COVER FOR
REFERENCE VOLUME

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# Section 1. NASA Specific Cost Estimating Resources

This volume provides a convenient, though not comprehensive, list of references for cost estimating. Some of these references were used in compiling this handbook; others should prove useful to the NASA Cost Estimating Community. This section is organized by resource type (e.g., NASA specific cost estimating resources versus general cost estimating resources) and by topic. In addition to the references listed below, a good locator source is the Library of Congress Online Catalog, which can be found at http://catalog.loc.gov/.

## 1.1 NASA Policy, Procedures, and Guidelines

To find NASA Agencywide directives please reference the NASA Online Directives Information System (NODIS) at http://nodis3.gsfc.nasa.gov/

### 1.1.1 NASA Policy Directives

- NPD 1001.0: NASA Strategic Plan
  http://nodis.hq.nasa.gov/displayDir.cfm?t=NPD&c=1001&s=0
- NPD 1000.0: NASA Strategic Management and Governance Handbook
  http://nodis.hq.nasa.gov/displayDir.cfm?t=NPD&c=1000&s=0
- NPD 1000.3C: The NASA Organization
  http://nodis3.gsfc.nasa.gov/displayDir.cfm?t=NPD&c=1000&s=3C
- NPD 7120.4C: Program/Project Management
  http://nodis.hq.nasa.gov/displayDir.cfm?t=NPD&c=7120&s=4C
- NPD 8700.1C: NASA Policy for Safety and Mission Success
  http://nodis.hq.nasa.gov/displayDir.cfm?t=NPD&c=8700&s=1C

### 1.1.2 NASA Procedures and Guidelines

- NPR 2830.1: NASA Enterprise Architecture Procedures – APPENDIX E: Approaches for Conducting Alternatives Analysis http://nodis3.gsfc.nasa.gov/displayDir.cfm?Internal_ID=N_PR_2830_0001_&page_name=AppendixE
- NPR 7120.5: Program and Project Management Processes and Requirements
  http://nodis3.gsfc.nasa.gov/displayDir.cfm?Internal_ID=N_PR_7120_005D_
- NPR 7123.1A: NASA Systems Engineering Processes and Requirements NPR
  http://nodis.hq.nasa.gov/displayDir.cfm?t=NPR&c=7123&s=1A
- NPR 7500.1: NASA Technology Commercialization Process
  http://nodis3.gsfc.nasa.gov/displayDir.cfm?t=NPR&c=7500&s=1
- NPR 8000.4: NASA Risk Management Procedural Requirements
  http://nodis3.gsfc.nasa.gov/displayDir.cfm?t=NPR&c=8000&s=4

## 1.2 NASA HQ Cost Analysis Division (CAD)

The Cost Analysis Division (CAD) performs various activities in support of its function as the cost estimating arm of Program Analysis and Evaluation (PA&E). The CAD provides cost estimates and analyses for potential future Agency programs and assesses available cost estimating tools to ensure that the Agency's cost estimations are continually improving and increasing in accuracy. The CAD also establishes and maintains cost analysis policy and cost estimating methodologies (with an emphasis on cost risk techniques) for the Agency and communicates these improvements to both internal and external stakeholders. These critical activities support ongoing budget analysis activities and provide leadership, guidance and policy direction for cost estimating and analysis across the Agency.

Specifically, the Cost Analysis Division:

- Identifies cost methodology and data weaknesses within the NASA community
- In close coordination with the Independent Program Assessment Organization (IPAO), jointly sponsors, coordinates, and disseminates research on cost and schedule estimating methods, models and data
- Recommends, coordinates and promulgates cost estimating policies and best practices in the NASA Cost Estimating Handbook
- Ensures cost estimate policies and best practices are followed by reviewing cost estimates at Key Decision Points
- Provides Independent Cost Assessments or other ad-hoc cost estimates or analyses for the IPAO upon request
- Assists PA&E's Strategic Investment Division in assessing program and project budget requests for cost and schedule realism
- Provides cost estimating support to PA&E Studies and Analysis Division
- Coordinates with other NASA offices to ensure policies and procedures are in place for effective cost management of projects
- Manages, directs, executes, and facilitates the Cost Analysis Steering Group (CASG) and approves all matters pertaining to the steering group
- Updates, promotes, and distributes the cost estimating career development guide
- Maintains the NASA Standard Work Breakdown Structure (WBS)
- Maintains Cost Analysis Data Requirement (CADRe) templates and reviews CADRe compliance
- Maintains the One NASA Cost Engineering Database (ONCE) and upgrades as necessary
- Updates and maintains the NASA New Start Inflation Index
- Maintains and reviews the NASA Cost Model Prospectus Library
- Maintains and reviews the NASA Cost Research Prospectus Library
- Maintains and reviews the NASA Cost Estimating Roadmap http://www.nasa.gov/offices/pae/organization/cost_analysis_division.html

### 1.2.1 NASA Cost Analysis Steering Group (CASG)

The NASA Cost Analysis Steering Group (CASG) serves as the Agency's forum for aerospace cost and risk policies, standards, and activities. Its purpose is to strengthen NASA's cost estimating standards and practices by improving tools, processes, and resources. This working group surveys, promotes, and records key innovations and achievements in the cost estimating field such as parametric cost modeling techniques and methodologies; cost, schedule, and risk models and applications; and cost management and policy. It also fosters cooperation and interchange across the Agency cost analysis community and promotes interdisciplinary understanding of costing aerospace systems and their applications to government and commercial endeavors. Its members—through their craft—provide Agency decision makers with credible cost and risk information.

Additionally, its mission encompasses the following:

- Coordinates the joint development of tools, methodologies, data, and training
- Communicates information about cost related research needed to improve the cost community and resolve challenges in the community
- Communicates information about new tools and updates to current models being used in the cost estimating community
- Encourages dialogue about NASA cost estimating and risk analysis policy
- Promotes professionalism, coordinated positions, and continuous improvement in cost analysis policies, risk analysis, standards, and activities.

Established in the late-1990s, this working group grew out of the Centers' need for a common body to resolve aerospace cost analysis issues. At the time, the head of Cost Analysis at the Independent Program Assessment Office (IPAO) led efforts to create the steering group. Initially the steering group focused on resolving immediate issues within the aerospace cost analysis community. Since then, with the creation of the CAD, the role of leading the steering group has shifted from the IPAO to the Director of the CAD. The group's roles have evolved to bring about Agency-wide improvements in cost estimating policies, practices, tools, and methodologies, as well as standards and professional development.

The CASG consists of senior representatives from each Center, including the Jet Propulsion Laboratory, and the Headquarters Mission Directorates. These principal members also make up a smaller subset called the Executive-Cost Analysis Steering Group (E-CASG) and are referred to as E-CASG focal points. The E-CASG meets on an as-needed basis at the request of the Director of the CAD, NASA Office of PA&E. The Director of the CAD or a delegate chairs the CASG. Each Center has both a primary and backup member for CASG and E-CASG meetings. The CASG meets three times a year at different NASA locations. Attendance and participation at the CASG meetings is on a voluntary basis.

As shown in Table 1-1, the following members play important roles with specific responsibilities:

**Table 1-1. Roles and Responsibilities**

| Role | Responsibilities |
|---|---|
| **Director of the Cost Analysis Division** | • Has final approval authority on all matters related to the CASG and E-CASG<br>• Coordinates CASG agendas |
| **CASG Chair** | • Coordinates, schedules, and selects location for CASG and E-CASG meetings<br>• Coordinates agendas with the CAD Director<br>• Chairs the meetings and keeps the meetings on track<br>• Ensures that action items are taken and posted, distributes action items, and works to close action items; ensures that appropriate time is on the CASG agenda to brief closed action items and provide status on open action items<br>• Maintains and uploads CASG and E-CASG records in electronic format on the PBMA CASG Web site<br>• Notifies members of meeting notices and agendas, collects presentations prior to meetings, and archives presentations<br>• Maintains the PBMA CASG Web site |
| **E-CASG Members** | • Fund their participation to each CASG and E-CASG meetings<br>• Support CASG and E-CASG meetings<br>• Provide inputs and presentations to the CASG and E-CASG<br>• Facilitate the closure of action items<br>• Solicit input from the cost community at their represented Center<br>• Communicate CASG and E-CASG meeting outcomes to their Center's cost community<br>• Periodically assume the responsibility of hosting the CASG meeting |
| **Support Contractors and Federally Funded Research and Development Centers** | • Attend CASG meetings and participate as advisors when they are directly involved in activities related to meeting agenda topics |

Organizational membership in the CASG from across NASA includes the following:

- PA&E CAD
- PA&E IPAO
- Ames Research Center (ARC)
- Dryden Flight Research Center (DFRC)
- Glenn Research Center (GRC)
- Goddard Space Flight Center (GSFC)
- Jet Propulsion Laboratory (JPL)
- Johnson Space Center (JSC)
- Kennedy Space Center (KSC)
- Langley Research Center (LaRC)
- Marshall Space Flight Center (MSFC)
- Stennis Space Center (SSC)
- Applied Physics Laboratory (APL)
- Headquarters Aeronautics Research Mission Directorate (HQ ARMD)
- Headquarters Exploration Systems Mission Directorate (HQ ESMD)
- Headquarters Science Mission Directorate (HQ SMD)
- Headquarters Space Operations Mission Directorate (HQ SOMD)

Support contractors and Federally Funded Research and Development Centers (FFRDCs) in the cost estimating business as NASA deems appropriate according to the agenda topics.

The CAD sponsors the annual NASA Cost Symposium Workshop where NASA cost estimators, including support contractors, present technical briefs on topics such as the status of cost model development, case studies, lessons learned, and other cost analysis research areas. The CAD also

maintains a Web site with cost estimating information and collaborative functionality to support the CASG community at large. This Web site at https://secureworkgroups.grc.nasa.gov/casg is maintained by the Cost Analysis Division with several Center-level administrators.

### 1.2.2 NASA Cost Data Requirement Descriptions (DRDs)

The NASA Data Requirements Description (DRD) is the equivalent of the Department of Defense (DoD) Contract Data Requirements List (CDRL). NASA typically utilizes a DRD, which is inserted into a request for proposal (RFP), to define the data in a contract that is to be delivered to the Government by the contractor. This data may be in any form specified, such as hard copy, electronic, and electronic mailable. The specific form of delivery to NASA is specified either in the Statement of Work (SOW) and/or in each individual DRD item. The DRD that the cost community is responsible for is the CADRe, which is an integrated DRD that includes the WBS, Cost Input Report, and Cost Estimate Report. The cost community may also have input into the Contract Performance Report and EVM DRDs.

- Contract Performance Report and EVM DRD examples http://ceh.nasa.gov/downloadfiles/NASA_CEH_Downloadable_Files.htm#NASA_CEH_Downloadable_Files_2.htm
- CADRe DRD example http://ceh.nasa.gov/downloadfiles/CADRe.html
- CADRe information and templates on the Cost Analysis Steering Group – PBMA Enhanced Security Work Group (requires membership) https://secureworkgroups.grc.nasa.gov/casg?go=z24617

### Standard Work Breakdown Structure (WBS)

The NASA Standard WBS for unmanned space systems is provided below. This WBS is now being used in CADRe Part C (Project Life Cycle Cost Estimate). At the time of this handbook's publication, a Standard WBS for Manned Space Systems was not available.

Downloadable versions of the Standard WBS are available through the following web sites:

- Cost Analysis Steering Group – PBMA Enhanced Security Work Group (requires membership) https://secureworkgroups.grc.nasa.gov/casg?go=178875
- NASA Cost Estimating Handbook Website http://ceh.nasa.gov/downloadfiles/CADRe.html

## Table 1-2. NASA Standard WBS

**1.0 SYSTEM NAME**
**1.1 Project Management**
**1.2 Systems Engineering**
**1.3 Safety and Mission Assurance**
**1.4 Science/Technology**
**1.5 Payload(s)**
**1.5.1 Payload Management**
**1.5.2 System Engineering**
**1.5.3 Payload Product Assurance**
**1.5.4 Instrument *n***
1.5.4.1 Instrument *n* Management
1.5.4.2 Instrument *n* Systems Engineering
1.5.4.3 Instrument *n* Assurance
1.5.4.4 Antenna
1.5.4.5 Optics
1.5.4.6 Sensors/Detectors
1.5.4.7 Structures & Mechanisms
1.5.4.8 Thermal Control
1.5.4.9 Electronics
1.5.4.10 Power
1.5.4.11 Pointing Subsystem
1.5.4.12 Harness & Cabling
1.5.4.13 C&DH
1.5.4.14 Ground Support Equip
**1.5.5 Integration, Assembly Test & Check out**
**1.6 Flight System \ Spacecraft**
**1.6.1 Flight System Project Management**
**1.6.2 Flight System Systems Engineering**
**1.6.3 Flight System Product Assurance**
**1.6.4 Spacecraft**
1.6.4.1 Spacecraft Management
1.6.4.2 Spacecraft Systems Engineering
1.6.4.3 Spacecraft Product Assurance
1.6.4.4 Spacecraft Structures & Mechanisms Total
1.6.4.4.1 Structures/Mech. Management
1.6.4.4.2 Structures/Mech. Systems Engineering
*Primary Structures*
1.6.4.4.3 Load Carrying Shell/Truss
1.6.4.4.4 Equipment Compartments
1.6.4.4.5 Booms
1.6.4.4.6 Adapters
*Secondary Structures*
1.6.4.4.7 Equipment (Instrument) Mountings
1.6.4.4.8 Ballast Mass
*Mechanisms*
1.6.4.4.9 Positioning
1.6.4.4.10 Deployment and Storage Equipment
1.6.4.4.11 Docking Mechanisms
1.6.4.4.12 Pyrotechnics
1.6.4.4.13 Structures/Mech. Subsystem I&T
1.6.4.5 Spacecraft Thermal Control
1.6.4.5.1 Thermal Management
1.6.4.5.2 Thermal Systems Engineering
*Active Devices*
1.6.4.5.3 Cryogenic Devices
1.6.4.5.4 Liquid Loops
1.6.4.5.5 Electric Cooling (Thermoelectric)
1.6.4.5.6 Electric Heaters Thermisters & Thermostats
1.6.4.5.7 Shutters
*Passive Devices*
1.6.4.5.8 Radiator Panel/Fins
1.6.4.5.9 Coatings
1.6.4.5.10 Heat Pipes
1.6.4.5.11 Insulation
1.6.4.5.12 Conductive Structures
1.6.4.5.13 Heat Activated louvers
1.6.4.5.14 Sun Shields
1.6.4.5.15 Second Surface Mirrors
1.6.4.5.16 Thermal Subsystem I&T
1.6.4.6 Spacecraft Electrical Power & Distribution
1.6.4.6.1 EPS Management
1.6.4.6.2 EPS Systems Engineering
*Electrical Power Generation*
1.6.4.6.3 Solar Cells
1.6.4.6.4 Nuclear Reactor
1.6.4.6.5 Radioisotope Thermionic Generator
1.6.4.6.6 Chemical (Fuel Cells)
1.6.4.6.7 Aux Power Unit(s)
*Electrical Power Conditioning*
1.6.4.6.8 Power Control Electronics
1.6.4.6.9 Power Conversion Electronics
1.6.4.6.10 Power Dissipation Devices
1.6.4.6.11 Power Distribution Electronics
*Electrical Power Storage*
1.6.4.6.12 Batteries
1.6.4.6.13 Charge Control Electronics
1.6.4.6.14 Harnesses & Cables
1.6.4.6.15 EPS Subsystem I&T
1.6.4.7 Spacecraft GN&C
1.6.4.7.1 GN&C Management
1.6.4.7.2 GN&C Systems Engineering
*Attitude Determination*
1.6.4.7.3 Earth (Horizon) Sensors
1.6.4.7.4 Sun Sensors
1.6.4.7.5 Star Tracker/Sensors
1.6.4.7.6 GPS Receivers
1.6.4.7.7 Imagers
1.6.4.7.8 Magnetometers
1.6.4.7.9 Altimeters
1.6.4.7.10 Inertial Reference Unit
1.6.4.7.11 Rate Gyros
1.6.4.7.12 Accelerometers
1.6.4.7.13 Bearings and Power Transfer Assembly
*Attitude Control*
1.6.4.7.14 Reaction Wheels
1.6.4.7.15 Momentum Wheels
1.6.4.7.16 Control Moment Gyros
1.6.4.7.17 Energy Storage Devices (Flywheels)
1.6.4.7.18 Magnetic Control Devices
1.6.4.7.19 Spin Control Devices
1.6.4.7.20 Control Electronics
1.6.4.7.21 GN&C Subsystem I&T
1.6.4.8 Spacecraft Propulsion
1.6.4.8.1 Propulsion Management
1.6.4.8.2 Propulsion Systems Engineering

*Tanks*
1.6.4.8.3 Oxidizer Tanks
1.6.4.8.4 Fuel Tanks
1.6.4.8.5 Propellant Tanks
1.6.4.8.6 Pressurant Tanks
1.6.4.8.7 Plumbing
*Maneuvering Thrusters*
1.6.4.8.8 Bipropellant
1.6.4.8.9 Monopropellant
1.6.4.8.10 Solar Electric
1.6.4.8.11 Ion
1.6.4.8.12 Electrostatic
1.6.4.8.13 Electromagnetodynamic
1.6.4.8.14 Cold Gas
*Translation Thrusters*
1.6.4.8.15 Bipropellant
1.6.4.8.16 Monopropellant
1.6.4.8.17 Solar Electric
1.6.4.8.18 Ion
1.6.4.8.19 Electrostatic
1.6.4.8.20 Electromagnetodynamic
1.6.4.8.21 Cold Gas
1.6.4.8.22 Solid Propellant
1.6.4.8.23 Liquid Propellant
1.6.4.8.24 Propulsion Subsystem I&T
1.6.4.9 Spacecraft Communications
1.6.4.9.1 Telecom Management
1.6.4.9.2 Telecom Systems Engineering
*Antennas*
1.6.4.9.3 Omnidirectional
1.6.4.9.4 Spiral
1.6.4.9.5 Horn
1.6.4.10 Patch
1.6.4.10.1 Parabolic
*Waveguides/Routers*
1.6.4.10.2 Diplexers
1.6.4.10.3 Triplexers
1.6.4.10.4 Multiplexers
1.6.4.10.5 Multicouplers
1.6.4.10.6 Coaxial Switches
1.6.4.10.7 RF Switches
1.6.4.10.8 Filters
1.6.4.10.9 Waveguide
*Radio Frequency Equipment*
1.6.4.10.10 Receivers
1.6.4.10.11 Transmitters
1.6.4.10.12 Transceivers
1.6.4.10.13 Transponders
1.6.4.10.14 Modulators
1.6.4.10.15 Demodulators
1.6.4.10.16 Traveling Wave Tube Assembly (TWTA)
1.6.4.10.17 Solid State Power Amplifiers
1.6.4.10.18 GPS Receivers
1.6.4.10.19 Downconverters
1.6.4.10.20 Upconverters
1.6.4.10.21 Telecom Subsystem I&T
1.6.4.11 Spacecraft C&DH
1.6.4.11.1 C&DH Management
1.6.4.11.2 C&DH Systems Engineering
1.6.4.11.3 Processors
1.6.4.11.4 Solid State Memory
1.6.4.11.5 Decoders
1.6.4.11.6 Command Units
1.6.4.11.7 Telemetry Units
1.6.4.11.8 Command Sequencers
1.6.4.11.9 Timing Units
1.6.4.11.10 Frequency Generators
1.6.4.11.11 Signal Conditioners
1.6.4.11.12 Data Switches
1.6.4.11.13 COMSEC
1.6.4.11.14 Interface Units
1.6.4.11.15 Tape Recorders
1.6.4.11.16 Disk Recorders
1.6.4.11.17 C&DH Subsystem I&T
1.6.4.12 Spacecraft Software
1.6.4.12.1 Software Management
1.6.4.12.2 Software Systems Engineering
1.6.4.12.3 CSCI Name 1
1.6.4.12.4 CSCI Name 2
1.6.4.12.5 Software Subsystem I&T

**1.6.5 Entry/Decent/Lander**
**1.6.6 Rover**
**1.6.7 Spacecraft Retirement & Disposal**
**1.7 Launch Vehicle/Services**
**1.8 Mission Operations System (MOS)**
**1.8.1 MOS Management**
**1.8.2 MOS Systems Engineering**
**1.8.3 Mission Operations Center**
**1.8.4 Science/Data Operations Center**
**1.8.5 Data Distribution & Archival**
**1.8.6 Communications/Network Infrastructure**
**1.8.7 Training**
**1.9 Ground Data System (GDS)**
**1.9.1 GDS Management**
**1.9.2 GDS Systems Engineering**
**1.9.3 Mission Operations Center**
1.9.3.1 Hardware
1.9.3.2 Software
1.9.3.3 Other
**1.9.4 Science/Data Operations Center**
1.9.4.1 Hardware
1.9.4.2 Software
1.9.4.3 Other
**1.9.5 Data Distribution & Archival**
1.9.5.1 Hardware
1.9.5.2 Software
1.9.5.3 Other
**1.9.6 Ground Stations**
**1.9.7 Communications/Network Infrastructure**
1.9.7.1 Hardware
1.9.7.2 Software
1.9.7.3 Other
**1.9.8 GDS Integration & Test**
1.9.8.1 Hardware
1.9.8.2 Software
1.9.8.3 Other
**1.10 System Integration, Assembly, Test & Check Out**
**1.11 Education & Public Outreach**

### 1.2.3 The NASA Cost Analysis Date Requirement (CADRe)

The CADRe is a NASA requirement mandated by NPR 7120.5. The CADRe documents the programmatic, technical, and life cycle cost information of a project. NPR 7120.5 specifically states that Category I and Category II Flight Systems and Ground Support Projects require the development of a CADRe and will typically require five CADRe submissions across the project life cycle. CADRes are developed following PNAR, PDR, and CDR site reviews, after launch, and during the last year of a project's planned life. The NASA Project Manager is responsible for the CADRe and has several options available to develop CADRes. The NASA Project Manager may choose to develop the CADRe within the Project Office with his/her own staff, or he/she may use one of the NASA Headquarters-sponsored support contractors to develop the CADRe. It is recommended that the projects include the CADRe as a DRD on contract(s) in order to ensure the proper data is available to complete the CADRe. Because the CADRe collects Full Cost information, it is likely that the project will have to perform final integration of a contractor prepared CADRe to include all Full Cost information.

The body of the CADRe contains three parts with templates for each:

- Part A contains general descriptive information about the project
- Part B contains hardware and software technical parameters necessary to estimate the project's life cycle cost

Part C contains the project's life cycle cost estimate (LCCE). Part C represents the Project's cost estimate and the Project Manager is responsible for collecting the inputs from the various participants including Full Cost elements and submitting an integrated cost estimate

CADRe templates (Parts A, B, and C) and information pertaining to the submission process and guidelines can be referenced at http://ceh.nasa.gov/downloadfiles/CADRe.html

#### CADRe Review and Submission Process

The CADRe process can vary, but will usually begin with a kickoff meeting between PA&E/CAD, Program Executive, Project Manager, Mission Directorate Cost Focal Point, and IPAO cost analyst(s). This meeting will cover the CADRe requirements and expectations and how the CADRe will be developed.

Support contractors, or Center personnel will develop the CADRe from supplied data. The information will populate the three CADRe sections based on the reference material provided by the Project. Typically, a large portion of Part A is assembled from the review material and various planning documents (Project Plan, Science Management Plan, etc.,) while Part B is completed using the Project's Master Equipment List (MEL) and Power Equipment List (PEL). Any additional technical parameters to be included in Part B may be obtained from the review material or other references. Finally, the cost data for Part C is obtained from the Project Business Manager. The structure of this data may vary from project to project, but it should be at a level of detail that allows mapping to the Part C outline found in the CADRe template.

During the process of creating the CADRe document, it is expected that there will be a low level of interaction with the Project Systems Engineer (or similar point of contact) to clarify any issues encountered while creating Parts A, B, and/or C. CADRe Parts A and B will be completed and

submitted for Draft Review by center management. The CADRe will then be given to the necessary individuals for any independent cost estimation activities. After the milestone review, Parts A and B may need to be updated slightly to reflect the final design presented and Part C can then be completed with the final project costs.

Center and PA&E staff will review the CADRe for compliance with the CADRe templates and make any necessary revisions. The revised CADRe will be submitted to the Project Manager for any necessary revisions and approval. Once the PM provides approval and signs the CADRe, it will be forwarded to the appropriate Mission Directorate contact and will then be forwarded to PA&E/CAD.

### Value of CADRe Process to NASA

The NASA financial system does not provide cost information that Project Managers and cost estimators need to develop credible cost estimates. NASA has no database or library that contains current or historical project data. The loss of historical records on projects has contributed to a lack of data needed to build credible cost models and cost estimates. The CADRe consolidates key project data pertaining to technical parameters that drive cost, as well as a project life cycle cost in the project's WBS along with a crosswalk to the NASA's cost estimating WBS. At its core, it captures and explains reasons for cost and schedule changes since the last CADRe submission. The cost estimates in the CADRe are critical to milestone decisions and determination of project life cycle costs. Furthermore, it provides historical traceability of project changes. The CADRe will be created and stored in the ONCE database, and the resulting database will help alleviate the Agency-wide problem of lack of data. CADRe and ONCE are extremely valuable to NASA because they will serve as a tool to provide data to inform the next generation of Cost Estimators, Project Managers, and other NASA employees. Center personnel can use data residing in the CADRe to update cost models with actuals to better project future costs of similar systems with greater precision.

### CADRe Availability

To date, developed CADRes are contained on CDs kept at the NASA Headquarters CAD. In the future, CADRes will be assessable via the ONCE database. Data access will be strictly controlled by the CAD. Various HQ personnel will have access to all CADRe data while other NASA Center personnel will have access to their own pre-launch CADRe data as well as all CADRes after missions have been launched.

## 1.2.4 One NASA Cost Engineering (ONCE) Database

The ONCE database will provide a common database for capturing NASA project cost, technical, and schedule data. Access rights will be granted for NASA users, consistent with access rights established with the CADRe initiative. The ONCE database will automate the manual CADRe process. ONCE is intended to be a web-based database that allows for electronic CADRE development while at the same time, populating the ONCE database. The database will consist of a repository of raw data from which analysts may draw information and perform analyses. The ONCE database will contain the CADRe data as developed and will include source documents. Users will be able to search, view and download the CADRe information either by project name or by one or more WBS elements, along with searchable technical and cost data

from the CADRe. ONCE will allow concurrent users to access the system over a secure internet connection.

Through CADRe and ONCE, NASA will have access to actual cost data from completed projects and thus this will enable the NASA cost community to help develop lessons learned from the past; allow the agency to understand the underlying causes of cost growth across its projects; form the basis for developing more realistic independent cost estimates, and; strengthen the ability to develop Cost Estimating Relationships (CERs); therefore, assisting in the development of better cost estimates of future similar projects.

### 1.2.5 NASA Inflation Index

The NASA New Start Inflation Index is updated annually and published on the CASG Process Based Mission Assurance (PBMA) website. This index has been created for the purposes of estimating new efforts and for normalizing historical cost from prior missions. The factors contained in this index should not be used to estimate NASA Civil Servant personnel costs or future costs of existing contracts. Defense Contract Audit Agency (DCAA) approved forward pricing indices should be used for all efforts that are already under contract.

Historically, NASA has experienced inflation that has run 1-2% higher than the standard CPI based indices. Therefore, NASA has relied on inflation data and projections that are specifically tied to Aerospace salaries, materials, and other relevant commodities. Due to the proprietary nature of the NASA New Start Inflation Index factors, this information can only be attained on the membership controlled CASG website on the PBMA Enhanced Security Work Group or from a Center's Chief Financial Officer's (CFO) office.

- CASG– PBMA Enhanced Security Work Group (requires membership) https://secureworkgroups.grc.nasa.gov/casg?go=205946

## 1.3 NASA HQ Independent Program Assessment Office (IPAO)

To ensure the highest probability of mission success, the IPAO, within the Office of PA&E, is responsible for enabling the independent review of the maturity, health, and status of the Agency's programs and projects at life cycle milestones. The IPAO ensures the objectivity, quality, integrity, and consistency of the independent review process required by NPR 7120.5 and NPR 7123.1. This independent program and project review process is a collaborative effort among PA&E, the Mission Directorates, the Office of the Chief Engineer, Office of Safety and Mission Assurance, Chief Health and Medical Office (as needed), the independent technical authority community at the NASA Centers, and the NASA Engineering and Safety Center (NESC) support of the Agency's Program Management Councils. The IPAO ensures that the review needs of each of these communities are met while maintaining the integrity and independence of the review process consistent with the Agency's governance model as documented in the NASA Strategic Management and Governance Handbook, NPD 1000.0.

Specifically, the IPAO:

- Develops and maintains the Agency handbook for the conduct of independent reviews

- Provides Review Managers for programs, category 1 and 2 projects, and special request reviews as assigned
- Develops independent project cost estimates and independent program cost analyses as part of the independent reviews, particularly at the preliminary approval (e.g., pre-non-advocate review) and approval (e.g., non-advocate review) key decision points, and to support congressional reporting requirements for the Agency
- Provides programmatic assessments of programs and projects, including compliance with NPR 7120.5, as a member of the independent standing review boards (SRBs) and facilitates the reporting of independent review results to all involved parties
- Procures and distributes Agency licenses and Jump Start programs for industry standard cost models and oversees the incorporation of improvements in collaboration with the PA&E/CAD
- Provides programmatic assessment tools (e.g., schedule assessment tools) to facilitate the highest quality independent review
- Develops lessons learned and recommends independent review process improvements for incorporation in Agency policies and guidance
- Performs other analyses, assessments, and duties as assigned.

### 1.3.1 IPAO Cost Estimate Sufficiency Review Checklist

This checklist (Version 1a) should be used to review project office cost estimate for reasonableness, completeness, consistency, and compliance with generally accepted estimating processes. The end result of the sufficiency review will provide decision makers with an assessment on the quality of the cost estimate. Figure 1-1 contains the sample report and a list of detail questions that will serve as a repository of other questions and "lessons learned" matters.

**PART ONE**

Project Name:

IPAO Reviewer:

Purpose of the SR: (example) This SR was done in conjunction with the project NAR.

Executive Summary:

1. Cost Readiness Level (CRL) of the cost estimate:
2. Bullet summary of the SR.

**PART TWO**

**Detail report (the level depends on the scope of the cost estimate)**

- Traceability. Assessment and justification.
- Reasonableness. Assessment and justification.
- Soundness. Assessment and justification.
- Verification. Assessment and justification.
- Validity. Assessment and justification.
- Accuracy/Consistency. Assessment and justification.
- Completeness: Assessment and justification

(This list should be expanded with other questions tailored to your project.)

**Risk related questions:**

- Have costs for discrete, identified risks been captured?
- How were inputs to cost-risk models (e.g., @Risk) developed?
- Were engineers consulted in the definition of the level of risks?
- Was CER, technical and correlation risk captured?
- Was both probabilistic and discrete risk analysis performed?
- Were the cost-risk distributions used justifiable?
- Were provisions for unknown-unknowns made in the estimate?
- Was schedule risk quantified along with cost-risk?
- Can the cost-risk analysis answer the questions: How many dollars are included to cover discrete risks?
- What are the risky WBS elements?
- What is the likelihood of an overrun?

Figure 1-1. IPAO Cost Estimate Sufficiency Report (SR)

Standards IPAO looks for:

1. Traceability. Information presented in a traceable fashion containing supporting documentation and technical data. IPAO cost estimator must be able to trace with the given information.
2. Reasonableness. Information presented in a logical manner with appropriate analogies and cost estimating relationships (CERs).
3. Soundness. Information, assumptions, and recommendations presented must be sound arguments. IPAO cost estimator will carefully consider expert judgments or assumptions.
4. Verification. Information presented must be verifiable by the IPAO cost estimator. The IPAO cost estimator will check databases that were used to verify the technical parameters on the cost elements.
5. Validity. Information presented must be logically correct, justifiable, and well-grounded. The IPAO cost estimator will review the ground rules and assumptions.

6. Accuracy/Consistency. Information presented is well organized, cohesive, supportable, and easily understood.
7. Completeness. Information presented must contain all necessary data, assumptions, and pertinent information.

How IPAO assesses cost estimates:

1. Receive the project cost estimate from the project office. What constitutes "project cost estimate": documentation that contains the numeric tables with all supporting narrative (in soft copy).
2. Check the administrative information. Who prepared the estimate? For what purpose was the project office estimate generated? How much effort (staff months) did it take to do the estimate? What was the cost estimating schedule? Is this estimate a new estimate or an update of a prior estimate? Has anyone else reviewed this estimate or the prior estimate and what were the findings?
3. Review of the cost estimate documentation. This is to verify that in fact there are adequate "materials" to conduct the sufficiency review. Is the documentation organized according to the WBS—if not, a logical manner that will provides structure for the IPAO cost estimator to follow. Are prior costs documented? Are the narratives explaining the estimating methodologies understandable? Are there pertinent historical information and project funding data? Are there supporting data or documentation available for those elements requiring further verification? Are the WBS definitions available? Can the IPAO cost estimator "replicate" what was done in the project office estimate—from the documentation?
4. Assuming a reasonable level of documentation is present, the next step is to conduct the traceability from the final cost estimate "rolled-up" number to the appropriate level that show the basis of the estimate. The IPAO cost estimator will select a cost element and "drill down" to the basis of the estimate. The drill down process depends on the cost element and how it is "bucketed" and "estimated." Generally, the estimator will track the number from one spreadsheet or chart to another and in the process "decompose" the summation number until he/she reaches a satisfactory level where the estimate is understood.
   a. As a guideline, the IPAO cost estimator will target high cost, high risk, and high interest cost elements. Depending upon the project, this may fall into the 80/20 rule, where 80% of the cost resides in 20% of the cost elements.
   b. Which cost elements are "pass through" elements?
   c. Once the cost elements are selected, the IPAO cost estimator will drill down each element tailored to its component or system.
5. There are many questions an estimator can ask to understand the cost estimate. These are suggested questions to be asked in a drill down exercise—this is not an inclusive list:
   a. Are the costs rational to prior actual costs?
   b. Are the ground rules and assumptions reasonable?
   c. Is the learning curve (if applicable) and slopes reasonable?
   d. Were historical data used?
   e. Were correct inflation rates used?
   f. Were appropriate methods used? Is the estimate reflecting analogies and databases that are within realm of reasonableness, such as technology, platforms, etc?
   g. Are the data points/range used in the cost estimate relevant?
   h. Are all pertinent costs included?

i. Are costs time-phased over the fiscal years? Both inflated and non-inflated dollars? What is the method of time phasing the point estimate? Is the project schedule consistent with cost estimate schedule used in the phasing?
j. Were analogous direct and overhead rates used?
k. Did the estimate capture applicable full cost?
l. Is appropriate cost risk analysis performed? Did the estimate capture the risks?
m. Did the estimate cover the "scope" of the program in review?
n. Did the estimate identify which cost elements were estimated and pass-throughs?
o. Did the estimate provide a cumulative distribution curve (S-curve)?

6. The IPAO cost estimate will submit an IPAO Sufficiency Review Report (see appendix A). The report will consist of:

   a. Executive summary (1-page) which will provide the cost estimate confidence level, via the Cost Readiness Level (CRL) and the rationale accompanying the assessment.
   b. Detail report.

### 1.3.2 Jump Start Program

To provide a running start on estimating at any Center by any new/experienced analyst (not just estimators), JUMP START will answer the common predicament faced by a new estimator challenged with a new project. Because of this situation, the estimator may end up asking a familiar question, "Where do I start?" Offering an immediate solution to these recurring situations, IPAO has provided the contractual vehicle for parametric model users to help setup the minimum required project-estimating task, allowing one to two days effort of expert help. The end results, in a relatively short time, are the new estimators--walking alone doing their own estimates.

The use of SEER or PRICE products requires the NASA user to setup the SEER or PRICE files by work breakdown structures and meaningful configuration of the estimating task. To facilitate this initial effort, each user requires a minimum effort that must be augmented by SEER or PRICE consultants to establish the first few steps of creating SEER or PRICE files. SEER or PRICE consultants will "Jump Start" the estimating and programmatic tasks.

**Objective**: The objective of JUMP START is to provide minimum technical assistance to NASA cost analysts throughout the Agency in conducting cost estimates and other programmatic tasks using SEER or PRICE products. This is a level of effort (labor-hours only) deliverable. Furthermore, each sub-task cannot be more than $3K each or 24 hours of expert consultation.

**Task**: The contractor will provide support to the NASA SEER or PRICE Model analyst in creating the cost estimate. The support will be in the form of mentoring the NASA SEER or PRICE Model analyst in creating model data files, data collection and evaluation, and model output evaluation.

| | |
|---|---|
| PRICE Jump Start POC | SEER Jump Start POC |
| Rich Greathouse | Ron Larson |
| 757-864-9465 | 757-864-4382 |
| richard.m.greathouse@nasa.gov | ronald.k.larson@nasa.gov |

# 1.4 NASA Websites

## 1.4.1 NASA Cost Estimating Websites

- Advanced Missions http://cost.jsc.nasa.gov/AMCM.html
- Aircraft Turbine Engine http://cost.jsc.nasa.gov/ATECM.html
- Airframe http://cost.jsc.nasa.gov/airframe.html
- Budget Request http://www.nasa.gov/about/budget/
- CPI Inflation Calculator http://cost.jsc.nasa.gov/inflateCPI.html
- Cost Spreading Model http://cost.jsc.nasa.gov/beta.html
- Cost Analysis Steering Group https://secureworkgroups.grc.nasa.gov/casg
- Cost Estimating Acronym Glossary http://cost.jsc.nasa.gov/acronyms.html
- Cost Estimating Databases http://cost.jsc.nasa.gov/data.html
- Cost Estimating Glossary http://cost.jsc.nasa.gov/glossary.html
- Cost Estimating References http://cost.jsc.nasa.gov/references.html
- Cost Estimating Resources http://cost.jsc.nasa.gov/resources.html
- Employment Cost Index Inflation Calculator http://cost.jsc.nasa.gov/inflation/eci/inflateECI.html
- GDP Deflator Inflation Calculator http://cost.jsc.nasa.gov/inflateGDP.html
- Inflation Calculator http://cost.jsc.nasa.gov/inflate.html
- Import Price Index (MPI) Inflation Calculator http://cost.jsc.nasa.gov/inflation/ipi/inflateIPI.html
- JSC Cost estimating http://cost.jsc.nasa.gov/
- Learning Curve Calculator http://cost.jsc.nasa.gov/learn.html
- Mission Operations http://cost.jsc.nasa.gov/MOCM.html
- NASA Congressional Budget and Strategic Plan http://www.nasa.gov/about/budget/index.html
- NASA Federal Acquisition Regulation (FAR) Supplement http://www.hq.nasa.gov/office/procurement/regs/nfstoc.htm
- NASA Full Cost Initiative Agencywide Implementation Guide http://www.hq.nasa.gov/office/oig/hq/audits/reports/FY99/pdfs/ig-99-024.pdf
- NASA Online Cost Models http://cost.jsc.nasa.gov/models.htm
- Producer Price Index Inflation Calculator http://cost.jsc.nasa.gov/inflation/ppi/inflatePPI.html
- Zapata, Edgar, and A. Torres, "Space Transportation Operations Cost Modeling and the Architectural Assessment Tool – Enhanced", American Institute of Aeronautics and Astronautics, IAA-99-IAA.1.1.01, 1999. http://science.ksc.nasa.gov/shuttle/nexgen/Tools1.htm#aate

### 1.4.2 NASA Center and Organization Websites

- Aerospace Technology Enterprise http://www.aeronautics.nasa.gov/
- Ames Research Center http://www.nasa.gov/centers/ames/home/index.html
- Chief Financial Officer http://www.nasa.gov/offices/ocfo/home/index.html
- Dryden Flight Research Center http://www.nasa.gov/centers/dryden/home/index.html
- Earth Science Enterprise http://www.earth.nasa.gov/flash_top.html
- Exploration Systems Mission Directorate http://exploration.nasa.gov/
- External Relations http://www.hq.nasa.gov/office/oer/
- Glenn Research Center http://www.nasa.gov/centers/glenn/home/index.html
- Goddard Institute for Space Studies http://www.giss.nasa.gov/
- Goddard Space Flight Center http://www.nasa.gov/centers/goddard/home/index.html
- Human Exploration and Development of Space Enterprise http://www.hq.nasa.gov/osf/heds/
- Human Resources and Education http://www.hq.nasa.gov/office/codef/
- Independent Validation and Verification Facility http://www.nasa.gov/centers/ivv/home/index.html
- Inspector General http://www.hq.nasa.gov/office/oig/hq/
- Jet Propulsion Laboratory http://www.jpl.nasa.gov/
- Johnson Space Center http://www.nasa.gov/centers/johnson/home/index.html
- Kennedy Space Center http://www.nasa.gov/centers/kennedy/home/index.html
- Kennedy Space Center Next Gen Site http://science.ksc.nasa.gov/shuttle/nexgen/rlvhp.htm
- Langley Research Center http://www.nasa.gov/centers/langley/home/index.html
- Legislative Affairs http://legislative.nasa.gov/
- Marshall Space Flight Center http://www.nasa.gov/centers/marshall/home/index.html
- NASA Advisory Council http://www.hq.nasa.gov/office/oer/nac/
- NASA Earth Science Acronyms http://gcmd.gsfc.nasa.gov/Resources/FAQs/acronyms.html
- NASA Headquarters http://www.nasa.gov/centers/hq/home/index.html
- NASA Headquarters Office of Program Analysis & Evaluation http://www.nasa.gov/offices/pae/home/
- NASA Headquarters Cost Analysis Division http://www.nasa.gov/offices/pae/organization/cost_analysis_division.html
- NASA Homepage http://www.nasa.gov/
- NASA Human Space Flight http://spaceflight.nasa.gov/home/index.html

- NASA HQ Office of the Chief Engineer http://oce.nasa.gov/oce/home/index.html
- Procurement http://www.hq.nasa.gov/office/procurement/
- Public Affairs http://www.hq.nasa.gov/office/codez/strahand/frontpg.htm
- Safety and Mission Assurance http://www.hq.nasa.gov/office/codeq/
- Science@NASA http://science.nasa.gov/default.htm
- Small and Disadvantaged Business Utilization http://www.hq.nasa.gov/office/codek/
- Space Science Enterprise http://science.hq.nasa.gov/
- Stennis Space Center http://www.nasa.gov/centers/stennis/home/index.html
- White Sands Test Facility http://www.wstf.nasa.gov/
- Wallops Flight Facility http://www.nasa.gov/centers/wallops/home/index.html

### 1.4.3 NASA General Information Websites

- NASA Acronym List (GSFC) http://www.sti.nasa.gov/nasaonly/acronym/main.html
- NASA Acronym List (MSFC) http://liftoff.msfc.nasa.gov/help/acronym.html
- NASA Earth Science Glossary http://gcmd.gsfc.nasa.gov/Aboutus/sitemap.html
- NASA Engineering Network (accessible behind NASA firewall only) http://nen.nasa.gov/portal/site/llis/menuitem.0f8027f6c389bc42b649cc1036793ea0/
- NASA Glossary of Financial Terms http://cost.jsc.nasa.gov/glossary.html
- NASA Lessons Learned Information System http://nen.nasa.gov/portal/site/llis
- NASA Spacelink http://spacelink.nasa.gov/
- NASA Strategic Management Handbook http://www.hq.nasa.gov/office/codez/strahand/frontpg.htm
- NASA Strategic Plan http://www.hq.nasa.gov/office/nsp/

### 1.4.4 NASA Online Publications

- The Critical Path Newsletter http://fpd.gsfc.nasa.gov/news.html
- NASA Procurement Countdown http://www.hq.nasa.gov/office/procurement/cntdwn.html
- NASA Systems Engineering Handbook http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19960002194_1996102194.pdf
- NASA Technical Report Service http://ntrs.nasa.gov/search.jsp

## 1.5 Model Prospectus Overview

This section contains a summary of the prospectus sheets on cost models and tools widely used in the space community (NASA, Air Force, and National Recognizance Organization [NRO]). The summaries are divided between models/tools that are actively used and based on current/updated databases, and those with historical/non-current databases. The cost models/tools are further divided among the following categories:

- Space flight development cost models
- Processing/operations cost models
- Ground development cost models
- Risk tools and calculation tools
- Database tools
- Software development cost models.

The prospectus sheets represent the results of a recent data collection project by NASA across these cost communities and will be updated frequently. Each sheet highlights important model/tool features, such as:

- Initial release date
- Last model update
- Planned updates
- Model/tool description
- Model/tool usage and applicability
- Strengths of the model/tool
- Limitations of the model/tool
- Data Source(s) for the model/tool.

The prospectus sheets also provide the current Point of Contact (POC) information. The cost model/tool POC can provide additional information and if the model/tool can be shared.

The prospectus sheets are currently available only on the Cost Analysis Steering Group – PBMA Enhanced Security Work Group. In the future, the sheets will be made available on the Cost Analysis Division (CAD) website.

Cost Analysis Steering Group – PBMA Enhanced Security Work Group (requires membership)
https://secureworkgroups.grc.nasa.gov/casg?go=z22324

The following graphics summarize the Cost Model Prospectus Sheets that are current as of November 30, 2007.

### 1.5.1 Active Models

Table 1-3 summarizes the models and tools that are actively used and are based on current and updated information.

## Table 1-3. Cost Models & Tools with Active Data

| Model Type | Cost Methodology: Parametric | Analogy | Build Up | Use in Phase: Pre-A | A | B | C/D | E |
|---|---|---|---|---|---|---|---|---|
| **Space Flight Development Cost Models** | | | | | | | | |
| Aerospace Small Satellite Cost Model (SSCM) [1] | ✓ | | | ■ | ■ | ■ | ■ | ■ |
| QuickCost [2] | ✓ | | | ■ | ■ | | | |
| Parametric Mission Cost Model (PMCM) | ✓ | | | ■ | ■ | | | |
| Parametric Cost Model | ✓ | | | ■ | ■ | | | |
| Integrated Cost an schedule Analysis Tool (ICSAT) | | ✓ | | ■ | ■ | | | |
| Focal Plane Array Business as Should Be Cost Model (FPAM) | ✓ | | | ■ | ■ | | | |
| Complexity Based Requirements Systems (CoBRA) | | ✓ | | ■ | ■ | | | |
| Air Force Launch Vehicle Cost Model | ✓ | | | ■ | ■ | | | |
| Advanced Missions Cost Model [3] | ✓ | | | ■ | ■ | | | |
| Advanced Projects Design Team Instrument Cost Model (APDTICM) [4] | ✓ | | | ■ | ■ | | | |
| Unmanned Spacecraft Cost Model (USCM8) [5] | ✓ | | | ■ | ■ | ■ | | |
| Predicting System Test Schedule | ✓ | | | ■ | ■ | ■ | | |
| Predicting Payload Schedules | ✓ | | | ■ | ■ | ■ | | |
| NASA Instrument Cost Model (NICM) | ✓ | ✓ | | ■ | ■ | ■ | | |
| Forecasting Technology (4Tek) | ✓ | | | ■ | ■ | ■ | | |
| SEER-H | ✓ | | | ■ | ■ | ■ | ■ | |
| PRICE-H | ✓ | | | ■ | ■ | ■ | ■ | |
| NASA Air Force Cost Model (NAFCOM) | ✓ | | | ■ | ■ | ■ | ■ | |
| **Processing / Operations Cost Models** | | | | | | | | |
| Operations Cost Model (OCM) | | ✓ | | ■ | ■ | | | |
| Model for Estimating Space Station Operations Cost (MESSOC) | ✓ | | | ■ | ■ | ■ | | |
| Space Operations Cost Model (SOCM) | ✓ | | | ■ | ■ | ■ | | |
| Shuttle Transition and Retirement | ✓ | | | ■ | ■ | ■ | | |
| Space Shuttle Program Retirement Model | ✓ | | | ■ | ■ | ■ | | |
| Shuttle Operations Simulation (ShuttOps Sim) | ✓ | | | ■ | ■ | ■ | ■ | |
| Launch and Landing Effects Ground Operations Model (LLEGO) | | | ✓ | | | ■ | ■ | ■ |
| Generic Environment for Modeling Future Launch Operations (GEM-FLO) | | | ✓ | | | ■ | ■ | ■ |
| E20 Supply Chain Sim | | | ✓ | | | ■ | ■ | ■ |
| **Ground Development Cost Models** | | | | | | | | |
| Ground Phasing Model | ✓ | | | ■ | ■ | | | |
| D4Cost | | ✓ | | ■ | ■ | | | |
| Method for Predicting Cost of Ground Segments for Space Systems | ✓ | | | ■ | ■ | ■ | ■ | |
| **Risk Tools and Calculation Tools** | | | | | | | | |
| Costimator | ✓ | | | ■ | ■ | | | |
| JSC Calculators [6] | ✓ | ✓ | ✓ | ■ | ■ | ■ | ■ | ■ |
| @Risk | ✓ | ✓ | ✓ | ■ | ■ | ■ | ■ | ■ |
| Minitab | ✓ | ✓ | ✓ | ■ | ■ | ■ | ■ | ■ |
| Crystal Ball | ✓ | ✓ | ✓ | ■ | ■ | ■ | ■ | ■ |
| ACEIT | ✓ | ✓ | ✓ | ■ | ■ | ■ | ■ | ■ |
| **Database Tools** | | | | | | | | |
| Root Cause Analysis Database | ✓ | ✓ | ✓ | ■ | ■ | ■ | ■ | ■ |
| Redstar Database | ✓ | ✓ | ✓ | ■ | ■ | ■ | ■ | ■ |
| **Software Development Cost Models** | | | | | | | | |
| CoStar [7] | ✓ | | | ■ | ■ | ■ | | |
| COCOMO II [8] | ✓ | | | ■ | ■ | ■ | | |
| PRICE S / True S / True IT | ✓ | | | ■ | ■ | ■ | ■ | |
| SEER-SEM | ✓ | | | ■ | ■ | ■ | ■ | |

[1] *SSCM was last updated in 2005, updates expected in 2007*
[2] *QuickCost was last updated in 2006, future updates expected*
[3] *Advanced Missions Cost Model was last updated in 2004, future updates expected*
[4] *APDTICM is updated yearly, but the database uses instrument data from the 80s through the late 90s*
[5] *USCM8 was last updated in 2001, USCM9 is being updated*
[6] *JSC Calculators are updated periodically*
[7] *CoStar is based on COCOMO CERs, but with expected yearly updates*
[8] *COCOMO II was last updated in 2000, but future calibrations to the model are expected*

### 1.5.2 Inactive Models

Table 1-4 summarizes the models and tools that are based on historical databases and have not been updated.

**Table 1-4. Cost Models & Tools with Inactive Data**

| Model Type | Cost Methodology: Parametric | Analogy | Build Up | Use in Phase: Pre-A | A | B | C/D | E |
|---|---|---|---|---|---|---|---|---|
| **Space Flight Development Cost Models** | | | | | | | | |
| Space Transportation Cost Model (TRANSCOST) | ✓ | | | ■ | ■ | | | |
| Solid Rocket Motor Cost Model (Part of Tecolote LVCM) | ✓ | | | ■ | ■ | | | |
| Profile Cluster Tool [1] | | ✓ | | ■ | ■ | | | |
| Process Oriented Production Cost Model | ✓ | | | ■ | ■ | | | |
| Passive Sensor Cost Model | ✓ | | | ■ | ■ | | | |
| HyperCost | ✓ | | | ■ | ■ | | | |
| Fast E | ✓ | | | ■ | ■ | | | |
| EHF / SHF Communications Cost Relationships Study | ✓ | | | ■ | ■ | | | |
| Cost Estimating Relationships for Nuclear Space Power and Propulsion | ✓ | | | ■ | ■ | | | |
| Cost Estimating Relationships for Non Nuclear Power and Dynamic Isotope Systems | ✓ | | | ■ | ■ | | | |
| CERs for Advanced Space Power and Electric Propulsion systems | ✓ | | | ■ | ■ | | | |
| Aerospace Satellite Cost Model | ✓ | | | ■ | ■ | | | |
| Aerospace Launch Vehicle Cost Model | ✓ | | | ■ | ■ | | | |
| Spacecraft Cost Engineering and Estimating Design Optimization (SCEEDOS) | ✓ | | | ■ | ■ | ■ | | |
| Solid Technology Assessment and Cost Evaluation Model (STACEM) | ✓ | | | ■ | ■ | ■ | | |
| Microwave and Digital Cost Analysis (MADCAM) | ✓ | | | ■ | ■ | ■ | | |
| International Space Station Analytical Cost Model (ISSAC) | ✓ | | | ■ | ■ | ■ | | |
| Digital Signal and Data Processor Model | | | ✓ | | | ■ | ■ | ■ |
| **Processing / Operations Cost Models** | | | | | | | | |
| Reliability Maintainability Tool (RMAT) | ✓ | | | ■ | ■ | | | |
| Architecture Assessment Tool-Enhanced (AATe) [2] | ✓ | | | ■ | ■ | | | |
| Mission Operations Cost Model | ✓ | | | ■ | ■ | | | |
| Activity Generator / Estimator (SAGE) [3] | | | ✓ | | | ■ | ■ | ■ |

[1] *Profile Cluster Tool was last updated in 2006, no planned updates are expected*
[2] *AATe was last updated in 2003, but no further updates are planned*
[3] *SAGE was last updated in 2004, but no further updates are planned*

## 1.6 Technology Readiness Level

NASA uses TRLs to measure the maturity of a technology. The TRL ratings provide a metric for determining risk associated with the insertion of new technology. NPR 7123.1A outlines TRL rating and their associated descriptions (see Figure 1-2). Cost estimators may use TRLs to document the maturation level of technology in the technical baseline of the system and to express the risks associated with WBS elements in the estimate.

- NPR 7123.1A: NASA Systems Engineering Processes and Requirements http://nodis3.gsfc.nasa.gov/npg_img/N_PR_7123_001A_/N_PR_7123_001A_.pdf
- Office of Safety and Mission Assurance Technology Readiness Level graphic http://www.hq.nasa.gov/office/codeq/trl/trlchrt.pdf

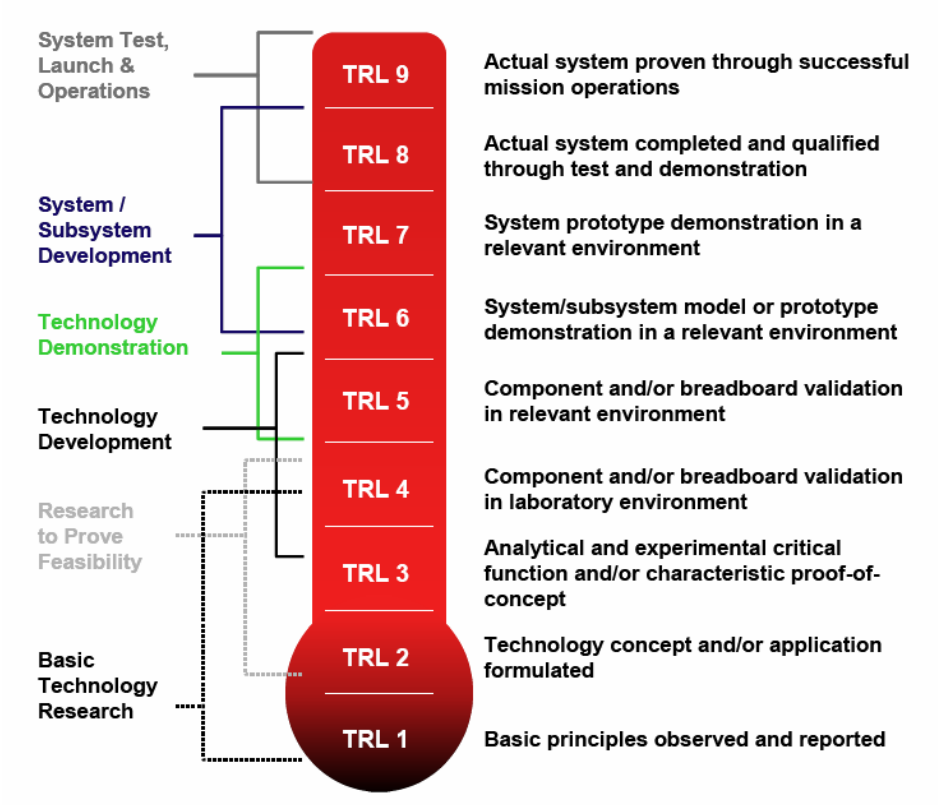


Figure 1-2. Technology Readiness Levels

## 1.7 NASA Cost Estimate Briefing Template

This template provides the estimator with a draft outline for a presentation that addresses the major points that should be covered in an estimate briefing. The estimator can use this template to ensure consistency and familiarity when briefing program leadership and NASA Headquarters organizations. The Power Point slides can be customized with program/project specific details and images.

- Blank: Provides program/project details and images
- Introduction: Provides background information on the estimate
- Project description: Provides narrative overview, mission statement, and concept of operations
- Scope: Communicates the key points and purpose of the estimate
- Groundrules and assumptions: Communicates the major groundrules and assumption
- Methodologies: Summarizes the cost estimating methodologies used in the estimate
- ICE Results and Comparisons: Provides a summary and comparison of various estimates
- Cumulative Probability Distribution: Provides the S curve of the estimate and displays the cost ranges
- Summary and recommendations: Outlines context of the estimate, any special circumstances surrounding the estimate, recommendations based on the estimate, and contact information

The Power Point version of the NASA Cost Estimate Briefing Template can be downloaded at: http://ceh.nasa.gov/downloadfiles/NASA_CEH_Downloadable_Files.htm#NASA_CEH_Downloadable_Files_2.htm

### 1.7.1 Sample Customer Feedback Form

Customer feedback can be used to capture lessons learned and improve the process and approach to conducting estimates for future efforts. This form is a sample that can be modified for your teams use after each estimate.

COST ANALYSIS OFFICE

CUSTOMER SURVEY

Project: _____ Date: _____

The Cost Analysis Office is always looking for ways to improve the quality of its services. Please take a few minutes to answer the following questions based on your expectations of our product. Your comments and suggestions will be used to improve processes and our ability to respond to your future requests for services.

| | | Always 5 | 4 | 3 | 2 | Never 1 |
|---|---|---|---|---|---|---|
| 1. | Did we effectively communicate with the project team to gain a good understanding of the project? | | | | | |
| 2. | Were any data collection forms and related preparation instructions clear and understandable? | | | | | |
| 3. | Was our final product clear and documented at the level of detail that you required? | | | | | |
| 4. | Did we provide appropriate supporting information to facilitate your understanding of the analysis scope and the methodology used? | | | | | |
| 5. | Were the significant cost drivers clearly explained? | | | | | |
| 6. | Were all your concerns/questions answered in a timely manner? | | | | | |
| 7. | Please provide us your ideas or suggestions which may help us develop better methods that you think will improve the quality of our response. | | | | | |
| 8. | Is there a service that we currently do not provide that you would find helpful? If yes, please describe and be as specific as possible. | | | | | |

| | | Excellent 5 | 4 | 3 | 2 | Poor 1 |
|---|---|---|---|---|---|---|
| 9. | How would you rate the overall service provided? | | | | | |

Thank you for your comments and suggestions.

Please return this form to: **Cost Analysis Office**

Figure 1-3. Customer Feedback Survey

# Section 2. Cost Estimating Resources

## 2.1 Online Cost Estimating/Analysis Resources

### 2.1.1 Other Federal Agency (Non – NASA) Guidelines and Websites

- To find DoD Issuances please reference the Department of Defense Issuances homepage at http://www.dtic.mil/whs/directives/index.html
- Army Cost & Economic Analysis Center (CEAC) http://www.asafm.army.mil/ceac/ceac.asp
- Carnegie Mellon Software Engineering Institute http://www.sei.cmu.edu/sei-home.html
- DoD 5000.2-R Mandatory Procedures for Major Defense Acquisition Programs (MDAPS) and Major Automated Information System (MAIS) Acquisition Programs http://www.dtic.mil/whs/directives/corres/pdf/500002p.pdf
- DoD 5000.4 Cost Analysis Improvement Group (CAIG) http://www.dtic.mil/whs/directives/corres/pdf/500004p.pdf
- DOE Environmental Management (EM) Applied Cost Engineering (ACE) Team http://www.em.doe.gov/Pages/aceteam.aspx
- Department of the Treasury http://www.ustreas.gov/
- e-Government http://www.whitehouse.gov/omb/egov/
- Federal Acquisition Regulation (FAR) http://www.arnet.gov/far/
- General Accounting Office (GAO) http://www.gao.gov/
- The Federal Activities Inventory Reform Act (FAIR), P.L. 105-270 http://www.whitehouse.gov/omb/procurement/fair-index.html
- Military Handbook 881 for WBS http://www.acq.osd.mil/pm/currentpolicy/wbs/MIL_HDBK-881A/MILHDBK881A/WebHelp3/MILHDBK881A.htm
- Office of Management and Budget (OMB) Circular No. A-11 Preparing and Submitting Budget Estimates http://www.whitehouse.gov/omb/circulars/a11/02toc.html
- Office of Management and Budget (OMB) Circular No. A-76 Performance of Commercial Activities http://www.whitehouse.gov/omb/circulars/a076/a076.html
- Office of Management and Budget (OMB) Circular No. A-76 Performance of Commercial Activities Revised Supplemental Handbook http://www.whitehouse.gov/omb/circulars/a076/a076s.html
- Office of Management and Budget (OMB) Circular No. A-94 Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs http://www.whitehouse.gov/omb/circulars/a094/a094.html
- Office of Personnel Management Salary Tables http://www.opm.gov/oca/payrates/

- Title 10 United States Code Section 2306a (10 USC 2306a)
  Cost or Pricing Data: Truth in Negotiations
  http://www4.law.cornell.edu/uscode/10/2306a.html
- Naval Sea Systems Command (NAVSEA) Cost Engineering and Industrial Analysis
  http://www.navsea.navy.mil/
- Office of Management and Budget (OMB) http://www.whitehouse.gov/omb/
- Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics
  www.acq.osd.mil/
- United States Government Standard General Ledger (USSGL)
  http://www.fms.treas.gov/ussgl/index.html

### 2.1.2 Online Research Tools

- DoD Dictionary http://www.dtic.mil/doctrine/jel/doddict/
- Project Management Glossary
  http://www.maxwideman.com/pmglossary/index.htm
- WorldWideWeb Acronym and Abbreviation Server
  http://silmaril.ie/cgi-bin/uncgi/acronyms

### 2.1.3 Online Publications

- Aerospace Systems Design in NASA's Collaborative Engineering Environment
  http://techreports.larc.nasa.gov/ltrs/PDF/1999/mtg/NASA-99-50iac-dwm.pdf
- Cost Analysis Improvement Group (CAIG) Operating and Support Cost Estimating Guide http://www.dtic.mil/pae/
- Contract Pricing Reference Guides
  http://www.acq.osd.mil/dpap/contractpricing/backup/index.htm
- Controller Magazine (Business Finance) http://www.businessfinancemag.com/
- Department of the Army Cost Analysis Manual
  http://www.asafm.army.mil/pubs/cdfs/cam/CAM.pdf
- Department of the Army Economic Analysis Manual
  http://www.asafm.army.mil/pubs/cdfs/manual/economic.pdf
- Department of Defense Operating and Support Cost Estimating Guide
  http://www.ncca.navy.mil/resources/caig_os_guide.pdf
- Department of Defense Parametric Estimating Initiative Handbook
  http://www.ispa-cost.org/PEIWeb/newbook.htm
- Department of Defense Primer on Cost Analysis Requirements Description (CARD)
  https://acc.dau.mil/CommunityBrowser.aspx?id=30382&lang=en-US
- Department of Energy (DOE) Office of Science Article on Learning Curves
  http://www.sc.doe.gov/sc-80/sc-82/430-1/430-1-chp21.pdf
- Federal Employee's News Digest http://www.federaldaily.com/
- GAO Defense Acquisition: Historical Insights Into Navy Ship Leasing
  http://www.gao.gov/archive/1999/ns99141t.pdf
- Government Executive http://www.govexec.com/
- NASA Watch http://www.nasawatch.com/

- The President's Management Agenda
  http://www.whitehouse.gov/omb/budintegration/pma_index.html
- RAND Reports http://www.rand.org/search/pubs_search.html
- Software Size Measurement: A Framework for Counting Source Statements (by Robert E. Park)
  http://www.sei.cmu.edu/pub/documents/92.reports/pdf/tr20.92.pdf

### 2.1.4 Professional Societies

- American Institute of Aeronautics and Astronautics (AIAA) http://www.aiaa.org
- American National Standards Institute (ANSI) http://www.ansi.org/
- American Society of Professional Estimators (ASPE)
  http://www.aspenational.com/
- Association for the Advancement of Computing in Education
  http://www.aace.org/
- The Association for the Advancement of Cost Engineering through Total Cost Management (AACE) International http://www.aacei.org/
- Association of Cost Engineers (ACostE) http://www.acoste.org.uk/
- Center for International Project and Program Management (CIPPM)
  http://www.iol.ie/~mattewar/CIPPM/
- International Cost Engineering Council (ICEC) http://www.icoste.org/
- International Function Point Users Group (IFPUG) www.ifpug.org
- International Project Management Association (IPMA) http://www.ipma.ch/
- International Society of Parametric Analysts (ISPA) http://www.ispa-cost.org/
- National Contract Management Association (NCMA) http://www.ncmahq.org/
- Project Management Institute (PMI) http://www.pmi.org/
- Society of Cost Estimating and Analysis (SCEA) http://www.sceaonline.net/
- Society for Risk Analysis (SRA) http://www.sra.org/
- Space Systems Cost Analysis Group (SSCAG) http://sscag.saic.com/

### 2.1.5 Colleges and Universities

- Air Force Institute of Technology (AFIT) http://www.afit.edu/
- Army Logistics Management College (ALMC) http://www.almc.army.mil/
- California State University, Long Beach (Regression)
  http://www.csulb.edu/~msaintg/ppa696/696regs.htm#REGRESSION
- Carnegie Mellon University http://www.cmu.edu/
- Defense Acquisition University (DAU) http://www.dau.mil/
- University of Exeter (Regression)
  http://www.people.ex.ac.uk/SEGLea/psy2005/simpreg.html
  http://www.people.ex.ac.uk/SEGLea/psy2005/basicmlt.html
- University of Southern California (Regression)
  http://www-rcf.usc.edu/~moonr/econ419/econ414_2.pdf

## 2.2 Cost Estimating Publications

### 2.2.1 Books

- *2002 Craftsman Cost Estimating Guides*
- *Advanced Engineering Economics* (by Chan S. Park and Gunter P. Sharp-Bette)
- *CHAOS Chronicles 3.0* (by the Standish Group)
- *CMMI Distilled* (by Ahern, Clouse, & Turner)
- *Construction Cost Analysis and Estimating* (by Phillip F. Ostwald)
- *Cost Estimating* (by Rodney D. Stewart)
- *Cost Estimator's Reference Manual* (by Rodney D. Stewart, Richard M. Wyskida, and James D. Johannes)
- *Design to Cost* (by Jack V. Michaels and William P. Wood)
- *Engineering Cost Estimating* (by Phillip F. Ostwald)
- *Estimating and Bidding for Heavy Construction* (by S.H. Bartholomew)
- *Estimating in Building Construction* (by Frank R. Dagostino and Leslie Feigenbaum
- *Estimating Software Costs* (by T. Capers Jones)
- *Financial Management Theory and Practice* (by Eugene F. Brigham and Michael C. Gapenski)
- *Function Point Analysis: Measurement Practices for Successful Software Projects* (by Garmus and Herron)
- *How to Estimate with Means Data & CostWorks* (by Saleh Mubarak and Means)
- *Investment Under Uncertainty* (by Avinash Dixit and Robert Pindyck)
- *IT Measurement: Practical Advice from the Experts* (by IFPUG)
- *Managing the Construction Process: Estimating, Scheduling, and Project Control* (by Frederick E. Gould)
- *Means Building Construction Cost Data (by R.S. Means Company, Inc.* (http://www.rsmeans.com)
- *Practical Software Measurement: Objective Information for Decision Makers* (by McGarry, et. al.)
- *Principles of Corporate Finance* (by Richard A. Brealey and Stewart C. Myers)
- *Probability Methods for Cost Uncertainty Analysis: A Systems Engineering Perspective,* Paul R. Garvey
- *Project Estimating and Cost Management*, Parviz F. Rad
- *Real Options; Managerial Flexibility and Strategy in Resource Allocation* (by Lenos Trigeorgis)
- *Real Options: Managing Strategic Investments in an Uncertain World* (by Martha Amram and Nalin Kulatilaka)
- *Reducing Space Mission Cost* (by James R. Wertz and Wiley J. Larson)
- *Reducing the Cost of Spacecraft Ground Systems and Operations,* Jiun-Jih Miau
- *Simplified Estimating For Builders And Engineers* (by Joseph E. Helton)

- *Software Assessments, Benchmarks, and Best Practices* (by Capers Jones)
- *Software Cost Estimation with COCOMO II,* by Barry W. Boehm
- *Space Mission Analysis and Design (SMAD)*, by Wiley J. Larson and James Richard Wertz
- *Space Transportation: A Systems Approach to Analysis and Design,* Walter E. Hammond
- *Statistical Methods for Learning Curves and Cost Analysis,* Matthew Goldberg, PhD
- *Technological Forecasting for Decision Making,* by Joseph P. Martino
- *The Economic Implications of Learning by Doing, The Reviewof Economic Studies, Vol. 2, No. 3*
- *The Goal Question Metric Method,* by van Solingen & Berghout
- *The Learning Curve and Pricing in Chemical Processing Industries, The RAND Journal of Economics, Vol. 15, No. 2*
- *The Mythical Man Month,* by Frederick P. Brooks
- Walker's Building Estimator's Reference Book, by Scott Siddens and Frank R. Walker Co.

### 2.2.2 Handbooks and Manuals

- Air Force Space Command (AFSC) Cost Estimating Handbook Series, Volume VI – Space Handbook
- Department of the Navy Center for Cost Analysis Software Development Estimating Handbook
- IFPUG Counting Practices Manual, Version 4.1.1
- IFPUG Case Study 1, Release 2.0: ERD, Hierarchical Process, DB2 Data Base, and GUI Windows
- IFPUG Case Study 2, Release 2.0: ERD, Data Flow Diagrams, IMS Data Base, Common User Access Screens
- IFPUG Case Study 3, Release 2.0: Class Diagram (UML), Use Case Diagrams, GUI Windows
- IFPUG Case Study 4, Release 1.0: Traffic Control Systems with Real-Time Components
- IFPUG Guidelines to Software Measurement ('96-'97)
- IFPUG Guidelines to Counting Logical Files
- IFPUG Guidelines to Counting Enhancements
- ISBSG Benchmark Summary Release 6
- NAFCOM Manual
- PRICE Manual
- SEER Manual

### 2.2.3 Papers and Reports

- Jacobs, Mark, "Space Operations Cost Model (SOCM) Version 1.0 User's Manual and Program Documentation", Science Applications International Corporation, January 1998

- Quintana, Mauricio, "ISSAC Model (Version 2.0) User Guide", Booz Allen Hamilton, December 2003
- Shishko, Robert, "MESSOC (Version 3.16) Algorithms Documentation and User Help Files" *in html*, Caltech Jet Propulsion Laboratory, October 2002.

# Section 3. Acronyms

In addition to the following list of defined acronyms, other useful cost terms can be found on the following websites:

| | | |
|---|---|---|
| Acronym Finder | ➡ | http://www.acronymfinder.com/ |
| Cost Estimating Acronym Glossary | ➡ | http://cost.jsc.nasa.gov/acronyms.html |
| NASA Acronym List (GSFC) | ➡ | http://library.gsfc.nasa.gov/Databases/Acronym/acronym.html |
| NASA Acronym List (KSC) | ➡ | http://www.ksc.nasa.gov/facts/acronyms.html |
| NASA Acronym List (MSFC) | ➡ | http://liftoff.msfc.nasa.gov/help/acronym.html |
| NASA Earth Science Acronyms | ➡ | http://gcmd.gsfc.nasa.gov/Aboutus/sitemap.html |
| Internet Acronym Server | ➡ | http://silmaril.ie/cgi-bin/uncgi/acronyms |

| | |
|---|---|
| AA | Associate Administrator |
| AACE | Association for the Advancement of Cost Engineering |
| AATe | Architectural Assessment Tool – Enhanced |
| ABC | Activity Based Costing |
| ACE | Advocacy Cost Estimate |
| ACEIT | Automated Cost Estimating Integrated Tools |
| ACEO | Assessments and Cost Estimating Office |
| ACWP | Actual Cost of Work Performed ("Actuals" or "Cost") |
| AFCRUH | Air Force Cost Risk and Uncertainty Handbook |
| AFIT | Air Force Institute of Technology |
| AFSC | Air Force Space Command |
| AFSMC | Air Force Space and Missile Systems Center |
| AGE | Aerospace Ground Equipment |
| AHP | Analytic Hierarchy Process |
| ALMC | Army Logistics Management College |
| AMCM | Advanced Missions Cost Model |
| ANP | Analytic Network Process |
| ANSI | American National Standards Institute |
| AO | Announcement of Opportunity |
| AoA | Analysis of Alternatives |
| APA | Allowance for Program Adjustment |
| APMC | Agency Program Management Council |
| ARC | Ames Research Center |
| ARR | ATLO Readiness Review |
| ASPE | American Society of Professional Estimators |
| AT | Acceptance Test (DSMS) |
| ATLO | Assembly, Test, & Launch Operations |
| ATP | Authorization to Proceed |
| AUW | Authorized Unpriced Work |
| BCA | Business Case Analysis |
| BCE | Baseline Cost Estimate |

| | |
|---|---|
| BCR | Benefit/Cost Ratio |
| BCTE | Baseline Cycle Time Estimate |
| BCWP | Budgeted Cost of Work Performed |
| BCWS | Budgeted Cost of Work Scheduled |
| BDE | Budget Direct Effort |
| BVS | Best Value Selection |
| BMO | Business Management Office |
| BOE | Basis of Estimate |
| BY | Base Year |
| CA | Cost Account |
| CADRe | Cost Analysis Data Requirement |
| CAICAT | Composite Affordability Initiative Cost Analysis Tool |
| CAIG | Cost Analysis Improvement Group |
| CAIV | Cost as an Independent Variable |
| CAM | Centrifuge Accommodation Module |
| CAO | Cost Analysis Office |
| CASA | Cost Analysis Strategy Assessment |
| CBA | Cost Benefit Analysis |
| CBB | Contract Budget Base |
| CBS | Cost Breakdown Structure |
| CCDR | Contractor Cost Data Report |
| CCE | Current Cost Estimate |
| CCP | Cost Credibility Plan |
| CCRM | Continuous Cost-Risk Management |
| CCT | Cost Credibility Team |
| CDF | Cumulative Distribution Function |
| CDG | Career Development Guide |
| CDR | Critical Design Review |
| CEA | Cost Estimation and Analysis |
| CEC | Cost Estimating Community |
| CEH | Cost Estimating Handbook |
| CER | Cost Estimating Relationship |
| CERT | Cost Estimation Reconciliation Team |
| CES | Cost Element Structure |
| CEWG | Cost Estimating Working Group |
| CFO | Chief Financial Officer |
| CFSR | Contract Funds Status Report |
| CIC | Capital Investment Council |
| CLIN | Contract Line Item Number |
| CM | Configuration Management |
| COCOMO | Constructive Cost Model |
| CoF | Construction of Facilities |
| COMET | Conceptual Operations Manpower Estimating Tool |
| CONOPS | Concept of Operations |
| COSMIC | Computer Software Management Information Center |
| CoSTER | Consortium on Space Technology Estimating Research |

| | |
|---|---|
| COTS | Commercial-off-the-Shelf |
| CPA | Critical Path Analysis |
| CPI | Consumer Price Index |
| CPIC | Capital Planning and Investment Control |
| CPM | Critical Path Method |
| CPR | Cost Performance Report |
| C/SCSC | Cost/Schedule Control System Criteria |
| CSE | Center for Software Engineering |
| CSRS | Civil Service Retirement System |
| C/SSR | Cost/Schedule Status Report |
| CTER | Cycle Time Estimating Ratio |
| CY | Calendar Year |
| CY | Constant Year |
| CY | Current Year |
| DACS | Data and Analysis Center for Software |
| DAU | Defense Acquisition University |
| DCAA | Defense Contract Audit Agency |
| DCF | Discounted Cash Flow |
| DCMA | Defense Contract Management Agency |
| DD | Design Development |
| DDT&E | Design, Development, Test & Evaluation |
| DFRC | Dryden Flight Research Center |
| DoD | Department of Defense |
| DR | Data Request |
| DR | Data Requirements |
| DRD | Data Requirements Description |
| DSMC | Defense Systems Management College |
| DSMS | Deep Space Mission Systems |
| DSN | Deep Space Network |
| DTC | Design to Cost |
| EA | Economic Analysis |
| EAC | Estimate at Completion |
| EADP | Economic Analysis Development Plan |
| ECHO | Environmental Costs of Hazardous Operations |
| ECI | Employment Cost Index |
| ECOM | ESA Cost Modeling Software |
| ECOS | ESA Costing Software |
| ECP | Engineering Change Proposal |
| EIA | Electronic Industries Alliance |
| EMP/EMI | Electromagnetic Pulse / Electromagnetic Interference |
| EOSDIS | Earth Observing Station Data & Information System |
| EQEA | Environmental Quality Economic Analyses |
| ERP | Enterprise Resource Planning |
| ESA | European Space Agency |
| ETC | Estimate to Complete |
| EVM | Earned Value Management |

| | |
|---|---|
| EVMS | Earned Value Management System |
| FACGSE | Spaceport Facility and GSE Acquisition Cost Estimator |
| FAI | Federal Acquisition Institute |
| FAIR | Federal Activities Reform |
| FAR | Federal Acquisition Regulation |
| FCA | Full Cost Accounting |
| FEA | Front End Analysis |
| FEA | Functional Economic Analysis |
| FERS | Federal Employees Retirement System |
| FFE | Friendly Front End |
| FFP | Firm Fixed Price |
| FH | Flight Hardware |
| FPA | Function Point Analysis |
| FRISK | Formal Risk Assessment of System Cost Estimates |
| FSW | Flight Software |
| FTE | Full-Time Equivalent (civil servant) |
| FV | Future Value |
| FY | Fiscal Year |
| G&A | General and Administrative |
| GAO | Government Accountability Office |
| GDP | Gross Domestic Product |
| GEM-FLO | Generic Environment for Modeling Future Simulation Launch Vehicle |
| GFE | Government Furnished Equipment |
| GOTS | Government-off-the-Shelf |
| GPRA | Government Performance and Results Act |
| GR&A | Ground Rules and Assumptions |
| GRC | Glenn Research Center |
| GSE | Ground Support Equipment |
| GSFC | Goddard Space Flight Center |
| HIT | Health Insurance Tax |
| HQ | Headquarters |
| HSF | Human Space Flight |
| HW | Hardware |
| IA | Independent Assessment |
| IAF | International Astronautics Federation |
| IAR | Independent Annual Review |
| IBPD | Integrated Budget Performance Document |
| IBR | Integrated Baseline Review |
| ICE | Independent Cost Estimate |
| ICR | Independent Cost Review |
| IDEA | ISS Downlink Enhancement Architecture |
| IEEE | Institute of Electrical and Electronics Engineers |
| IFM | Integrated Financial Management |
| IEMP | Integrated Enterprise Management Program |
| IFMS | Integrated Financial Management System |
| IFPUG | International Function Point Users Group |

| | |
|---|---|
| IGCE | Independent Government Cost Estimate |
| ILCCE | Independent Life Cycle Cost Estimate |
| IMLEO | Initial Mass in Low-Earth Orbit |
| IMS/IMP | Integrated Master Schedule/Integrated Master Plans |
| IND | Interplanetary Network Directorate, (formerly TMOD) |
| IOC | Initial Operating Capability |
| IPAO | Independent Program Assessment Office |
| IPI | International Price Index |
| IPR | Initial Program Review |
| IPT | Integrated Product Team |
| IR&D | Independent Research and Development |
| IRM | Information Resource Management |
| IRR | Internal Rate of Return |
| IRS | Internal Revenue Service |
| ISAT | Inter-Center Systems Analysis Team |
| ISE | Intelligent Synthesis Environment |
| ISO | International Organization for Standardization |
| ISPA | International Society of Parametric Analysts |
| ISS | International Space Station |
| ISSAC | International Space Station Analytical Cost |
| I&T | Integration and Test |
| IT | Information Technology |
| ITMRA | Information Technology Management Reform Acquisition |
| IV&V | Independent Verification and Validation |
| JPL | Jet Propulsion Laboratory |
| JSC | Johnson Space Center |
| Kbase | Knowledge Base |
| KPP | Key Performance Parameter |
| KEPP | Key Engineering Performance Parameters |
| KSC | Kennedy Space Center |
| L&FB | Leave and Fringe Benefits |
| LaRC | Langley Research Center |
| LCC | Life-Cycle Cost |
| LCCE | Life Cycle Cost Estimate |
| LOC | Lines of Code |
| LOE | Level of Effort |
| LOOS | Launch and Orbital Operations Support |
| LSBF | Least Squares Best Fit |
| MAIS | Major Automated Information Systems |
| MC | Management Council |
| MCC | Mission Control Center |
| MCPR | Modified Cost Performance Report |
| MDAPS | Major Defense Acquisition Programs |
| MESSOC | Model for Estimating Space Station Operations Costs |
| MICM | Multi-Variable Instrument Cost Model |
| MIL-STD | Military Standard |

| | |
|---|---|
| MNS | Mission Needs Statement |
| MOU | Memorandum of Understanding |
| MPV | Mid-Point Value |
| MR | Management Reserve |
| MS | Microsoft |
| MSFC | Marshall Space Flight Center |
| MSI&T | Mission System Integration and Test |
| NAFCOM | NASA/Air Force Cost Model |
| NAR | Non-Advocate Review |
| NASA | National Aeronautics and Space Administration |
| NBS | New Business Systems |
| NCC | Negotiated Contract Cost |
| NCCA | Naval Center for Cost Analysis |
| NCMA | National Contract Management Association |
| NCRD | NASA Cost-Risk Database |
| NDI | Non-Developmental Item |
| NODIS | NASA On-line Directives Information System |
| NPD | NASA Policy Directive |
| NPG | NASA Procedures and Guidelines |
| NPR | NASA Procedural Requirement |
| NGR | NASA Procedures and Requirements |
| NPV | Net Present Value |
| N/R | Not Relevant |
| NRA | NASA Research Announcement |
| NroC | Integrated RMAT OCM/COMET Model |
| NWODB | New Ways of Doing Business |
| O&M | Operating and Maintenance |
| O&S | Operations and Support |
| OCM | Operations Cost Model |
| ODC | Other Direct Cost |
| OLS | Ordinary Least Squares |
| OMB | Office of Management and Budget |
| ONCE | One NASA Cost Estimating database |
| OPCU | Orbiter Power Converter Unit |
| OSP | Orbital Space Plane |
| OTB | Over Target Baseline |
| PAA | Program Analysis and Alignment |
| PAPAC | Provide Aerospace Products and Capabilities |
| PBS | Product Breakdown Structure |
| PC | Personal Computer |
| PCA | Program Commitment Agreement |
| PCAT | Project Cost Analysis Tool |
| PCC | Program Cost Commitment |
| PCD | Performing Center Director |
| PDC | Project Design Center |
| PDCR | Preliminary Design and Cost Review |

| | |
|---|---|
| PDF | Probability Density Function |
| PDR | Preliminary Design Review |
| PERT | Program Evaluation and Review Technique |
| PFA | Program Formulation Agreement |
| PI | Principal Investigator |
| PLCCE | Project Life Cycle Cost Estimate |
| PM | Program/Project Manager |
| PMA | President's Management Agenda |
| PMB | Performance Measurement Baseline |
| PMC | Program Management Council |
| PME | Prime Mission Equipment |
| PMI | Project Management Institute |
| PMSR | Project Mission System Review |
| PO | Program Office |
| POC | Point of Contact |
| POE | Program Office Estimate |
| PP | Planning Package |
| PPBE | Planning, Programming, Budgeting & Execution |
| PPI | Producer Price Index |
| PRA | Probabilistic Risk Assessment |
| PRICE | Parametric Review of Information for Cost and Evaluation |
| PRICE H | PRICE Hardware |
| PRICE HL | PRICE Hardware Life Cycle |
| PRICE M | PRICE Microcircuits |
| PRICE S | PRICE Software |
| PS | Protect Scenario |
| PV | Present Value |
| PWD | Procurement Work Directive |
| QA | Quality Assurance |
| QFD | Quality Function Deployment |
| R&D | Research and Development |
| RDT&E | Research, Development, Test, and Evaluation |
| REVIC | Revised Intermediate COCOMO |
| RFP | Request for Proposal |
| RLV | Reusable Launch Vehicle |
| RMAT | Reliability, Maintainability Analysis Tool |
| RMO | Resource Management Office |
| ROI | Return on Investment |
| ROM | Rough Order of Magnitude |
| RSS | Residual Sum of Squares |
| RY | Real Year |
| SBM | Scenario Based Method |
| SCEA | Society of Cost Estimating and Economic Analysis |
| SCT | Software Costing Tool |
| SEE | Standard Error of the Estimate |
| SEER | System Evaluation & Estimation of Resources |

| | |
|---|---|
| SEER-DFM | SEER Design for Manufacturability |
| SEER-H | SEER Hardware Estimation and Life Cycle Cost Analysis |
| SEER-IC | SEER Custom Integrated Circuit Development |
| SEER-SEM | SEER Software Estimation Model |
| SEER-SSM | SEER Software Sizing Model |
| SEI | Software Engineering Institute |
| SEMP | System Engineering Master Plan |
| SER | Schedule Estimating Relationship |
| SICM | Scientific Instrument Cost Model |
| SIR | Savings to Investment Ratio |
| SLOC | Source Lines of Code |
| SMAD | Space Mission Design and Analysis |
| SME | Subject Matter Expert |
| SMO | Systems Management Office |
| SOCM | Space Operations Cost Model |
| SORCE | Software Resource Center |
| SPP | Summary Planning Package |
| SQA | Software Quality Assurance |
| SQI | Software Quality Improvement |
| SRA | Society for Risk Analysis |
| SRCR | Software Review/Certification Review |
| SRR | Software Requirements Review |
| SSA | Social Security Administration |
| SSC | Stennis Space Center |
| SSCM | Small Satellite Cost Model |
| SSCRH | Space Systems Cost Risk Handbook |
| SVLCM | Spacecraft/Vehicle Level Cost Model |
| SW | Software |
| TAB | Total Allocated Budget |
| T&M | Time and Materials |
| T1 | Theoretical First Unit Value |
| TBD | To Be Determined |
| TCO | Total Cost of Ownership |
| TCOR | Total Cost of Ownership Reduction |
| TDRSS | Tracking and Data Relay Satellite System |
| TIM | Technical Interchange Meeting |
| TIMS | Tactical Information Management System |
| TOA | Total Obligation Authority |
| TOR | Terms of Reference |
| TPM | Technical Performance Measure |
| TRL | Target Requirement List |
| TRL | Technical Readiness Level |
| TRR | Test Readiness Review |
| TSP | Thrift Savings Plan |
| TSS | Total Sum of Squares |
| TY | Then Year |

| | |
|---|---|
| UB | Undistributed Budget |
| UFE | Unallocated Future Expense |
| USC | United States Code |
| USCM | Unmanned Spacecraft Cost Model |
| USSGL | United States Government Standard General Ledger |
| WBS | Work Breakdown Structure |
| WP | Work Package |
| WYE | Work Year Equivalent (contractor) |

# Section 4. Glossary

@RISK – Risk Analysis and Simulation add-in for Microsoft Excel® or Lotus® 1-2-3. @RISK uses Monte Carlo simulation that allows taking all possible outcomes into account. Replace uncertain values in the spreadsheet with @RISK functions, which represent a range of possible values. Select bottom-line cells, like Total Profits, as outputs, and start a simulation. @RISK recalculates the spreadsheet, each time selecting random numbers from the @RISK functions entered. The result is distributions of possible outcomes and the probabilities of getting those results. The results illustrate what could happen in a given situation, but also how likely it is that it will happen.

Accounting Estimate – Uses engineering estimates of reliability, maintainability, and component cost characteristics, etc. to build estimates from the "bottom-up" for each cost category.

Acquisition Strategy – The method utilized to design, develop, and deploy a system through its life cycle. It articulates the broad concepts and objectives, which direct and control the overall development, production, and deployment of a materiel system. It is the framework for planning, directing, contracting for, and managing a program. It provides a master schedule for research, development, test, production, fielding, modification, postproduction management, and other activities essential for program success.

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

Analogous System Estimate – With this technique, a currently fielded system (comparable system) similar in design and/or operation of the proposed system is identified. The cost of the proposed system is developed by taking the fielded system's data and adjusting it to account for any differences. Analogous estimates are also called Comparative or Extrapolated estimates.

Analysis of Alternatives (AoA) – Broadly examines multiple elements of project or program alternatives including technical risk and maturity, and costs. AoAs are intended to illuminate the risk, uncertainty, and the relative advantages and disadvantages of the alternatives being considered; show the sensitivity of each alternative to possible changes in key assumptions; and aid decision-makers in judging whether or not any of the proposed alternatives offer sufficient operational and/or economic benefit to be worth the cost.

Analytic Hierarchy Process (AHP) – Structures problems into a hierarchical structure in order to reduce complexity. AHP is a feature of Expert Choice software.

Analytic Network Process (ANP) – Uses non-linear models to demonstrate the relationship between the elements. ANP is a feature of Expert Choice software.

Announcement of Opportunity (AO) – This is generally used to solicit proposals for unique, high cost research investigation opportunities that typically involve flying experimental hardware

provided by the bidder on one of NASA's Earth-orbiting or free-flying space flight missions. Selections through AO's can be for periods of many years, involve budgets of many millions of dollars for the largest programs, and usually are awarded through contracts, even for non-profit organizations, although occasionally grants are also used.

Assumption – A supposition on the current situation or a presupposition on the future course of events, either or both assumed to be true in the absence of positive proof. Assumptions are necessary in the process of planning, scheduling, estimating, and budgeting.

Automated Cost Estimating Integrated Tools (ACEIT) - Is a family of applications that support the analysis, development, sharing, and reporting of cost estimates and provides a framework to automate key analysis tasks and standardize the estimating process.

Baseline – The technical performance and content, technology application, schedule milestones, and budget (including contingency and APA) which are documented in the approved Program and Project Plans.

Base Year (BY) – A term used to define a year that is: (1) the economic base for dollar amounts in a proposal estimate, (2) the base for rate calculation or projection, or (3) the starting point for the application of inflation factors.

Benefit to Cost Ratio (BCR) – The benefit cost ratio measures the discounted amount of benefits that the project generates for each dollar of cost. Fundamentally, the computation of the benefit/cost ratio is done within the construct of the following formula: Benefits/Cost.

Best Value Selection – Best Value Selection (BVS) is most commonly used in proposal evaluation. BVS seeks to select an offer based on the best combination of price and qualitative merit of the offeror's submission, thus reducing the administrative burden on the offerors and the Government. BVS takes advantage of the lower complexity of mid-range procurements and predefines the value characteristics that will serve as discriminators among offers submitted.

Beta Curve – Can be used for spreading parametrically derived cost estimates. The Beta Curve's shape can tailored by modifying two parameters (cost fraction and peakedness). It is highly flexible and can approximate the normal distribution curve. It is used for R & D type contracts whereby costs build up slowly during the initial phases, and then escalates as the midpoint of the contract approaches.

Break-Even Analysis – Analysis used to uncover the point when the cumulative value of savings is equal to the cumulative value of investment.

Business Case Analysis (BCA) – Is a method to aid decision makers in the comparison of alternative approaches, options, or projects. A BCA considers not only all life cycle costs identified by a Life Cycle Cost Estimate (LCCE), but also other quantifiable and non-quantifiable benefits for all possible alternatives.

Coarse Screening – Step 5 of a Trade Study where the number of candidate solutions is reduced (if necessary) by eliminating those candidates unacceptable for delta cost, risk, safety, performance, schedule, or other reasons.

Commercial-Off-The-Shelf (COTS) – Commercial items that require no unique government modifications or maintenance over the life cycle of the product to meet the needs of the procuring agency.

Competitive Sourcing Analysis Studies (A-76 Studies) – Competitive sourcing is an economic analysis conducted to determine the most cost effective method of obtaining services that are available in the commercial market. Agency missions may be accomplished through commercial facilities and resources, Government facilities and resources or mixes thereof, depending upon the product, service, type of mission and the equipment required. The prevailing regulations for the Competitive Sourcing studies are the OMB Circular No. A-76 Revised Supplemental Handbook, Performance of Commercial Activities, revised 1999.

Compounding – Process of going from today's values, or present values (PVs), to future values (FVs).

Constant (Base) Year Dollars – This phase is always associated with a base year and reflects the dollar "purchasing power" for that year. An estimate is in constant dollars when prior-year costs are adjusted to reflect the level of prices of the base year, and future costs are estimated without inflation. A cost estimate is expressed in "constant dollars" when the effect of changes in the purchasing power of the dollar (inflation) has been removed.

Constructive Cost Model (COCOMO) – A parametric software cost estimating tool developed and described by Dr. Barry Boehm in his book Software Engineering Economics. COCOMO has three standard modes of software development: Organic, Semi-Detached, and Embedded. The Air Force Cost Analysis Agency's REVIC model is based on the original COCOMO model.

Contingency – Reserves, including funding, schedule, performance, manpower, and services, allocated to and managed by the Program/Project Manager for the resolution of problems normally encountered to mitigate risks while ensuring compliance to the specified program/project scope.

Contract Cost Analysis – Contract cost analysis is the traditional method for analyzing a contractor's proposal. It is the analysis of the separate cost elements and profit of (1) an offeror's cost and pricing data and (2) the judgmental factors applied in projecting from the data to the estimated costs. The analyst does this to form an opinion on the degree to which the proposed costs represent what the contract should cost.

Contract Funds Status Report (CFSR) – A report normally required on cost or incentive type contracts to inform the buyer of funds used and status of remaining funds.

Contract Line Item Number (CLIN) – Items listed in a contract and priced individually. Some may be options.

Contract Work Breakdown Structure (WBS) – A breakout or subdivision of a project typically down to level three which subdivides the project into all its major hardware, software, and service elements, integrates the customer and contractor effort, provides a framework for the planning, control, and reporting. A WBS applied within a contract.

Contractor Cost Data Report (CCDR) – A U.S. Department of Defense report developed to provide contract cost and related data in a standard format.

Contractor Estimate – Title 10 United States Code Section 2306a requires prospective prime contractors and their subcontractors to submit certified cost or pricing data in support of their proposals. They must submit cost data in the SF 1411 format, which requires the contractor to separate the proposal and supporting data into the following groups: Purchased parts, Subcontracted items, Raw material, Engineering labor, Engineering overhead, Manufacturing labor, Manufacturing overhead, Other general and administrative (G&A), and Profit.

Correlation – a statistical technique used to determine the degree to which variables are related or associated. Correlation does not prove or disapprove a cause-and-effect relationship.

Cost Analysis Division (CAD) – The CAD is located at NASA Headquarters and performs various activities in support of its function as the cost estimating arm of the Office of Program Analysis and Evaluation (PA&E). The support includes providing cost estimates for potential future Agency programs and assessing available cost estimating tools to ensure that the Agency's cost estimations are continually improving and increasing in accuracy. The Cost Analysis Division also develops cost analysis policy for the Agency, and is available to perform quick turn-around cost analyses in support of the Studies and Analysis Division and the Strategic Investments Division.

Cost Analysis Improvement Group (CAIG) – The OSD's Cost Analysis Improvement Group (CAIG) provides an independent cost estimate. The CAIG's independent cost estimates provide useful cost information to DoD decision-makers. The CAIG estimates are intended primarily as internal working documents to ensure that senior officials receive the most candid and complete information about weapons acquisition programs.

Cost Analysis Office (CAO) – The Cost Analysis Offices at each NASA Center provide analysis, independent evaluations, and assessments of Center programs/ projects, including programs delegated to the Center as lead center. Some examples of the roles of a CAO are: Serve as the Center's focal point for independent cost estimating and analysis for programs and projects, Support Non Advocate Reviews (NARs), Independent Annual Reviews (IARs), and Independent Assessments (IAs) of Center programs and projects, and Provide cost analysis expertise to the IPAO to support independent reviews as requested.

Cost Analysis Data Requirements (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.

Cost Analysis Steering Group (CASG) – Serves as the Agency's forum for aerospace cost and risk policies, standards, and activities. Its purpose is to strengthen NASA's cost estimating standards and practices by improving tools, processes, and resources. It also fosters cooperation and interchange across the Agency cost analysis community and promotes interdisciplinary

understanding of costing aerospace systems and their applications to government and commercial endeavors.

Cost as an Independent Variable (CAIV) – The process of examining cost drivers by holding cost independent. CAIV is founded upon two primary principles: first, system costs are constrained. Whereas some programs do obtain additional funding when needed, such funding is often at the expense of other programs or future modernization and second, "trade space" is the foundation for smart decisions. Trade space is the range of alternatives available to decision makers. It is four-dimensional, comprising performance, cost, schedule, and risk impacts.

Cost Benefit Analysis (CBA) – An analytic technique that compares the costs and benefits of investments, programs, or policy actions in order to determine which alternative or alternatives maximize net profits. Net benefits of an alternative are determined by subtracting the present value of costs from the present value of benefits. CBA is comprised of 8 steps: analysis of the current environment, perform gap analysis, identify alternatives, estimate costs, perform sensitivity analysis, characterize and value benefits, determine net value of each alternative, and perform risk analysis.

Cost Driver – Those input variables that will have a significant effect on the final cost.

Cost Element Structure (CES) – A unit of costs to perform a task or to acquire an item. The cost estimated may be a single value or a range of values.

Cost Estimating – A methodology involving the application of quantitative techniques to calculate and forecast development, production, operation and support, and disposal costs (I.e., life-cycle costs) within a scheduled time frame and defined scope. Included in these costs are an assessment and evaluation of risks and uncertainties. The methodology involves preparing or obtaining a work breakdown structure, gathering, normalizing, and verifying cost data, developing cost estimating relationships (CERs), evaluating specific elements of costs, and evaluation of the reasonableness and appropriateness of the cost data. NASA follows this methodology for the development of cost estimates for space system hardware, space system software, construction of facilities, and research and development of technology (R&T). The results are used to assist decision makers in determining the optimal use of resources and to make cost-effective decisions throughout the life cycle.

Cost Estimating Community (CEC) – Includes all the cost estimating and cost analysis practitioners within the NASA workforce.

Cost Estimating Relationship (CER) – A mathematical relationship that defines cost as a function of one or more parameters such as performance, operating characteristics, physical characteristics, etc.

Cost Estimation and Analysis (CEA) Competency – The total capability of an organization to provide the cost estimates required by the organization for budget planning and execution, and program planning and approval.

Cost Overruns – The amount by which actual costs exceed the baseline or approved costs. Cost overruns can also refer to the amount by which a contractor exceeds or expects to exceed the estimated costs, and/or the final limitations (the ceiling) of a contract.

Cost Performance/Schedule Trade Study – Systemic, interdisciplinary examination of the factors affecting the cost of a system to find methods for meeting system requirements at an acceptable cost. This is achieved by analyzing numerous system concepts to find ways to attain necessary performance while balancing essential requirements that must be satisfied for the system to be successful. The objective of the cost-performance trades is not to minimize the cost of the system, but to achieve a specified level of cost reduction established by the target costing system.

Cost Readiness Level (CRL) – CRLs are designed to communicate the quality of the cost estimate by designating an associated CRL for each cost estimate to be funded in the Planning, Programming, Budgeting, and Execution (PPBE) process. CRLs have the same 1 to 9 ordinal scale as the NASA Technical Readiness Level (TRL).

Cost Risk – Risk due to statistical uncertainty in the cost estimate, technical parameter uncertainty, economic factors, rate uncertainty, schedule uncertainty, and programmatic & technological factors.

Cost Spreading Model – Takes the point-estimate derived from a parametric cost model and spreads it over the project's schedule, resulting in the project's annual phasing requirements.

Crystal Ball – Software that employs an analytical technique, called Monte Carlo Simulation to provide the capability to conduct risk and uncertainty analyses within the construct of Excel-based models.

Cumulative Average Curve – Predicts the average unit cost of a set number of production units. Also, referred to as the Wright curve or the Northrop curve.

Cumulative Distribution Function (CDF) Curve ("S" Curve) – A display of cumulative costs, labor hours or other quantities plotted against time. The name derives from the S-like shape of the curve, flatter at the beginning and end and steeper in the middle, which is typical of most activities (and whole project). The beginning represents a slow, deliberate but accelerating start, while the end represents a deceleration as the work runs out.

Data Requirement Description – The NASA Data Requirements Description (DRD) is the equivalent of the Department of Defense (DoD) Contract Data Requirements List (CDRL). The DRD defines the data in a contract that is to be delivered to the Government by the contractor. This data may be in any form specified, such as hard copy, electronic, and electronic mailable. The specific form of delivery to NASA is specified either in the SOW and/or in each individual DRD item. The DRD that the cost community is responsible for is the CADRe, which is an integrated DRD that includes the WBS Structure, Cost Input Report, and Cost Estimate Report. the CADRe DRD is proposed as a DR on Category I and high risk Category II flight projects at NASA.

Decision Tree – A graphic representation of the sequence of a specific activity or operation.

Delphi – A process where a consensus view is reached by consultation with experts. Often used as an estimating technique.

Descriptive Statistics – Descriptive statistics provide basic information on the nature of a particular variable or set of variables. In general, descriptive statistics can be classified into three groups, those that measure 1) central tendency or location of a set of numbers (i.e., mode, median, mean, etc.), 2) variability or dispersion (i.e., range, variance, standard deviation, etc.), and 3) the shape of the distribution (i.e., moments, skewness, kurtosis, etc.).

Direct Costs – Direct costs are costs that are obviously and physically related to a project at the time they are incurred and are subject to influence of the project manager. Examples of direct costs include contractor-supplied hardware and project labor, whether provided by civil service or contractor employees.

Discount Factor – The discount factor (also called the discount rate) is used to make dollar amounts occurring in different time periods commensurable so that they may be combined into a single number. The discount factor can be used to calculate present value (PV), present discounted value (PDV), or future value (FV). The present value discount factor for period n is 1/(1+r)^n) or equivalently, (1+r)^(-n). The future value discount factor for period n is (1+r)^n. Where r is the interest rate, and n is the number of periods measured from the present to when the future dollar amount or cash flow occurs. Typically, r is expressed as an annual rate, in which case the number of periods should be measured in years.

Discounted Cash Flow (DCF) – A cash flow summary that has been adjusted to reflect the time value of money.

Discounting – Technique for converting forecasted amounts to economically comparable amounts at a common point or points in time, considering the time value of money.

Earned Value Management (EVM) – A management technique that relates resource planning to schedules and to technical cost and schedule requirements. All work is planned, budgeted, and scheduled in time-phased increments constituting a cost and schedule measurement baseline.

Earned Value Management System (EVMS) – A management system and related sub-systems implemented to establish a relationship between cost, schedule, and technical aspects of a project, measure progress, accumulate actual costs, analyze deviations from plans, forecast completion of events, and incorporate changes in a timely manner.

Economic Analysis (EA) – Systematically identifies the costs and benefits of each suitable future course of action. An EA specifies the objectives and assumptions, addresses appropriate alternative courses of action, includes cost of the alternatives, and describes benefits and/or effectiveness of each alternative.

Economic Analysis Development Plan (EADP) – Constructed prior to an Economic Analysis and should include, at a minimum, the mission, background, purpose, constraints, assumptions, cost element structure, cost and benefit estimating methodology, system description, configuration, schedules, and issues.

ECONPAK – Army-developed economic analysis tool, picked by HQs, to evaluate Construction of Facilities projects for Cost Benefit analyses.

e-Government – The Office of Electronic Government in the General Services Administration was formerly named the Office of Electronic Commerce. E-Government is about using technology to enhance access to and delivery of information and services to citizens, business partners, employees, agencies, and government entities.

Environmental Quality Costs – Those costs that are specifically related to activities within the Army environmental program including pollution prevention, compliance, restoration, and conservation.

Environmental Quality Economic Analysis (EQEA) – Supports decision making associated with environmental quality costing alternatives. Environmental quality costs are those costs that are specifically related to activities including pollution prevention, compliance, restoration, and conservation. NASA NSTS 22254, Method for Conduct of Space Shuttle Program Hazard Analyses provides specific guidance related to conducting an EQEA.

Estimate at Completion (EAC) – Actual cost of work completed to date plus the predicted costs and schedule for finishing the remaining work. It can also be the expected total cost of an activity, a group of activities, or of the project when the defined scope of work is completed.

Estimate to Completion (ETC) - The expected cost needed to complete all the remaining work for a schedule activity, work breakdown structure component, or project.

Expert Choice – Advanced decision support application that uses Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP) to help quantify qualitative decisions.

Factor Cost Estimate – Cost factors are often used to address those program/project elements that must be accounted in the cost estimate but are largely undefined early in the design. Examples of cost elements that could be developed using factors and percentages include contractor fee, Advanced Development, Operations Capability Development, Program Support, and Center and agency taxes.

Federal Activities Inventory Reform (FAIR) Act – The FAIR Act directs Federal agencies to issue each year an inventory of all commercial activities performed by Federal employees, e.g., those activities that are not inherently governmental. OMB is to review each agency's Commercial Activities Inventory and consult with the agency regarding its content. Upon the completion of this review and consultation, the agency must transmit a copy of the inventory to Congress and make it available to the public. The FAIR Act establishes a limited administrative appeals process under which an interested party may challenge the omission or the inclusion of a particular activity on the inventory as a commercial activity. With completion of the inventory, including the challenge and appeals process, the FAIR Act requires agencies to review the activities on the inventory.

Fixed Cost – costs of an activity (manufacturing, production, assembly, operation, maintenance, etc) that do not vary significantly with the measure of the product or service output. Though these costs will be incurred regardless of the output of the system, the starting point scope of

fixed costs are often determined by factors that can be controlled such as design, capacity planning, and infrastructure scope and business process steps. While traditionally used in commercial practice to refer to items such as rent, or property taxes, in aerospace it is often the cost to maintain physical infrastructure, information flows, and workforce, at basic levels necessary to supply a range of required demand such as launch rate or production rate.

Front-end Analysis – Front-end analysis is comprised of two parts: a needs assessment and a task analysis. A needs assessment is the systematic effort to gather opinions and ideas from a variety of sources on performance problems or new systems and technologies. Task analysis breaks down job tasks into steps and solves performance problems. Task analysis works to determine the operational components of an objective, describe what and how they are to be performed, describe the sequence and describe the scope.

Full Cost Accounting – Full cost accounting ties all Agency costs (including civil service personnel costs) to major activities. All costs will be associated with an activity and, as a result, referred to as a cost object.

Function Point Analysis (FPA) – A standard methodology for measuring software development and maintenance using function points. Function points is a standardized metric that describes a unit of work product suitable for quantifying software that is based on the end-user's point of view.

Functional Economic Analysis (FEA) – Economic Analysis type that documents the review of an entire functional process or sub-process, such as the use of alternative launch vehicles, etc. It requires a risk assessment of each alternative solution, requesting a high and low estimate for each cost element and subsequent probability distribution of expected costs.

Full Time Equivalent (FTE) - In the U.S. Federal government, FTE is defined by the Government Accountability Office (GAO) as the number of total hours worked (Annual leave, sick leave, and compensatory time off and other approved leave categories are considered to be "hours worked" for purposes of defining FTE employment) divided by the maximum number of compensable hours in a work year as defined by law. For example, if the work year is defined as 2,080 hours, then one worker occupying a paid full time job all year would consume one FTE. Two employees working for 1,040 hours each would consume one FTE between the two of them. FTEs do not include military personnel, uniformed services, or contract support.

Future Value (FV) – Is the value of a set of cash flows at some future point assuming a certain interest rate and the time value of money.

Gap Analysis – Step Two in the CBA process. After evaluation of the current environment, the results of the current process are compared to the investment's stated objectives (i.e., a "to-be" environment). The outcome of this comparison enables determination of current environment shortfalls and identifies change opportunities. The gaps between where the organization is today and how it wants to look after the investment represent the opportunities for improvement.

General and Administrative (G&A) Cost – G&A costs are costs that cannot be related or traced to a specific project, but benefit all activities. Such costs are allocated to a project based on a

reasonable, consistent basis. Examples of G&A costs include costs associated with financial management, procurement, security, and legal activities.

Government-Off-The-Shelf (GOTS) – GOTS are pre-packaged software or (less commonly) hardware purchase alternatives. The technical staff of the government agency for which it is created typically develops them. It is sometimes developed by an external entity, but with funding and specification from the agency. Because agencies can directly control all aspects of GOTS products, these are generally preferred for government purposes.

Grassroots Cost Estimating – This costing methodology approach involves the computation of the cost of a WBS element by estimating the labor requirements (in terms of man-hours or man-years, for example) and the materials costs for the specific WBS line item. It is also referred to as "bottoms-up," or engineering build-up estimating.

Ground Rules and Assumptions (GR&A) – Ground rules and assumptions include both internal and external circumstances or events that are believed likely to happen. They describe the major decisions and the economic environment that affects the cost estimate. Ground rules and assumptions are based on the operation, maintenance and support of the system. Ground rules and assumptions generally include: the O&M period, base year of dollars, type of dollars, inflation indices, costs to be included or excluded, guidance on how to interpret the estimate properly, and clarification to the limit and scope in relation to acquisition milestones.

Independent Annual Review (IAR) – An IAR provides the status and performance of the project to the NASA Program Management Council (PMC) and is conducted to validate conformance to the Program Commitment Agreement (PCA) by detailing the progress/milestone achievement against original baseline; cost, schedule, and technical content evaluation and review of the project over its entire life cycle, technical progress, risks remaining, and mitigation plans, and any project deficiencies that will result in revised projections exceeding predetermined thresholds .

Independent Cost Analysis (ICA) – An independent analysis of program resources and financial management associated with the program content over the program's budget horizon, conducted by an impartial body independent from the management or advocacy chain of the program. ICA includes, but is not limited to, the assessment of cost estimates, budgets, and schedules in relation to the program and its constituent projects' technical content, performance, and risk. ICAs may include Independent Cost Estimates (ICE), assessment of resource management, distribution and planning, and verification of cost-estimating methodologies. (ICAs are not life-cycle cost estimates but are assessments of the adequacy of the budget and management practices to accomplish the work scope through the budget horizon; as such, ICAs can be performed for programs/projects when a life-cycle ICE is not warranted.)

Independent Cost Estimate (ICE) – An independent project cost estimate prepared by an office or other entity that is not under the supervision, direction, advocacy, or control of the project (or its chain of command) that is responsible for carrying out the development or acquisition of the program/project. An ICE is bounded by the project scope (total life cycle through all phases), schedule, technical content, risk, ground rules, and assumptions and is conducted with objectivity and the preservation of integrity of the cost estimate. ICEs are generally developed

using parametric approaches that are tailored to reflect the design, development state, difficulty, and expertise of team members.

Independent Life Cycle Cost Estimate – A life cycle cost estimate developed outside normal channels which generally includes representation from cost analysis, procurement, production management, engineering and project management.

Independent Program Assessment Office (IPAO) – The IPAO is a headquarters office located at Langley Research Center (LaRC). The IPAO role in cost estimating is to provide leadership and strategic planning for the cost estimation core competency by: interfacing with the Agency CFO and the Office of the Chief Engineer at NASA Headquarters regarding cost analysis requirements and processes, providing instruction on cost tool use, developing specialized cost tools, ensuring consistent, high-quality estimates across the Agency, fostering a "pipeline" of competent NASA analysts, providing independent, non-advocate cost estimates and cost-benefit analyses, and chairing the Cost Estimating Working Group and the annual NASA Cost Symposium Workshop.

Indirect Costs – Costs, which, because of their incurrence for common or joint objectives, are not readily subject to treatment as direct costs.

Inflation – An increase in the volume of money and credit relative to available goods and services resulting in a continuing rise in the general price level.

In-House Project – One that is conducted onsite or in the immediate vicinity of a NASA Center in which most major technical, business, and management tasks are performed primarily by the Center's civil service workforce.

Integrated Baseline Review (IBR) – An IBR is a formal project-level review that includes total project (contracted as well as in-house NASA) efforts. It is conducted jointly with personnel responsible for the efforts. Specifically, an IBR verifies that the technical content of the performance measurement baseline is consistent with the contract scope, work breakdown structure, and actual budget and schedule; ensures that effort personnel have identified all risks and are aware of their responsibilities for their management; ensures that there is a logical sequence of effort planned consistent with the contract schedule; ensures the disciplined implementation of all project Earned Value Management Systems (EVMS); establishes a forum through which the Program/Project Manager and the technical staff gain a sense of ownership of the cost/schedule management process; and establishes the baseline for the life of the contract. A term used to define a year that is: (1) the economic base for dollar amounts in a proposal estimate, (2) the base for rate calculation or projection, or (3) the starting point for the application of inflation factors.

Integrated Budget Development Plan (IBDP) – NASA's consolidated budget document.

Integrated Financial Management (IFM) – NASA new integrated financial management system used to track budget and project costs.

Integration Complexity Risk – Includes risks associated with the number of data dependencies, the number of actual interfaces between this module and other modules, and the technical issues involved regarding programming and application solutions.

Interest – The service charge for the use of money or capital, paid at agreed to intervals by the user, and commonly expressed as an annual percentage of principal.

Internal Rate of Return (IRR) – The Internal Rate of Return (IRR) is another ROI metric used to measure an investment. The IRR is defined as the rate at which a bond's future cash flows, discounted back to today, equal its price. It is also defined as discount rate at which the NPV equals zero. IRR can be estimated using the formula:

IRR = NPV = PV Benefits - PV Costs = 0.

Learning Curve – Learning curves, sometimes referred to as improvement curves or progress functions, are based on the concept that resources required to produce each additional unit decline as the total number of units produced increases. The term learning curve is used when an individual is involved and the terms progress function or an improvement curve is used when all the components of an organization are involved. The learning curve concept is used primarily for uninterrupted manufacturing and assembly tasks, which are highly repetitive and labor intensive.

Lease – A lease is a long-term agreement between a user (lessee) and the owner of an asset (lessor) where periodic payments are made by the lessee in exchange for most of the benefits of ownership.

Lease vs. Buy Decision – The Lease vs. Buy decision has three steps: estimate the cash flows associated with borrowing and buying the asset, estimate the cash flows associated with leasing and asset, and compare the two financing methods to determine which has the lower cost. The decision rule for the acquisition of an asset is: buy the asset if the equivalent annual cost of ownership and operation is less than the best lease rate that can be acquired from an outsider.

Lessee – Renter or the user of the asset. Lessee contracts to make a series of payments to the lessor, and in return, gets to use the asset for the lease term.

Lessor – Legal owner and normally is entitled to the tax privileges of ownership like depreciation deductions or investment tax credits, if they are available. At the end of the lease period, the equipment reverts to the lessor.

Level of Effort (LOE) – Effort of a general or supportive nature which does not produce definite end products or results, i.e., contract for man-hours.

Life Cycle Cost (LCC) – The total cost for all phases of a project or system including design, development, verification, production, operations, maintenance, and disposal.

Linear Regression – A mathematical modeling technique that finds the linear equation parameters that satisfy the criteria of minimizing the sum of the squared errors between the actual values and those estimated by the equation. It is also referred to as Simple Regression.

Logical Decisions for Windows – Software that allows evaluation of numerous alternatives based on a hierarchy of goals and objectives.

Manual Software Estimation – Manual software estimation typically utilizes a simple, straightforward methodology to derive effort, cost, and schedule. This includes analogy, engineering buildup, or cost estimating relationship (CER) factors.

Margin – The allowances carried in budget, projected schedules, and technical performance parameters (e.g., weight, power, or memory) to account for uncertainties and risks. Margin allocations are baselined in the formulation process, based on assessments of risks, and are typically consumed as the program / project proceeds through the life cycle.

Market Risk – Includes risks associated with the stability of vendors and their software and related tools and services within the market (in this case federal HR commercial off-the-shelf [COTS] product market).

Model – A representation of a system broken into its component factors, or parts, such as to mimic or behave as the actual system would, were such parts or factors to be varied and intermixed. A model is used to gain knowledge about a system without actually executing the system.

Monte Carlo Simulation – Calculates numerous scenarios of a model by repeatedly picking random values from the input variable distributions for each "uncertain" variable and calculating the results.

Multivariate Regression – A mathematical modeling technique that relates two or more independent variables to a dependent variable through a predetermined equation that minimizes the sum of the squared error.

NASA / Air Force Cost Model (NAFCOM) – A parametric estimating tool for space hardware that uses cost estimating relationships (CERs) that correlate historical costs to mission characteristic to predict new project costs.

NASA Research Announcement – An NRA is used to announce research in support of NASA's programs, and, after peer or scientific review using factors in the NRA, select proposals for funding. Unlike an RFP containing a statement of work or specification to which offerors are to respond, an NRA provides for the submission of competitive project ideas, conceived by the offerors, in one or more program areas of interest. NRAs may result in grants, contracts or cooperative agreements.

Net Present Value (NPV) – Is the sum of the present value of the estimated future benefits minus the present value of the initial investment/cash outflows.

Nominal Discount Rate – The nominal discount rate is adjusted to reflect expected inflation used to discount Then Year (inflated) dollars or nominal benefits and costs.

Non-Advocate Review (NAR) – An independent verification of a candidate project's plans, LCC status, and readiness to proceed to the next phase of the projects life cycle. A Pre-NAR is conducted when the project is moving from Phase A to Phase B. A NAR is conducted when a project is moving from Phase B to Phase C.

Non-Developmental Item (NDI) – Non-Developmental Items (NDI) are items, other than real property, that are customarily used for Non-Government purposes.

Non-Linear Regression – Is a mathematical technique of modeling a non-linear functional relationship. Non-linear regression can be performed using variable transformations or analytical techniques (such as Gauss-Newton interpolation).

Non-Quantifiable Benefits – Are those that cannot be reduced to quantified values. Non-quantifiable benefits include enhanced information security, consistency and compatibility throughout the enterprise, improved quality, enhancement of best practices, adherence to statutory and regulatory requirements, and enhanced modernization.

Normalize – A method to adjust data to a common predetermined basis. Cost data is often normalized to remove the effects of inflation and to adjust the project content to match a defined WBS.

Ontology: An ontology is required to achieve truly consistent communication between analysts and decision makers (re.NASA NExIOM Primer). Ontologies resemble faceted taxonomies but use richer semantic relationships among terms and attributes, as well as strict rules about how to specify terms and relationships. Because ontologies do more than just control a vocabulary, they are thought of as knowledge representation. The oft-quoted definition of ontology is "the specification of one's conceptualization of a knowledge domain."
(from http://www.noisebetweenstations.com/personal/essays/metadata_glossary/metadata_glossary.html)

Operating and Maintenance Costs (O&M) – Those operating expenditures incurred in the normal course of business to operate, maintain, support and update the system. O&M costs are a subset of recurring costs.

Ordinary Least Squares (OLS) – Regression technique that works to find the best possible equation (relationship) between variables while minimizing the squares of error terms.

Parametric Cost Estimate – An estimating methodology using statistical relationships between historical costs and other project variables such as system physical or performance characteristics, contractor output measures, or manpower loading, etc. Also referred to as "top down" estimating.

Parametric Estimation – Involves the development and utilization of cost estimation relationships between historical costs and program, physical, and performance characteristics. The analysis uses analysis tools, or models, that relate hardware elements, complexity, and risks of failure to expected costs – a parametric analysis.

Payback Period – The payback period is the time required for the cumulative value of savings to be equal to the cumulative value of investment. The payback period measures the number of years needed to recover the investment or break even. The accept-reject criterion for this financial indicator is the ability of the program to equal or better the organization's required payback period.

Point Estimate – An estimate with a single point result, rather than a probabilistic estimate with a cost range.

Present Value – Reflects in today's terms the value of future cash flows adjusted for the time value of money. Present value is calculated from the time series of constant dollars estimates, using the real discount rate as specified by OMB policy.

PRICE H/HL/M – A suite of hardware parametric cost estimating models that estimate development, production, and operations and support costs. The suite allows for generating estimates at any WBS level, which includes integration and test cost calculations. The models operate in Microsoft Windows and interface with Microsoft Excel, Project, and other office tools. Monte Carlo risk simulations capability is available with the suite.

PRICE S – A suite of software sizing, development cost, and schedule, along with associated software operations and support cost models. The models operate in Microsoft Windows and interface with Microsoft Excel, Project, and other office tools. Monte Carlo risk simulations capability is available with the suite.

Probability Density Function (PDF) – In mathematics, a probability density function (pdf) is a function that represents a probability distribution in terms of integrals. Informally, a probability density function can be seen as a "smoothed out" version of a histogram: if one empirically samples enough values of a continuous random variable, producing a histogram depicting relative frequencies of output ranges, then this histogram will resemble the random variable's probability density, assuming that the output ranges are sufficiently narrow.

Productivity Paradox – The productivity paradox is a phenomenon where the programming language that seems to have the best productivity metrics (e.g. effort per SLOC), actually results in the highest total cost because the language is less efficient than other, more modern programming languages.

Program – A strategic investment by a Mission Directorate or Mission Support Office that has a defined architecture, and/or technical approach, requirements, funding level, and a management structure that initiates and directs one or more projects. A program defines a strategic direction that the Agency has identified as needed to implement Agency goals and objectives.

Program Commitment Agreement (PCA) – is the agreement between the MDAA (Mission Directorate Associate Administrator) and the NASA AA (Associate Administrator) that authorizes transition from formulation to implementation. The PCA is prepared by the Mission Directorate with support from the Program Manager, as requested. The PCA documents Agency requirements, program objectives, management and technical approach and associated architecture, technical performance, schedule, cost, safety and risk factors, internal and external agreements, independent reviews, and all attendant top-level program requirements.

Program Office Estimate (POE) – A detailed estimate of acquisition and ownership costs normally required for high-level decisions. The estimate is performed early in the program and serves as the base point for all subsequent tracking and auditing purposes.

Program Formulation Agreement (PFA) – The PFA establishes resource estimates, cost risks, contingency reserves, and related Level 1 requirements for the formulation phase of a program's lifecycle.

Program Work Breakdown Structure (WBS) – A hierarchical structure, usually product oriented, that organizes, defines, and graphically displays the hardware, software, services, and other work tasks necessary to accomplish the program objectives.

Project – a specific investment identified in a Program Plan having defined requirements, a life-cycle cost, a beginning, and an end. A project also has a management structure and may have interfaces to other projects, agencies, and international partners. A project yields new or revised products that directly address NASA's strategic needs.

Project Schedule Risk – Schedule risk is defined as uncertainty in the project completion or fielding schedule, and the subsequent impact on costs and level of benefits. A stretched-out schedule may increase costs due to extended level-of-effort funding requirements, and result in delivery of systems too late to have the desired effect (reduced benefits). Project Schedule Risk should address factors such as the thoroughness of project approach and plan, the degree to which plans incorporate risk mitigation techniques, and the impact of not meeting or adjusting the project's anticipated timeline.

Quantifiable Benefits – Quantifiable benefits are those that can be measured or assigned a numeric value, such as dollars, physical count of tangible items, time, revenue, or percentage change. Dollar valued benefits comprise cost reductions, cost avoidance, and productivity improvements. Quantifiable benefits are calculated by subtracting the cost of an alternative from the cost of baseline operations over the period of the estimate (normally 10 years for IT investments).

Real Discount Rate – Discount rate adjusted to eliminate the effects of expected inflation used to discount Constant Year dollars or real benefits and costs.

Real Options Approach – The real options approach is a financial technique for valuing investment alternatives. This approach is primarily a decision tool that indicates whether or not to proceed with an investment after pre-established decision points are reached. This approach is more suited to large scale, multi-year acquisition projects where NASA would need to decide whether to continue spending or abandon a specific project. This approach integrates NPV techniques with a decision-tree framework to determine the whether a project should proceed or be terminated.

Regression Analysis – Examines the relation of a dependent variable (response variable) to specified independent variables (explanatory variables). The mathematical model of their relationship is the regression equation. The dependent variable is modeled as a random variable because of uncertainty as to its value, given only the value of each independent variable. A regression equation contains estimates of one or more hypothesized regression parameters ("constants"). These estimates are constructed using data for the variables, such as from a sample. The estimates measure the relationship between the dependent variable and each of the independent variables. They also allow estimating the value of the dependent variable for a given value of each respective independent variable.

Request for Proposal (RFP) – A formal invitation containing a scope of work, which seeks a formal response (proposal) describing both methodology and compensation to form the basis of a

contract. The Request For Proposal consists of a Solicitation Letter, Instructions to Bidders, Evaluation Criteria, Statement of Work, and a System Specification. The provider issues an RFP to potential subcontractors.

Reserve – A provision in the project plan to mitigate cost and/or schedule risk. Often used with a modifier (e.g., management reserve, contingency reserve) to provide further detail on what types of risk are meant to be mitigated and indicate who holds the reserve.

Return on Investment (ROI) – The strict meaning of ROI is "Return on Invested Capital." Most business people, however, use "ROI" simply to mean the incremental gain from an investment, divided by the cost of the investment. ROI is the net benefit expressed as a percentage of the investment amount:

ROI = NPV / PV Investment

REVIC – Parametric software cost estimating tool distributed by the Air Force Cost Analysis Agency that implements the Intermediate Constructive Cost Model (COCOMO) developed and described by Dr. Barry Boehm in his book Software Engineering Economics.

Risk – A situation in which the outcome is subject to an uncontrollable event stemming from a known probability distribution.

Risk Analysis – Process of examining each identified risk area to: isolate the cause; investigate the associative risk effects (e.g. dependencies/correlations); and determine the probable impacts.

Risk Assessment – Process of identifying and analyzing critical process and entity risks to increase the likelihood of meeting cost, performance (technical), and schedule objectives.

Rough Order of Magnitude (ROM) Estimates – It is an estimated cost based on approximate cost models or expert analysis. It is usually based on top-level requirements or specifications, and an overall prediction of work to be done to satisfy the requirements. The ROM is usually used for financial planning purposes only.

Savings to Investment Ratio (SIR) – The NPV of the savings divided by the NPV of the investment. The savings is the difference in the recurring costs between the status quo alternative and the proposed alternative. When the SIR equals one then discounted payback occurs.

Service Cost – Service costs are costs that cannot be specifically and immediately identified to a project, but can subsequently be traced or linked to a project and are assigned based on usage or consumption. Examples of services costs include automatic data processing and fabrication.

Scope of Work – The work involved in the design, fabrication and assembly of the components of a project's deliverable into a working product.

SEER-DFM – A software tool used to evaluate product and manufacturing costs, including variables that affect the manufacturing process such as labor, assembly, process, part design, and material. (Design for Manufacturability)

SEER-H – A development and production estimation and management tool that predicts, measures, and analyzes resources, materials and schedules for an array of products and complex systems. It presents a view of the operational and maintenance costs of a product throughout its life cycle. (Hardware Estimation and Life Cycle Cost Analysis)

SEER-IC – A complement to SEER-H, helps estimate custom integrated circuit development and production costs, generate specifications, and evaluate potential yields. (Custom Integrated Circuit Development)

SEER-SEM – A development and program management tool that predicts, measures, and analyzes costs, schedules, risks, and reliability for software projects. (Software Estimation Model)

SEER-SSM – A software-sizing tool that creates realistic and highly reliable estimates of a project's scope. (Software Sizing Model)

Sensitivity Analysis – A technique used to discover how sensitive the results from cost, economic, and financial analyses are to changes in the input values of the variables used to calculate the results. A high degree of sensitivity is a warning to interpret the results of the model with care and circumspection, especially because many of the input variables themselves, will have been estimated and therefore be subject to error.

Should Cost Analysis – A study of contract price, which reflects reasonably achievable contractor economy and efficiency. It is accomplished by a government team of procurement, contract administration, audit and engineering representatives performing an in-depth cost analysis at the contractor's and subcontractor's plants. Its purpose is to develop a realistic price objective for negotiation purposes.

Simulation – A representation in time of a system, especially representing the interaction of parts of a system, including the effects of randomness and interference as the system parts interact with each other. A simulation is used to gain knowledge about a system operation without actually exercising the system.

Source Lines of Code (SLOC) – Is a software metric used to measure the size of a software program by counting the number of lines in the text of the program's source code. SLOC is typically used to predict the amount of effort that will be required to develop a program, as well as to estimate programming productivity or effort once the software is produced.

Space Operations Cost Model (SOCM) – A tool used to estimate space mission operations costs for future NASA projects. The estimating methodology is based on a mix of parametric estimating relationships derived from collected data and constructive approaches capturing assessments of advanced technology impacts and reflecting experience from current mission planning teams. At completion, SOCM will include modules for Planetary and Earth Orbiting robotic science missions, Orbiting Space Facilities, Launch/Transportation Systems, and Human Spaceflight (Lunar/Mars) missions.

Spiral Development – A form of evolutionary acquisition in which a desired goal or functional capability is identified, but the end-state requirements are not known at the outset. Those requirements are refined through test and demonstration, risk management, and continual

user/operator feedback. Each spiral is an incremental step toward the desired goal or functional capability. Spiral development is seen as an approach to rapidly field systems incorporating the latest available technologies resulting from technology maturation investments. In spiral development, the product to be delivered is not specified at the outset, but instead, contractors and the Agency work in partnership to find the best way to meet the desired goal or functional capability.

Status Quo System – The system as it currently exists.

Target Costing – Structured approach to determine the cost at which a system or product with specified performance and reliability must be produced to shift the decision point toward proceeding with the project.

Technical Risk – Technical risk is defined as uncertainty in the system performance or "benefits." Technical risk may result from an immature technology, use of a lower-reliability component, degree to which products employ the latest standards in technology and design, availability of skilled resources to support the product, and then degree of tailoring required. Technical risk can be reflected in increased costs (to fix the technical problem) and lower overall system benefits.

Then-Year Dollars (TY) – Dollars that are escalated into the time period of performance of a contract. Sometimes referred to as escalated costs, or inflated costs.

Time Phased Costs – Costs that have been allocated to a schedule (e.g. deployment schedule and/or operating concept).

Time Value of Money – The time value of money refers to the fact that a dollar in hand today is worth more than a dollar promised at some future time. By compounding and discounting, the time value of money adjusts cash flow to reflect the increased value of money when invested. The time value of money also reflects that benefits and costs are worth more if they are realized earlier.

Tool-Driven Software Estimation – Parametric tools that are based on data collected from hundreds or thousands of actual projects. The algorithms that drive them are derived from the numerous inputs to the models from personnel capabilities and experience and development environment to amount of code reuse and programming language.

Total Cost of Ownership (TCO) – Is the total cost to the Agency for a course of action. TCO reflects not only the cost of development or purchase but all aspects in the further use, operations, and maintenance of equipment, devices, or systems considered. This includes the costs of training support personnel and the users of the system, costs associated with failure or outage, diminished performance incidents, costs of security breaches (in loss of reputation and recovery costs), costs of disaster preparedness and recovery, floor space, electricity, testing expenses, quality assurance, marginal incremental growth, decommissioning, etc.

TOC is comprised of cost to research, develop, acquire, own, operate, and dispose of weapon and support systems, other equipment and real property, the costs to recruit, train, retain, separate

and otherwise support military and civilian personnel, and other cost of business operations in DoD.

Trade Study – A technique for comparing alternatives for the purpose of deciding which of them is preferred. Trade studies (also known as trade-off analyses) support decisions throughout the systems engineering process, including (but not limited to) functional allocation choices, performance requirements definition, physical architecture and design choices, technology selection, and risk management. Trade studies may be formal, as in the case of an Analysis of Alternatives (AoA), or informal using engineering judgment or "back-of-the-envelope" analyses, but in either case, the selection of the preferred alternative is based on specific quantitative criteria.

Unallocated Future Expense (UFE) – A provision in the project plan to mitigate cost and/or schedule risk.

Uncertainty – A situation in which the outcome is subject to an uncontrollable event stemming from an UNKNOWN probability distribution.

Unit Curve – One of the two types of learning curve approaches. The unit curve calculates the unit value for a specific quantity point. Using the unit curve approach, the unit cost is reduced by a constant percentage. Also referred to as the Crawford or Boeing curve.

Value Engineering – A cost reduction methodology aimed at reducing the cost of a product or service in its production and/or operational phase. This is achieved by elimination, alteration, modification, or substitution of items without adversely affecting product performance or features.

Variable Cost – costs of an activity (manufacturing, production, assembly, operation, maintenance, etc) that vary with the measure of the product or service output. These costs may be direct or in-direct. Being identified as variable requires a connection of the cost to the product or service being produced. This cost may be visible and direct, or allocated, less traceable and in-direct.

Variance – A measure of the degree of spread among a set of values; a measure of the tendency of individual values to vary from the mean value. It is computed by subtracting the mean value from each value, squaring each of these differences, summing these results, and dividing this sum by the number of values in order to obtain the arithmetic mean of these squares.

Vendor Quote – An estimated cost provided by a vendor for a specific product or service.

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 project's objectives.

"What-If" Analyses – The process of evaluating alternative strategies.

Wrap Rate – NASA wrap rates can be defined as those additional charges that should be included in project/program estimates because they are a part of doing business from which projects/programs receive benefit. Examples (not all inclusive) of these charges or additional costs can include such items as: system engineering, project management, workstation maintenance, application programming, computer usage, facilities, and fabrication.

# Section 5. Acknowledgements

WIP

# Section 6. Index

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