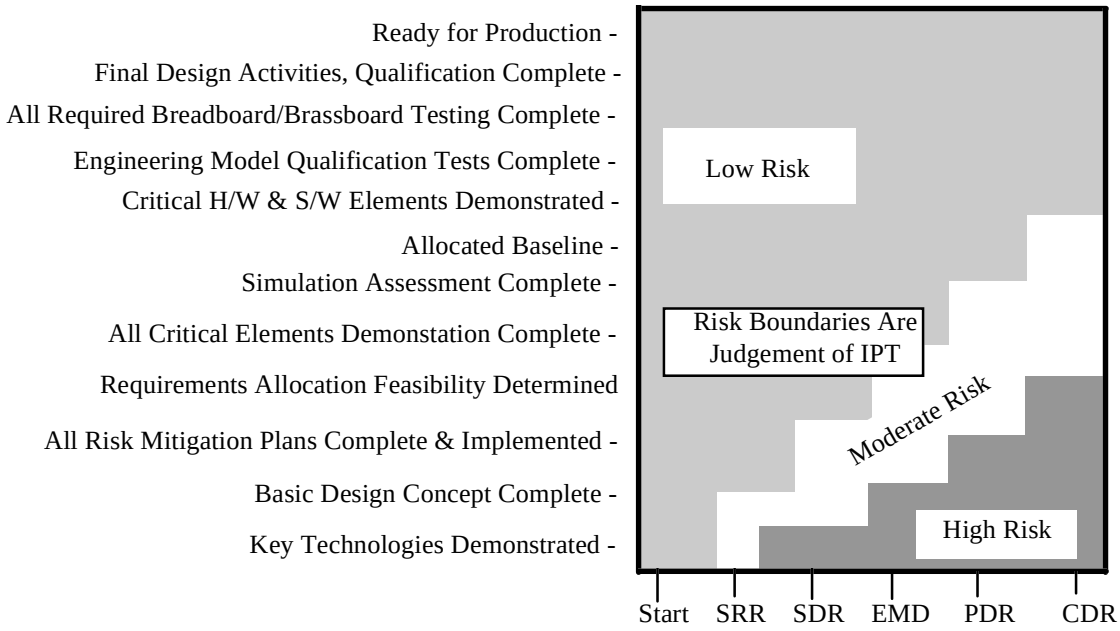
4.6.1. Ensure the risk process is worked through the IPT structure. This requires the IPTs at each WBS level scrub and approve the risk abatements of lower levels. It is important to abate risk where possible before passing one up to the next WBS level. In addition, the IPT must communicate potential EAC growth to all levels of management. As part of this effort, the IPT should ensure aggressive abatement plans are implemented and make sure ongoing results of the risk management process are formally documented and briefed as appropriate during program reviews.

4.7. Risk Monitoring. Risk monitoring activities are integral to good program management. At a top level, the program management reviews and technical milestones provide much of the information used to indicate any technical, schedule, and cost barriers to the program objectives and milestones being met.

4.7.1. Successful risk management programs include timely specific reporting procedures tied to better communication. Normally, documentation and reporting procedures are defined as part of the risk management strategy planning before contract award, but they may be added or modified during contract execution as long as the efforts remain within the scope of the contract or are approved as part of a contract change. Some teams use risk management notebooks with up to date team subsections, schedule feedback of risk information to team leads and program management and communicate with the customer on risks when appropriate.

4.7.2. Risk management can be effectively incorporated into program management reviews, where users and other team members are provided an opportunity to review risk management status. One example of a status presentation is shown on Figure 4.5.

Figure 4.5.


Ready for Production -
Final Design Activities, Qualification Complete -
All Required Breadboard/Brassboard Testing Complete -
Engineering Model Qualification Tests Complete -
Critical H/W & S/W Elements Demonstrated -
Allocated Baseline -
Simulation Assessment Complete -
All Critical Elements Demonstation Complete -
Requirements Allocation Feasibility Determined
All Risk Mitigation Plans Complete & Implemented -
Basic Design Concept Complete -
Key Technologies Demonstrated -
Low Risk
Risk Boundaries Are Judgement of IPT
Moderate Risk
High Risk
Start
SRR
SDR
EMD
PDR
CDR

For specific identified risks, more detailed yet top-level risk information can be presented to the program management team or external customer in a format similar to the one on Figure 4.6.

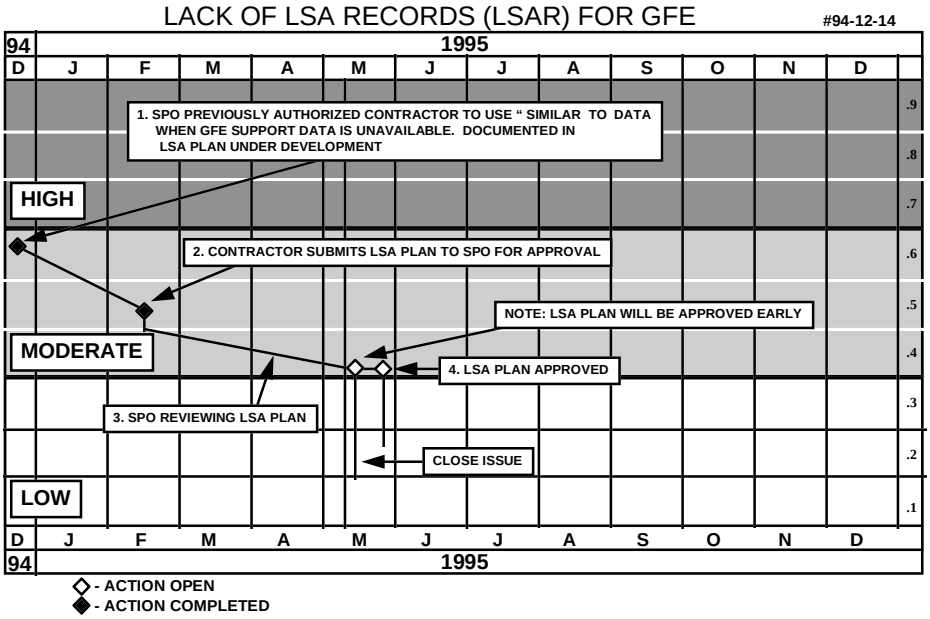
Figure 4.6.

Risk Management Status

Risk Plan #	Risk Profile	High	Moderate	Low	Status/Comment
94-12-9	Non-stock Listed Spares				Data still in review; need to assign part numbers.
94-12-10	Engineering Updates			Closed	Data reviewed; updates not required at this time.
94-12-11	Spares & Support			Closed	
94-12-12	Long Lead Requisitions				Spares listing approved in definitization conference. No current abatement plan.
94-12-13	T.O. Validation			Closed	Closed Issue
94-12-14	**Lack of LSA Records for GFE**				**Contractor LSA plan submitted for approval; rescheduled for 5/95.**
94-12-15	Program Parts Obsolescence				Analysis in work, identifying last opportunity buys.
94-12-51	Design Maturity			Closed	Studying Commercial Mux Interface.
94-12-16	System Y Interface Definition				Questions about antenna location and cable raised risk.

4.7.3. Although this level of reporting can provide quick review of overall risk status for identified problems, more detailed risk planning and status can be provided on individual risk items. For example, some program IPTs have found a combination of risk level and scheduled activities provides a quick graphical quick overview of risk status for either internal or external review. One method for graphically showing risk status for an individual item is included on Figure 4.8.

Figure 4.7.


LACK OF LSA RECORDS (LSAR) FOR GFE
#94-12-14
94
1995
D J F M A M J J A S O N D
1. SPO PREVIOUSLY AUTHORIZED CONTRACTOR TO USE " SIMILAR TO DATA WHEN GFE SUPPORT DATA IS UNAVAILABLE. DOCUMENTED IN LSA PLAN UNDER DEVELOPMENT
HIGH
2. CONTRACTOR SUBMITS LSA PLAN TO SPO FOR APPROVAL
NOTE: LSA PLAN WILL BE APPROVED EARLY
MODERATE
4. LSA PLAN APPROVED
3. SPO REVIEWING LSA PLAN
CLOSE ISSUE
LOW
.9
.8
.7
.6
.5
.4
.3
.2
.1
- ACTION OPEN
- ACTION COMPLETED

4.8. More On Risk Management Implementation. Risk management activities are integral to key program office and contractor or supplier processes. Illustrative examples have been given in this chapter to initiate interest in getting more details on these and related ideas which contribute to improved risk management. In addition to the information in this pamphlet and sources included in Chapter 5, there is nothing that can replace first-hand experience and lessons learned. Networking within government and industry to extract the best ideas, techniques, methods, and information can only help teams seeking to improve their implementation of risk management.

Chapter 5

RISK MANAGEMENT

5.1. Overview. Provides slected documents for additional information and guidance.

5.2. Applicable Documents.

5.2.1. DoD Directive 5000.1, *Defense Acquisition,* Revised: March 15, 1996. Replaces DoD Directive 5000.1, "Defense Acquisition," February 23, 1991 (reference (a)) and DoD Directive 8120.1, "Life-Cycle Management of Automated Information Systems," January 14, 1993. The acquisition management system governed by this Directive provides for a streamlined management structure and event-driven management process that emphasizes risk management and affordability and that explicitly links milestone decisions to demonstrated accomplishments.

5.2.2. DoD 5000.2-R, *Mandatory Procedures for Major Defense Acquisition Programs and Major Automated Information Systems*, March 15, 1996. DoD 5000.2-R describes in detail certain core issues which must be addressed at the appropriate milestone for every acquisition program. These issues include program definition, program structure, program design, program assessments, and periodic reporting. How these issues are addressed shall be tailored consistent with common sense, sound business management practice, applicable laws and regulations, and the time-sensitive nature of the requirement itself.

5.2.3. DoD 4245.7-M, "Transition from Development to Production," September 1985. This document provides a structure for identifying technical risk areas in the transition from a program's development to production phases. The structure is geared toward development programs but, with modifications, could be used for any acquisition program. The structure identifies a template for each major program technical management and systems engineering activity. The template includes potential areas of risk and methods to reduce the risk potential in each area.

5.2.4. Guidelines for Successful Acquisition and Management of Software Intensive Systems, Version 1.0, December 1994, Lloyd K. Mosemann (Deputy Assistant Secretary of the Air Force (Communications, Computers, and Support Systems)). Several sections of this document contain material relevant to risk management, including portions of Chapter 4 (Systems and Software Engineering), Chapter 6 (Strategic Planning), and Chapter 9 (Managing Process Improvements). The material presented applies to both hardware and software items.

5.2.5. Air Force Materiel Command Pamphlet 63-3, S***ingle Manager (SM) Roles and Responsibilities Under Integrated Weapon System Management (IWSM).*** This pamphlet includes a brief summary of some characteristics of a sound risk management process.

5.2.6. Systems Engineering Management Guide, Defense Systems Management College, January 1990, Section 15. This document section is devoted to risk analysis and management and provides a good overview of the risk management process.

5.2.7. The AFSC Cost Estimating Handbook, Air Force Systems Command, Volume I, no date, Section 13. This section is devoted to cost risk and uncertainty, and provides a good overview of estimating cost risk. In addition, the methodologies presented can at least be partially applied to other types of quantitative risk analysis.

5.2.8. A Systems Engineering Capability Maturity Model, Version 1.0 Software Engineering Institute (Carnegie Mellon University), Handbook SECMM-94-04, December 1994. This handbook describes one approach to conducting an Industry Capabilities Review. Section PA 10 (pp. 4-72—4-76) discusses software risk management. The material presented in this handbook also can be tailored to apply to system and hardware risk management.

5.2.9. Program Managers Handbook," Defense Systems Management College, Fact Sheet 4.5, June 1992, pp. 4.5-1-4.5-6. This handbook fact sheet includes a summary of the risk management process. (Fact Sheet 4.6, pp. 4.6.1—4.6.4 includes a summary of Design To Cost.)

5.2.10. Risk Management Concepts and Guidance, Defense Systems Management College, March 1989. The entire document is devoted to various aspects of risk management.

5.2.11. Acquisition Software Development Capability Evaluation," AFMC Pamphlet 63-103, 15 Jun 94. This pamphlet describes one way to conduct an Industry Capabilities Review. This two volume pamphlet was generated from material originated at Aeronautical Systems Center. The concepts support evaluations during source selection and when requested by IPTs. The material presented in this pamphlet also can be tailored to apply to system and hardware risk management.

5.2.12. NAVSO P-6071: Navy "best practices" document with recommended implementations and further discussion on the material in DoD 4245.7-M.

5.2.13. Taxonomy-Based Risk Identification, Software Engineering Institute, Carnegie Mellon University, CMU/SEI-93-TR-6 (ESC-TR-93-183), June 1993. This report describes a method to facilitate the systematic and repeatable identification of risks associated with the development of a software-dependent project. This method has been tested in active government-funded defense and civilian software development projects. The report includes macro-level lessons learned from the field tests.

5.2.14. Barry W. Boehm, Software Risk Management, Institute of Electrical and Electronics Engineers, IEEE Computer Society Press, 1989, pp. 115-147. This portion of the book contains a very good overview of the risk management process focused on software.

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