DATA REQUIREMENT DESCRIPTION

Cost Analysis Data Requirement (CADRe) Number: XX-XXX

USE: The Cost Analysis Data Requirement (CADRe) serves to define the programmatic, technical, risk and risk-adjusted life cycle cost information project in a single, internally consistent document that evolves throughout the project life cycle. The CADRe is also needed to support Continuous Cost-Risk Management (CCRM) (see pages 13-15 for a brief CCRM summary and the NASA Cost Estimating Handbook for a more detailed explanation at www.ceh.nasa.gov).

CADRe is first required at the end of Pre-Phase A. At this early point, the CADRe will contain a project definition, cost drivers and cost estimates and a risk-based LCCE at the lowest WBS element level practical. Subsequent CADRe submissions shall be provided before major milestones and will provide more detailed data. The initial submission of the CARDe should not exceed 10 pages in length. Subsequent submission should not exceed 50 pages in length (exclusive of the cost estimate and supporting data).

OTHER DRD INTERRELATIONSHIP: Work Breakdown Structure; Earned Value Management Report; Integrated Master Schedule; Risk Management Plan & Reports; Phase Implementation Plans; PRA Plans and Reports, 533 Reports.

REFERENCES: NASA Cost Estimating Handbook (www.ceh.nasa.gov); DoD 5000.4M (CARD); DoD 5000.2M (Cost Performance Report); DD 2734 (CPR) (www.dior.whs.mil)

FIRST SUBMISSION: The initial CADRe shall be submitted 90 days after the start of the acquisition phase or when contractors submit their proposals for contract award, whichever occurs first. It will be the project manager's responsibility to add Full Cost effects to the CADRe and/or integrate information from multiple prime contractors.

SUBSEQUENT SUBMISSIONS: The CADRe shall be submitted (or entered into a web page or other Integrated Collaborative Environment) 60 days after the end of each calendar year with data as of the end of the calendar year and 90 days prior to scheduled milestone events, e.g., SRR, PDR, CDR, and LRR (see below).

DOCUMENT FORMATS: The contractor may submit the CADRe in contractor format. The government prefers that these document be a natural outgrowth of the firm's systems engineering process and products. These documents should be as brief as possible to adequately describe the system and they shall be in electronic format. The government prefers the documents in the Microsoft Office products: Word, Excel, PowerPoint, and Project. However, any other electronic format is acceptable.

DELIVERY METHODS: The CADRe documents may be delivered directly to the government via CDs or be made available to the government from the contractor's web page, or any other acceptable electronic means.

DISTRIBUTION: Project Offices (as determined by the project); Office of the Chief Engineer (IPAO/Cost Division); Office of the Chief Financial Officer (Cost Analysis Division). The contractor shall notify the government COTR via both e-mail and letter when the documents are distributed electronically.

PREPARATION INSTRUCTIONS: The guidance contained in this document describes the contents of the CADRe. It is a guide for content rather than format. It is, in general, allowable to reference existing project documentation for appropriate sections of the CADRe, provided source documents are easily accessible, but relevant extracts (at a minimum) should be attached to the CADRe in order to provide a complete, stand-alone document.

This CADRe DRD has been developed to combine and streamline the contents of several separate DRDs into one comprehensive and internally consistent data requirement in an effort to provide better information to both the Project Manager and to NASA cost assessment organizations. The CADRe is equivalent to two previously used DRDs - the Cost Analysis Requirements Description (CARD), and the Life Cycle Cost Estimate (LCCE) and adds Cost-Driver Technical Parametric data - combining their key elements in a single, coordinated report. The CADRe, like the CARD, is "owned" by the project and populating its content can be contractually required.

The CADRe is an NPR 7120.5 requirement on Category I and Category II flight projects. While the CADRe has been structured as a potential *Contract* Data Requirement, it is left to the discretion of the Project Office to determine whether to use the CADRe as a contract Data Requirement. The NASA project manager will probably provide the initial CADRe prior to the existence of a systems contract. Subsequent CADRe submission will be completed by the prime contractors, if required by the NASA project manager. Ultimately, it will be the NASA Project Manager's responsibility to provide certain other parts of later CADRe submissions that are outside the scope of the prime contractor:

- The Project Manager will be responsible for providing the Full Cost additions to the project contract costs (including civil service labor, service pool costs, Center and Corporate G&A, etc).
- The Project Manager will be responsible for providing the technical and programmatic cost drivers and cost estimates/value of Government or customer furnished equipment or services and/or subcontractor work not under the purview of the prime contractor. However, the project manager will typically request these inputs from the contractors.

- If more than one prime contractor is involved in the project, the Project Manager will be responsible for providing CADRe submissions that integrate the prime contractor technical and programmatic cost drivers and cost estimates.

The project technical description in the CADRe shall be sufficient to allow the generation of an ICE. The project/contractor will use the same CADRe technical description to provide a periodic LCCE. Most of the technical and programmatic information is requested in a tabular format, organized by Work Breakdown Structure (WBS) element for each project. This is intended to ease the burden of DRD preparation while improving the relevance of information for both the project management team and organizations charged with performing independent project assessments. A major benefit resulting from use of the CADRe is actual cost for each WBS element that is used to update NASA cost models.

The level of detail of the WBS is expected to expand over time as designs mature. Over the acquisition life cycle of the project, the CADRe will capture the initial understanding of the project and the earliest cost estimate and how the project and its cost evolve over time. The final acquisition phase CADRe submitted at IOC will reflect the "as built" project and the actual acquisition cost for inclusion in the Agency cost-estimating database. By the point at which a Critical Design Review (CDR) is held, the CADRe should include information at a relatively low level of the WBS, probably WBS Level 6 for most hardware components and CSCI-level for software elements. At the completion of the project (e.g., IOC), a final CADRe will be prepared and delivered by the contractor and project, which reflects the "as built" configuration and cost of the project at the level of detail defined at that time. CADRe submissions will continue during Phase E to collect mission operations and data analysis cost and disposal cost (if any). Specific frequency of these reports shall be separately negotiated.

NASA intends that no proprietary, confidential or sensitive business information be included in the CADRe. Freedom of Information Act (FOIA) law defines confidential business information to be data that provides visibility into elements of cost (labor rates, overhead rates, G&A rates, profit rates and similar rates and factors). It is a CADRe requirement to report costs rolled into the project WBS *without* visibility into elements of cost/rates and factors. Likewise, CADRe does not collect proprietary technical information such as insight into production processes etc. Rather, CADRe only collects performance specifications as technical cost drivers.

CADRe submissions are not to be marked as "proprietary", "sensitive" or display any other confidential business information markings.

The CADRe shall contain, at a minimum, the following information:

Part A – General Descriptive Information (in narrative form supplemented by tables, figures and graphics as appropriate)

- **Description** – Provide a top-level description of the system, including functions to be performed, measurements to be obtained, and key performance parameters. A functional block diagram and/or photograph or drawing of the system (with major elements identified) shall be provided. For CADRe purposes, document the baseline project description that is being used as the basis for budget forecasts (i.e. excluding other options that might still be in the trade space at any given point in the project evolution).

- **Mission/Objective -** Describe the overall mission(s) of the system, including interfaces and functional relationships to other systems. Include a description of the concept of operations (CONOPS) for the system.

- **Configuration –** Provide complete work breakdown structure (WBS) and WBS Dictionary. Table 1 provides the initial WBS for the XXX at WBS level 3. Elements may be expanded below these elements as needed.

Table 1 – Required Top-Level WBS for (System Name)

Element Name
(System Name)
Program Management
Systems Engineering, Assembly, Integration & Test
Safety and Mission Assurance
Space Vehicle
Structures and Mechanisms Subsystem
Thermal Control Subsystem
Electrical Power Subsystem
Attitude Control
Crew Subsystem
Environment Control and Life Support Subsystem
Propulsion Subsystem
Communications, Command and Data Handling
Spacecraft Bus Flight System Software
Spacecraft Bus Flight Applications Software
Spacecraft Vehicle Systems Engineering, Assembly, Integration, Test & Program Management
Payload
Mission Operations

Ground Systems
Launch Systems
Education & Public Outreach
Science

Government-Furnished Equipment and/or Property - Identify and describe any hardware and/or software elements that will be furnished by the Government. For items such as joint-use of facilities, availability and schedule constraints should be identified along with any cost-sharing provisions.

- **Project Management and Systems Engineering -** Describe the responsibilities and functions of the project office. Include current and anticipated funding levels (by fiscal year) for all project elements and funding lines/sources. Describe the systems engineering plan for the project.

- **Acquisition Plan -** Describe the contract type(s), acquisition strategy and schedule for system development, procurement and implementation. Provide an Integrated Master Schedule (IMS) that includes major milestone dates for SRR (System Requirements Review), PDR (Preliminary Design Review), CDR (Critical Design Review), LRR (Launch Readiness Review), etc. Lower-level schedules should be included when known. Describe contract type(s), fee structure(s) and any acquisition strategies assumed such as NWODB (New Ways of Doing Business), CAIV (Cost As an Independent Variable) or corporate investment(s).

- **Heritage –** In Part A, provide at a summary level (e.g. WBS Level 2), any heritage or analogous systems that are being used to reduce development/production costs. Describe any ECP/ECO (Engineering Change Proposal/Engineering Change Order) activity that modified original system performance requirements (in order to understand requirements creep/evolution).

- **Test Plan –** If available within the current phase of the program, describe all testing to be conducted by the developing organization(s) and/or other agencies to include equipment, subsystem and system-level testing. Testing includes assessment of functionality, reliability, utility, operational effectiveness, supportability, etc.

- **Project Risks -** Identify programmatic and technological aspects of the project that present potential or demonstrable risks to the schedule and/or budget of the project and their effects on specific WBS elements. Include an identification of cost-correlated WBS elements. Describe risk mitigation philosophy and processes. As the project proceeds through its life cycle, this information should be updated to document the interim results of the risk mitigation project and to include any risks identified since the last CADRe release.

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- **Track to Prior Release -** Summarize changes made since release of the previous CADRe. If no changes occurred from one year to the next, the contractor is not required to resubmit that document, but state this is the case in this document. If changes occur from one period to the next, the contractor shall summarize each of those changes in this report and submit the applicable document. This report will also document evolution in the project, specifically addressing changes in design approach and/or schedule changes.

Part B – Technical Data

The project manager and/or contractor shall provide hardware and software metric data that will permit an independent team to estimate the system's cost. The minimal required set of data is contained in the hardware and software metrics reports which can be found at the following web site: www.ceh.nasa.gov. Typical system level hardware metric data include mass, volume, dimensions, type of mission (manned vs unmanned), mission destination, mission life and percent of new design. The hardware metric report requests different information for each WBS element. For example, the report requests type of power, e.g., solar, nuclear or fuel cell for the power subsystem requests the, while the type operating frequencies and number of frequencies are requested for the Command, Communication, and Data Handling elements. Typical software metric data include type of application, development environment, projected size (new, reused, and modified), effort and schedule.

Part C – Life Cycle Cost Estimate

This part of the CADRe shall address the overall project Life Cycle Cost Estimate (LCCE), consistent with the Project vision for the construction and operations of its Systems. A system is defined as an integrated set of attributes consisting of, but not limited to, design, development, test and evaluation (DDT&E) and production through the end of operations and disposal. The LCCE in this section is the Project Office's own estimate. It should be consistent with the basis of estimate contained in Parts A and B of the CADRe (which may be used by independent cost estimating organizations within NASA). Part C must be physically separable from the remainder of the CADRe so that Parts A and B can be provided to Independent Assessment organizations without providing cost information.

At a minimum, medium and high-risk WBS elements shall be identified and cost impacts due to these risks will be included in the LCCE. The contractor shall utilize a credible methodology to develop cost-risk probability distributions that define best and worst case cost-risk scenarios as part of the LCCE. Appropriate statistical techniques shall be applied in combining cost estimating and technical cost-risk that includes WBS element cost-risk correlation analysis. In addition to probabilistic distributions derived from either Monte-Carlo simulations or analytic techniques (e.g., Method of Moments), the

contractor shall also estimate the discrete mitigation costs for these risks based on their probabilities of manifesting discrete changes in the technical parameters (e.g., increased component mass or power regulation). Refer to the NASA Cost Estimating Handbook (http://www.ceh.nasa.gov/) for further information on cost risk analysis.

The LCCE documentation shall provide:

a. LCCE team memberships, including basic functional organizational memberships and names of cost experts.
b. LCCE methodology (or methodologies) and models used, by phase of project: System design cost analysis methodology and parametric or other cost models, analogy, or "grass roots/WBS-based"—or combinations of the three. Cost-risk probability distributions shall be justified along with cost-risk methodologies employed. Provide cost and economic models, backup and supporting data, ground rules and assumptions.
c. Actual non-recurring and recurring costs incurred to date by WBS, component, subsystem, and development phase. Table 3 below provides the required cost information for the initial WBS level of detail.

Table 2 – Resource Report

Element Name	Cumulative Actual Costs Incurred To Date								Estimated Cost At Completion							
	Labor		Mateiral (Subcontracts)		Other		Total		Labor		Mateiral (Subcontracts)		Other		Total	
	N/R	R	N/R	R	N/R	R	N/R	R	N/R	R	N/R	R	N/R	R	N/R	R
System Name																
Program Management																
Systems Engineering, Assembly, Integration & Test																
Safety and Mission Assurance																
Space Vehicle																
Structures and Mechanisms Subsystem																
Thermal Control Subsystem																
Electrical Power Subsystem																
Attitude Control																
Crew Subsystem																
Environment Control and Life Support Subsystem																
Propulsion Subsystem																
Communications, Command and Data Handling																
Spacecraft Bus Flight System Software																
Spacecraft Bus Flight Applications Software																
Spacecraft Vehicle Systems Engineering, Assembly, Integration, Test & Program Management																
Payload																
Mission Operations																
Ground Systems																
Launch Systems																
Education & Public Outreach																
Science																

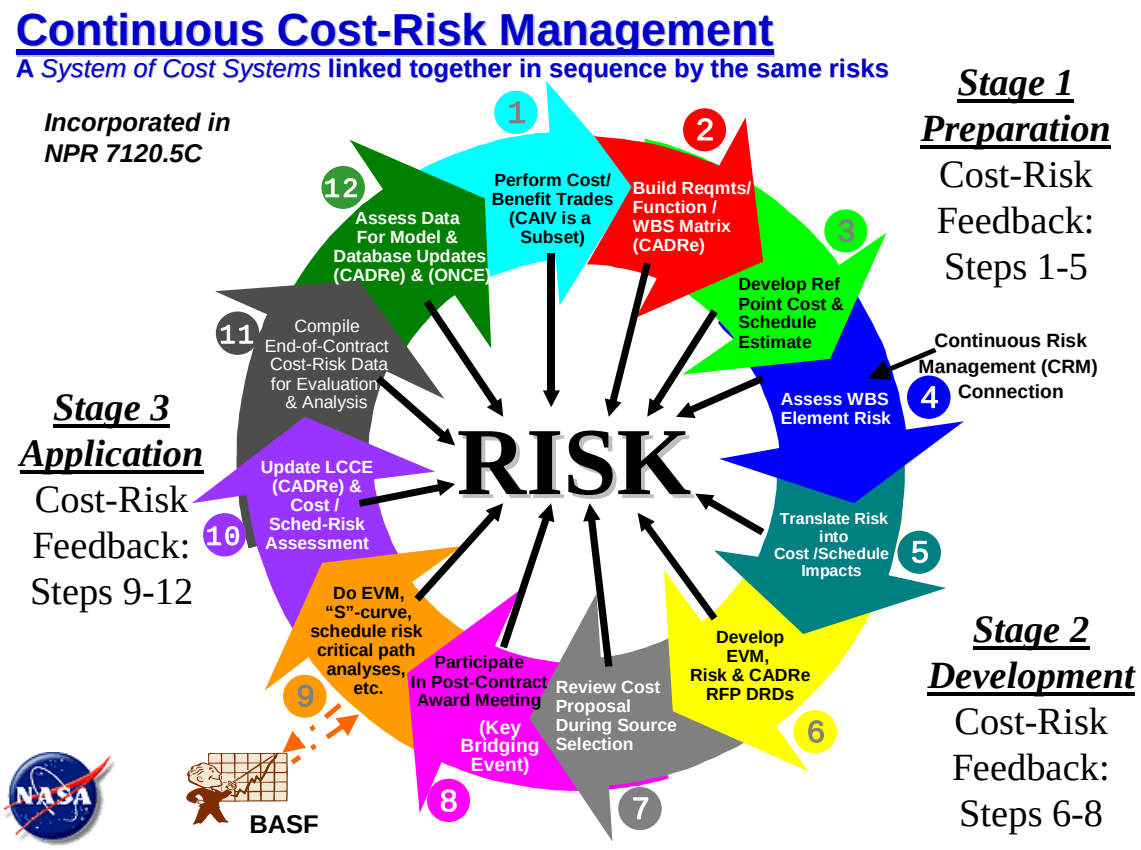
For those WBS elements that contain software, provide a final Software Metric Report (actual size, effort and schedule data for each software release – see www.ceh.nasa.gov for sample report).

d. Actual operations cost incurred to date (if applicable), including the cost for operations capability development, by subsystem, facility, and function.

e. LCCE scope with key guidelines and assumptions, including schedules, inflation rates, labor categories, recurring and non-recurring costs and assumptions, projections for technology developments, sensitivity analyses and cost risk analyses. The LCCE must include sufficient information to allow an independent estimator/analyst to understand how the estimate was constructed, understand the impacts of key assumptions and inputs, and determine a level of confidence in successfully completing the system(s) within the estimated cost.
f. LCCEs for WBS elements by project phase (i.e., DDT&E, production, operations): for given assumptions and environments, highlight possible cost drivers, uncertainties, and risks. Level of detail shall be consistent with System Design Methodology.
g. Summary presentation of LCCE in tabular form (Microsoft Excel™ template available from the NASA Headquarters Cost Analysis Division) indicating phase costs (i.e. Phase A, Phase B, Phase C/D), either actual for sunk-costs or estimated for future costs, non-recurring and recurring, by major project segment by year in constant, base and inflated dollars. Include narrative identification and explanation for cost growth stemming from all technical, programmatic, and project configuration sources delineated in accordance with the following two general categories and specify cause timeframes:

    - *'Risk-Driven Cost & Schedule Growth' (RDCG & RDSG)* is cost and schedule growth, overruns or funded changes, linked to technical risk drivers (e.g., technology maturity, design/engineering, complexity, integration, etc.) and key engineering performance parameters (e.g., dynamic load resistance, operating voltage, radiation resistance, emissivity, etc.);
    - *'Externally-Driven Cost & Schedule Growth' (EDCG & EDSG)* is cost and schedule growth, overruns or funded changes, linked to external factors (e.g., requirements changes, technical enhancements not driven by risk, perturbations to budgets by external agents causing schedule changes, labor strikes, business base changes, etc.);
    (NOTE: Sources for both categories of this cost and schedule growth can be specifically identified in the Earned Value Management Cost/Schedule Performance Report variance analysis reporting – Cost Performance Report Format 5).

h. Detail presentation of each WBS element making up each project segment cost, non-recurring and recurring, by year in constant, base and inflated dollars. This detail cost breakout should correspond to the tabular format of the Part B Technical Data except that the Part C information will include costs and be separable when required.



In order to meet the space project cost challenges for the next decade and beyond, NASA cost management processes must evolve from traditional methods to modes that are truly transformational. The new focus for cost management at NASA will be Continuous Cost-Risk Management (CCRM). Additionally, the days of implementing cost management as a set of "stovepipe" activities are over. In reality, cost management is a series of related cost activities and involves three main Stages that are linked together through a shared set of project risks. Cost management, in effect, IS the management of cost-risk and can be characterized as continuous feedback on cost-risk. Feedback is essential to the transformation of cost management into a dynamic, continually reacting system where focused reporting of metrics on medium and high-risk drivers alert the project manager that a negative cost trend has been identified and requires action. The three Stages of Continuous Cost-Risk Management: *Preparing* for cost-risk feedback; *Developing* cost-risk feedback; and, *Applying* cost-risk feedback, occur at different points in time during an acquisition phase and involve the collaboration among cost estimators, project engineers, project managers, procurement analysts and Earned Value

Management (EVM) specialists in managing the challenges presented by the risks. Cost management is NOT a grouping of unrelated stove-piped cost activities but is a "system of cost systems" based on viewing 12 cost activities normally treated as stovepipes as a continuum of activities interconnected through risk. This CCRM repeats in most acquisition phases.

The first Stage in Continuous Cost-Risk Management, *Preparing* for cost-risk feedback, involves NASA project teams performing three main activities: cost/performance trades (e.g., Cost as an Independent Variable (CAIV)); developing a definition of the program (e.g., part of the Cost Analysis Data Requirements (CADRe)) and, producing a range of possible costs (e.g., probability density function (PDF) and cumulative distribution function (CDF) or "S"-curve). CAIV trades flow out of a well-defined Concept of Operations (CONOPS) and demonstrate a commitment to evolutionary acquisition by being initiated in pre-Phase A for earliest implementation. These cost/performance trades are the first opportunity for representing the potential cost impacts due to risk. The CADRe will contain the definition of the project (analogous to the DoD Cost Analysis Requirements Description or CARD) for use by cost estimators where the traceability from Work Breakdown Structure (WBS) element, through functions, to initial requirements will be clearly identifiable. The cost range exemplified in a PDF and CDF involves developing a reference point cost estimate from a cost model (e.g., NAFCOM, PRICE, SEER, etc.), and incorporating cost model estimation, technical and correlation risk. Participants in the *Preparing* for cost-risk feedback Stage of the CCRM are mainly cost estimators, project engineers and project managers. This represents the starting point for cost-risk management. From this point forward the challenge will be in managing to the cost level chosen, no matter what cost-risk margin has been included.

The second Stage in Continuous Cost-Risk Management is *Developing* the feedback to manage the cost-risks. Since hardware contractors are selected to develop NASA systems, they must be informed about the potential cost-risk impacts identified by the NASA cost teams for their attention, monitoring, management, and reporting to the NASA project office. They must be informed in the Request for Proposal (RFP) Data Requests (DR) to produce multiple products that reflect the status and trends of these potential cost-risks. For example, as part of the CADRe, they will be required to produce a Life Cycle Cost Estimate (LCCE) for the proposal and LCCE updates at significant contract milestones (at least annually) as part of the contractual effort. The "S"-curve products of these requirements will enable the measurement of variance changes in the cost-risk distribution over time reflecting the management of risk and cost-risk. The CADRe will also require that initial key technical parameters, and changes to them over time, be documented along with actual costs associated with all WBS elements. These data will eventually populate the One NASA Cost Engineering (ONCE) database, keeping a record of project cost behavior for updating NASA cost models and available for cost analysis. Requirements to monitor, manage, and report monthly on the top medium and high-risk WBS elements identified during the *Preparing* Stage will be

included. When required, a monthly earned value report will also be in the RFP, requiring performance measurement, variance analysis and corrective action reporting on all WBS elements, with a special focus on medium and high-risk WBS elements. These reports will require monthly Estimates at Completion (EAC) on all elements with a special focus on medium and high-risk WBS elements. Electronic access to these data will also be required. Other sources for monitoring and managing the top medium and high-risk WBS elements can come from Technical Performance Measure (TPM), Risk Management, Technical Interchange Meeting (TIM), Integrated Product Team (IPT) and Probability Risk Assessment reports. Based in part on the way bidders address these RFP requirements in the cost proposals submitted, NASA will select a winning bidder and set up a post-award meeting with the selected contractor to verify the proposed cost-risk management methods. If EVM is required on the effort, the meeting at which this discussion takes place (along with baseline validation) is called an Integrated Baseline Review (IBR). Participants in *Developing* cost-risk feedback are the cost estimators, project engineers, project managers, procurement analysts and EVM specialists.

The third Stage in cost-risk management is *Applying* the cost-risk feedback for managing costs. If the first two Stages in cost-risk management, *Preparing* for cost-risk feedback and *Developing* cost-risk feedback, have been properly accomplished, the cost-risk feedback from the EVM (or similar) system, supported by TPM reports, Risk Management Reports, TIM minutes, IPT meeting minutes, etc., will give the project manager the highest quality information possible for managing those WBS elements most likely to drive cost growth. The focus for reporting, analysis and action will be on medium and high-risk WBS elements since they were identified for specific reporting in the RFP and addressed by the winning contractor in his proposal. If cost and schedule performance analysis indicates problems, a decision to reiterate a cost/performance trade (part of the *Preparing* for cost-risk feedback Stage above) may have to be made, for a possible adjustment to a system requirement. EVM performance analysis, focused on risk impacts to cost and schedule, will enable development of monthly EACs providing the project manager crucial feedback on the potential cost effects of the risks. This information provides the project manager with focused insight into the cost-risk in order to better manage his/her costs. CADRe-required updates to the initial LCCE estimate at significant milestones (at least annually) can be analyzed for changes (hopefully reductions) in “S”-curve variances, indicating progress in managing risks and cost-risks. At the end of the effort a volume of high-quality cost, risk, and cost-risk information will have been collected that can be added to the ONCE database for follow-on contractor performance analysis, cost-risk methodology calibration and updating cost models in order to better cost estimate future projects. Participants in *Applying* cost-risk feedback are primarily project engineers, project managers and EVM specialists with cost estimator involvement during cost/performance trades (if required), and updating “S”-curves, databases and cost models.