DATA REQUIREMENT DESCRIPTION

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

USE: The Cost Analysis Data Requirement (CADRe) serves to define the project in a single, internally consistent document, identify programmatic, technical, cost and risk drivers that evolve throughout the project life cycle and quantify both in a life cycle cost estimate (LCCE). When Part C (Life Cycle Cost Estimate) is detached, it also provides a common technical and programmatic baseline for the Government to perform an independent life cycle estimate (LCCE) on the contractor cost proposal.

The CADRe is first required at the end of Pre-Phase A. At this early point, the CADRe will contain a project definition, programmatic, technical, cost and risk drivers and a risk-based LCCE at the lowest WBS element level practical; subsequent CADRe submissions will provide more detailed 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); MIL-HDBK-881

FIRST SUBMISSION: The initial CADRe shall be submitted 90 days after the start of the acquisition phase or 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.

- End of Pre-Phase A CADRe
  - Project description, technical and programmatic cost drivers and estimated cost provided at WBS Level 2
    - Project Management (PM)
    - Project Systems Engineering (SE)
    - Project Assembly, Integration and Test (AI&T)
    - Total Bus
    - Total Experiment Package/Payload
    - Launch Services

SUBSEQUENT SUBMISSIONS: At a minimum annually or in conjunction with major contract and/or project milestones as directed by the project and at the end of each major Phase (e.g., pre-Phase A, Phase A, Phase B, Phase C/D, etc.) and in support of NASA Independent Cost Estimates (ICEs).

- End of Phase A CADRe (near SRR)
  - Project description, technical and programmatic cost drivers and estimated cost provided at WBS Level 3
    - PM, SE, AI&T (remain at WBS Level 2)
    - Bus Subsystems (e.g. Electrical Power)
    - Experiment A
    - Experiment B
    - Experiment C
    - Launch Services (remains at WBS Level 2)

- End of Phase B CADRe (near PDR)
  - Project description, technical and programmatic cost drivers and estimated cost provided at WBS Level 4
    - PM, SE, AI&T (remain at WBS Level 2)
    - Bus Major Assemblies (e.g. Solar Array, Batteries, Electrical Power Distribution)
    - Experiment A by major subsystem
    - Experiment B by major subsystem
    - Experiment C by major subsystem
    - Launch Services (remains at WBS Level 2)

- Phase C/D CADRe (at major milestones like CDR but at least annually)
  - Project description, technical and programmatic cost drivers and estimated cost provided at WBS Level 4/5
    - PM, SE, AI&T (remain at WBS Level 2)
    - Bus Major Assemblies (e.g. Solar Array, Batteries, Electrical Power Distribution)
    - Experiment A by major subsystem
    - Experiment B by major subsystem
    - Experiment C by major subsystem
    - Launch Services (remains at WBS Level 2)

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).

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. While it does not incorporate the Work Breakdown Structure (WBS) DRD, the information contained in the CADRe DRD must conform to the approved project/contract WBS in order to ensure that it includes each and every element of the entire project.

As projects evolve through their life cycle, the CADRe shall be revised at major milestones (or annually if more than 12 months is planned between major milestones) to reflect a current status of all cost-relevant information. Additionally, when preparations for a NASA ICE begin more than three (3) months after the latest CADRe has been prepared, an updated CADRe must be provided to the NASA ICE team if there have been changes to the Project which impact any elements of the CADRe. 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 5 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 same level of the WBS cited above. When the technical and programmatic description of the project is finalized, it can be used in conjunction with the actual project costs to provide valuable data for accurate estimation of the cost of future projects.

Thus, 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, at IOC, will reflect the "as built" project and the actual acquisition cost for inclusion in the Agency cost-estimating database. CADRe submissions will continue during Phase E to collect mission operations and data analysis cost and disposal cost (if any).

The CADRe is a NPR 7120.5C requirement on Category I 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. Experience has shown, that like a CARD, the CADRe is probably most efficiently developed by the Project Office with the assistance of the Center's cost estimating office. The NASA Headquarters Cost Analysis Office is also prepared to provide assistance in developing the initial project CADRe. It will be necessary for the NASA project manager to provide the initial CADRe prior to the existence of a systems contract. Ultimately, it will also continue to 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.
- 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 produce an Independent Cost Estimate (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 WBS element. 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 end-of-contract actual cost for each WBS element that is used to update NASA cost models.

It is the intent of NASA 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 (at levels 2 through 4/5 as discussed above) *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. As an example, CADRe collects the beginning of life solar array capacity (kilowatts) but does not require insight as to how the array is manufactured or details about its inner workings.

CADRe submissions are not to be marked as "proprietary", "sensitive" or display any other confidential business information markings. SETA contractors who support NASA on cost normalization tasks and Cost Estimating Relationship (CER) development will typically further normalize the cost and technical information provided in CADRe submissions. Access to the resulting database will be strictly controlled and granted only to authorized Government users.

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)

> Note: Most, if not all, of the information below can be extracted from other project documents and included in the CADRe. Supporting documentation may be supplied on CD or other appropriate electronic media (examples: Project Plan, Systems Engineering Management Plan, Work Breakdown Structure and Dictionary, Master Schedules, Requirements Documents, Parts Program, Major Review Documentation/Briefings such as SRR, PDR, CDR, etc.).

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.

- **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. In Part B, provide details of where and how these heritage system elements will be used (Technical Data), including planned and actual project schedule and costs for the reference systems at WBS Level 3 (subsystem level) for Phase A CADRe submittals and WBS Level 4/5 for Phase B CADRe submittals. 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 -** 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.

- **Concept of Operations -** Identify the life-cycle staffing requirements for the system, broken out by major functional activity (see below) and project phase:

    - System Engineering
    - Project Management
    - Design Engineering
    - Quality Assurance
    - Assembly, Integration & Test
    - Manufacturing
    - Operations
    - Maintenance
    - 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.

- **Track to Prior Release -** Summarize changes made since release of the previous CADRe. This section will document evolution in the project, specifically addressing changes in design approach and/or schedule changes.

Part B – Technical Data (in tabular form)

The following data should be provided in a Microsoft Excel™-compatible spreadsheet at a level of detail consistent with the definition of the system and its elements. A Microsoft Excel™ template of a spreadsheet meeting the requirements of this DRD is available from the NASA Headquarters Cost Analysis Division or from the NASA Cost Estimating Handbook available on the web at http://www.ceh.nasa.gov/.

Basic Information for all Elements

Provide, in a tabular format (Microsoft Excel™ template), relevant technical and programmatic information for each element in the WBS. Sufficient information is required to permit a project assessment team to perform an independent cost estimate of the individual items and the complete project. Examples of appropriate information include WBS number, nomenclature, functional description, quantities, mass, volume, dimensions, contingency margins, heritage, design effort, internal redundancy, unusual integration challenges, key schedule dates and risk information.

Ron: Relative to what is coming just below, you need to clarify to the reader that some of this stuff won't be available until PDR and a few of the things you are asking for may not even be available to CDR.

Structural/Mechanical Elements

For Structure and Mechanisms Subsystem Elements, provide the following information in addition to the Basic Information:

- Materials (i.e. aluminum, honeycomb, carbon fiber, etc.) Ron: Like this—they might not have this until PDR—what do you think?
- Manufacturing precision/tolerances (absolute and over distance) Ron: too detailed it seems to me—they will not be able to do this until CDR. Suggest delete or maybe give them a 1 to 5 type scale.
- Positioning precision and stability (for mechanisms) Ron: ditto above or make it clearer what we want or provide them a 1 to five type scale.

Thermal Control Elements

For Thermal Control Subsystem Elements, provide the following information in addition to the Basic Information:

- Active Elements (i.e. heaters, louvers, heat pipes, cryo pumps, etc.)
- Passive Elements (i.e. surface treatment, cold plates, radiators, stored cryogenics)
- Maximum thermal load Ron: Another example of something not known until PDR
-

Electrical Power Elements

For elements of the Electrical Power Subsystem, provide the following information in addition to the Basic Information:

- For solar generators indicate beginning-of-life power (watts), total array area, cell technology (i.e. Si, GaAS, advanced multi-junction), substrate material, coverglass technology, overall power conversion efficiency, nominal bus voltage, mounting/deployment, etc.ditto
- For batteries indicate technology (i.e. NiCd, LiIon, AgZn, NiH2, etc.) total capacity in AH, number of cells, peak current draw, maximum discharge (%).ditto
- For power control components indicate maximum allowable voltage and current fluctuations.ditto

Attitude Control Elements

For Attitude Control Subsystem elements, provide the following information in addition to the Basic Information:

- Describe attitude accuracy and knowledge requirements, slew rates and dead-bands.
- Describe key performance parameters for each Attitude Control sensor (i.e. Sun, Horizon, Star, etc.) and actuator (i.e. Magnetic torquers, gyroscopes, CMGs, FMWs, etc.)

Guidance and Navigation Elements

For Guidance and Navigation Subsystem elements, provide the following information in addition to the Basic Information:

- Describe the processor and storage requirements.
- Describe the required accuracy and precision of space vehicle position and velocity.

- Describe key performance parameters for each G&C sensor (i.e. Sun, Star, GPS, Horizon, etc.).

Propulsion Elements

For Propulsion Subsystem elements, provide the following information in addition to the Basic Information:

- Fuel(s) and pressurant(s) used in the Propulsion Subsystem
- Describe tank materials, maximum pressure, volume, internal zero-g devices
- Vacuum thrust and specific impulse for each engine/thruster, total subsystem impulse.

Data Handling Elements

For elements of the Data Handling Subsystem, provide the following information in addition to the Basic Information:

- Describe on-board data management (storage capacity, data manipulation, etc.).
- Maximum data rate (Kbps).
- Total transmit power (Watts) for each RF element.
- Frequency bands utilized (i.e. S-, Ku-, Ka-, X-, etc.).
- Describe the antenna type(s) used and the number of feeds utilized.

Tracking, Telemetry and Command Elements

For TT&C Subsystem elements, provide the following information in addition to the Basic Information.

- Describe on-board data storage requirements.
- For RF elements of the TT&C Subsystem, describe transmit power (Watts), maximum data rate (Kbps), Frequency band(s) utilized.
- Describe the antenna type(s) used and the number of feeds utilized.

Payload/Instrument/Sensor Elements

In addition to the Basic Information, provide the following information for instruments And/or sensors in the space vehicle Payload:

- Operating frequency band(s)
- Peak Power (Watts) and duty cycle (%)
- Peak data rate
- Describe any stabilized or scanning platform and the required performance parameters
- Describe on-board processing or pre-processing of payload data

- **Software Elements**

Provide, in a tabular format (Microsoft Excel™ template available from the NASA Headquarters Cost Analysis Division or from http://www.ceh.nasa.gov/), relevant technical and programmatic information for each software project element in the WBS. Sufficient information is required to permit a project assessment team to perform an independent cost estimate of the individual items and the complete project. Examples of appropriate information include WBS number, nomenclature, functional description, total size (in KSLOC), delivered new code, unique code, common code, reused code, total effective code (EKSLOC) contingency margins, heritage, design effort, development model/methodology (i.e. spiral, waterfall, etc.), code growth, key schedule dates and risk information.

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 Life Cycle Cost Estimate 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. Life Cycle Cost Estimate team memberships, including basic functional organizational memberships and names of cost experts.
b. Life Cycle Cost Estimate 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 development and production cost incurred to date by WBS, component, subsystem, and development phase. Actual operations cost incurred to date (if applicable), including the cost for operations capability development, by subsystem, facility, and function (for example, turnaround processing).
d. Life Cycle Cost Estimate 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.
e. Life Cycle Cost Estimates 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.
f. 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 that cost and schedule growth caused by overruns and funded or unfunded 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 that cost and schedule growth caused by overruns and funded or unfunded 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).
g. 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.