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Independent Program Assessment Office

SOPI 5.0-2

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STANDARD OPERATING PROCEDURE INSTRUCTION

SOPI 5.02: BASELINE

PROGRAMMATIC ASSESSMENT PROCESS

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1.0 PURPOSE

The purpose of this Standard Operating Procedure Instruction (SOPI) is to document the Program Analysis Group (PAG) process for supporting Standing Review Boards (SRBs) through the completion of an analysis of Program/project (P/p) programmatic processes and products as called out in the latest version of NASA Procedural Requirement (NPR) 7120.5. These include all of the following evaluation criteria:

a. Alignment with and contribution to Agency needs, goals, and objectives, and the adequacy of requirements flow-down from those

b. Adequacy of technical approach, as defined by NPR 7123.1 entrance and success criteria

c. Adequacy of the integrated cost, schedule and risk estimate and funding strategy in accordance with NASA Procedural Directive (NPD) 1000.5

d. Adequacy and availability of resources other than budget

e. Adequacy of the risk management approach and risk identification and mitigation per NPR 8000.4A

f. Adequacy of management approach

2.0 REFERENCES

NPR 7120.5	NASA Space Flight Program and Project Management Requirements
NM 7120-81	NASA Interim Directive to NPR 7120.5D
NPR 1000.5	Policy for NASA Acquisition
NPR 7123.1	NASA Systems Engineering Processes and Requirements,
NPR 8000.4	Agency Risk Management Procedural Requirements
SP-2010-3403	NASA Schedule Management Handbook, January 2010
NASA-STD-7009	NASA Technical Standard, Standard for Models and Simulation
GAO-09-3SP	Government Accounting Office (GAO) Cost Estimating and Assessment Guide

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3.0 SCOPE

This SOPI applies to all programmatic assessment activities conducted by IPAO. It will include all phases of the assessment from review planning through the quality reviews, final report and presentation of materials to the governing Program Management Council (PMC). It is the PAG lead analyst's responsibility to ensure that all the SOPI requirements are adhered to by government and contractor personnel supporting the analysis.

Programmatic functions include requirements management, scheduling, resource management, budgeting, cost estimating, acquisition /contracting, risk management, performance tracking, and control. Each of these functions plan, execute, track, assess and report information necessary for P/p success. There is no standard organizational structure that dictates where these functions reside. They may be located in the Business Management, Program Planning and Control Office, a technical organization like Systems Engineering and Integration, or a Chief Engineer's Office.

Wherever they reside, their processes and products are related and should be using the same requirements, Work Breakdown Structure (WBS), planning assumptions, etc. The Independent Program Assessment Office (IPAO) is looking not only at how each functional area performs, but also how the P/p coordinates across the functions to ensure that, for example, both the budget and scheduling groups are using the same workforce assumptions for planning and analysis purposes.

4.0 BACKGROUND

An Independent Programmatic Analysis (IPA) is conducted by an impartial body, free from the management or advocacy chain of the program. The purpose of the IPA is to determine whether the P/p's planned budget and schedule are adequate to accomplish the proposed technical work. The intent is to help identify any potential risks not already identified and the potential impact to the planned cost and schedule. The IPA is an integration of independent cost, schedule, and risk analysis.

Flight development programs, with some exceptions, have a requirement for an initial independent assessment by the SRB at the Pre-Program Approval Review (PPAR) Key Decision Point (KDP) 0. Flight development projects, which are not initiated through the Announcement of Opportunity (AO) process, may have an independent assessment by the SRB at the Mission Confirmation Review (MCR) KDP A. Missions initiated through the AO process have their initial independent assessment by the SRB at the Pre-Non-Advocate Review (PNAR) KDP B. The scope and depth of the review will be expanded as the project reaches the Program Approval Review (PAR) KDP I, Project Non-Advocate Review (NAR) KDP C and continue through the P/p life cycle; reference NPR 7120.5 and NM 7120-81. There are special instances where an IPA is performed at the request of governing authorities.

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5.0 PAG INDEPENDENT PROGRAMMATIC ANALYSIS

The PAG provides cost and schedule expertise to conduct programmatic analysis that supports the overall SRB assessment at the various Life Cycle Reviews (LCRs). PAG activities are coordinated with the SRB by the Review Manager (RM) from the IPAO Evaluation and Assessment Group (EAG), who administers the independent reviews required per the NASA governance model.

The programmatic review emphasis changes as the P/p progresses over time in its life cycle. Early on, the assessment is on the P/p plan realizing that data and basis will evolve over time. As the plans mature the assessment will focus on the baseline. After the baseline is established, the assessment should focus on performance. The SRB Engagement Life-Cycle Roadmaps for P/p's can be found in the SRB Handbook which can be downloaded from the IPAO website: www.nasa.gov/ipao.

5.1 PAG REVIEW TIMELINE

The generic review timeline for programs and projects is shown in Figure 5.0-1. The timeline shows the interaction necessary between the cost and schedule analysts (CA/SAs) the other SRB team members and the P/p. Under the current paradigm a considerable amount of pre-work is required months prior to the site review in order to achieve a report out to the APMC no later than 30 days after the one page summary to the Decision Authority (DA) (which occurs within 48 hours of the site review). The IPA analysis needs to be 90 to 95% complete prior to the site visit.

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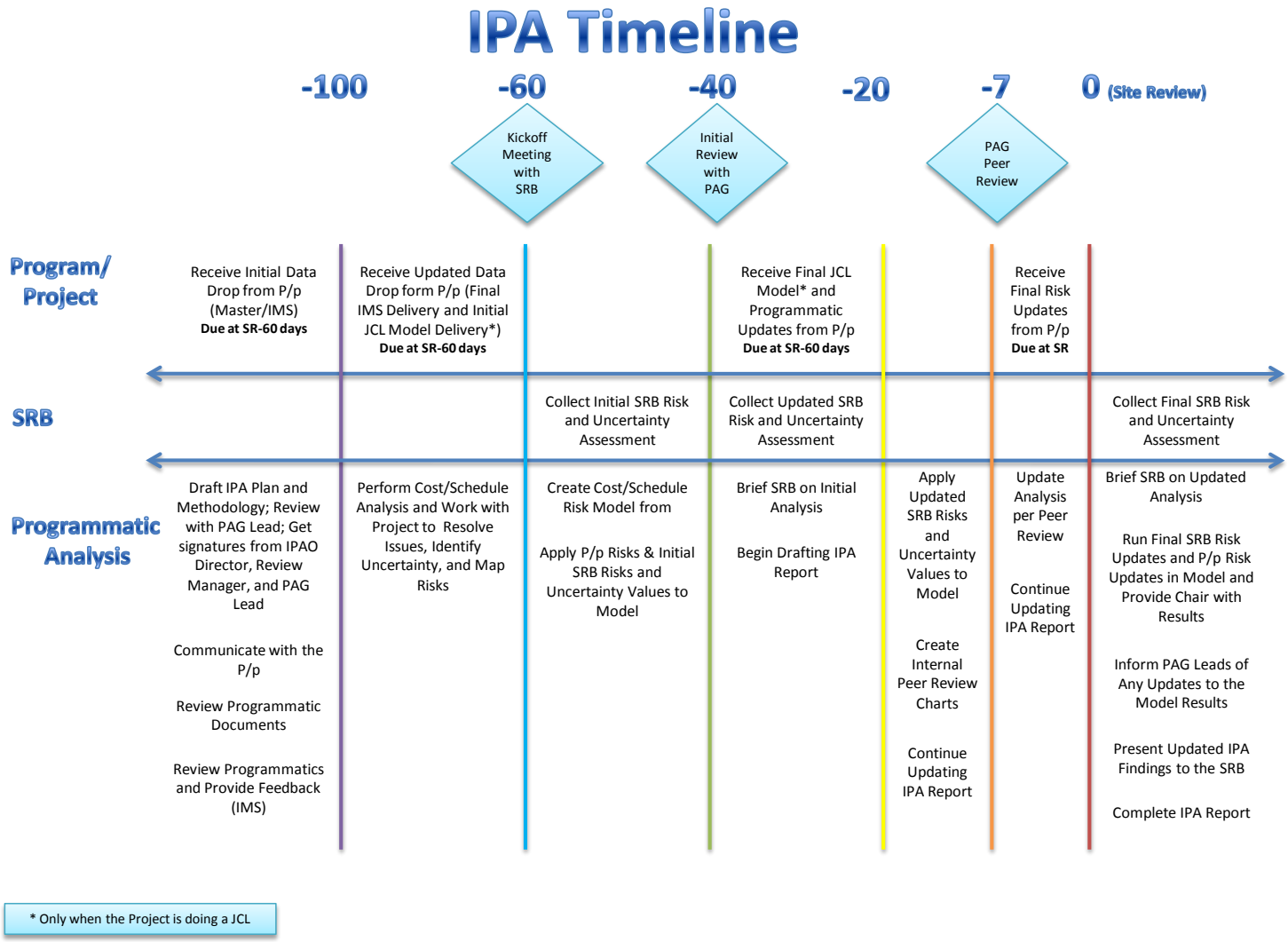

FIGURE 5.0-1 Independent Programmatic Analysis Timeline

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5.2 DEVELOP A PROGRAMMATIC ANALYSIS PLAN (PAP)

The PAG Cost Analyst (CA) and Schedule Analyst (SA) serving on the SRB independent review team will facilitate the planning process and produce a PAP.

The review plan will include all of the following elements:

- Scope of review
  - What projects are included (if multiple project/tightly coupled program)
  - What is/is not included in review scope
  - Project processes and products that will be assessed
  - What P/p milestones are being used, e.g. 2013 Initial Operating Capability (IOC), etc
- Review Resources
  - List cost/schedule analysts, identify who is providing them (contractor, PAG Civil Servant (CS), In situ)
- Approach/Methodologies/Tools to be used by the P/p and/or PAG analysts
  - Analysis approach/methodology
  - P/p tools and models
- Information Required
  - Refer to NPD 1000.5, NM 7120-81,NPR 7120.5, NPR 7120.8 and NPR 7123.1 requirements
  - List of P/p documents required
  - List of P/p product deliverables
- Review Schedule – SRB/P/p coordinated timeline
  - P/p document delivery complete date
  - P/p product deliverables complete date
  - Analysis complete date
  - Site review dates
  - Model development and Analysis Timeline
  - PAG cost and schedule analyst planning meeting

The standard PAP template can be found in Appendix A.

5.2.1 PAP TIMELINE

As soon as a review is planned the assigned programmatic analysts will contact the P/p Point-of-Contact (POC) to begin planning the timeline for the IPA component of the review. This timeline will include delivery dates of products from the P/p to the review team, coordination meetings, due dates for SRB inputs, etc. The timeline will be included in the PAP. A standard timeline can be found in the PAP template in Appendix A.

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This agreed upon timeline should be incorporated into the general review timeline that is developed by the RM and SRB Chair.

5.2.2 PROGRAM/PROJECT DATA REQUIREMENTS

A generic list that includes the nominal inputs associated with conducting an IPA is included in the PAP (see Appendix A). Some may have more relevance to human or robotic missions or to specific points of time in the P/p life cycle. The programmatic analysts and RM should work together to determine what products are applicable to a specific review before coordinating with the P/p for the review timeline or to finalize the Terms of Reference (TOR).

Existing project data and formats will be used when possible to minimize additional expenditure of resources. Products are expected to be at different maturity levels at different points in the project life cycle. As the products are updated throughout the life cycle of the P/p, the SRB will expect to receive the latest versions for continuous assessment and analysis at the various reviews.

Data Products

P/p deliverables will be standard documents that are generally defined or called out in NPR documents or are accepted as general best practices in the project control community. Standard deliverables to the SRB are included in the PAP template in Appendix A.

5.2.3 PAG LEAD AND IPAO DIRECTOR REVIEW OF PAP

When the PAP has been finalized it will be presented by the lead CA and SA for review and to the PAG lead and IPAO Director for approval. The EAG lead, Principal Review Manager (PRM), and RM will be invited to this review to provide comments to ensure that there are no conflicts with the general review requirements or timeline.

5.3 PROGRAM/PROJECT PROCESS/PRODUCT SUFFICIENCY REVIEW

The sufficiency review process is initiated by PAG to review the P/p products and processes for reasonableness, completeness, consistency, and compliance with generally accepted standards of excellence in the following areas as found in NM 7120-81/NPR 7120.5.

a. *Alignment with and contributing to Agency needs, goals, and objectives, and the adequacy of requirements flow-down from those*

b. *Adequacy of technical approach, as defined by NPR 7123.1 entrance and success criteria*

c. *Adequacy of the integrated cost and schedule estimate and funding strategy in accordance with NPD 1000.5*

d. *Adequacy/availability of resources other than budget*

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e. *Adequacy of the risk management approach and risk identification and mitigation per NPR 8000.4*

f. *Adequacy of management approach*

5.3.1 STANDARDS FOR SUFFICIENCY/ADEQUACY

Because "adequacy" is an imprecise term, PAG has developed a reference guideline using "industry best practice" standards to determine how to assess the "adequacy" of a product or process throughout the P/p life cycle. These definitions are in Appendix B Sufficiency Review Criteria**.**

5.3.2 CONDUCTING A SUFFICIENCY REVIEW

The sufficiency review is conducted to determine if the P/p products and processes are "adequate"' to meet the intent of NM 7120-81/NPR 7120.5 which is to ensure that P/p technical goals, objectives and requirements can be met on time and within budget. To be "sufficient" a process must be easily understood and followed by the person responsible for producing the product (i.e. a budget or schedule plan), executing the plan and analyzing/reporting the results to management. To be "sufficient" a product must follow NASA requirements documents and "industry standard best practices." For instance, basis of estimate best practices from the government and industry have been compiled in Appendix C. Best practices for scheduling can be found in the NASA Schedule Management Handbook (NASA/SP-2010-3403).

Findings

The evaluation process should culminate into a set of findings categorized into the NM 7120-81/NPR 7120.5 programmatic areas and documented in the IPA report. A finding is a conclusion reached by the SRB based on examination or investigation supported by evidence or data. A finding can be a strength or weakness which is further categorized into an issue, concern or observation. A strength is a finding that describes a feature of the program or project that, in the judgment of the SRB, is better than expected at a particular stage of the life cycle. A strength could also be an observed attribute from which the rest of the Agency could benefit. A weakness is something that constitutes a threat to the future success of the program or project. If it is deemed critical, it should be treated as an "issue" in the SRB findings. An "issue" may be a deficiency, or set of deficiencies taken together, that are judged to substantially affect the ability of the project to meet its requirements within the planned cost and schedule. Each issue should be accompanied by evidence that substantiates the criticality to program or project success. A weakness that is worthy of mention, but is not critical to the success of the program/project, should be treated as a "concern" in the findings and supported by substantiating evidence. An observation is noteworthy information worth documenting that could lead to a concern or issue in the future.

The following sections describe how the PAG conducts a sufficiency analysis for each of the NM 7120-81/NPR 7120.5 programmatic areas:

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Alignment with and contributing to Agency needs, goals, and objectives, and the adequacy of requirements flow-down from those

Requirements refers to the process by which the program/project identifies the scope of the individual projects needed to accomplish the overall mission objectives. This includes the requirements flow-down, how well they are defined and their stability. This would include any dependencies on other program requirements both within and outside NASA. A lack of clear requirements leads to a large amount of uncertainty in the resources needed to successfully execute the program plan. Changes in requirements may change the scope of what the program's individual project missions are able to accomplish and may also change the necessary resources for mission success including budget and time.

The IPA will include an SRB assessment of the requirements for which the baseline is established and determine whether they may change significantly in the next design cycle(s) or phases of the program or project. This should include an assessment of any trade studies that have been performed or de-scope plans that have been produced.

Adequacy of technical approach, as defined by NPR 7123.1 entrance and success criteria

The IPA will include an SRB assessment of the technical approach for which the baseline is established and determine whether there are assumptions or practices worth noting that may affect the program or project's budget and schedule. Some specific items worth noting are technical margins, technology readiness level, heritage assumptions, rework, and sparing plans which can affect design, manufacturing, and test cycles. Any changes in technical content should be noted over the life cycle which may affect the program or project's budget or schedule.

Adequacy of the integrated cost and schedule estimate and funding strategy in accordance with NPD 1000.5

P/p schedules include key events and milestones, detailed implementation logic networks, a resource-loaded Critical Path Method (CPM) master schedule, an Integrated Master Schedule (IMS), project-to-project interdependency lists and/or other information that defines the work to be done to meet P/p requirements, the time it takes to accomplish the work, dependencies between activities, resources required to get the work done, and availability of the resources to ensure they will be ready when needed. The analysis includes an assessment of the schedule's Basis of Estimate (BOE) based on the best practices described in Appendix C. Schedule management best practices should follow guidance from the NASA Schedule Management Handbook.

A schedule health/quality check will be conducted using the Defense Contract Management Agency (DCMA) fourteen-point schedule assessment criteria. The Schedule Test and Assessment Tool (STAT) software tool is available from NASA for use in assessing these criteria on schedules submitted in Microsoft Project. The health check determines the quality of the schedule structure in accordance with the Critical

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Path Method (CPM) scheduling methodology. Additional information on the schedule health check can be found in the NASA/SP-2010-3403, NASA Schedule Management Handbook.

A schedule analysis will be performed to evaluate the content of the schedule against the P/p plan: scope, Work Breakdown Structure, and requirements along with the adequacy of available resources, resource and budget phasing and schedule management processes such as Earned Value Management (EVM) and procedures.

The Independent Schedule Assessment and Integrated Cost and Schedule Risk Analysis Process are documented in Appendix D. Appendix D Attachment D-1 is the Schedule Health Check Software Release form that needs to be filled out and sent to Marshall Space Flight Center (MSFC) to obtain a copy of the software.

Adequacy or sufficiency of P/p project cost estimates and budgets depend on the viability of the data and assumptions that are used.

Estimating refers to the process by which the scope of the P/p's technical and programmatic content are translated into the estimates of cost and schedule durations based on resource requirements and availability. The analysis will include an assessment of the cost and schedule estimating methods used along with their BOE. The BOE should follow best practices as described in Appendix C.

Budgeting refers to the process by which estimates are formalized into final commitment, obligation and cost plans, which must be managed. A thorough understanding of commitments, obligations, and liens is required to see what may be constraining the program or project. The analysis will include an assessment of whether the budget plan has been coordinated with the schedule plan to ensure that the funds are available when needed for the program and the individual projects and, once executed, how budget and schedule are performing against the original plans. At certain KDPs PAG will generate internal benchmarks which may include an Independent Cost Estimate (ICE) per procedures included in Appendix E. An ICE is a requirement for project KDP B and KDP C, but may also be required under special circumstances.

Although NM 7120-81/NPR 7120.5 does not specifically call for a review of the "adequacy of the budget", PAG will determine if the budget is "adequate" based on availability of funds in both a specific fiscal year or over all funding of the P/p. This will include an assessment of the budget trace back to the budget submit, individual cost estimates and an IMS. This also includes the basis for any cost and schedule confidence level analysis that may have been performed to create the JCL. Appendix F contains JCL analysis practices.

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Adequacy/availability of resources other than budget

The analysis includes an assessment of requirements for resources other than the budget which includes workforce, facilities, interagency partners, international partners, and infrastructure. This includes how well their time phased budget plan aligns with the schedule and availability of these resources.

The analysis will include an assessment of workforce planning, any skill mix, retention, obsolescence, and ramping issues.

The analysis will include an assessment of the facilities, availability, costs, and supporting infrastructure.

The analysis will include an assessment of any mission partner's potential impact to cost and schedule

Adequacy of the risk management approach and risk identification and mitigation per NPR 8000.4

Risk and Reserve Management refers to the process by which technical and programmatic risks are identified and program/project management utilizes budget and schedule reserves to plan for and respond to these potential problems.

The IPA will include:

a. Assessment of the BOEs for any cost or schedule mitigation plans for the identified risks. The BOEs should follow best practices described in Appendix C.

b. SRB supported assessment of the risks which may include new risks that are identified by the SRB (not identified by the program/project) with associated cost and schedule impacts.

c. SRB supported assessment of the risks which may include adjustments to assumptions made by the program/project with associated cost and schedule impacts. Specific areas of interest are Technology Readiness Levels and heritage.

d. Assessment of the reserve strategy and the current state of the reserves in relation to where projects are in their prospective life cycles.

e. Assessment of whether risk has been properly accounted for in the program/project cost, schedule, or JCL process. This assessment may include an evaluation of the coefficient of variation (CV) (a measure of dispersion defined as the standard deviation divided by the mean) of the top-line of each phase of the estimate. Examining lower level elements is desirable; however, the range in acceptable answers is much broader. A higher value indicates a wider dispersion or a flatter s-curve. CVs at 0.35 or above are indicative of a high risk program. CVs near 0.15 are indicative of a program with low or modest risks often associated with very optimistic ranges. However, these rules-of-thumb are very commodity dependent and a function of where the program is in the life cycle. For

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instance, a CV of 0.50 would not be unexpected for long range planning estimates. Space programs at an early stage of development should exhibit a CV of 0.40 or greater.

Adequacy of management approach

The IPA includes an assessment of the management processes including acquisition strategy, budgeting, tracking, reporting and control. "Sufficient" analysis and reporting provides management insight into trends, problems, issues, and risks so mitigation strategies can be developed and implemented in time to avoid cost overruns or schedule slips. Reporting should include watch lists for areas that are trending negative and decision packages and/or options analysis to give management alternative solutions to problems that can or are impacting the cost/schedule plans. Tracking and control refers to the process by which the cost and schedule progress is collected and compared to the baseline plan. This can include EVM as well as other plan/actual comparison methodologies that probe into the causes of deviations to the plan and provide a potential mitigation plan.

The analysis will include an assessment of the acquisition plans, including major contracts, scope, and contract types.

The IPA will include an assessment of the EVM or EVM equivalent tools or methodologies, and how well the P/p utilizes them. This also includes an assessment of the results and how well the program has performed to date. Under certain circumstance an independent EVM analysis may be conducted.

Reporting refers to the process by which planning, tracking and analysis results are distilled and provided to both project and program management including to whom the plans and the status are reported, what level of detail, and how often.

The management approach also refers to having adequate staffing, training and communications, Information Technology (IT) resources, etc. throughout the internal project organization and with external partners, contractors and other groups.

5.4 PAG INDEPENDENT MODELING AND/OR BENCHMARKING PROCESS AND PRODUCTS

In general, the role of the programmatic analysts is to determine the quality or sufficiency of the products produced by the P/p. There may be times when it is necessary for the analysts to produce their own independent cost estimates, schedule risk models or other products to be used as benchmarks against those developed by the P/p.

5.4.1 PAG PROCESS

Performing independent programmatic assessments is a role of the SRB supported by the expertise of the PAG analysts. The assessment includes an independent cost and schedule analysis of the P/p plan, including the JCL when required, to ascertain the

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P/p's ability to accomplish the technical requirements. The cost analysis may be supported by an Independent Cost Estimate (ICE). The level of detail and the type of assessment in each topic area varies, depending on whether it is a P/p and where it is in its life cycle.

The PAG Analysts will be provided whatever information, model access, documentation, and insight necessary to recreate the P/p baseline. The baseline estimate should then be able to be adjusted for any assumptions or changes per assessment by the SRB. This includes the recreation of the P/p JCL by the PAG Analysts and generation of an adjusted JCL based on SRB inputs, when a JCL is required.

Any models or methodologies used in the benchmark comparisons should be similar in process type and overall value to those produced by the P/p. If significant variations of the estimated project costs or durations versus the benchmarks exist, those inconsistencies should be identified and commented upon.

It is essential that when independent analysis products are produced that the PAG Analysts follow the same documentation standards, including developing a complete BOE, that are required from the P/p.

The Basis of Estimate (BOE) should identify all estimate reviews or independent estimates that have taken place to date. Results including any BOEs should be attached or referenced.

The BOE should provide an overview of the major differences between the current estimate and the last published estimate prepared for/by this P/p. Also, it should identify the cost and schedule impacts due to scope changes, different assumptions, pricing updates, budget constraints, labor, productivity adjustments, estimate refinement, etc.

More detail about the process for the Independent Schedule Analysis (ISA) and Schedule Risk Analysis (SRA), the cost estimate benchmark (including the Independent Cost Analysis (ICA) and ICE), and developing a Joint Confidence Level (JCL) can be found in Appendices D, E, and F, respectively.

5.4.2 PAG PRODUCTS

Independent Programmatic Analysis (IPA) Report

The integrated cost, schedule, and risk assessment will be documented in a single product, the IPA report. The IPA will be endorsed by the SRB technical members, and the SRB team as a whole will take ownership. Under circumstances where the SRB is not willing to fully endorse the IPA, the PAG analyst will document the findings in the report and present them as an individual member's opinion. The IPA Report template can be found in Appendix G.

The IPA Report will include the following types of analyses:

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Independent Cost Analysis (ICA) Assessment

As part of the IPA, the SRB conducts an ICA of P/p resources including the budget and financial management associated with the program content. ICAs include, but are not limited to, the assessment of the BOE of cost estimates, budgets, and schedules in relation to the P/p and its constituent projects' technical content, performance, and risk. BOEs are evaluated by the SRB on the basis of completeness, transparency, accuracy and realism. Using the ICA, the SRB assesses the adequacy of the budget and management practices to accomplish the work scope through the budget horizon.

Independent Cost Estimate (ICE)

An ICE is an independent cost estimate that is sometimes prepared as an internal benchmark to support the ICA. ICEs are typically produced at KDP B (Mission Definition Review (MDR), System Definition Review (SDR)/Preliminary Non-Advocate Review (PNAR)) and KDP C (Preliminary Design Review (PDR)/Non-Advocate Review (NAR)) but are also generated if warranted by special circumstances to support the review. The ICE is based on the same project definition documentation and technical baseline as used for project Life-Cycle Cost Estimate (LCCE) then is adjusted to reflect the design, development state, and difficulty of the project, based on the expertise of the SRB team members and their assessment of the technical risks.

Independent Schedule Assessment/Schedule Risk Analysis (ISA/SRA)

As part of the IPA, an ISA/SRA is conducted by the SRB. The schedule assessment is the responsibility of the full membership of the SRB led by the PAG schedule analyst. The schedule assessment is based on an ISA/SRA, which will be accomplished through the schedule health/quality check, schedule analysis, including critical path analysis, and the integrated cost and schedule risk analysis. This assessment will help the SRB develop an understanding of the realism and completeness of the P/p schedule, assess risk, and identify where there may be inadequate phasing of available resources verses required resources. The entire technical team should participate in identifying schedule risk areas based on sound technical judgment and area of expertise. The SRB members will be made aware of the results of the assessment.

A program ISA/SRA is performed more from a strategic viewpoint using the program plan/roadmap to assess the viability of the program planning over the life cycle. A program ISA/SRA assesses the Program's long-term alignment with sponsor goals and objectives. In tightly coupled programs individual project schedules should be rolled up into an Integrated Master Schedule (IMS), allowing the SRB to assess the integrated effects across all projects.

A project ISA/SRA focuses on the detail implementation plan for that specific project. Items used in performing the assessment include, but are not limited to, the project plan, schedule management plan, risk management plan, WBS, project and SRB identified risks, project IMS, and project detail schedules.

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Joint (Cost and Schedule) Confidence Level (JCL) Assessment

The IPA may also include JCL assessments for certain reviews. Per NPD 1000.5 each P/p being reviewed is required to submit a JCL at KDP C, when a P/p undergoes a re-baseline, or under special circumstances determined by the convening authorities. This assessment is intended to show the level of confidence that the Agency can commit to externally, and that the P/p will be able to accomplish its technical goals and execute its plan on schedule within budget. The SRB is responsible for analyzing the submitted P/p JCL model to determine the validity of the input parameters, the reasonableness of the assumptions, and overall quality of the product. Additionally, the SRB will assess the P/p risks and adjust any likelihood/consequence assumptions and uncertainty ranges, and/or add new risks or uncertainty ranges to P/p JCL model and evaluate the impact to the plan. The fundamental ICA, ISA, and SRAs support the assessment of the JCL.

Assessment of Resources Other than Budget

The IPA includes an assessment of resources (other than budget). Resources (other than budget) are essential elements of successful program functionality, or project implementation and operation. These resources include: *manpower, fabrication, assembly, test facilities and equipment, test beds, ground support equipment, launch sites, communication networks, and mission operation centers*. They can be either government or privately held resources. The SRB is expected to assess the adequacy (availability and capacity) of these resources relative to the needs of the P/p throughout the life cycle.

Risk Management Assessment

The IPA includes a risk management assessment. Each P/p is expected to develop and execute a Risk Management Plan as part of their responsibilities. The plan is an approach for managing risks; it focuses on identifying potential technical problems and programmatic risks that might affect the planned cost and/or schedule. During the life cycle the P/p will carry an evolving set of risks, with associated liens against reserves. Risk management is a dynamic activity with new risks being added as existing risks are retired, either through mitigation actions which will decrease consequence and/or diminished likelihood. The SRB is expected to assess the P/p's plan to manage risk, independently adjust the likelihood and consequence as necessary, introduce new risks if necessary, and thereafter independently evaluate the possible cost and schedule impacts to the P/p. The SRB risk input is used in the SRA.

Management Approach Assessment

The IPA also includes an evaluation of how well the P/p is managing its responsibilities as part of each Independent Life-Cycle Review (ILCR). The scope of this evaluation includes the management approach (organizational structure, integrated product teams, lines of authority, work breakdown structure, etc.); management practices (how effective are the control methods, how are the EVM tools being used, etc.); acquisition planning

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adequacy (make/buy decisions, procurement strategies, partnership arrangements; and methods of communication/reporting (meetings, document obligations, leadership participation, etc.).

5.5 PAG IPA PRODUCT QUALITY REVIEW PROCESS (PEER REVIEW)

The Peer Review will be held at least one week prior to the site review to check the quality and completeness of the presentation package. This review must be completed before the presentation package is submitted to the SRB Chair and RM. The PRM and RM must be invited to the Peer Review. The goal is to ensure that the presentation is sound, project status is well documented, and the information can be defended when presented to management. Any major updates to the results following the site review will be presented to the PAG lead.

The following list describes the steps to be followed for the internal quality review:

(1) Set Review Date (Site Review – 125 days): The PAG Analysts will set the date for the Peer Review and ensure that it meets the requirements for subsequent management briefings leading to the governing PMC. The Analysts communicate this meeting date/time to the team and community. The date will be documented in the IPA Plan.

(2) Decide if Products are Ready (Site Review – 40 days): The PAG Lead will decide if the IPA is ready for submission. If the PAG Lead finds significant problems with the product, the Analysts will update materials and return for additional review meeting.

(3) Post materials for review (Site Review – 10 days): Review materials will be sent to the team, or posted in an appropriate location, with notification to the team and community. Target date is 3 days prior to review.

(4) Conduct Peer Review (Site Review – 7 days): PAG Lead conducts Peer Review meeting; IPA Analysts present product; PAG Lead conducts discussion. Target date is three days prior to need date for product; this is a guideline, earlier is better.

(5) Site Review Updates (Site Review + 7 days): Any pertinent updates to the previous analysis following the site review will be presented to the PAG Lead.

(6) Report to Director/Deputy Director: PAG Lead informs EAG Lead and the IPAO Director/Deputy Director of results of the review.

(7) Deliver findings (Site Review + 10 days): Analysts brief findings to the SRB RM and SRB.

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5.6 PAG DATA ARCHIVING PROCESS

The PAG work related to supporting a review will be archived on the IPAO I:Drive. The archiving will be the responsibility of the PAG lead analyst assigned to the review. The archiving of PAG generated documents, analysis, and supporting data will follow the hierarchy shown in the following outline. A template of this hierarchy is available on the I:Drive under the folder titled “PGA Analysis”. The template requires the folder’s name to contain the specific type of review, date, and PAG lead analyst’s name. Under this folder a structure will be used for archiving categorized by; PAG generated, SRB generated, and Program/project generated. The intent is not to include in this archive every iteration of analysis or model run but the final one leading to the findings. All supporting data for this final run must be archived. Figure 5.6-1depicts the PAG data archival process.

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- PAG Analysis
  - *Program/Project Name*
    - *Review-Year-Lead Analyst Last Name*
      - PAG Documentation
        - Products
          - 01_PAP
          - 02_Kick-Off Presentation
          - 03_SRB JCL Model (if applicable)
          - 04_Peer Review Presentation
          - 05_IPA Report
        - Analysis
          - Schedule Analysis
          - Cost Analysis
          - JCL Analysis
      - SRB Supporting Documentation
        - SRB Subsystem Reports/IMIRs
        - Pertinent Emails
        - SRB Risk List and Assessment
      - Program/Project Documentation
        - Presentations
          - Subsystem Presentations
          - Site Visit
        - Data
          - IMS
          - JCL Model (if applicable)
          - Trend Reports, MSRs, etc
          - Risk List

FIGURE 5.6-1 PAG DATA ARCHIVING HIERARCHY

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APPENDIX A INDEPENDENT PROGRAMMATIC ASSESSMENT (IPA) PLAN

Independent Programmatic Assessment (IPA) Plan

for the

Independent Life Cycle Systems

Review Name

of the

Program/Project Name

Date

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SIGNATURE PAGE

Submitted by:

_____

Lead Analyst Name
Independent Programmatic Analysis (IPA) Lead
Programmatic Analysis Group, IPAO

Approved by:

_____

Richard M. Greathouse
Programmatic Analysis Group, Lead

Concur by:

_____

Review Manager Name
Evaluation and Assessment Group

_____

Dr. James Ortiz
Director IPAO

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Project Name
Review Name

Programmatic Analysis Plan (Template)
Date

Purpose of the Programmatic Analysis Plan

The purpose of this plan is to provide a roadmap for the Independent Programmatic Analysis (IPA) component of the ***XXX*** Review ***(XXX)*** of the *XXX (XXX)* Project that is scheduled for ***DATE***.

Project Description

Include a short paragraph summarizing the Project.

The SRB will conduct reviews in accordance with the latest version of NM 7129-81, NPR 7120.5 and NPR 7123.1 for the life cycle gate of ***XXX*** Review (***XXX***), including the key decision point (KDP)-***X***. An Independent Programmatic Assessment (IPA) will be prepared using methodologies as appropriate for ***XXX***. In accordance with NPD 1000.5, ***XXX*** milestone ***does/does not*** require a Joint Confidence Level (JCL) assessment. [Reference: ***XXX*** Project Terms of Reference]

History

Include a short paragraph summarizing the Project's last review, if applicable. For example:

XXX successfully completed Phase ***X*** and Milestone KDP-***X*** efforts with a ***XXX (XXX)*** on ***DATE***. The ***Agency*** Program Management Council (***A***PMC) approved ***XXX*** for entrance into Phase ***X*** on ***DATE***.

Analysts

Cost Analyst: ***Name (Organization/Company)***

Schedule Analyst: ***Name (Organization/Company)***

Independent Programmatic Analysis (IPA) Overview

Per the Standing Review Board Handbook (SRB HB for 7120.5), the Independent Programmatic Analysis (IPA) consists of an Independent Cost and Schedule Analysis. The IPA is conducted by SRB cost and schedule analysts in concert with other SRB members. However, the IPA team may require one or more separate meetings and/or communications with the Project Office business management staff in order to completely review and understand detailed budget and schedule documents and procedures. The IPA team will also require Project Office data at sufficient lead time prior to the ***XXX*** in order to conduct their analyses. IPA findings and recommendations are discussed, coordinated and influenced by findings and recommendations of the

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SRB, though they may be stand alone IPA results as well. The final outcome will be an integrated assessment of cost and schedule documented in an Independent Programmatic Assessment (IPA) report.

The assigned cost and schedule analysts will work with the SRB technical review members to develop an IPA. The IPA team members will perform fact finding, collect data, conduct interviews (principally with, but not necessarily limited to, the Project Office business management staff), participate in overall SRB meetings, and conduct splinter meetings with the business staff and other staff as required. The cost and schedule analysts will interface and coordinate with other SRB team members to obtain independent validation of cost and schedule data inputs, as well as other technical contents, which include but are not limited to technical parameters, risks, programmatic data, schedule, and funding. The analysis may also include an assessment of the Project's Joint Confidence Level (JCL) (if required for the Project) and an evaluation of any associated cost/schedule impacts identified by the SRB.

The Independent Programmatic Analysis (IPA)

The IPA includes a review of a number of areas to ensure that the planned schedule and budget are adequate to accomplish the proposed technical content. These areas include; requirements, technical, estimating, scheduling, budgeting, risk, and managing. These areas are directly related to the NM 7120-81/7120.5D Success Criteria.

Requirements refers to the process by which the Project identifies the scope needed to accomplish the overall mission objectives. It includes the requirements flow-down, how well they are defined and how stable they are. It also includes any dependencies on other Project requirements both within and outside NASA. A lack of clear requirements leads to a large amount of uncertainty in the resources needed to successfully execute the Project's plan.

Technical refers to any potential technical risk that has a known impact associated with cost and technical uncertainty and growth. This includes such things as technology development or inadequate technical margins.

Estimating refers to the process by which the scope of the Project and the individual Project's technical and programmatic content are translated into the resource estimates. It includes an assessment of the cost and schedule estimating methods used, along with their basis of estimate, and how effectively the Project is utilizing it. An independent cost estimate (ICE) that is sometimes prepared as an internal benchmark to support the ICA.

Scheduling refers to the process of planning activities, their sequence and associated durations allotted for completion of an objective. The schedule assessment consists of three parts: schedule health/quality check, the schedule analysis, and the integrated cost and schedule probabilistic risk assessment. The first part is a quality assessment of the Project's schedule, as well as the schedule planning and management process. The second part determines the schedule validity and performance. The third part

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provides the likelihood that the Project, under the influence of risks, can achieve its planned key milestones.

The schedule analysis approach consists of evaluating the schedule and schedule planning and management process against the Defense Contract Management Agency (DCMA) fourteen-point assessment criteria. It also includes verifying scheduling best practices per the NASA Schedule Management Handbook, NASA/SP-2010-3403.

The schedule risk analysis approach involves using the Project's schedule as the basis of the schedule-risk model and evaluating it in support of the Government Accounting Office (GAO) nine-point assessment criteria. All relevant risks carried by the Project are mapped to appropriate Work Breakdown Structure (WBS) tasks. The Standing Review Board (SRB) will identify any additional risks that are necessary to be included in the schedule-risk model. A likelihood value and probability distributions of impact will be assigned to each of the risks. This evaluation includes understanding the activity durations to determine if they are reasonable or if there is an unreasonable level of uncertainty that needs to be included in the schedule-risk analysis. Uncertainty ranges will be mapped to Project tasks as appropriate, and as determined by the SRB. Monte-Carlo simulations using an approved schedule-risk tool will show the possible risk-induced schedule slip.

Budgeting refers to the process by which estimates are formalized into a final budget, which must be managed. It includes an assessment of whether the budget is available when needed for the Project.

Reserves/Margins refer to the planned resources available to respond to estimating uncertainty and potential problems associated with technical and programmatic risks. It includes an assessment of the reserve management strategy and the current state of the reserves in relation to where the projects are in their prospective life-cycle and their risks.

Resources other than Budget refers to the resources such as the workforce, facilities and external partners that are needed to execute the plan. It includes an assessment of the adequacy, availability, and capacity of these resources.

Risk refers to the process of managing the possible events that can inhibit achieving the plan. It includes an assessment of the Risk Management Plan and whether it is being followed. It also includes an independent assessment by the SRB of the likelihood and consequences. The assessment includes the identification of any new risks by the SRB, not previously identified, and the associated likelihood and consequence.

Managing refers to the process by which management plans and controls the resources. This includes an assessment of the Program Plan, Program Commitment Agreement (PCA), work breakdown structure (WBS), WBS dictionary, Acquisition Plan, Schedule Management Plan, Technical, Schedule and Cost Control Plan. It includes an assessment of the EVM process, tools, results, and how well the information is used for planning and control. This also includes an assessment of the Reporting process by which budgeting and tracking results are distilled and provided to both Program and

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Agency management. It includes to whom the plans and the status are reported, what level of detail, and how often.

The cost analyst will work closely with the schedule analyst throughout the entire SRB evaluation period to ensure that cost and schedule analysis results are consistent and complementary. The cost assessment results will be incorporated into the schedule-risk analysis.

IPA Methodology: Include a paragraph describing how the IPA will be performed with respect to the cost, schedule, and risk assessment. Describe methodologies and analysis tools to be used in performing the assessment.

The Joint Confidence Level (JCL) Analysis (if applicable)

Include a short paragraph discussing how the Cost and Schedule Analysts will review the Project's JCL.

Information Required from the XXX Project to Accomplish the IPA

1) *Program/project Plan*
2) *WBS and WBS Dictionary*
3) *Technical, Schedule, and Cost Control Plan*
4) *Staffing Requirements and Plans*
5) *Infrastructure Requirements and Plans*
6) *Acquisition Plan and Major Contracts*
7) *P/p schedules: Management/Master Schedule, IMS, and supporting detailed schedules*
8) *P/p cost estimate*
9) *Time-phased budget allocation by WBS*
10) *BOE, rationale, ground rules, and/or assumptions for all cost/budget/schedule estimates*
11) *Cost and Schedule Reserves and Basis for the Reserves*
12) *Risk Management Plan*
13) *Risk List (the set of risks currently being tracked; to include risk statements, likelihood and consequence scores, risk mitigation activities with expected closure dates and rationale, and any related cost impacts) and how liens are reflected in budget and schedule*
14) *Earned Value Management (EVM) data or equivalent. Baseline schedule and actual performance- to-date, showing root causes for any growth. Baseline budget plan and actual performance-to-date, showing root causes for any growth*

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15) *Status Reports (quarterly for previous years, plus last 3 months), to include full time equivalent (FTE) and WYE manpower*

16) *CADRe*

17) *Mass Properties Report and Power Estimates (if applicable)*

18) *Software Source Lines of Code by Function or WBS (if applicable)*

19) *JCL Model and assumptions*

Planned Schedule

Step	Activity/Schedule	Planned Date (Due Date)	Description
Step 1	IPA Plan Review with PAG Lead	SR Start - 125 days	The cost and schedule analysts brief the outline for analysis to the PAG lead before developing the IPA Plan.
Step 2	IPA Plan Review with IPAO Director and Review Manager	SR Start - 120 days	The IPA Plan is developed as a joint effort between the cost and schedule analysts, which covers the Tools, Approach, Analysis Method, Timeline, and Unique Needs for the IPA.
Step 3	Initial Communication with the Program/Project (P/p)	SR Start - 115 days	Obtain programmatic contact information from the Review Manager. Provide these P/p personnel with an overview of the IPA and the required input. This step supplements the TOR and gives the P/p specifics about expected data deliveries to the SRB. Negotiate the schedule data date to be used for the SRA.
Step 4	Data Drop (#1)	SR Start - 100 days	All available data* will be collected from the P/p for preliminary analysis. Anything missing from the SRB's initial data request (Step 2, -115 days) shall be noted and delivered as soon as the P/p has the data available. If the first set of data is not delivered on time it will be reported to the SRB Chair and the PAG lead.
Step 5	Review P/p Schedule (STAT) and Provide Feedback	SR Start - 82 days	The Schedule Analyst will provide the P/p feedback about the schedule health check (STAT). Allow the P/p 1 week to "fix" any errors and provide an updated schedule.
Step 6	IPA Overview Presentation to SRB at SRB Kickoff Meeting	SR Start - 60 days	Brief SRB on IPA Plan, including what is needed from SRB members.
Step 7	Data Drop (#2)/Initial JCL Model Delivery	SR Start - 60 days	This is the second/final data drop from the P/p, which should include updated technical, cost, and schedule data drop, BOEs, risks, model delivery. Any new schedule performance data and/or programmatic data should be provided. If the P/p is doing a JCL, the completed model should be delivered. The P/p should present their basis of estimate to SRB, and provide complete data package supporting the JCL model.

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Step 8	Initial SRB Risk Assessment	SR Start - 60 days	Initial independent SRB risk assessment is due to the cost and schedule analysts. The SRB needs to identify and score (likelihood and consequence distribution) the risks, including SRB-identified, as well as P/p-identified risks. The SRB should also consider areas of cost and schedule uncertainty.
Step 9	Initial IPA Report/Status to PAG Lead	SR Start – 40 days	The cost and schedule analysts should provide the PAG lead with status update charts (health check, critical path analysis, etc.) of the IPA to-date, including the draft Independent assessment of cost/schedule plans, and JCL model (if applicable) with regards to technical content/risks.
Step 10	Final JCL Model & Programmatic Updates Delivery /Updated SRB Risk Assessment	SR Start – 20 days	Identification of any new risks or changes to previous SRB risk assessment. The SRB needs to identify and score (likelihood and consequence distribution) the risks, including SRB-identified, as well as P/p-identified risks. The SRB should also consider areas of cost and schedule uncertainty.
Step 11	PAG Internal Peer Review	SR Start - 7 days	Internal PAG peer review of IPA results to-date.
Step 12	Status Briefing to SRB	SR Start - 5 days	A status briefing of IPA charts showing results to-date will be provided to the SRB.
Step 13	Site Review Start	SR Start	The Start of the Site Review
Step 14	Site Review End	SR End	The End of the Site Review
Step 15	Obtain Final Inputs from SRB	SR End	Obtain any new risk information from SRB learned at the Site Review. (Last Day of Site Review)
Step 16	Finalize IPA	SR End + 5 days	Incorporate any new risk information from SRB learned at the Site Review
Step 17	Inform PAG Lead of Any Updates	SR End + 7 days	Inform the PAG Lead of any changes to the IPA from the Site Review and SRB assessment.
Step18	Final IPA Findings to SRB Chair	SR End + 10 days	Final IPA findings are delivered to the SRB and Chair. (Slides)
Step 19	IPA Report Completed	SR End + 20 days	IPA SRB final report is published.
Step 20	KDP	SR End + 30 days	Key Decision Point.

Planned IPA Products

The IPA team will produce a detailed written report and briefing of its proceedings, findings and recommendations with the purpose of enhancing Project budgetary and schedule success. Positive findings and best cost practices will be identified, in addition

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to any issues/recommendations. The report and briefing will provide details of quantitative and qualitative assessments completed by the IPA team. The report will be kept internal to the Agency to preserve the integrity of the independent review process unless and until released by the Convening Authorities.

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APPENDIX B REVIEW CRITERIA GUIDANCE

Estimate Standards

When conducting a sufficiency/adequacy review, the analysts will look for evidence that the estimate adheres to the following standards:

Traceability: Information is presented in a traceable fashion containing supporting documentation and technical data. PAG Analysts must be able to trace with the given information.

Reasonableness: Information is presented in a logical manner with appropriate analogies and cost estimating relationships (CER).

Soundness: Information and assumptions used to perform the cost estimate must be clearly documented and rational. Recommendations must logically follow from the cost estimate results. PAG Analysts will carefully consider expert judgments or assumptions.

Verification: Information presented must be verifiable by the PAG Analysts. The PAG Analysts will check databases that were used to verify the technical parameters of the cost elements.

Validity: Information presented must be correct, justifiable, and well referenced. The PAG Analysts will review the ground rules and assumptions.

Accuracy/Consistency: Information presented is well organized, cohesive, supportable, easily understood, and follows generally accepted estimating processes.

Completeness: Information presented must contain all necessary data, assumptions, and pertinent information.

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Schedule Assessment Table

The Schedule Assessment Table below was developed using key points from the NASA Schedule Management Handbook (NASA/SP-2010-3403). This table can be used by the schedule analyst and the SRB to rate the P/p schedule and schedule management processes.

The rating scheme and associated definitions used in the assessment table are as follows:

Numerical Descriptor	Definitions / Narrative Descriptor
5	All schedule related information/data required and requested is available and is fully detailed to the end of the life cycle. Schedule processes, management and schedule health attribute are fully defined. No action required to get to entrance of next milestone.
4	Schedule information/data available has sufficient detail appropriate for tracking life cycle progress. Opportunities for improvement exist and may be highly recommended; however, not mandatory at this phase/milestone/review cycle. Gaining of efficiencies is possible.
3	Schedule information/data available has detail to track development progress. Marginally acceptable for this milestone. Program/project has a plan to correct any minor deficiencies. Follow on action commensurate with time available prior to entrance of next milestone.
2	Schedule information/data lacks adequate detail to meet basic requirements for this milestone review. Information not complete, only templates exist and are not tailored, requirements identified but not addressed or quantified.
1	Unacceptable status for this milestone review. Schedule information/data does not exist.

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The column headings in the schedule assessment table below represent the project schedule elements that are assessed and the rows represent scheduling best practices found in the NASA Schedule Management Handbook (NASA/SP-2010-3403).

Project Element → / Scheduling Best Practice ↓		Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Comments
Schedule Management Tool Considerations	Functional Capabilities												
	Interface Capabilities												
	Technical Capabilities												
Pre-Schedule Development	Assignment of Project Planner/Scheduler												
	Program/Project Scope												
	Project Work Breakdown Structure												
	Project Organizational Breakdown Structure												
	Project Funding												
	Project Documentation												
	Baseline Change Log												
	Schedule Requirements												
Integrated Master Schedule Development	Task/Activity Definition												
	Task/Activity Sequencing												
	Duration Estimating												
	Resource Planning												
	Schedule Reserve Planning												
	Establishing the IMS Baseline												

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Project Element → / Scheduling Best Practice ↓		Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Comments
Status Updates and Schedule Maintenance	Status Update Accounting												
	Schedule Maintenance												
	Schedule Data Backup and Archive												
Schedule Assessment and Analysis	Levels of Insight												
	Schedule Logic Credibility Health												
	Critical Path Identification and Analysis												
	Schedule Performance Trend Analysis												
	Baseline vs. Current Comparison Analysis												
	Schedule Margin Assessment												
	Validate Cost/Schedule Integration												
	Cost/Schedule Risk Assessment and JCLs												
	Duration Compression												
	Earned Value Schedule Analysis												
Schedule Control	Baseline Content												
	Baseline Control Processes												
	Re-Planning												
	Re-Baselining												
	Current Schedule Control												
Schedule	Management Summary												

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Project Element → / Scheduling Best Practice ↓		Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Element Name	Comments
Reporting	Detailed Logic Network												
	Critical Path Identification												
	Total Slack Report												
	Schedule Risk												
	Schedule Margin Metrics												
	Performance Trends												
Schedule Data and Lessons Learned Archival	Lessons Learned												
	Historical Narrative												
	Data Statistics												
	Schedule Archives												

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Risk Management Assessment Table

The Risk Management Assessment Table below was developed using key points from the Agency Risk Management Procedural Requirements document (NPR 8000.4A). This table can be used by the schedule analyst and the SRB to determine whether the risk management requirements have been met.

Does the P/p Meet the Requirement? →		Met (Yes or No)	Metric/Comments
Risk Management Requirements ↓			
General Risk Management Requirements for the PM (Section 3.1.1 of NPR 8000.4A)	Ensure that the RIDM and CRM processes are implemented within the unit (Requirement).		
	Designate the risk manager(s) for that unit (Requirement).		
	Ensure that the designated risk manager has experience in risk and decision analysis and in the CRM process (Requirement).		
	Ensure that key decisions of the organizational unit are risk-informed (Requirement)		
	Ensure that risks are identified and analyzed in relation to the performance requirements for each acquisition of the organizational unit and risk analysis results are used to inform the source selection (Requirement).		
	Ensure, and concur in, the definition of elevation thresholds to be applied by lower-level organizational units reporting to the unit (Requirement).		
	Ensure that cross-cutting risks and interdependencies between risks are properly identified as cross-cutting and either managed within the unit or elevated (Requirement).		
	Coordinate the management of cross-cutting risks being managed within the unit with other involved organizational units; e.g., Centers, Mission Support Offices, programs, projects (Requirement).		
	Ensure that dissenting opinions arising during risk management decision making are handled through the dissenting opinion process as defined in NPR 7120.5D (Requirement).		
	Ensure that risk management activities of the organizational unit support, and are consistent with, ongoing internal control activities defined in NPD 1200.1 (Requirement).		
	Ensure that the RIDM and CRM processes are implemented within the unit (Requirement).		
General Risk	Facilitate the implementation of RIDM and CRM (Requirement).		

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Does the P/p Meet the Requirement? →		Met (Yes or No)	Metric/Comments
Risk Management Requirements ↓			
Management Requirements (Section 3.1.2 of NPR 8000.4A)	Ensure that appropriate training is provided to organizational unit staff on risk management policies, tools, and processes, and ensure that the training material is consistent with the requirements of this NPR (Requirement).		
	Ensure the development of a Risk Management Plan that:		
	(1) Is integrated into the Systems Engineering Management Plan (SEMP), when applicable per NPR 7123.1 (Requirement for program/project units)		
	(2) Explicitly addresses safety, technical, cost and schedule risks (Requirement).		
	(3) Delineates the organizational unit's approach for applying RIDM and CRM within a graded approach (Requirement).		
	(4) For each performance requirement, documents, or indicates the reference, whether its associated risks (including the aggregate risk) are to be assessed quantitatively or qualitatively and provides a rationale for cases where it is only feasible to assess the risk qualitatively (Requirement).		
	(5) Defines categories for likelihood and consequence severity, when risk characterization requires specifying risks in terms of such categories (Requirement).		
	(6) Identifies stakeholders, such as Risk Review Boards, to participate in deliberations regarding the disposition of risks (Requirement).		
	(7) Establishes risk acceptability criteria, thresholds, and elevation protocols (the specific conditions under which a risk management decision must be elevated through management to the next higher level) (Requirement).		
	(8) Establishes risk communication protocols between management levels, including the frequency of content of reporting, as well as identification of entities that will receive risk tracking data from the unit's risk management activity (Requirement).		
	(9) Delineates the processes of coordination of risk management activities and sharing of risk information with other affected organizational units (Requirement).		
	(10) Documents the concurrence of the organizational unit management to which the risk manger's organizational unit reports, including its risk reporting requirements (Requirement).		
	Periodically review the risk management plan to ensure its currency (Requirement).		

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Does the P/p Meet the Requirement? →		Met (Yes or No)	Metric/Comments
Risk Management Requirements ↓			
Requirements for the Risk-Informed Decision Making (RIDM) Process (Section 3.2 of NPR 8000.4A)	Ensure that performance measures defined for the organizational unit are used for risk analysis of decision alternatives to assist the RIDM (Requirement).		
	Ensure that the bases for performance requirements baselines (or rebaselines) are captured (Requirement).		
	Negotiate institutional support performance requirements with Center support units when required to meet program/project requirements (Requirement for program/project units).		
	Ensure that performance measures defined for the organizational unit are used to scope the unit's CRM process (Requirement).		
Requirements for the Continuous Risk Management (CRM) Process (Section 3.3 of NPR 8000.4A)	Implement the CRM process (as defined in the NPR in paragraph 3.3.2) (see also Figure 4 and associated discussion) (Requirement).		
	Coordinate the unit's CRM process with the CRM processes of organizational units at levels above and below, including contractors if applicable (Requirement).		
	Ensure that risk documentation is maintained in accordance with NPD 1440.6 and NPR 1441.1, and under formal configuration control, with a capability to indentify and readily retrieve the current and all archived versions of risk information and the Risk Management Plan (Requirement).		
	The risk manager of any given unit shall ensure that the execution of the risk identification step is thorough and consistent with the baseline performance requirements of that unit (Requirement).		
	The risk manager shall ensure that risk analyses performed to support RIDM are used as input to the “Identify” activity of CRM (see paragraphs 3.2.a and 3.2.b) (Requirement).		
	The risk manager shall ensure that the results of risk identification are documented to provide input to the “Analyze” step and to characterize the risks for purposes of tracking (Requirement).		
	The risk manager shall determine the protocols for estimation of the likelihood and magnitude of the consequence components of risks, including the timeframe, uncertainty characterization, and quantification when appropriate, and document these protocols in the Risk Management Plan (Requirement).		

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Does the P/p Meet the Requirement? →			
Risk Management Requirements ↓		Met (Yes or No)	Metric/Comments
	When a risk management decision is elevated from a lower-level organizational unit, the risk manager shall recalibrate the associated risk with respect to the requirements, thresholds, and priorities that have been established at the higher level, and enter the recalibrated risks into “Plan,” “Track,” and “Control” activities at the higher level (Requirement).		
	Wherever determined to be feasible (as documented in the Risk Management Plan), the risk manager shall ensure the characterization of aggregate risk through analysis (including uncertainty evaluation), as an input to the decision-making process (Requirement).		
	The risk manager shall ensure that analyzed risks are prioritized and used as input to the “Plan,” “Track,” and “Control” activities (paragraphs 3.3.2.3 through 3.3.2.5) (Requirement).		
	The risk manager shall ensure that the results of the “analyze” step are documented and communicated to unit management (Requirement).		
	Each organizational unit manager, supported by the risk manager, shall ensure that decisions made on the disposition of risks (including decisions regarding implementation of control measures) are informed by the risk analysis results and are consistent with the defined thresholds established in paragraph 3.1.2.c.(7) (Requirement).		
	The organizational unit manager shall ensure that only one of the following possible risk dispositions is applied to any given risk and that, depending on the risk disposition, the appropriate requirement, below, is applied (Requirement): [accept, mitigate, close, watch, research, elevate]		
	For “mitigate,” “watch,” and “research,” the organizational unit manager, supported by the risk manager, shall designate an appropriate entity to implement the disposition (Requirement).		
	The risk manager shall ensure that all risks categorized as “watch” have decision points, dates, milestones, necessary achievements, or goals identified (Requirement).		
	The risk manager shall ensure the development and implementation of a process for acquiring and compiling observable data to track the progress of the implementation of risk management decisions (Requirement).		
	The risk manager shall ensure the dissemination of tracking data to entities identified in the Risk Management Plan as recipients of these data (Requirement).		

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Does the P/p Meet the Requirement? →			
Risk Management Requirements ↓		Met (Yes or No)	Metric/Comments
	The risk manager shall ensure the evaluation of tracking data in order to advise its organizational unit management on the status and effectiveness of decisions implemented in paragraph 3.3.2.3.c (Requirement).		
	The organizational unit manager shall provide feedback to affected organizational units, including the sponsoring unit at the next higher level, on any changes in the status of tracked risks such as, but not limited to, acceptance of a risk or changing a mitigation plan (Requirement).		
	Based on the tracking data, in order to control a given risk, the risk owner shall recommend actions to the organizational unit manager and oversee implementation of risk control actions with which the organizational unit manager has concurred (Requirement).		

JCL Quality Standards

- Overarching principles: Transparent, traceable, defendable and timely (T, T, D & T)
- Project ownership (Must be able to explain and defend the product)
- Cost and schedule base-estimates must
  - Have a clear basis for the estimates
  - Include all the cost elements and schedule activities
  - Be supported by relevant data
- All possible risks, threats, liens, uncertainties, mitigation strategies and opportunities must be explicitly quantified and included in cost, schedule or both
  - Probability of occurring
  - Estimated cost, schedule (or both) consequences
- Address available annual resources
- Incorporate impacts of cost and schedule performance to date
- JCL product documentation/model must describe
  - Basis for base schedule duration and logic
  - Basis for base cost estimates

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- Risks included and basis for probability and consequences
- Risks excluded and why
- Description of JCL method used

Sample Review Questions

Example Review Questions
Adequacy of Schedule and Schedule Performance
1. Is the integrated master schedule (IMS) integrated with customer and/or partner schedules? a. Have all milestones and deliverables been identified? b. Have critical path(s) been identified? c. How is the IMS being used by the program?
2. What has been the schedule performance to date?
3. Is the current schedule margin or reserve adequate given the technical challenges and identified risks of utilizing the program or project's technical approach? a. Is the schedule reserve, if any, funded? b. Is the program likely to meet current schedule baselines?
4. Is the program or project effectively managing schedule interdependencies? a. Between projects/elements in the Program? b. Tied to projects in other NASA Programs (for example, are there technologies or designs needed that are being developed in other projects under other Programs that are needed)? c. Tied to Program outside the Agency?
5. How effective are the program or project processes for analyzing and establishing the flight opportunity schedule?
6. How effective is the program or project's independent assessment of project schedules and schedule performance?
Adequacy of Budget and Cost Performance
1. Have cost growth or budget insufficiency issues existed to date?
2. Does the Independent Cost Analysis indicate that there will be program/project success if full funding is received consistent with the program/project's estimated costs?

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3. Have the program/program's processes that ensure constituent program/project elements have sufficient financial resources as needed (including phased life cycle budgets) to meet their requirements worked effectively?
4. Are budget reserves sufficient for mission success given the program's technical approach and identified risks?
5. Does the program or project have unresolved cost threats relative to budget baselines?
6. Have the program or project's acquisition strategy and procurement approaches worked efficiently?
7. Are the cost estimates of candidate projects effectively assessed, properly evaluated and valid?
8. How effective is the program or project's business management oversight of its projects (and/or funds provided by projects to the program)?
9. Within the 5-year fiscal planning horizon, does the program have adequate resources for its constituent projects that are in implementation? a. Does the program/project have adequate reserves to manage potential project implementation cost problems? b. Is the Program or Project able to re-phase project budgets as needed and appropriate?
Adequacy of Resources other than Budget
1. Are sufficient resources, other than budget, available to the program/project when required to ensure Program/Project success?
2. Are the current workforce profiles achievable as required to ensure program/project success? a. Is the necessary workforce, with the proper skills, available to accomplish the program/project's tasks (including contractors)? b. Is sufficient workforce stability expected to exist for successful program/project execution? c. Are the planned work shifts reasonable to complete the work?
3. Do the necessary facilities and equipment identified and available to accomplish the Program/Project tasks remain available and have they been adequately planned and funded as part of the program/project? a. Are there schedule conflicts with other programs/projects or external entities?

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4. Are there adequate natural resources and materials available to accomplish the program/project tasks?
5. Is the appropriate level of program/project support, expertise, and other resources being provided projects in a timely and effective manner? Does the timeliness of program/project decisions meet project needs?
6. Are supporting mission directorates, NASA Centers, and other organizations (including international partners) allocating appropriate resources to meet the program/project's requirements?

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APPENDIX C BASIS-OF-ESTIMATE BEST PRACTICES

The following section is based on information provided from the following references:

(1) Association for the Advancement of Cost Engineering (AACE) International Recommended Practice No. 34R-05, Basis of Estimate, Total Cost Management Framework: 7.3 – Cost Estimating and Budgeting, May, 2007

(2) Documentation Guidance for FAA Cost Estimates (Cost Basis of Estimate [BOE]), Investment Cost Analysis Branch, ASD-410, Federal Aviation Administration, Version 1.0, January 2003

A Basis of Estimate (BOE) is a required component of cost and schedule estimates which describes the scope of work to be accomplished under a set of given assumptions. The template outlined in the following sections provides guidelines for the structure and content of a BOE. When prepared correctly, an experienced analyst can use the BOE to understand and assess the estimate and with supporting documentation be able to recreate the estimate. A well-written BOE achieves those goals by clearly and concisely documenting the estimate being prepared. Specifically it should include as a minimum the scope, pricing basis, schedule duration basis allowances, assumptions, exclusions, risks, and any deviations from standard practices. In addition the BOE is a documented record of pertinent communications that have occurred between the estimator and the project.

A well prepared BOE will:

- Document the overall project scope.
- Establish the baseline for scope, quantities, cost and schedule for use in trending over time.
- Facilitate the review and validation of the cost and schedule estimate
- Provide the historical relationships between cost and schedule estimates throughout the project life cycle.
- Alert the program or project team to potential cost and schedule risks.
- Provide a record of all documents used to prepare the estimate.

It is understood that not all organizations that prepare estimates employ the same processes and practices, and therefore, may deviate either in part or in its entirety. However, the information should be documented or be referenced in some form.

RECOMMENDED PRACTICE

The primary intent of this appendix is to provide a guideline for the topics and contents to be included in a typical BOE. Before describing the template contents there are a few significant considerations. The Analyst will note that:

The BOE establishes the context of the estimate, and supports review and validation.

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- Be able to support your facts and findings.
- Describe the tools, techniques, estimating methodology, and supporting data
- Identify other projects that were referenced or benchmarked during estimate preparation.
- Develop the cost/schedule estimates and the BOE concurrently.

LEVEL OF DETAIL IN THE BASIS OF ESTIMATE

It is often not a simple matter to determine just how much detail should be provided in a BOE. Several factors may come into play during the preparation of the estimate that will help determine the required level of detail. Estimates are prepared at various stages of a project. A more detailed estimate will generally require a more detailed BOE; however that is not always the case. A conceptual estimate will probably be based on a limited amount of scope but may require a more detailed basis of estimate. It's not uncommon for a conceptual estimate BOE to be more thorough than one prepared for a more detailed estimate because there are often more assumptions made at the conceptual stage of a project that require greater documentation. Conversely, there may be times when the project definition is so complete it could be sufficiently referenced or so simplistic that a BOE does not require a great amount of detail. A three or four page document may be sufficient to convey the BOE. Typically, a more expensive a project will require a more detailed BOE. However, projects of lesser cost can require an extensive BOE to fully communicate major assumptions that constrain or reduce the cost particularly for high visibility for program or projects.

BASIS OF ESTIMATE CONTENT

The following describes the suggested topics and contents included in a typical BOE.

Scope Description

Provide a brief concise description that identifies the scope of the estimate. List or provide reference to the WBS elements covered by the estimate. Describe the timeframe covered by the estimate. A semi-detailed description [or appropriate references] of the scope of work should be provided for each major segment of the project. Provide the organizational structure and identify the physical location(s) where the work is to be performed. Identify any costs that are excluded from the estimate. Examples of excluded costs may include costs that have been covered by other programs or projects, costs covered by other government agencies, or sunk costs. Indicate any primary trades, if any that are included in the estimate.

Technical Description

Provide a brief technical description of the system (or appropriate references). In this section, the estimator will identify the types and status of engineering and design deliverables that were provided to prepare the estimate including any design basis assumptions. Design heritage assumptions for hardware and software cost elements

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should be identified and supported by rationale. Attachments to the estimate basis that could be referenced could include the requirements document, specifications, master equipment list (MEL), list of deliverables, design drawings, operations concept, etc. The MEL should designate mass with and without margin including a clear definition, method, and justification. Mass, power, Software Lines of Code (SLOC), and other technical performance margin assumptions for hardware and software cost elements should be identified and explained as well.

Planning Basis

The overall planned schedule with activities and key milestones should be provided. This section documents the project management, engineering, design, procurement, fabrication, testing and construction approaches to the project. The schedule should include activities that cover all of the major life cycle phases including design, development, production, integration and test and operations, major procurements by fiscal year, the number of flights per year or manifest assumed, etc. The contracting and resource strategies should be identified, as well as any assumptions that were made with regard to the workweek schedule (hours worked per days, days worked per week, shifts worked per day, etc.) and planned use of overtime. Any assumptions made regarding facilities, construction, lease, or use of specialized construction equipment should also be noted here. Funded schedule reserve margin will be identified to verify sufficient resources to meet NASA guidance.

Methodology

The BOE should indicate the estimating methodology used to prepare the cost and schedule estimates for each WBS element. The BOE should describe the derivation of its estimated cost and schedule in sufficient detail to allow an independent reviewer to determine whether the estimate is complete, accurate, and realistic. The estimate should identify one or more of the following methods and supporting data for each WBS element:

Time and Materials Estimates

Workforce or Labor – For labor hours, Full Time Equivalents (FTEs), or Work Year Equivalents (WYEs), the BOE should describe in detail how the effort and the duration were determined.

Provide direct wage rates for associated labor described above and identify the source

Provide indirect rates for associated labor described above and identify the source

Materials – The BOE should list the material or procurements and source of price estimates:

Catalog Price and Source

Vendor Quote (include name, validity date)

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Firm Price

ROM estimate

Not to Exceed (NTE) estimate

Delivery Date

Minimum Lot Buys

Subcontract Estimates

The BOE should describe the work to be performed and how the price was determined

Vendor Quote (include name, validity date) and contract type

Firm Price

Rough Order of Magnitude (ROM) estimate

NTE estimate

Delivery Date

Analogy with previous subcontract

Provide any crosschecks used

Indirect Rates applied to material purchases

Parametric Estimates

The BOE should describe any Cost or Schedule Models used and how they were applied

Provide input assumptions for all model inputs

Source documentation

Model runs

The BOE should describe any Cost Estimating Relationships (CERs) used, their source, and how they were applied. It should also provide the basis for estimating the durations of schedule activities, assumptions of when key milestones should occur if they are not calculated based on schedule logic and durations.

Provide input assumptions

Source documentation

Complete CER equation form including all variables, coefficients, and adjustment factors applied

List of historical data points included in CER underlying database

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For each independent variable, range of values covered in the historical database, or better yet, the mean and standard deviation of the values in the database

Factor Estimates

The BOE should describe any factors or percentages used including the base for calculations and the source for the factor

Analogy Estimates

The BOE should describe the analogous system(s) and explain how and why it was used, explain any scaling or adjustments made to the data for the analogy. Document any historic schedule plan/actual data from analogous missions or projects that was used in the estimate

Engineering Judgment

The documentation should describe the thought process and justification for an Engineering Judgment type of estimate

Facility Estimates

Construction – The documentation should describe the facility to be built, modified, or reconditioned, and basis for the estimate

The description of the facility should include at a minimum the footprint size in square feet, volume, and any unique requirements for the facility. Unique requirements could include power and commodities required and any requirements for hazardous operations, clean rooms, and support equipment and a quantification of the requirements.

Usage – The documentation should describe the facility and basis for the estimate

Training Estimates

The documentation should describe the type of training required and basis for the estimate

Transportation Estimates

The documentation should describe transportation required and basis for the estimate

Travel Estimates

The documentation should describe the travel required and basis for the estimate

Time Phasing

The documentation should describe the analytic approach and justification to distribute costs over time.

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Specify the phasing methodology (i.e., 60% cost in 50% time, ramp-up/down percentages if applicable, level of effort tasks with constant funding each year, etc.).

Include a discussion of the sensitivity of cost to schedule. The documentation should describe how the costs would be expected to behave if there was a schedule slip or compress. Also, it should describe if there are any standing army or large fixed cost effects.

Risk Adjustments

The documentation should describe any adjustments made to the estimate based on the project risk list. Further, it should identify any quantified risks included in the cost and schedule estimates and provide a rationale for all risks excluded from the project technical, schedule, or cost baseline.

Aggregated Results

The documentation should describe how various cost estimates are aggregated into summary tables

Also, it should show how individual results for all BOEs sum into a total program/project cost matrix that can be compared to the budget on a fiscal year-by-fiscal year, line item-by-line item basis (see “Comparison Traceability to Budget” under Section 6.9).

SPECIAL CONSIDERATIONS

Allowances

The BOE should properly identify the level and types of allowances used in the estimate. Also, it should properly describe the basis for the common estimating allowances such as minimum lot buys, material take-off allowances, overbuy allowances, yields, design allowances for engineered equipment, and sparing.

Special Assumptions

Included in this section are any other assumptions made by the estimator but not documented elsewhere in the estimate. This may include such assumptions as an adequate labor supply being available, adequate funding available, etc. Small assumptions can change into major assumptions throughout the life of the project.

For example, the BOE can include any EVM data that supports any assumptions made at any major milestones (Preliminary Design Review (PDR), Critical Design Review (CDR), etc.). EVM will indicate if the project is accomplishing what was planned (within schedule and budget). If the project is over-budget or behind schedule, their estimate-to-complete should be adjusted accordingly, and be traceable back to their assumptions that were violated or unforeseen technical issues, etc.

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Exclusions

The BOE should document all potential items of cost which a reviewer might associate with the project, but for which no costs have been included in the estimate.

Exceptions

The BOE should identify any anomalies or variances to their standard estimating practices. This section should document any significant deviations from the project and/or engineering deliverables normally required for the applicable class of estimate.

RISK ANALYSIS

Summary of how the standard methodologies were adjusted for cost estimating, technical, schedule, and other risks.

Description of any risk analyses conducted (e.g., Monte Carlo simulation, identification of risk mitigation strategies) including probability distribution assumptions and how their results were used to create the probabilistic estimate.

If a formal risk analysis study has been prepared, then it should be described (e.g. methodology, technique, etc.). In particular, this section should identify those cost elements that have been identified with high or very high risk or opportunity values.

A risk analysis report (or summary) should be provided as a reference or an attachment to the BOE. Any allowance for anticipated changes in scope or to cover the costs for items that may be required that have not yet been specifically identified (known unknowns) but are included in the current project scope, should be identified and documented here. This is typically referred to as management reserve.

Description of the process used to distribute risk dollars among WBS elements and over fiscal years. It should show a comparison of the program operating plan cost estimate to the expected NASA Obligation Authority (NOA) including carryover funding by year.

Statement to the fact if the risk analysis specifically excludes changes in project scope, and unforeseen major events such as earthquakes, prolonged labor strikes, etc...

The resultant cost risk assessment should be expressed as a cost risk reserve in addition to the point estimate.

BENCHMARKING, QUALITY ASSURANCE, AND TRACEABILITY

Benchmarking

The BOE should document any comparisons of overall estimate with similar past projects, historical data, and industry data. Any projects used in the benchmark comparisons should be similar in process type and overall value. If significant variations of the estimated project costs and or durations versus the benchmarks exist, those

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inconsistencies should be identified and commented upon. A more detailed benchmark analysis report may be referenced or included as an attachment to the BOE.

Estimate Quality Assurance

The BOE should identify all estimate reviews or independent estimates that have taken place to date. Results including any BOEs that should be attached or referenced.

Comparison Traceability to Previous Estimate

The BOE should provide an overview of the major differences between the current estimate and the last published estimate prepared for this project. Also, it should identify the cost and schedule impacts due to scope changes, different assumptions, pricing updates, budget constraints, labor, productivity adjustments, estimate refinement, etc. A more detailed reconciliation or cost trending report should be provided as an additional attachment if necessary. This should be presented on an annual and total basis.

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ATTACHMENT C-1 SAMPLE BASIS OF ESTIMATE EVALUATION FORM

WBS Number	WBS Level	WBS Element	Formal BOE	Traceable	Defined Scope/ Baseline	Schedule Durations	Estimating Methodology	Basis Provided	Complete	Accurate	Realistic	Time Phasing	Risk Methodology	Discrete Risk Analysis	Comments
123456	1	Project	- - - - -	- - - - -	- - - - -	- - - - -	Summation	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
123456	2	Project Management	- - - - -	- - - - -	- - - - -	- - - - -	Summation	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
123456.0	3	Project Management	G	G	Y	R	Time & Materials	G	G	Y	R	G	R	G	
123456.0	3	Business Management					Time & Materials								
123456.0	3	Risk Management					Time & Materials								
123456.0	3	Procurement Management					Time & Materials								
123456.0	3	Facilities Management					Time & Materials								
123456	2	Systems Engineering	- - - - -	- - - - -	- - - - -	- - - - -	Summation	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
123456.0	3	Systems Engineering Management					Time & Materials								
123456.0	3	System Requirements					Time & Materials								
123456.0	3	System Interface & Configuration					Engineering Build-Up								
123456.0	3	System Verification and Validation					Time & Materials								
123456.0	3	Trade Studies					Time & Materials								
123456.0	3	Systems Risk Management Plan					Time & Materials								
123456	2	Safety and Mission Assurance	- - - - -	- - - - -	- - - - -	- - - - -	Summation	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
123456.0	3	Safety & Mission Assurance Management					Time & Materials								
123456.0	3	System Safety					Time & Materials								
123456.0	3	System Reliability					Time & Materials								
123456.0	3	Quality Assurance					Time & Materials								
123456.0	3	Environmental Safety					Time & Materials								
123456	2	Science and Technology	- - - - -	- - - - -	- - - - -	- - - - -	Summation	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
123456.0	3	Science and Technology Management					Analogy								
123456.0	3	Science Requirements					Analogy								
123456.0	3	Science Development					Analogy								
123456	2	Payloads	- - - - -	- - - - -	- - - - -	- - - - -	Summation	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
123456.0	3	Payloads Management					Time & Materials								
123456.0	3	Payloads Requirements					Time & Materials								
123456.0	3	Payload #1 Development	- - - - -	- - - - -	- - - - -	- - - - -	Summation	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
123456.0	4	Payload #1 Subsystem #1 Development					Analogy								
123456.0	4	Payload #1 Subsystem #2 Development					Analogy								
123456.0	3	Payload #2 Development	- - - - -	- - - - -	- - - - -	- - - - -	Summation	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
123456.0	4	Payload #2 Subsystem #1 Development					Parametric CER								
123456.0	4	Payload #2 Subsystem #2 Development	- - - - -	- - - - -	- - - - -	- - - - -	Summation	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
123456.0	5	Payload #2 Subsystem #2 Component #1 Development					Parametric CER								
123456.0	5	Payload #2 Subsystem #2 Component #2 Development	- - - - -	- - - - -	- - - - -	- - - - -	Summation	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
123456.0	6	Payload #2 Subsystem #2 Component #2 Part #1 Development					Engineering Build-Up								
123456.0	6	Payload #2 Subsystem #2 Component #2 Part #2 Development					Engineering Build-Up								
123456.0	3	Payload Systems Integration & Testing					Analogy								
123456	2	Spacecraft	- - - - -	- - - - -	- - - - -	- - - - -	Summation	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
123456.0	3	Spacecraft Management					Factor								
123456.0	3	Propulsion					Analogy								
123456.0	3	Architecture					Parametric CER								
123456.0	3	Avionics					Parametric CER								
123456.0	3	Thermal Control					Parametric CER								
123456.0	3	Software					Parametric CER								
123456	2	Mission Operations	- - - - -	- - - - -	- - - - -	- - - - -	Summation	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -

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APPENDIX D INDEPENDENT SCHEDULE ASSESSMENT AND SCHEDULE RISK ANALYSIS PROCESS

Background

The schedule assessment consists of three processes: schedule health/quality check, the schedule analysis, and the integrated cost and schedule probabilistic risk assessment. All members of the SRB will provide input to the schedule assessment and the schedule risk analysis.

There is a particularly close relationship between the Cost Analyst (CA) and the Schedule Analyst (SA) both of whom are responsible for the Integrated Programmatic Assessment (IPA). It is important that the SA and the cost estimator work together from the beginning of the SRB review cycle to ensure that the results of their stand alone products can be integrated during this phase of the analysis. Assumptions about workforce and materials, rates and procurement costs and how they will be applied to the schedule simulation model must be agreed to very early on.

The Review Manager (RM) will facilitate the communication between the SA and the SRB and Project as necessary. The IPAO Lead SRA will provide oversight of the activities and will review the schedule assessments/analysis.

The Kick off meeting should stress the importance of early analysis to have a successful site review (i.e. the use of the STAT tool; negotiate data date to be used for assessment; review schedule for IPA/Terms of Reference (TOR) (planned and completed task dates)).

Schedule Assessment Process

Overview

Schedule assessments are performed to determine if the schedule submitted by the P/p has been developed using standard best practices per the Government Accounting Office (GAO) and the NASA/SP-2010-3403, NASA Schedule Management Handbook. The schedule logic, activity durations and availability of resources will be assessed to determine the potential impact on schedule uncertainty. P/p schedule management policies and practices will also be assessed to determine if current analytical tools are being utilized and whether adequate reports and information can be provided to managers to make informed decisions.

Schedule Assessment Criteria

Per the latest version of NPR 7120.5 the project schedule products can be at different levels of maturity throughout the life cycle. The questions to be asked and the criteria for judging the answers should be based on where the project is in the life cycle and these requirements:

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"Adequate" Criteria at Each Phase

Pre-Phase A – Conceptual Studies' schedules should include major development and integration milestones representing: key milestones, project reviews, integration points, external and internal interfaces, and deliverables. The Pre-Phase A – IMS has minimal detail with the exception of the concept studies which should contain detailed schedule plans. Phase A – Concept and Technology Development preliminary schedules should have significantly more detail than the Pre-Phase A schedules. Milestones should have predecessor and successor activities. A preliminary critical path should be identifiable; there should be reasonable slack on the activities. Funded schedule reserve should be included and resources should be identified. The phased schedule should be synchronized with the project phase budget. Preliminary requirements by subsystem, remaining trade studies, preliminary and final design by subsystem, long lead procurements, preliminary systems engineering products, preliminary safety and mission assurance products, fabrications by subsystem, subsystem and system integration flow, subsystem and system testing , documentation development, flight simulations software development and deliverables, hardware development and test, test operations development for ground and flight should all be identified in the schedule during Phase A.

From the beginning of Phase B and on, the schedule should have adequate detail for the near-term period of approximately one year. Durations should not exceed one month. A rolling wave approach for planning the out-years may be used providing that the total scope of the project is identified within the schedule and that all WBS elements are included. Durations for the out-year planning phases can be further decomposed as the schedule matures. Phase B – Preliminary Design & Technology Completion baseline schedules are the foundation for measuring project schedule performance throughout implementation. Reporting and other schedule management criteria should be in place and in practice by the project. Regular status updates, reporting and performance analysis should be taking place in the project office. The schedule should be detailed enough to accommodate the collection of actuals (time and cost) at the appropriate WBS level. The IMS will receive final baseline approval at the end of Phase B. The baseline will then serve as the EVM performance measurement baseline.

Phase C – Final Design and Fabrication: In Phase C, the schedule should focus on completing the final design and on releasing drawings for detailed and component level designs. Fabrication tasks should identify the work required for developing the hardware. Specific tasks include: software functional design, coding, debugging, unit tests, integrated testing, software verification and validation, and IT hardware development, integration, and test. Product deliverables and interfaces (hand-offs) to hardware assembly and systems integration should be detailed in the schedule.

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Phase D – System Assembly, Integration & Test: Phase D schedule focus should be on requirements verification for hardware and software components to be assembled and then integrated into subassemblies, subsystems, and system reflecting the work required for final assembly, integration and test. Tasks for quality assurance, final systems acceptance reviews, finalization of operations procedures, operations training and certification should be scheduled. All hardware deliveries for launch should be identified. Pre-launch work should be verified and completed by the Flight Readiness Review in support of KDP-E.

Phase E – Launch Operations and Sustainment: The focus of the schedule for Phase E is the definition of tasks for execution of the Mission Operations Plan: final verification and validation reports, flight readiness reviews, final processing of launch hardware, ground operations, service preparation for launch, launch activities through achieving operational orientation, or-orbit activities relating to mission tracking, commanding, telemetry, trajectory, systems analysis, mission payload initialization sustainment.

Phase F – Decommissioning: The focus of the schedule for Phase F should be on de-orbit preparation and execution, abandonment of in-place flight hardware, recovery of project assets, data/equipment disposition and storage, final environmental impact disposition and resolution, lessons learned, contract closeouts, and final public education and notification of reporting.

Schedule Health/Quality Check

The health/quality of the critical path method schedule, with respect to schedule structure and maintenance, is reviewed by criterion established by the Defense Contracting Management Agency (DCMA): schedule logic, leads, lags, relationship types. hard constraints, high float, negative float, high duration, invalid dates, resources, missed tasks, a critical path test, the critical path length index, the and the baseline execution index.

The DCMA 14 Point Schedule Assessment (Attachment D-1) criteria may be used to perform the health check. The SA will need to verify that the meeting the DCMA criteria is adequate enough to deem the schedule “healthy.” In certain instances, even though the DCMA 14 Point Assessment criteria has been met, the schedule could still be suffering from errors that will not allow the critical path to be determined by true logic, and thus the schedule risk analysis will give erroneous results .

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The SA may also use the NASA Schedule Test and Assessment Tool (STAT) software for a top-level look at the quality of the P/p schedule. Attachment D-2 is the Schedule Health Check Software Release form that needs to be filled out and sent to MSFC to get a copy of the STAT software.

The NASA STAT tool provides a red/yellow/green assessment based on the following criteria:

- For missing predecessors, successors, less than 5% is green, from 5%-10% is yellow and greater than 10% is red; the overall rating is 20%
- For constraints and deadlines, less than 10% is green, 10% to 15% is yellow, and greater than 15% is red; the overall rating is 15%
- For tasks needing updates; the overall rating is 20%; actual starts/finishes after the status date; the overall rating is 10%; and tasks marked as milestones, 0% is green, greater than 0% up to 5% is yellow, and greater than 15% is red; the overall rating of tasks marked as milestones but have duration greater than 0 is 5%.
- For summaries with logic ties, less than 2% is green, 2%-3% is yellow, greater than 3% is red; the overall rating is 10%.
- The overall project rating is determined by assigning a numeric value to the different colors, i.e., red=1, yellow=2, and green=3.
- The numbers are summed and a weighting factor is applied to determine the final results. The average results are color coded as follows: red is less than 1.75; yellow 1.75 – 2.5; and green greater than 2.5.

Similar schedule health/quality check functions exist within software such as Primavera Risk Analysis (*previously Pertmaster*), Acumen FUSE, and Steelray Analyzer.

Once the analyst performs the health/quality check of the schedule, it is important to work with the project (scheduler) to resolve issues within the schedule network. This is an iterative process and involves ensuring that logic ties are correct and that constraints are only being used to lock early dates in place as they will need to be removed when performing the integrated cost and schedule probabilistic risk assessment.

The objective is to resolve as many of the health check issues as possible with the project so that the schedule model used for the risk assessment will provide the most accurate dates and a true critical path. Issues should be resolved by the project within their schedule so that the corrections are made in the project's network and not in a schedule model that will not be used to manage the project.

The schedule health/quality check analysis should be accomplished within the time period prescribed by the IPA Timeline. Any issues that are not resolved within the time period outlined should be reported to the PAG Lead. The final STAT health/quality check should be documented in the IPA presentation and report. The overview of the

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initial health check, the final health check and details of the final health check should be included as an appendix in the IPA.

Schedule Analysis Process

The process of determining the schedule validity and performance is accomplished by reviewing and evaluating the schedule to determine if it meets the GAO nine point best-practices criteria.

1. All activities must be defined using the Work Breakdown Structure(WBS) at some level of detail. This is validated by reviewing the project scope, requirements and WBS to ensure that all elements in the WBS and the entire scope of the P/p are accounted for in the schedule
2. All activities must be sequenced and related using network logic. The schedule should be horizontally and vertically integrated. Key interface points must be defined.
3. The activities must be resource-loaded with labor, material, and overhead.
4. The duration of each activity must be estimated, usually with reference to the resources to be applied and their productivity, along with any external factors affecting duration.
5. The P/p master schedule and critical path must be defined.
6. Total float/slack, the amount of time a task can slip before affecting the critical path, for activities must be calculated.
7. A schedule risk analysis must be run for larger, more complex, important, or risky programs.
8. The schedule should be continuously updated using logic and durations to determine dates.
9. The schedule should be analyzed continuously for variances and changes to the critical path and completion date.

Schedule performance trends, such as the following, can be analyzed to determine how well the project is performing.

- Schedule Performance and Work-off Trends
- Cumulative Baseline vs. Actual Task Finishes and Baseline Execution Rate
- Schedule Performance Efficiency Analysis
- Linear Projection of Actuals Based on Schedule Performance
- Total Slack Trend Based on Schedule Performance
- Baseline Schedule vs. Current Schedule

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- Assessing the schedule margin
- Correlating and validating the cost and schedule
    - Assessing Resources (Histogram of Over allocated resources)
- Performing earned value schedule analysis

Schedule Risk Analysis

Overview

Once the analyst has completed the schedule assessment and analysis, it is time to start schedule risk analysis. The schedule risk analysis will be performed to determine the impact of technical or programmatic risks and uncertainties (that are uncovered during the schedule assessment or identified by the P/p or Standing Review Board (SRB) members) on the ability of the P/p to execute the schedule as planned. The combined uncertainty and risk analysis will be used to support recommendations for the amount of funded schedule reserve the P/p should be carrying. In accordance with the GAO, the schedule risk analysis aims to answer 11 fundamental questions:

1. Does the schedule reflect all work to be completed?
2. Are the P/p critical dates used to plan the schedule?
3. Are the activities sequenced logically?
4. Are activity interdependencies identified and logical?
5. If there are constraints, lags, and lead times, are they required, and is documentation available to justify the amounts?
6. How realistic are the schedule duration estimates?
7. How were resource estimates developed for each activity and will the resources be available when needed?
8. How accurate is the critical path and was it developed with scheduling software?
9. How reasonable are float estimates?
10. Can the schedule determine current status and provide reasonable completion date forecasts?
11. What level of confidence is associated with the P/p schedule completion date? Does it reflect a schedule risk analysis and the organization's or stakeholder's risk tolerance?

Creating the Schedule Risk Model

This work should begin as soon as the P/p has delivered its final data drop (i.e. 60 days prior to the Site Review). The final data drop will include updates of all data drop items, but most importantly the updated, "healthy" schedule and the updated risk list. The SA will use these items as the basis for the schedule risk analysis model. However, if the P/p schedule does not pass the initial health check, or the P/p does not have an appropriate schedule, the SA will develop a model using P/p data. The model should replicate the behavior or the P/p schedule including the critical path. It should be built at

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a level of detail that allows the identified risks to be logically linked/mapped to the affected tasks.

The model can be created using a variety of Monte Carlo simulation tools, including but not limited to: Primavera Risk Analysis, Palisade's @Risk for MS Project, Deltek's Risk +, and Intaver Institute's RiskyProject. Before work starts, the SA will obtain approval on tool choice from the Lead SA.

Any assumptions or minor adjustments that need to be made to the schedule due to the import process from the scheduling software to the analysis software should be documented and included in an appendix in the IPA report.

Constraints

In order to allow the schedule logic to drive the schedule dates, all constraints should be removed prior to running the Monte Carlo simulations. This will allow the SA to understand the impact of the uncertainty and the discrete risks on the schedule dates.

Level of Effort (LOE) Tasks

In general, level of effort (LOE) tasks, which represent support efforts (e.g. project management, administration, safety and mission assurance), do not have discrete products. These tasks are measured with the passage of time, in many cases running the entire duration of the P/p, tying to the start and end dates of the P/p. These tasks should never reflect a schedule variance and thus should not have schedule risks or uncertainty tied to them in the schedule risk model. The SA should verify that LOE tasks do not appear on the post-simulation critical path.

Margin and Reserve

Margin (contingency, buffer)/Reserve is typically placed throughout the schedule where discrete risks have been identified. It may also be put at the end of the schedule to capture all those "unknown" things that may go wrong. Probabilistic analysis by the SA attempts to determine whether the current reserve/margin is adequate given the SRB assessment of the level of uncertainty and discrete risks.

Margin/Reserve artifacts may take the form of margin tasks, artificial leads and lags, or constraints. To properly model how the risks and uncertainty impact the schedule dates and to understand whether the P/p has enough reserve/margin, the reserve/margin lines in the schedule should be set to zero duration for the purpose of analysis (Margin should be removed prior to applying uncertainty distributions to tasks and prior to adding probabilistic branching for discrete risk paths). Removing the reserve/margin will maintain the logic of the schedule without inflating the risk impacts due to this extra, unallocated time being left in the schedule and pushing out the launch or lifecycle end date even further. The exercise of zeroing out the reserve/margin will pull back the launch and/or lifecycle end date by "x months." The SA needs to verify that the P/p supports that there are "x months of schedule reserve/margin in the current plan." If there are discrepancies, the SA needs to resolve them before proceeding with the analysis.

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Schedule Margin/Reserve must be funded ($$), if it isn't then it serves no useful purpose and is illusory. Thus Schedule Margin/Reserve tasks should be seen as a lien against Cost Reserves and P/p should be able to explain how many reserve dollars are allocated to any schedule reserve task embedded within the IMS. If the P/p place their schedule reserve at the end of the IMS activity it is generally easier for them to determine/justify the associated dollars amount than if they distribute it throughout the schedule. A good rule of thumb is that the dollar allocation should be equal to the planned monthly dollar burn rate (relating to that schedule path) times the number of months of planned schedule reserve. As reserves are spent down by the P/p the SA should ensure that Schedule Margin/Reserve is also reduced appropriately and any remaining still has a realistic reserve dollar allocation.

In many cases, a P/p will put a mitigation activity in the schedule, using some of the P/p margin. Because this amount of time is "dedicated" to a specific task or tasks (it will not be exchanged to perform other functions or do other work), it is no longer considered margin (it has been allocated or is a lien) and will not be removed from the schedule for the purpose of the analysis. This point needs to be made clear to the SRB, so that they understand that the amount of P/p margin has been reduced by these mitigation activities. The SA will need to document the assumptions about the reserve/margin and mitigation(s) in the IPA report.

If the SA comes to the conclusion after performing the analysis that the reserve/margin is not adequate, he/she will be able to show how much additional resources would be needed (schedule and cost, if the model is cost-loaded) to meet a particular performance confidence level.

Best Practices:

- ***Interview P/p to understand the assumptions and constraints around the margin (how it is being used in the schedule)***
- ***Remove the reserve/margin to perform the Monte Carlo analysis***

Cost Mapping

The SA will also work with the CA to tie the cost estimate to the model. The SA and CA will need to determine the appropriate WBS level for the cost mapping. This may be dependent on the level of cost and schedule information that was made available by the P/p. The cost numbers to be used in the model will come from the CA's estimate, not from the P/p.

Correlation

NASA schedules tend to have a large number of parallel tasks. This parallelism contributes to merge bias in a schedule risk analysis. This leads to an overstatement of

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the risk. Thus, there is a need to correlate schedule durations. The methodology for this is to be determined (TBD)[1].

OR…Schedule activities are inherently correlated through schedule logic.

Uncertainty

The Schedule Risk Analysis will consider schedule uncertainty, which is inherent in the schedule development process. Uncertainty will generally be a factor based on logic (does the project use constraint dates and/or logic to achieve desired end dates or to meet milestone target dates?) activity durations, resource availability, or performance-to-date (EVM data). Uncertainty does not have a likelihood value. Uncertainty is not turned "off and on" in the Monte Carlo simulation; some level of uncertainty will always be applied in the simulation based on SRB input.

The SRB will be asked to comment on the uncertainty of a given element and/or subsystem. A standard set of ranges (TBD)[2] will be provided to the SRB. The SRB will be asked to choose uncertainty values for each element and/or subsystem for the P/p. This exercise will take place at the same time as the risk scoring exercise, which is described in the next section.

The SA will take the SRB uncertainty inputs and map them appropriately in the schedule model. This activity may require communication with the P/p scheduler and/or risk manager to determine the appropriate mapping for each risk. Uncertainty should be applied to those tasks that the SRB feels are "uncertain."

Risks

The Schedule Risk Analysis will consider the discrete P/p risks that will impact the schedule if they occur. Risks are events that have some probability of occurring (likelihood) and some impact (consequence) range if they do occur.

The SA will work with project information and the SRB members to develop an appropriate risk list. All members of the SRB, including the cost estimator, will be involved in the schedule risk analysis process. Prior to scoring the discrete risks, they need to be evaluated by the SA to determine whether they are genuine risks (e.g. if there is not a discrete event that takes place to determine that the risk has measurable consequences, then it is likely some form of uncertainty) and should be included in the probabilistic assessment.

The SA will work with the RM to request SRB input to the P/p's risk list. This will occur three separate times: once immediately after receiving the P/p's final data drop (Site Review – 60 days), once again about a month prior to the Site Review, and finally on

[1] Methodologies for schedule correlation are currently being vetted within the user community and results and effects are being researched. Anticipate that this will be completed by the next release.
[2] Methodologies for uncertainty ranges are currently being vetted within the user community and results and effects are being researched. Anticipate that this will be completed by the next release.

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the last day of the Site Review. The first two instances will gauge the risks as the SRB members attend the subsystem reviews, and will allow the SA put initial risk values into the schedule model. The final input will be used for a final run of the model. The results will be added to the IPA report.

For the first risk input request, the SA will work with the RM to send the P/p's risk list to the SRB in a spreadsheet format (Attachment D-3). Each SRB member will be asked to weigh in on the likelihood scoring and consequence distribution of the risk for which they are familiar and add any new risks that they may have identified by attending the subsystem reviews. The spreadsheet contains areas for providing rationale for each of the SRB member's entries, which should be based on experience, best judgment and comparison with similar projects that have dealt with like risks. This rationale will serve as IPAO's basis of estimate for the risk values entered in the integrated model. If several SRB members weigh in on the same risk, the SA will request that the Chair coordinate reconciling the scores between the SRB members in a timely manner. In order to make the request of the Chair, the SA should work with the RM. Although the P/p should have provided a mapping of the Project-identified risks to the appropriate task (or at least the appropriate WBS number), there is an additional column that the SRB members can use to list tasks affected by the risk, if they have such insight. The SRB will be given one week to provide input to the risks values.

The SA will take the SRB risk inputs and map them appropriately in the schedule model. This activity may require communication with the P/p scheduler and/or risk manager to determine the appropriate mapping for each risk. Discrete risks should be mapped at the lowest level possible.

Running the Schedule Risk Model

After collecting the first round of SRB risk and uncertainty inputs, an initial Monte Carlo analysis of at least 1,000 iterations should be run.

The SA should look at the risk drivers (tornado chart) and try to gain an understanding of why certain risks are having greater impact on the schedule. Updated results can be obtained after receiving the second iteration of risk and uncertainty scoring from the SRB.

Briefing the Analysis Results

Analysis results from the each iteration of analysis should be included in slides for the PAG Peer Review. Specific charts that should be included in the PAG Peer Review presentation include the following (also, see IPA Report Template in Appendix G):

- SRB risk spreadsheet, showing the P/p's risks, as well as the SRB input to those risks and any newly identified risks
- A list of the risks that were intentionally left out of the analysis and rationale for why they were left out (this may be due to SRB opinion)

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- Tornado charts showing the risk drivers (sensitivity—how big, criticality—how often, and cruciality—how big and how often)
- S-curves showing the integrated cost and schedule results, including the joint cost and schedule confidence levels
- Sensitivities showing the impact to the S-curve from mitigating (turning off) specific risks (updated tornado charts should be created after turning off each risk, as the order of the risk drivers may change)
- Stochastic critical path (this can be a top level snapshot of the schedule showing the areas that appear on the critical path as a result of applying the risks through Monte Carlo simulation)

At the Peer Review, the PAG Cost and Schedule Lead Analysts may suggest changes to the model. The SA will rerun the model with the PAG Leads' input as well as the final SRB's risk inputs at the end of the Site Review. The PAG Peer Review charts should be updated with the new results and provided to the PAG Leads (Site Review + 5 days). The results will also be provided to the SRB for final comments, as well as the SRB Chair (Site Review + 10 days).

Analysis results from each iteration should be included in the Final IPA Report, which is due 20 days after the Site Review.

Integrated Cost and Schedule Probabilistic Risk Assessment (Joint Confidence Level)

The CA and SA will work together to assess the P/p's Joint Confident Level (JCL) as a result of the risk assessment, in accordance with the guidance provided to the P/p in the Schedule Management Handbook. The P/p will provide the JCL model and documented assumptions for the analysts to review.

Many reasons exist for performing a separate benchmark, such as flaws in the schedule, lack of a basis of estimate for the costs included in the model, or even modeling methodology issues. In any case where the PAG Leads feel it is necessary, a separate benchmark, consisting of an integrated cost and schedule probabilistic risk assessment will be produced by the CA and SA. Ideally, the SA would follow the same overall process laid out in the Schedule Risk Analysis Section of this Appendix. If possible, the SA would map the P/p's cost numbers in the model as an additional iteration (having already mapped the CA's cost numbers for the first iteration). This independent benchmark gives the analysts a frame of reference when assessing the P/p's JCL results without having altered too many variables..

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ATTACHMENT D-1 DCMA 14 POINT ASSESSMENT CRITERIA

Metric	What it is	Goal
Logic	Predecessors and Successors	1 ea. task
Leads	Overlap/Concurrency between tasks (negative lag)	0
Lags	Delay between linked tasks	<=5%
Relationship Types	Other than Finish to Start (FS)	>= 90%
Hard Constraints	Must start or finish & no later than	<=5%
High Float	Float > 2 months	<=5%
Negative Float	Float < 0 days	0
High Duration	Tasks > 2 months	<=5%
Invalid Dates	Forecast dates prior to or actual dates after current status date	0
Resources	Hours/Dollars for each tasks	All resource loaded
Missed Tasks	Negative completion variance	<=%5
Critical Path Test	Broken logic due to missing dependencies	No large neg. float
Critical Path Length Index (CPLI)	$\frac{\text{Critical Path Length + Total Float}}{\text{Critical Path Length}}$	>= 1.00
Baseline Execution Index (BEI)	Ratio of completed tasks to tasks planned to be complete	>= 1.00

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ATTACHMENT D-2 SCHEDULE HEALTH CHECK SOFTWARE RELEASE FORM

Date Requested:	
Software Title:	
MFS Number:	MFS #32602
Requestor Full Name:	
Requestor Company: Organization:	
Requestor Company Web Address	
Government Contract No.: Government POC: ● Name / org ● e-mail ● phone	
Requestor Mailing Address	
Requestor - Phone Number	
Requestor Email Address:	
<u>Declaration of Citizenship</u> **Example:** ***I, [your name] am a citizen of the United States of America.*** **or** ***I, [your name] hold a Green Card allowing me to live, work and conduct business in the United States of America.***	
Proposed use for requested Software?	Support IPAO SRB schedule analysis task

DISCLOSURE: The provided SOFTWARE is intended for domestic United States of America use only, and shall not be made available to any foreign national person or entity, whether inside or outside of the United States of America.

Send Schedule Health Check SW form to Ken Poole (kenneth.w.poole@nasa.gov) at MSFC.

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ATTACHMENT D-3 RISK SPREADSHEET FOR SRB INPUT

					Likelihood (% chance of occurring)			Consequence (Duration *Beyond* Already Scheduled [days])									
Risk Type Identified by Project (Cost, Schedule, or Technical)	Rank	Risk ID	Title	Statement	L	%	likelihood rationale	C	min (optimisitic)	min rationale	ml (most likely)	ml rationale	max (pessimistic)	max rationale	Risk Owner	Associated WBS #	Specific Activities Impacted
	1																
	2																
	3																
	4																
	5																
	6																
	7																
	8																
	9																
	10																
	11																
	12																
	13																

Risk Type Identified by SRB (Cost, Schedule, or Technical)		SRB-Risk ID	Title	Statement	L	%	likelihood rationale	C	min (optimisitic)	min rationale	ml (most likely)	ml rationale	max (pessimistic)	max rationale	Risk Owner	Associated WBS #	Specific Activities Impacted
		SRB-1															
		SRB-2															
		SRB-3															
		SRB-4															
		SRB-5															
		SRB-6															
		SRB-7															
		SRB-8															

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APPENDIX E INDEPENDENT COST ESTIMATE BENCHMARKING PROCESS

PURPOSE

The purpose of this Standard Operating Procedure Instruction (SOPI) is to document the Independent Program Assessment Office (IPAO) process for conducting an Independent Cost Estimate (ICE).

SCOPE

The procedure described herein applies to all IPAO employees tasked with requesting, developing or contributing to IPAO independent cost estimates. This procedure applies to all IPAO team members whether civil servant or non-civil servant.

REFERENCES

NASA Procedural Requirements (NPR) 7120.5, NASA Space Flight Program and Project Management Requirements

NASA Cost Estimating Handbook, 2004

DEFINITIONS

Advocacy Cost Estimate (ACE): Prepared by cost analysts who are a part of the project team and provide project management with an estimated cost based on translating the technical and design parameters characteristics into cost estimates using established cost estimating methodologies.

Cost Analysis Data Requirement (CADRe): The CADRe defines, and provides quantitative and qualitative descriptions of, the program characteristics from which cost estimates will be derived. As such, the CADRe ensures that cost projections developed by the program/project offices and the independent review organizations are based on a common definition of the system and program.

Full Cost Accounting: Method of cost accounting that allows for the collection and visibility of the total cost of a project/program. Full cost accounting ties all Agency costs to major activities. All costs are associated with an activity and, as a result, referred to as a cost object. There are two major categories of costs under NASA Full Cost Accounting: Direct Costs and Indirect Costs. Direct Costs include Procurements, Civil Service Salaries and Benefits, Travel, and Service Pools (Facilities, Information Technology, Science and Engineering, Fabrication, Test, and Wind Tunnel). Indirect Costs include Center and Corporate General and Administrative (G&A) costs.

Ground rules and Assumptions: A documented set of circumstances or events that are significant to the cost/schedule outcome of the system. They are based on the likely development, manufacture, operation, maintenance, support and disposal of the system. Ground rules and assumptions generally include: the scope of the estimate, number of flight units, number of test articles, base year of dollars, type of dollars, inflation indices, costs to be included or excluded, guidance on how to interpret the

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estimate properly, and clarification to the limit and scope in relation to acquisition milestones.

Independent Cost Estimate (ICE): Cost estimate developed by a source external to the project office with no conflict of interest with the project.

Work Breakdown Structure (WBS): A technique for representing all the components, software, services, and data contained in the project scope statement. It establishes a hierarchical structure or product oriented "family tree" of elements. It is used to organize, define and graphically display all the work items or work packages to be done to accomplish the objectives of the project.

Indirect Rates: Multiplier typically used by contractors to convert direct labor rates to fully burdened rates. Usually includes indirect costs such as overhead, G&A, information technology support, facilities, insurance, utilities, and others. Also known as “wrap rates” or “wraps.”

Pass-Through Cost: Generally those cost elements that the estimators have concluded that estimation of those elements do not materially add value to the cost analysis. This may be due to known or fixed costs or pricing tables where estimation does not enter the discussion.

COST ESTIMATING PROCESS

1. The lead estimator will develop an initial cost estimate that emulates the project cost using an independent methodology.
2. The cost estimator(s) will use the Work Breakdown Structure (WBS) developed by the project. The cost estimator(s) may deem it necessary to develop the estimate at a different level than the Project. If a WBS has never been developed for the project then one may need to be created.
3. The cost estimator(s) will obtain a CADRe from the project, which will be the basis for cost estimates containing the description of features pertinent to costing the system being developed and acquired. The CADRe provides a system technical description and programmatic information to create a common baseline used by the project office to develop their estimates. It is intended to have enough detail to support an ICE and represent the baseline the project is planning to.
4. For hardware estimates, the cost estimator(s) will obtain a master equipment list (MEL) from the project, which will be the basis for cost estimates containing the description of features pertinent to costing the system being developed and acquired.
5. The cost estimator(s) will establish ground rules and assumptions, which are critical in any estimate and should be clearly prominent in all documentation and presentation material that the estimator prepares. These will define the project

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clearly and enable estimators to be consistent about what costs are being included and excluded for the current estimate and future comparisons.

6. The cost estimator(s) will select the most appropriate costing methodology or approach for the project and determine the methodology for the estimate. This methodology will depend upon the type of system being estimated and the data available. Cost estimating methodologies selected will also vary depending on the phase of the project; some methodologies are more appropriate during different project phases.

7. The cost estimator(s) will collect and normalize appropriate and applicable cost and technical data for regression analysis and/or model calibration to support a methodology. Once the cost estimating methodologies and cost models are selected, the estimator(s) must gather the required data to populate the model inputs.

8. The cost estimator(s) will obtain cost estimating data inputs from the SRB to based on their independent technical assessment of the Project and identification of risks.

9. The cost estimator(s) will update the initial cost estimate with the SRB input: populate the model with data, calculate the cost, re-check formulas and data entry to ensure accuracy, and document each input and formula for the detail estimate documentation. The update will be vetted to the SRB.

10. The cost estimator(s) will develop the cost range, produce a probabilistic cost estimate, conduct a sensitivity analysis, conduct “What-if” analyses to determine the project’s cost drivers have a significant effect on the final cost which can determine design (or programmatic) parameters that require the most attention.

11. The cost estimator(s) will prepare ICE briefing material and supporting documentation to be used for internal presentations consisting of the IPAO ICE standard briefing chart format (scope, ground rules & assumptions, methodology distribution, S-curve, cost/budget track, and budget comparison) and provide applicable backup charts.

12. The PAG cost estimators will evaluate ICE analysis and products by conducting a PAG Product Quality Review (PQR). The PAG Lead will determine if revisions are required to the ICE analysis and products. If major revisions are required, the cost estimators will re-convene for another PAG PQR meeting.

13. The cost estimator(s) will participate in the IPAO PQR to be conducted per IPAO SOPI 6.0-2, IPAO Product Quality Review Process. After the IPAO PQR, the IPAO PAG Lead may determine that revisions are required to the ICE briefing package. If so, the lead cost estimator will revise the products. Upon revision, the cost estimator will brief the PAG Lead and the IPAO Director to obtain approval of changes. The IPAO Director will determine if there is a need to re-convene the IPAO PQR to review these changes. If there is no material format

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or content change, the lead cost estimator will use the final ICE for supporting and finalizing the IPA.

14. If there is a material format or content change to the IPAO quality reviewed product, the lead cost estimator will brief the PAG Lead and the IPAO Director to obtain approval of changes. Upon approval, necessary changes and updates to the ICE and IPA will be completed.

15. The cost estimator(s) will document the ICE in a final report. It will include the entire cost estimating process with standardized content and format to maintain internal consistency, promote completeness and quality. The report will be archived following the IPAO SOPI 7.0-1, Review Closeout Process.

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APPENDIX F JOINT CONFIDENCE LEVEL ANALYSIS PRACTICES

BACKGROUND

NASA NPD 1000.5 defines acquisition as the process for obtaining the systems, research, services, construction, and supplies that the Agency needs to fulfill its mission. The goal of NASA's acquisition process is to effectively and efficiently support programs and projects in meeting their programmatic, institutional, technical, cost, and schedule commitments. NASA's broad concept of acquisition means that everyone in NASA and everyone supporting NASA have a role in acquisition. It is NASA policy to base acquisition on realistic cost estimates and achievable schedules. To ensure this policy, all space flight and information technology programs will develop a joint cost and schedule probabilistic analysis and be baselined or re-baselined and budgeted such that there is a **70 percent probability** of achieving the stated life cycle cost (LCC) and launch schedule. (Applicable decision authorities may approve a different joint confidence level.) The program's or project's proposed cost and schedule baseline are to be assessed by an independent review team. The program or project is to present and justify its resulting cost and schedule to the decision authority of the responsible Agency-level management council. The independent review team is to discuss with the decision authority its key concerns with the plans and baselines proposed by the program or project. The goal of the JCL is to assist NASA in establishing budgets and schedules that will meet programmatic, institutional, technical, cost and schedule commitments.

JOINT CONFIDENCE LEVEL PROCESS

The IPAO PAG Analysts serving on the SRB independent review team will facilitate the process.

COST ANALYSIS

A cost estimate will be developed in accordance with section XX of this document

SCHEDULE ANALYSIS DATA

A schedule analysis will be developed in accordance with section XY of this document

INTEGRATION OF COST AND SCHEDULE DATA

Integration of cost and schedule is otherwise known as the Joint (Cost/Schedule) Confidence Level analysis

JCL ANALYSIS

The development of stand-alone cost estimates and integrated schedules is well understood. NASA has been providing both to management for many years. Schedules were historically determined independently of cost, and budgets were often set without consideration of schedule. However, it is desired by NASA management to have a methodology that integrates cost and schedule together to determine the

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probability that the program or project can be executed on time and within the approved budget. This methodology should assist management in setting budgets, reserves, and schedules that establish obligations with NASA's stakeholders that can be met. There are many ways of integrating cost and schedule analysis, and the methods described within this SOPI are by no means exhaustive.

JCL Issues

Cost and schedule are interrelated. Schedule slips can lead to increases in cost, as most of NASA's business is "one-of-a-kind", with high fixed programmatic costs that must be paid on a regular basis. When unrealistic schedule milestones are set, achieving these milestones can lead to increased effort and costs (overtime, tired work force, mistakes that must be corrected, etc.) On the other hand, if milestones can be achieved early, cost savings can result. It is clear that schedule is not simply an input to cost, but is dependent on many of the same factors that drive costs. Increased cost can sometimes "buy down" schedule; extra money is spent to meet a deadline. Therefore, cost and schedule are correlated; the value of one is indicative of the value of the other, and must be modeled "jointly" to establish a JCL.

Parametric JCLs

In a parametric approach to JCL, probabilistic cost and schedule distributions are generated independently. They are then combined into a joint cost-schedule distribution, avoiding "double-counting" of risk through the use of correlation matrices. Many tools are available for this approach, with a few tools shown below:

NAFCOM

PRICE

SEER

ACEIT

Crystal Ball

@RISK

MS Project

Oracle's Primavera Risk Analysis

One parametric approach to JCL is set forth by Book and Garvey. Cost risk is assessed and the top-level distribution is modeled as a lognormal (or normal) distribution. Schedule risk is assessed and the overall schedule risk is modeled as a lognormal (or normal) distribution. The two distributions are combined into a bivariate distribution by assigning a correlation between the two and by treating the two distributions as the marginal distributions of a bivariate lognormal (or bivariate normal, or bivariate normal-lognormal) distribution.

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Based on historical data from 50 NASA programs, the correlation between development cost and development schedule is 60%.

Assessment Based ("Bottoms-Up") JCLs

Assessment based JCLs normally start with a fully integrated, resource-loaded schedule. The schedule starts with a full understanding of the requirements and good communication with program management and development team. It relies on quantifying the unbiased requirements line-by-line, establishing appropriate links between activities within the schedule, resources applied to each activity, and bridging each issue/activity to programmatic functions. The schedule will indicate when what happens to one task (or tasks) is likely to happen to other(s) [a positive correlation]; what happens to one task (or tasks) is likely to cause the opposite to happen to other(s) [a negative correlation]. A good integrated schedule risk will address both of these situations and allow one to adjust task durations (which may or may not impact costs) accordingly. In this approach, the dependence relationship is structurally established through resource loading. Risk factors can be assigned to both cost and schedule to produce a JCL.

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APPENDIX G INDEPENDENT PROGRAMMATIC ANALYSIS REPORT TEMPLATE

Executive Summary [one to two page summary including a brief introduction of review coverage, any major strengths, and the major issues to include programmatic assessment criteria below covering schedule, cost, resources, risk, and performance as a minimum] [This summary is placed in the SRB report appendix]

Criteria Rating Table [This table is also placed in the SRB report appendix]

Criteria	Rating	Comments
Alignment with and contributing to Agency needs, goals, and objectives, and the adequacy of requirements flow-down from those.	G/Y/R	
Adequacy of technical approach, as defined by NPR 7123.1A entrance and success criteria, and other technical considerations.	G/Y/R	
Adequacy of the integrated cost and schedule estimate and funding strategy in accordance with NPD 1000.5.	G/Y/R	
Adequacy/availability of resources other than budget	G/Y/R	
Adequacy of the risk management approach and risk identification and mitigation per NPR 8000.4	G/Y/R	
Adequacy of management approach	G/Y/R	

Background

- Brief Project Description
- Scope [what is the scope of the review; technical content, schedule, life cycle]
- Analysis Methodology/Basis [describe the methodology used to conduct the assessment]

Alignment with and contributing to Agency needs, goals, and objectives, including the adequacy of requirements flow-down [requirement changes or issues worth noting that may affect the cost/schedule plan]

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Adequacy of technical approach, as defined by NPR 7123.1 entrance and success criteria [technical issues worthy of noting that may affect the cost/schedule plan]

- What are the technical and programmatic schedule drivers?

Adequacy of the integrated cost and schedule estimate and funding strategy in accordance with NPD 1000.5

- Estimating [Schedule and Cost]
    - Process [Assessment of the program/project process for estimating cost and schedule]
    - Basis of Estimate [Assessment of the program/project basis for estimating effort, rates, usage, costs, prices, schedule durations, uncertainty, including rationale for allocation of resources and cost to schedule activities]
- Analysis and Results [including benchmark comparisons if applicable]
    - DCMA 14 Point Schedule Assessment (Schedule Logic, Credibility Health Check)
        - What are the current Start and finish of the network?
        - What is the current status date (timenow)?
        - Are there tasks with actual start or finish after the current status date?
        - Are there tasks in progress with finish dates before the current status date? These are ones that need new forecast dates or actual finish dates.
        - What is the % of completed tasks/milestones?
        - Are tasks updated using actual starts/ actual finish or just percent complete?
        - How many of the tasks/milestones have a total float/slack over 100 days (or another threshold)?
        - How many of the tasks/milestones have a total float/slack greater than 25% of the remaining duration?
        - Are there predecessors and successors for each task?
        - Is a Finish-to-Finish (FF) or Start-to-Start (SS) constraint with leads or lags used to force start or end dates?
        - What are the constrained dates (other than As Soon As Possible, ASAP) in the schedule?

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        - What is the calendar for the schedule, does it provide time for education, holidays, vacations, sick leave, etc.?
    - Schedule/Cost Baseline Analysis and Performance Trends (Show changes from previous reviews; Show trends over the entire life cycle)
        - At the appropriate time in the life cycle, has the P/p baselined the schedule and put it under configuration control?
        - Is there a schedule baseline and is it under the change management process? If not when planned?
        - How many tasks are behind schedule based on baseline (if applicable)?
        - Has the schedule been baselined?
        - Is there a schedule change process in place?
        - Has the program/project documented its Schedule Management processes? What is the process for managing and reporting schedule information?
        - What performance trends have emerged since the baseline was established?
        - How does the current schedule compare with previous versions?
        - How has the P/p been performing to date?
    - Schedule/Cost Benchmark Comparisons [Show comparisons with past programs/projects]
    - Cost Phasing [Assessment of whether the SRB feels that the program/project has adequate funding in the appropriate years to execute the plan to the schedule]
    - Schedule/Cost Uncertainty [Assessment of whether the program or project has considered adequate uncertainty for estimating resources, costs, and durations; Show SRB input for schedule-risk and/or JCL model]
- Risk Analysis (Show Project-identified and SRB-identified cost, schedule, and technical risks that map to the IMS and the critical path)
- Budget
    - Process [Assessment of the Program/Project process for determining the budget and how it traces to any cost or schedule estimates including any “overguide” discussion]
        - What are the budget ground rules and assumptions?

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        - How are cost and schedule estimates integrated into an overall P/p budget?
        - How does the Program report budget and schedule information up the management chain?
        - Is the Program able to re-phase project budgets as needed and appropriate, and at what level is the authority given for this? Within the 5-year fiscal planning horizon, does the Program have adequate resources for formulation of new projects, the implementation of which are largely beyond the budget horizon?
    - Basis [Assessment of the Program/Project basis for determining phased budget]
        - What is the basis of estimate for the cost and schedule estimates behind the latest PPBE projections?
    - Phasing [Assessment of the Program/Project process for determining the budget phasing and how it traces to any cost or schedule estimates]
        - Is the budget time-phased, including breakdown by WBS?
        - Is the budget clearly based on the schedule and required resources over time?
- Reserves/Margins
    - Process [Assessment of the Program/Project process for determining reserves and margins schedule/cost]
        - How are liens reflected in budget and schedule including cost and schedule reserves and the basis for reserves?
        - How is the program/project managing funded schedule reserve?
    - Results [Evaluation of the reserves and margins included in Program/Project schedule/cost estimates]

- JCL [if applicable, an assessment of the Program/Project JCL process, basis of; baseline, uncertainties and risks, results and comparison with any SRB adjusted or added risks]
    - What is the current JCL process?
    - How tool is being used for the JCL?
    - Has Program JCL been completed in a previous review? If so, how does it compare with the current JCL and what are the reasons for the differences?

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Adequacy/availability of resources other than budget

- Workforce [Assessment of adequacy of resources over time including evaluation of ramp up and ramp down]
    - Are resources identified for each task? (This may be in some database rather than in a resource loaded schedule.)
    - What is the staffing history and projected future requirement/plan?
    - Does the project avoid extreme dependence on specific individuals?
    - Do you have sufficient staff to support the tasks identified in the activity network?
    - Is the staffing plan based on historical data of level of effort, or staff months on similar projects?
    - Do you have sufficient staff to support the tasks identified in the activity network?
    - Have alternative staff buildup approaches been planned?
    - Does the staff buildup rate match the rate at which the project leaders identify unsolved problems?
    - Is there sufficient range and coverage of skills on the project?
    - Is there adequate time allocated for staff vacations, sick leave, training, and education?
    - Are staffing plans regularly updated to reflect reality?
    - Are people working abnormal hours? What are the critical resources? How many of these are on the critical path?
    - Does the schedule account for resource overlap either within the project or conflicts between this and other projects for the same workforce, facilities, etc?
- Facilities [Assessment of adequacy and availability of resource such as test facilities, assembly buildings, etc. when required by program/project
    - What are potential facility/equipment conflicts?
- Partners [Assessment of any partners and potential impact to cost and schedule [plans]

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Adequacy of risk management approach and risk identification and mitigation per NPR 8000.4

- Risk Management Process [Assessment of the Program/Project Cost /Schedule Risk Analysis including basis for mitigation plans]
- SRB Risk Assessment [Process and Cost/Schedule Risk Analysis with impacts to Program/Project Plan]
    - What schedule related risks are on the program/project risk list?
    - Are there additional complexities due to number of organizations, i.e. international partners, multiple industry or center organizations, etc?
    - What are the risk mitigations, and how do they affect budget and/or schedule?
    - Does the P/p currently have any unresolved cost threats relative to the P/p's budget baselines and identified risks?
    - What is the level of uncertainty based on activity durations (project will provide their Basis of Estimate), availability of resources required to implement the work and identification/inclusion of the total program/project scope?

Adequacy of management approach

- Acquisition
- P/p Management Plans
    - P/p Plan (Schedule, Cost, Technical Plans)
        - Is there a requirements document?
        - How are the Program requirements used in the cost estimating, schedule development and budgeting projections?
    - Risk Management Plan
- Schedule Management
        - Schedule Interdependencies
            - Has each external interface been identified?
            - Have critical dependencies of each external interface been documented?
            - Has each external interface been ranked based on potential project impact?

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        - Have procedures been established to monitor external interfaces until the risk is eliminated or substantially reduced?
        - Have agreements with the external-interface controlling organizations been reached and documented?
        - Does the schedule allow for all inter-dependencies?

- WBS and WBS Dictionary
    - Are the requirements compatible with the WBS?
    - Is the WBS product oriented?
    - Is there a WBS dictionary?
    - Are all WBS items covered in the schedule? Does the schedule include all the program/project WBS elements?
- EVM
    - Process
        - Have the P/p's acquisition strategies and procurement approaches worked efficiently?
        - How does the Program track and oversee funding provided to projects? Are EVM-like systems used? How is technical progress measured against funding consumed? Are planning packages identified for work beyond 12-18 months?
        - Independent Analysis [If Applicable] How has the P/p been performing to date?
        - What are the root causes for any growth in cost and/or schedule?
- Reporting
    - Are standard reports available for review?
    - Is the schedule consistently updated at all levels on Gantt, PERT, and Critical Path charts every two weeks?
    - Are performance trends being analyzed and reported to management?
    - Who provides the schedule status? Who gets the reports? Are they used for making decisions?
    - Are standard reports generated for different levels of management?
    - Is the content of the reports adequate for decision making?

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- Do the reports give the manager a realistic understanding of the current status of the project including warning signs of *potential* problems?
- Do the standard reports include critical path assessment, plan/actual status, milestone trends, slack utilization, and reserve status?
- Does the project understand the difference between activity slack that is calculate and reserve that is determined by the project and inserted into the schedule at key risk points or at the end of the schedule?

Appendices

- ICE Benchmark [if applicable]
- Supporting Material

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Required Chart Examples

Criteria	Rating	Rationale
Alignment with and contributing to Agency needs, goals, and objectives, including the adequacy of requirements flow-down		
Adequacy of technical approach, as defined by NPR 7123.1 entrance and success criteria		
Adequacy of the integrated cost and schedule estimate and funding strategy in accordance with NPD 1000.5		
Adequacy/availability of resources other than budget		
Adequacy of risk management approach and risk identification and mitigation per NPR 8000.4		
Adequacy of management approach.		

Numerical Descriptor	Schedule Adequacy Definitions / Narrative Descriptor
5	All schedule related information/data required and requested is available and is fully detailed to the end of the life cycle. Schedule processes, management and schedule health attribute are fully defined. No action required to get to entrance of next milestone.
4	Schedule information/data available has sufficient detail appropriate for tracking life cycle progress. Opportunities for improvement exist and may be highly recommended; however, not mandatory at this phase/milestone/review cycle. Gaining of efficiencies is possible.
3	Schedule information/data available has detail to track development progress. Marginally acceptable for this milestone. Program has a plan to correct any minor deficiencies. Follow on action commensurate with time available prior to entrance of next milestone.
2	Schedule information/data lacks adequate detail to meet basic requirements for this milestone review. Information not complete, only templates exist and are not tailored, requirements identified but not addressed or quantified.
1	Unacceptable status for this milestone review. Schedule information/data does not exist.

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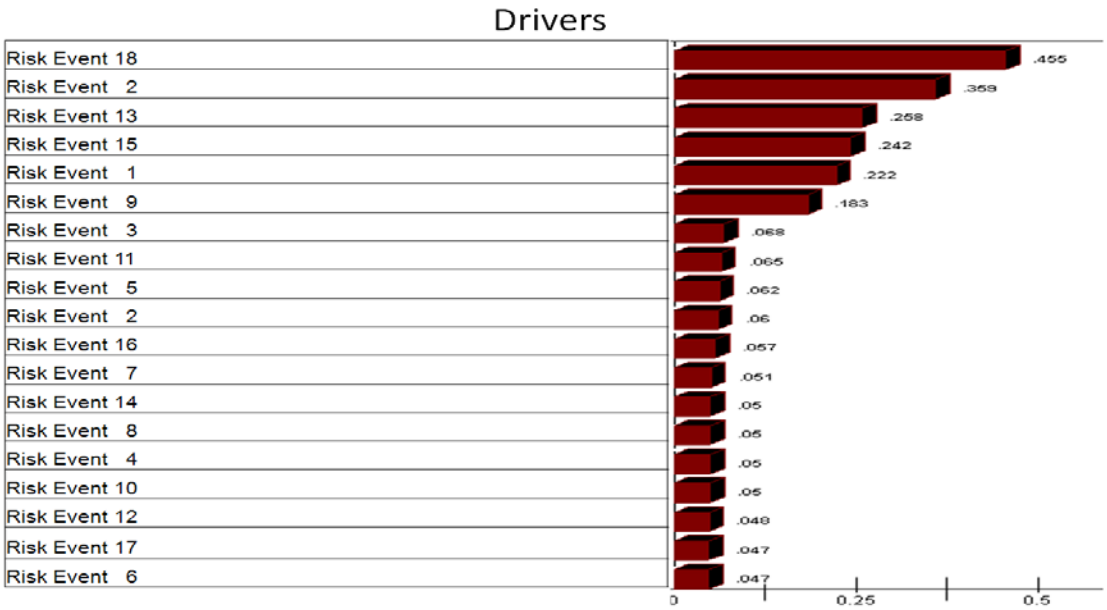
SRB Risk Analysis Impact on Plan

Baseline	mo/day/yr	$xxx	Schedule Impact Delta (days)	Cost Impact Delta (dollars)
Case	LRD 70%	Cost 70%		
All SRB Risks				
2,10,7				
Risk 2				
Risk 10				
Risk 7				
Risk 5				
Risk 8				
Risk 6				
Risk 1				
Risk 3				
Risk 4				

Tornado Chart



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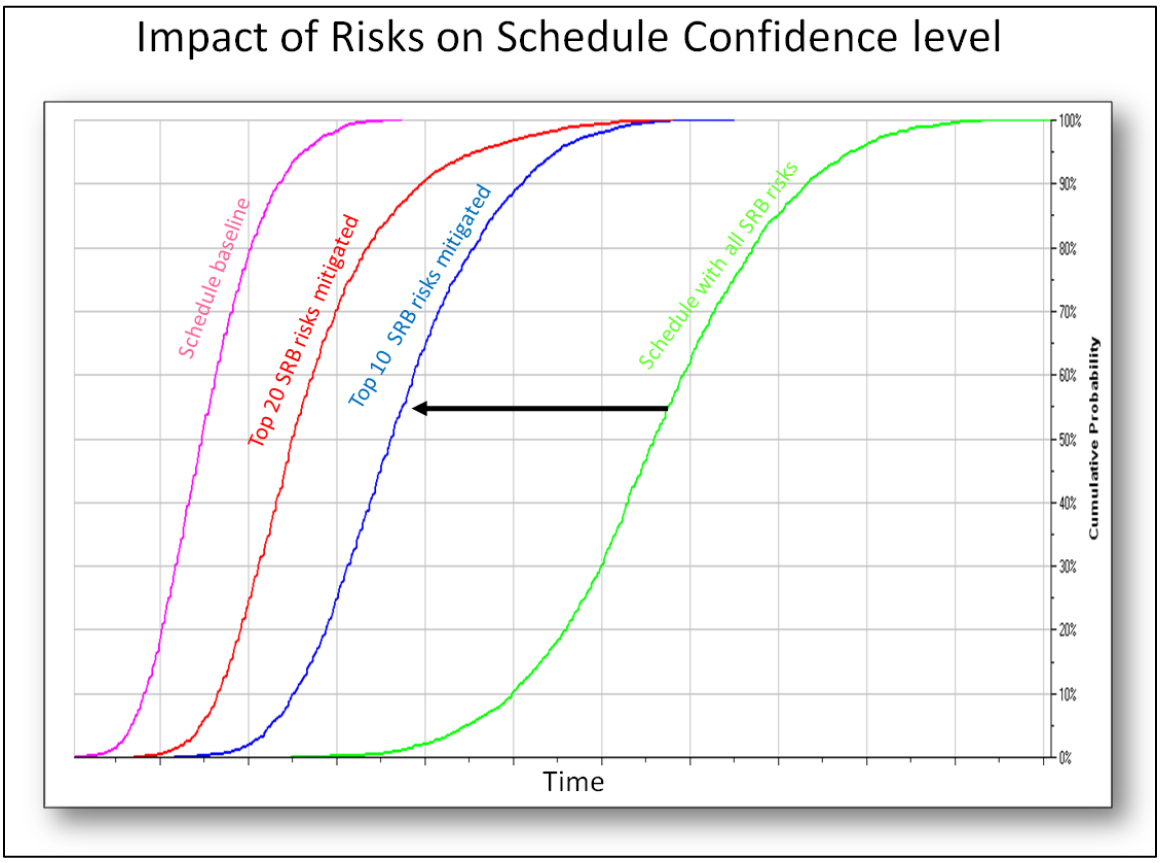

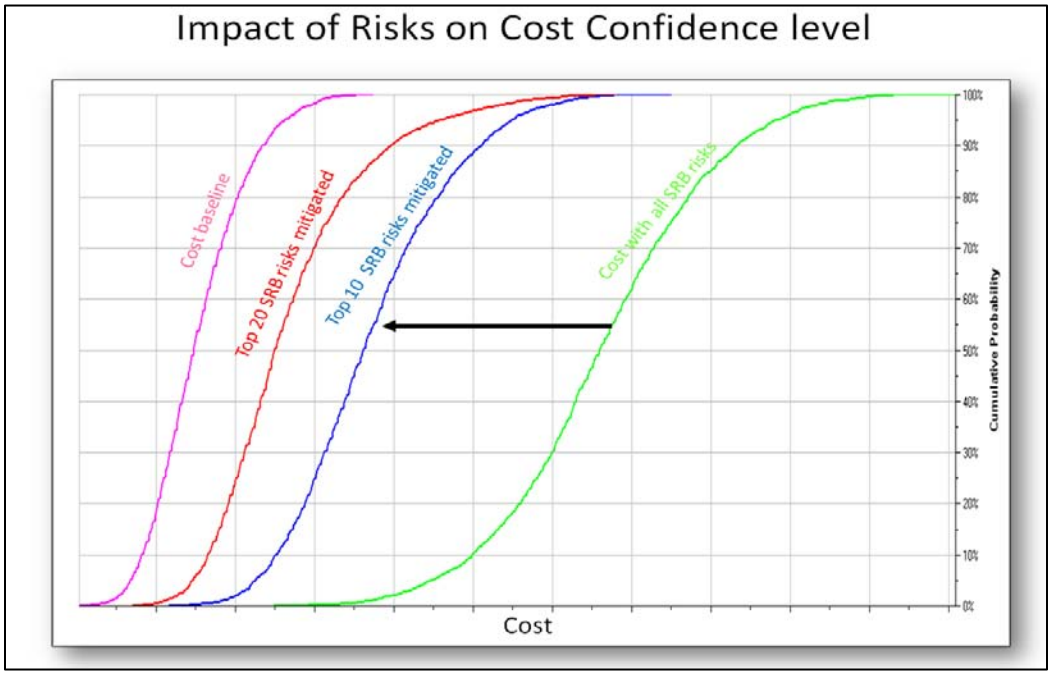

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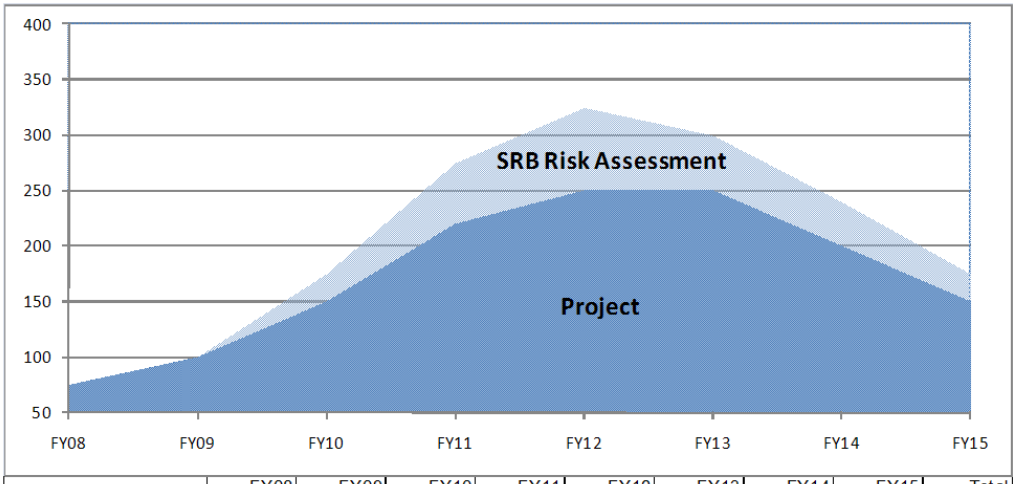
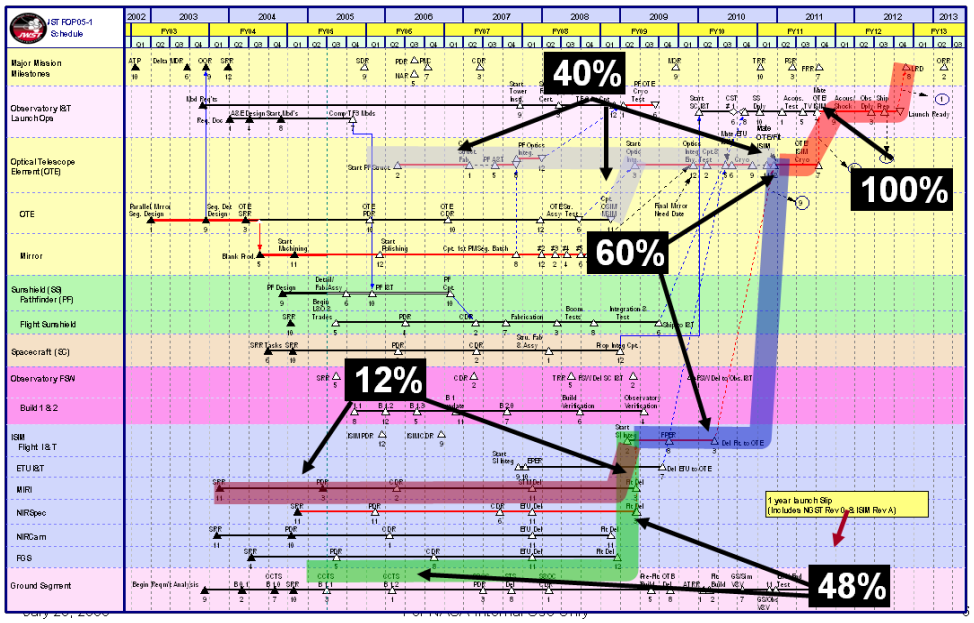
Phasing Comparison



	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	Total
Project	75	100	150	220	250	250	200	150	1395
Project with SRB Risks	75	100	175	275	325	300	240	175	1665

Risk Assessment
Stochastic Critical Path



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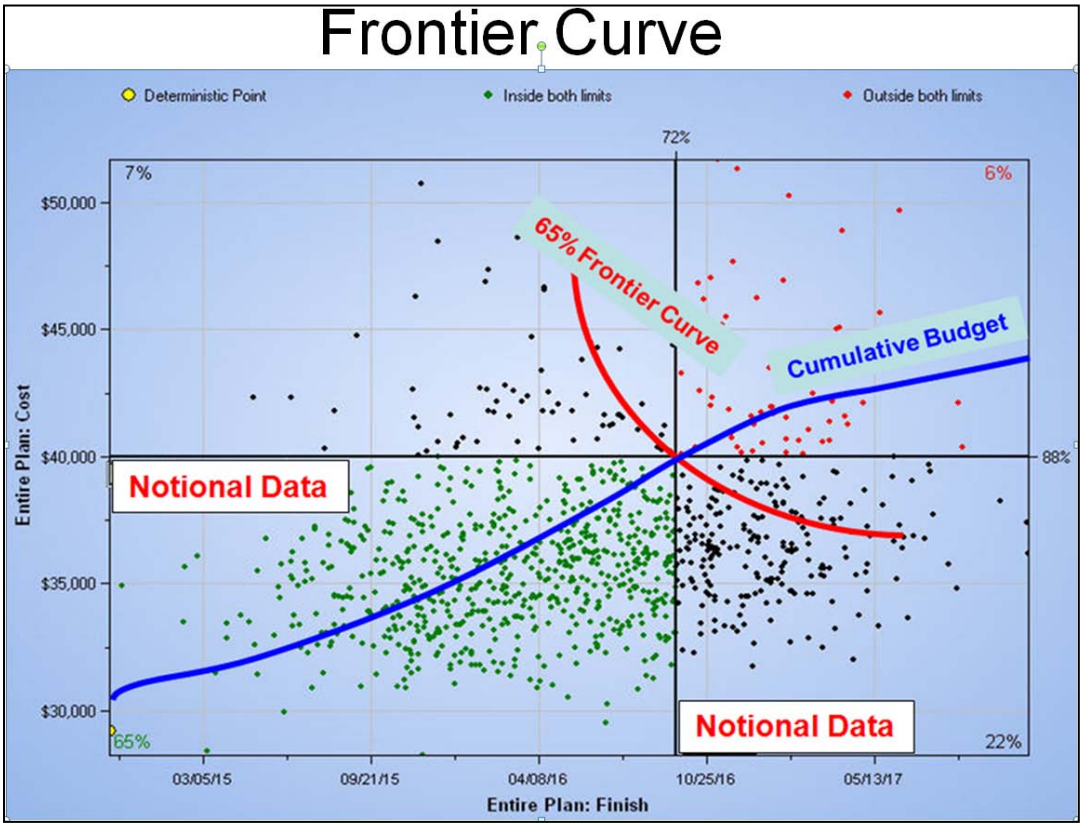

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ICE BENCHMARK REPORT TEMPLATE

(Included in ICA as Appendix when required)

EXECUTIVE SUMMARY

BACKGROUND

- GROUND RULES AND ASSUMPTIONS
- TECHNICAL BASELINE
  - TECHNICAL INPUTS
  - SCHEDULE/MANIFEST

PRIMARY ESTIMATE

- ESTIMATING WBS/DICTIONARY
- METHODOLOGY
- CERS/KNOWLEDGE BASE/COMPLEXITIES/ANALOGIES/HERITAGE
- SOFTWARE DEVELOPMENT AND MAINTENANCE
- INTEGRATION
- TEST INCLUDING ANY SPECIAL FACILITIES
- LAUNCH VEHICLE/OPS [IF APPLICABLE]
- TIME-PHASING

UNCERTAINTY ASSESSMENT/METHODOLOGY

DISCRETE RISK ASSESSMENT/METHODOLOGY

PRIMARY ESTIMATE RESULTS

SECONDARY ESTIMATE

- ASSUMPTIONS
- METHODOLOGY
- INPUTS
- RESULTS
- COMPARISON TO PRIMARY ESTIMATE

COMPARISONS

- POINT ESTIMATE COMPARISON
- TIME-PHASED COMPARISON
- RISK IMPACT COMPARISON

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APPENDIX H ACRONYMS

AA	Associate Administrator
AACE	Association of the Advancement of Cost Engineering
ACE	Advocacy Cost Estimate
AO	Announcement of Opportunity
APMC	Agency Program Management Council
BEI	Baseline Execution Index
BOE	Basis of Estimate
CA	Cost Analyst
CADRe	Cost Analysis Data Requirement
CDR	Critical Design Review
CER	Cost Estimating Relationships
CPLI	Critical Path Length Index
CPM	Critical Path Method
CRM	Continuous Risk Management
CS	Civil Servant
CV	Coefficient of variation
DA	Decision Authority
DCMA	Defense Contract Management Agency
EAG	Evaluation and Assessment Group
EVM	Earned Value Management
FF	Finish to Finish
FS	Finish to Start
FTE	Full Time Equivalent
G&A	General and Administrative
GAO	Government Accounting Office
HB	Handbook
ICA	Independent Cost Analysis

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ICE	Independent Cost Estimate
ILCR	Independent Life-Cycle Review
IMS	Integrated Master Schedule
IOC	Initial Operating Capability
IPA	Independent Programmatic Analysis
IPAO	Independent Program Assessment Office
ISA	Independent Schedule Assessment
IT	Information Technology
JCL	Joint Confidence Level
KDP	Key Decision Point
LCR	Life Cycle Review
LCC	Life Cycle Cost
LCCE	Life Cycle Cost Estimate
LOE	Level of Effort
MCR	Mission Confirmation Review
MDR	Mission Definition Review
MEL	Master Equipment List
MSFC	Marshall Space Flight Center
NAR	Non-Advocate Review
NASA	National Aeronautics and Space Administration
NOA	NASA Obligation Authority
NPD	NASA Procedural Directive
NPR	NASA Procedural Requirements
NTE	Not-To-Exceed
P/p	Program/project
PAG	Program Analysis Group
PAP	Programmatic Analysis Plan
PAR	Program Approval Review

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PBMA	Process Based Mission Assurance
PCA	Program Commitment Agreement
PDR	Preliminary Design Review
PM	Program Manager/Project Manager
PMC	Program Management Council
PNAR	Preliminary-Non-Advocate Review
POC	Point of Contact
PPAR	Pre-Program Approval Review
PQR	Product Quality Review
PRA	Probability Risk Assessment
PRM	Principal Review Manager
RIDM	Risk-Informed Decision Making
RM	Review Manager
ROM	Rough Order of Magnitude
SA	Schedule Analyst
SDR	System Definition Review
SEMP	Systems Engineering Management Plan
SLOC	Software Lines of Code
SOP	Standard Operating Procedure
SOPI	Standard Operating Procedure Instruction
SRA	Schedule Risk Analysis
SRB	Standing Review Board
SS	Start to Start
STAT	Schedule Test and Assessment Tool
TBD	To Be Determined
TOR	Terms of Reference
WBS	Work Breakdown Structure
WYE	Work Year Equivalent

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