NASA/SP-20240010542

Observations on Space Flight Program and Project Commercial Partnerships and NASA Tailored Program Management Approaches

August 2024

Table of Contents

1. Introduction

1.1. Purpose and Background

This document provides information for new programs and projects considering the use of a commercially oriented partnership acquisition approach. The information is based on two recent commercial partnership experiences: 1) the Commercial Crew Program (CCP) and 2) the Human Landing System (HLS). This document distills observations from these acquisition experiences and the associated application of a tailored program/project management approach.

1.2. NASA's Changing Acquisition Approach

Over a decade ago, NASA leadership established an objective to seek a more commercial approach to cargo and human launch capabilities. With the initial successes, NASA sought to broaden commercial participation into space exploration, including human landers. There were several reasons, such as the potential for reduced cost and scheduling while maintaining an acceptable level of risk.

Therefore, the acquisition strategy necessitated a shift to accomplish the innovative approach. For CCP, there were no purely commercial, certified launch vehicles available. It would take a phased approach to a blend of public and private funding to build a capability that would provide a consistent and reliable industrial base of "commodity" launch vehicles and services. The contracts would shift from the ***traditional***, cost-plus life cycle development with government participation and oversight to a new hybrid ***non-traditional*** model, which would transition over time based on successful milestones. HLS was challenged further with its acquisition strategy as NASA and industry had not developed a human lander in over 50 years.

Traditional Approach

The traditional, historical approach used by NASA for large space flight programs/projects involves a FAR-based acquisition that competes and awards contracts to a prime contractor and several subcontractors to design, develop, manufacture, test, and integrate a system under NASA's supervision where ultimate ownership of the product(s)is transferred to NASA. These contracts are often cost-plus contracts that are fully reimbursable to the contractor, with NASA keeping most of the risks. In this document, the entity with which NASA has a contract is called a contractor or provider.

Examples of the traditional approach include Apollo, the Space Transportation System (STS) (also known as the Space Shuttle), the International Space Station (ISS), and more recently, Orion. Under the traditional approach, NASA develops highly detailed requirements and specifies standards, and the contractor builds the system to meet these requirements and standards. NASA personnel are deeply involved and have decision-making responsibilities in design, processing, testing, launching, and operations to ensure safety and reliability.

Non-Traditional Approach

Non-traditional acquisitions are used for programs to include when NASA does not intend to own and operate the systems(s) under development, as was the case for CCP. Non-traditional

acquisitions may rely on non-FAR based agreements concluded under the "Other Transaction Authority" (OTA) of the Space Act, commonly known as Space Act Agreements (SAAs)[1], or on a combination of agreements and contracts. In this non-traditional approach[2], the model shifts from contracts that are fully reimbursable to partnerships that include cost sharing with the commercial partner. In this document, the entity NASA has a SAA is called a partner.

A recent example of a non-traditional approach is CCP and the use of SAAs to partner with commercial companies for the development and demonstration of commercial crew transportation capabilities, ground, and mission operations capabilities and, subsequently, acquisition and certification of NASA crew transportation services using fixed price contracts (e.g., Commercial Crew Program). For HLS, NASA's goals for a non-traditional approach were different than for CCP, as HLS is part of a broader complex integrated in-house and non-in-house system of systems. However, the principles of the acquisition approach had many similarities as the phased approach through formulation and then into development was based on tailoring (milestones, reviews, and KDPs…) and managing oversight and insight.

1.3. Key Observations

Applying NASA's non-traditional acquisition approaches prompted NASA to develop processes, practices, and expectations that are different from those used for traditional acquisition approaches. The observations in this document summarize two programs to highlight this approach's attributes. The key takeaways include the following:

1. Partner milestone requirements established/codified in the contracts with partners/ vendors that were negotiated with partners and tailored to meet program/ project goals/ objectives. The NASA program/project established a PM approach per 7120.5 including applicable tailoring to cover the PM activities performed by NASA.
    a. The NASA reviews and KDPs were tailored to fit the PM approach and provide insight to NASA decision authorities.
        i. Standing Review Boards' (SRBs) findings or equivalent decisions provided for clear oversight and insight aligned to meet the PM review approach frequency and products for entrance and exit success criteria.
    b. NASA insight/oversight engagement was established to achieve NASA's clearly defined requirements within the budget and schedule constraints.
        i. Contract and/or SAA language was negotiated to ensure that the statements of work reflected the NASA deliverables for partner reviews, data, and NASA engagement to support the PM approach.

[1] NASA's "Other Transaction Authority" (OTA) granted by Congress under the National Aeronautics and Space Act (51 United States Code (U.S.C.) § 20113(e)).
[2] For additional information on NASA Partnerships refer to *NPD 1050.7, Authority to Enter into Partnership Agreements* and two associated guides: *NAII 1050-1D, Space Act Agreements Guide* and *NAII 1050-3B, NASA Partnerships Guide.*

2. In formulation, there are more unknowns about partner capabilities and final NASA requirements. A hybrid contracting approach supported incentivizing and rewarding partner participation and innovation. The phased approach early in the lifecycle using some cost plus and some FFP options with partners achieved NASA's goals for CCP and is showing similar success for HLS.
    a. The approach supported reducing "undefinitized" contract actions, that are prevalent in the traditional cost-plus contracts. The traditional approach undefinitized contract actions practices made project management more challenging and left NASA having all the risk to meeting mission requirements. The innovative approach reduced risk as clear stable requirements shifted to earlier in the lifecycle.

3. Risk shifts more towards the partners/vendors versus NASA as a project transitions from formulation to development. This is based on NASA requirements now being stable and vendor capabilities being matured and demonstrated.
    a. This allows for the use of contract options like Firm Fixed Price (FFP) as a partner capability reaches a proper risk and maturity posture clearly understood by NASA and the partners.

4. Competition was used in the acquisition strategy, which incentivized partners to bring their best teams, technology, and internal investment to support NASA's goals for human space flight.
    a. The approach allowed for insight on options for partners' capabilities and sustainability. Specifically, the approach provided a way to have insight into the industrial base, which allowed for risk reduction decisions by NASA.

5. Intellectual property and ownership of designs, data, and systems was made clear, agreed to, and codified in contract language.

The information reflected in this document is based on the CCP and HLS analysis and experience, and reflects these program's perspective. For subject matter expert information, please contact the following organizations:

- Commercial Crew Program – Space Operations Mission Directorate
- Human Landing System – Exploration Systems Development Mission Directorate
- Procurement – Office of Procurement
- Procurement Law – Office of the General Counsel
- Program and Project Management Policy – Chief Program Management Officer

In addition, Program/Project Managers considering utilizing a commercial partnership approach should consult the Office of Procurement and Office of General Counsel to obtain advice on best and most current acquisition/agreement approaches and associated laws that best suit the program/project objectives.

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1.4 Document Structure

Chapter 2 summarizes observations and details on the Commercial Crew Program.

Chapter 3 summarizes observations and details on the Human Landing Systems Program.

Chapter 4 summarizes overall observations on the life cycle and management structures used by non-traditional programs and projects and discusses key strategies, techniques, and methodologies developed by these programs and projects.

Chapter 5 provides conclusions.

Appendices C through F provide information on foundational aspects of program and project management including types of programs and projects, types of reviews, types of contracts and agreements, and insight and oversight models, respectively.

Appendix I provides references from which much of the material in this document was adapted and pointers to other helpful sources.

Chapter 2. Commercial Crew Program Observations

2.1 Overview

Commercial Crew Program (CCP) Approach

The purpose of the CCP is to facilitate the development of a U.S. commercial crew space transportation capability with the goal of achieving safe, reliable, and cost-effective access to and from low Earth orbit (LEO) and the ISS. CCP's scope involves design, development, demonstration, and certification of end-to-end CTSs, including ground operations and integration, launch, abort, rendezvous, proximity operations, docking, orbital operations, reentry, recovery, and safe disposal or return. The required systems for CTS are spacecraft (including any launch abort or launch escape system), launch vehicle, ground systems, and mission systems.

To accomplish this effort, funded SAAs were used to enable initial development and demonstration of launch vehicles and ground and mission operations capabilities. Subsequently, certification and NASA crew transportation services were acquired using fixed price contracts. Through the CCP, NASA ensured that the United States ended its reliance on foreign crew transportation to the ISS. Direct engagement with private industry enables NASA to enact high-level safety and performance requirements for industry's development, testing and operation of a safe, cost-effective CTS. Commercial contractors will be able to transport NASA astronauts to and from the ISS via their CTS, as soon as NASA certifies those systems to carry NASA personnel in accordance with NASA requirements.

The CCP approach fostered the development of a robust U.S. commercial space industry that allows companies to design, build, own, and operate their own CTSs and related ground systems, control centers, and support infrastructure using their own efficient and effective manufacturing and business operating techniques. It also enabled NASA to purchase CTS transportation services directly from those companies. This model supports NASA's goal to be one of many

customers of robust commercial space industry providers, regulated by the appropriate U.S. Government regulatory authorities.

Two-Phase Process

CCP implemented a two-phase process to successfully enable, certify, and purchase commercial human space flight services while providing incentives to private industry to invest in CTS development:

Phase 1: NASA uses SAAs to support the design and development of commercial crew transportation capabilities. SAAs provide a cost-effective approach by which commercial partners can be innovative, creative, and flexible in their design solutions to develop a commercial CTS capability, while maintaining competition for future stages of the program. NASA requirements may not be imposed on commercial partners through an SAA; however, commercial partners may seek NASA's expertise in human space flight through SAAs.

Phase 2: NASA used Federal Acquisition Regulation (FAR)-based contracts for the certification of commercially developed capabilities and for the procurement of crew transportation services to and from the ISS to meet NASA requirements. NASA remains committed to ensuring that the requirements, standards, and processes for CTS certification for all commercial missions are held to the same safety standards as Government human space flight missions using systems developed under NASA's traditional acquisition approach. Under the certification contracts, NASA certifies that commercial partners' certification plans are compliant with NASA requirements. Results of the commercial partner's development, tests, analyses, demonstrations, and/or inspections under the certification contracts are formally evaluated to obtain CCP concurrence in the commercial partner's progress toward CTS certification. Following the CCP determination of readiness, the CCP facilitates an Agency-level review to grant approval for the commercial partner to transport NASA and NASA-sponsored personnel to the ISS, based on evidence of satisfactorily completing the CTS certification.

Tailoring Program Management Processes

The CCP tailored the NPR 7120.5 program life-cycle requirements to allow for a new generation of industry innovation, design solutions, manufacturing processes, operational methods, and engineering techniques.

NASA developed requirements at a level high enough to allow engineering trades and minimize the need to change NASA requirements. NASA developed and provided the certification requirements for crew safety, integrated system performance, standards, and ISS interfaces, but the commercial contractor controlled lower-level requirements.

NASA developed and officially released safety and certification requirements to solicit feedback directly from industry early in the program's life cycle. The feedback enabled the baseline of the requirements documents within a year, and over the next two years only limited updates were needed. This enabled NASA to incorporate changes and solidify the safety and certification requirements included in formal Requests for Proposal (RFP) issued to industry. These requirements provided the basis for certification strategies and served as a framework for the eventual NASA certification efforts and future service contracts. Traditionally, unlimited requirement changes throughout the program life cycle were allowed by NASA programs, with

NASA incurring additional costs and schedule impacts for each requirements change. The CCP strategy demonstrated that developing the appropriate requirements at a high level, defining requirements closure, and minimizing requirements changes, all through a "partnership" with commercial interests, assisted the U.S. in returning to human space flight in record time for orders of magnitude less cost.

Program-Level Acquisition Phases

As shown in Figure G-1, the CCP comprised several staged program-level acquisitions that helped mature overall commercial capabilities, culminating in the present capabilities that provide crew and cargo transportation to and from the ISS. The first three acquisitions fell under Phase 1 - the design and development phase (SAAs). The remaining acquisitions fell under Phase 2 - the certification and services acquisition phase (contracts).

In support of this framework, NASA released the certification and services requirements document for Phase 2 at the beginning of Commercial Crew Development (CCDev) in 2010, providing partners with a detailed understanding of NASA's future certification and services requirements. This approach replaced a traditional NASA strategy of releasing often rudimentary requirements that were repeatedly updated after contract awards and minimized the need for requirement iteration, thereby lowering the risk of increased program costs.

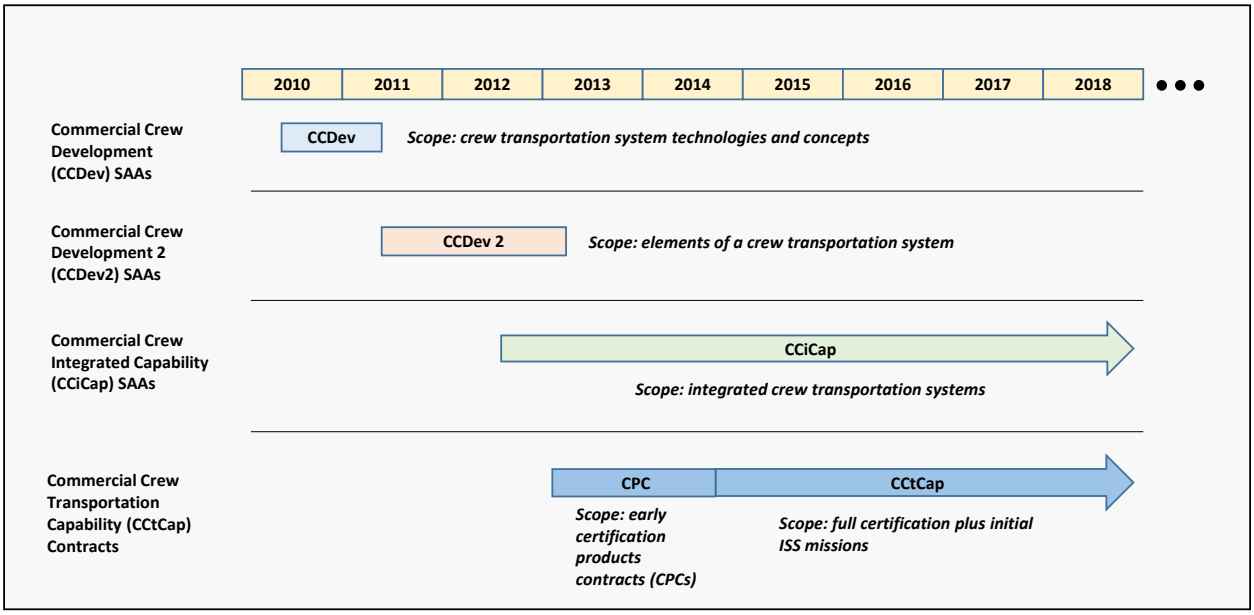


Figure G-1 Commercial Crew Program Staged Acquisitions

Phase 1: Design and Demonstration

Under CCDev, five U.S. companies were awarded funded SAAs to identify and mitigate human space flight transportation risks associated with their capabilities. (See Appendix E for additional information on SAAs).

Under Commercial Crew Development 2 (CCDev2), four U.S. companies were awarded funded SAAs, and three U.S. companies were awarded unfunded SAAs to further develop and

demonstrate partner-identified technologies (such as integrated launch abort systems and nose cone designs) to mature critical areas in their proposed capabilities.

Under the CCDev and CCDev2 SAA awards, commercial partners addressed functions analogous to those expected during Phase A Concept Technology and Development and Phase B Preliminary Design and Technology Completion of a NASA project life cycle. Commercial partners were encouraged to emphasize actual hardware development and testing as risk mitigation and maturation of the transportation capability versus design studies. In addition, NASA allowed the companies to mature their transportation capabilities through interactions with NASA experts in human space flight.

Under Commercial Crew Integrated Capability (CCiCap), funded SAAs were awarded to three companies to continue development and demonstration of their integrated transportation designs and conduct demonstration flights of their respective transportation systems. Commercial partners were encouraged to exhibit progress toward an orbital crewed demonstration flight and risk reduction activities.

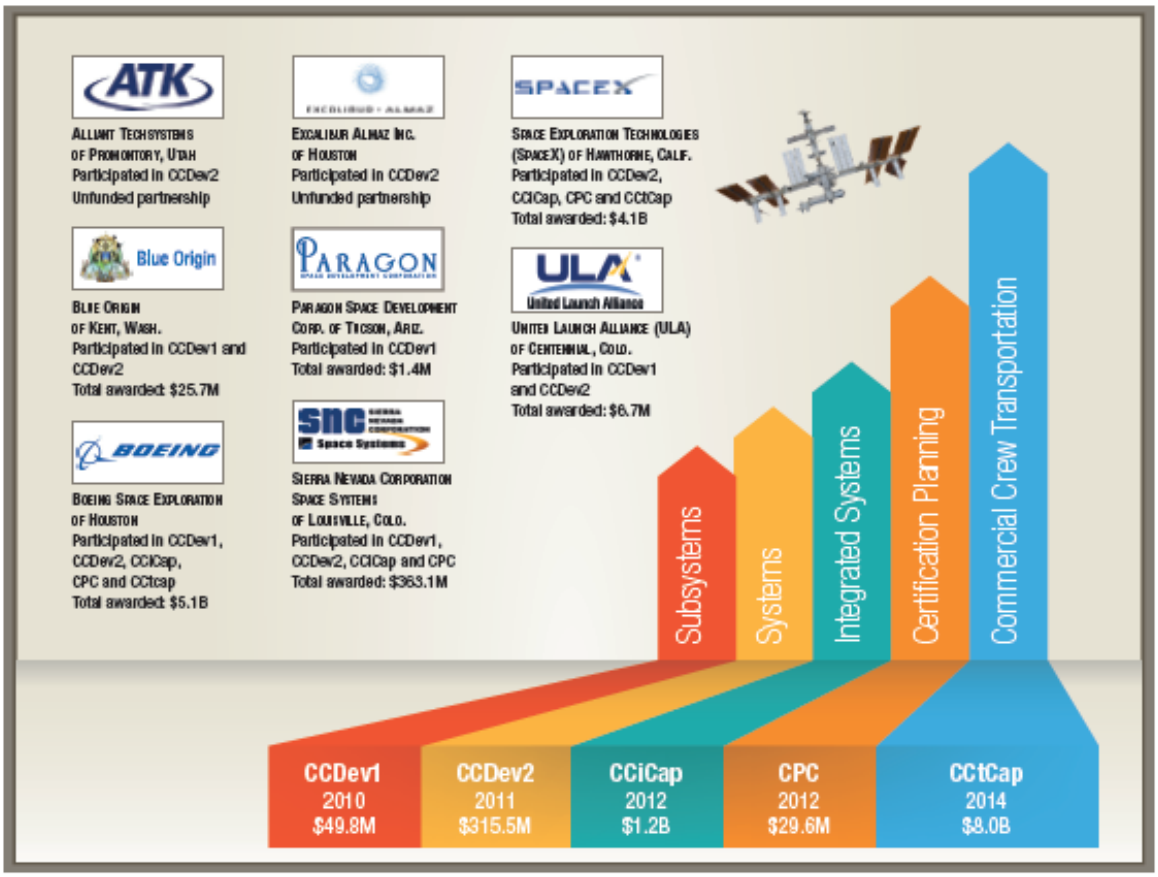
Through the issuance of SAAs for Phase 1, NASA was able to stimulate efforts within the U.S. industrial base to understand the intricacies of human space flight and to mature their initial concepts into viable spacecraft, enabling routine and cost-effective space transportation services that could be purchased by NASA and other customers.

Phase 2: Certification and Services Acquisition

Under Phase 2, certification and services acquisition, NASA initially awarded three firm fixed price (FFP) Certification Products Contracts (CPCs) to begin the process of ensuring integrated CTSs met Agency flight safety and performance requirements and standards to transport NASA and international partner (IP) crews to and from the ISS. Through CPCs, U.S. contractors submitted several key deliverables to NASA's CCP to assess how the contractors' CTSs met NASA certification and safety requirements. Those deliverables included: Certification Plan, Verification and Validation Plan, Alternate Standards, Hazard Reports, and proposed variances. The CPCs identified and reduced final contract risks, allowing for more complete Commercial Crew Transportation Capability (CCtCap) proposals.

At the successful completion of CPC and using a second FFP contract process for selection of contractors for CCtCap, the CCP concentrated on certification, including additional identification of engineering standards and the suite of tests and analyses required to prove that a contractor's CTS meets the high-level NASA requirements and is safe for NASA and IP crews. Two companies were awarded FAR-based, FFP contracts with indefinite delivery indefinite quantity (IDIQ) components. (See Table E-3 for a description of contract types, including IDIQ.) Under CCtCap, the contractor must provide evidence that its CTS meets NASA certification and safety requirements to obtain NASA approval and final certification. Once its CTS is approved and certified, NASA may purchase services from the contractor for transporting NASA and IP crew to and from the ISS.

Figure G-2 shows the partners for Phase 1 SAAs and the contractors Phase 2 contracts.



CCDev1=CCDev in the text of this document

Figure G-2 Commercial Crew Partners and Contractors

2.2 Tailoring of NPR 7120.5 Requirements

Because of the uncoupled nature of the SAA and contract awards to multiple companies (each of which could be considered a project of its own), the closest NPR 7120.5 life cycle model to the CCP structure is an uncoupled or loosely coupled program. (See Appendix C, Figure C-2 for the NASA life cycle for uncoupled or loosely coupled programs.)

Since the CCP was a pathfinder in following a commercial partnership approach, and SAAs do not enable levying requirements on the partner, the NPR 7120.5 program management approach was tailored early in the life cycle with respect to the NASA managed CCP activities. This was noted at an APMC meeting with the recognition that future tailoring would be needed after contracts were awarded in the certification phase. Figure G-3 shows the initial concept for tailoring the NPR 7120.5 uncoupled or loosely coupled program life cycle for the fourth and final CCP acquisition, the CCtCap. This tailoring approach was approved by the Agency Program Management Council (APMC) on October 25, 2012.

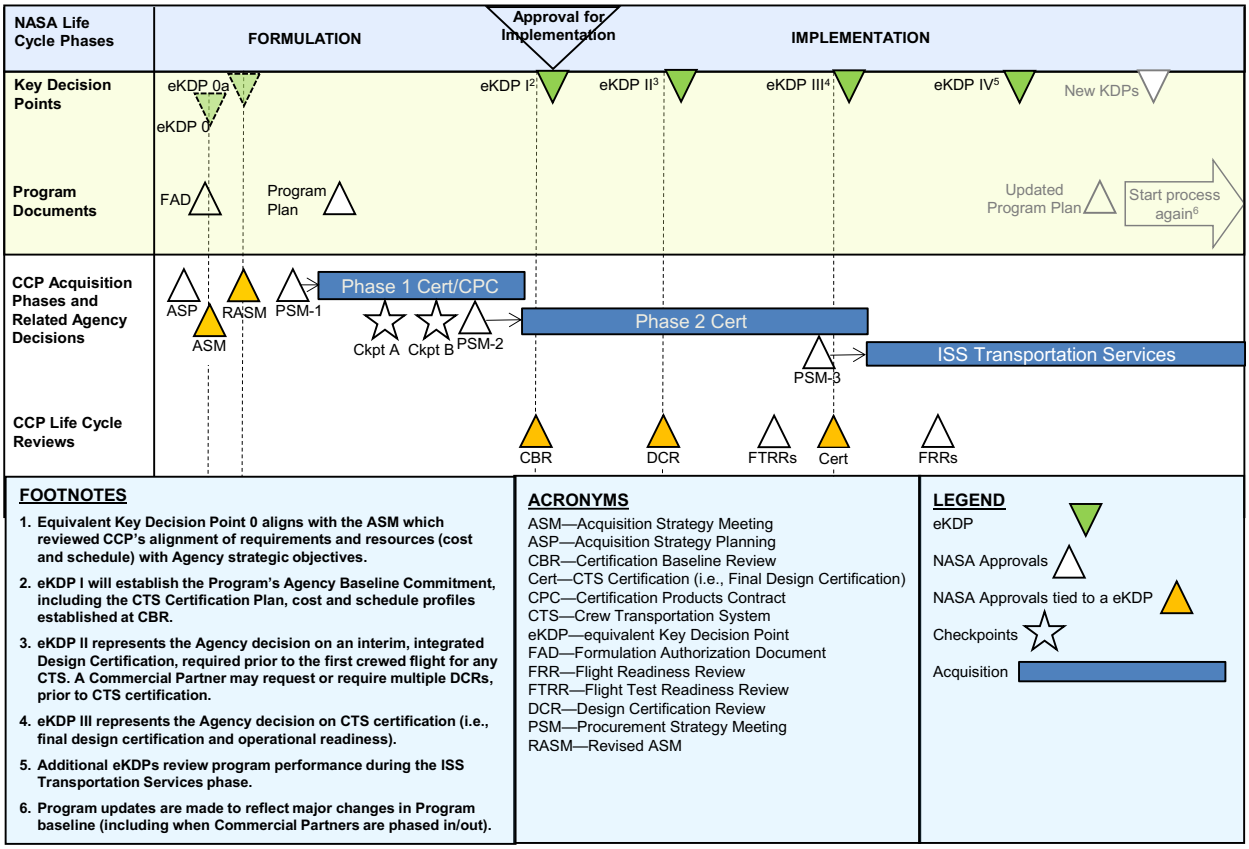


Figure G-3 Initial Concept for Commercial Crew Program Tailoring Approach

(Taken from APMC Briefing, October 25, 2012)

Equivalent Key Decision Point I and Annual Program Progress Reviews

Because the primary risks had been shifted from NASA to the industry contractors, and since the product designs and intellectual properties would be retained by the contractor, discussions at the planned NASA senior-level management decision gates would be different from discussions at a traditional Key Decision Point (KDP). The program's initial approach was to call these modified reviews "equivalent KDPs" or eKDPs as shown in Figure G-3. During eKDP I, the NASA Decision Authority (DA) agreed that the traditional KDP framework did not fully align with these non-traditional contracts and agreed to a tailored approach that eliminated requirements for additional NASA senior-level management decision gates (i.e., KDPs). CCP was a pathfinder in implementing 7120.5 in the context of a commercial partnership approach. Based on experience gained and the flexibilities enabled by tailoring, the Agency current practice is to maintain alignment with the review nomenclature per 7120.5 and not rename reviews, since the review content can be tailored. Through the CCP's approved acquisition strategy and use of FFP contracts, upcoming, required contract milestones and monthly status briefings had considerable overlap with KDPs. In addition, The DA directed that Program Progress Reviews (PPRs) (also known as Annual Reviews) be conducted by the NASA Associate Administrator (AA) through the Program Management Council (PMC) governance structure where CCP management would provide program maturity, risks, technical issues and mitigations, and schedule updates. (See Figure G-5.) PPRs were conducted from 2016 until 2018.

PPRs assessed the program's progress and determined the program's ability to execute with acceptable risk within cost and schedule constraints. PPRs were not KDPs and were not used to make certification decisions. In support of each PPR, the Standing Review Board (SRB) performed an independent assessment of the program's performance, risk, management, and resources, focusing on milestone progress, top risk status, and Human Rating Certification status, and reported directly and only to the APMC. The PPR approach limited CCP overhead and the interruption of regular work by streamlining and limiting the formality of the SRB reporting process. There were no Readiness-to-Proceed assessments or Snapshot Reports. Periodic Directorate Program Management Councils (DPMCs) were conducted, with agreement by the chairs of the Integrated Center Management Council to hold its meetings concurrently with the DPMC.

Human Rating Certification Reviews

After the award of the CCtCap contracts in 2015, and in parallel with annual PPRs through 2018, CCP conducted a series of Human Rating Certification reviews with NASA senior level management to demonstrate the incremental progress of the industry contractors towards meeting CCP's certification and safety requirements, which encompassed NASA's human rating requirements (HRR). While PPRs were focused on program performance, the Human Rating Certification reviews enabled NASA management to understand the contractors' progress toward meeting CCP requirements and to ensure that NASA leadership understood its obligations for Certification of Flight Readiness (CoFR). The NASA AA assumed the role of the DA in certifying the Boeing and SpaceX designs for human rating. (As of the publication of this document, SpaceX has completed human rating certification and Boeing is continuing to work toward human rating certification.)

Technical Reviews

As shown in Figure G-3, beginning in July 2018 the CCP performed life cycle reviews but used flexibility to adjust those reviews as needed based on the technical maturity of the contractors' design. The NASA AA determined that certification decisions would be informed by the Design Certification Reviews, the Flight Test Readiness Reviews (FTRRs), and Flight Readiness Reviews (FRRs) leading to CoFR and the final SRB assessment in November 2018.

In addition, the NASA AA determined that major program milestones and program status would be reviewed during regular NASA technical reviews, including:

- Design Certification Reviews,
- Prior to uncrewed demonstration flight tests at the FTRRs, and
- Prior to spacecraft abort tests and crewed flight tests at the FRRs.

These reviews would serve to verify that the commercial systems met NASA's safety and performance requirements.

When the CCP began test flights in 2019, the NASA AA determined that CCP performance would be reviewed at Baseline Performance Reviews (BPRs) and major program reviews. The

NASA AA also determined that after certification of the Boeing and SpaceX designs, the CCP would conduct Program Implementation Reviews (PIRs), as required by NPR 7120.5.

Independent Technical Assessments

For independent assessment reviews, the SRB membership for the CCP included representatives from NASA and industry representatives not aligned with the CCP program (including from NASA's former Independent Program Assessment Office). The CCP SRB was established to support PPRs (which were conducted by the NASA AA at the APMC) where they reviewed acceptance criteria for the contract milestones and, as observers, attended the associated milestone reviews.

The CCP requested that additional independent testing and independent technical assessments and analyses be performed by the NASA Engineering and Safety Center (NESC), NASA Safety Center, and the NASA Independent Verification and Validation (IV&V) Program to support safety, mission success, and engage proactively to help avoid/mitigate future problems.

Independent Cost and Schedule Risk Assessment

CCP was a pathfinder for implementation of commercial partnerships and applicability of the Joint Cost and Schedule Confidence Level (JCL) analysis requirement to these commercial partnerships was in question. When the CCP developed its cost and schedule baseline approach, a JCL analysis was not considered a practical methodology for assessing CCP's risk posture since the partner retained ownership of its integrated CTS, contributed corporate investment, and shared in program risks. In addition, a traditional JCL analysis was not considered feasible because CCP utilized FFP contracts with limited data availability. (Based on experience gained, the Agency now considers JCL analysis to be a best practice for FFP contracts.)

Instead of a JCL analysis, the Cost and Schedule Analysis Office at the Johnson Space Center (JSC) performed independent cost and schedule risk assessments, based on the Memorandum of Understanding (MOU) between CCP and the Cost Analysis Division (CAD) of the Office of the Chief Financial Officer (OCFO), which later became part of OCFO's Strategic Investments Division. The MOU documented the CCP's intent to perform a JCL assessment with a tailored Quantitative (cost) Risk Analysis (QRA) and a Schedule Risk Analysis (SRA). The QRA assessed cost and risk to create a probabilistic cost risk value, and the SRA assessed contractor schedule and risk to provide a probabilistic schedule slip risk value. The results of these analyses provided the overall programmatic risk posture for all programmatic scope related to the remaining development and certification effort.

External Audits and Reviews

Since CCP was a pathfinder for commercial partnerships and relied on commercial partners to fly NASA crews, the external stakeholders had a heightened interest in this program. Additional external audits and reviews were regularly conducted by the U.S. Government Accountability Office (GAO), the NASA Office of the Inspector General, the NASA Aerospace Safety Advisory Panel (ASAP), and the NASA Advisory Council.

2.3 NASA Insight/Oversight

The CCP helped to define and focus discussions on NASA insight/oversight models to accommodate the change in thinking in NASA's development and operation of human space flight vehicles from the traditional NASA program to a commercial program.

Oversight at NASA typically involves approving and directing the performance of the contractor. CCP oversight was limited to NASA approvals of specified contract deliverables and achievement of paid milestones, which were focused on satisfaction of engineering/safety requirements. Insight does not carry approval authority. Rather, it involves parallel (i.e., in-line) observation or review of the contractor's processes and performance that does not directly affect the production schedule (i.e., no waiting for approval). (See Appendix F for more extensive explanations of insight and oversight.)

For CCP, the commercial partners own and manage the designs, procedures, hardware assets, ground facilities, and intellectual property. NASA oversees the certification of the CTS for NASA's use and then purchases transportation services as a customer. To certify the CTS for NASA's use, NASA needs enough information and data about the commercial systems to understand the Agency's risk in flying NASA and NASA-sponsored crewmembers. This information and data are gathered through a combination of insight and oversight.

The CCP deliberately shifted more accountability to the commercial contractors, in comparison to the traditional NASA program approach. Figure G-4 shows how the CCP allocated program activities traditionally performed by NASA between NASA and the commercial contractor in the CCtCap contracts were conducted.

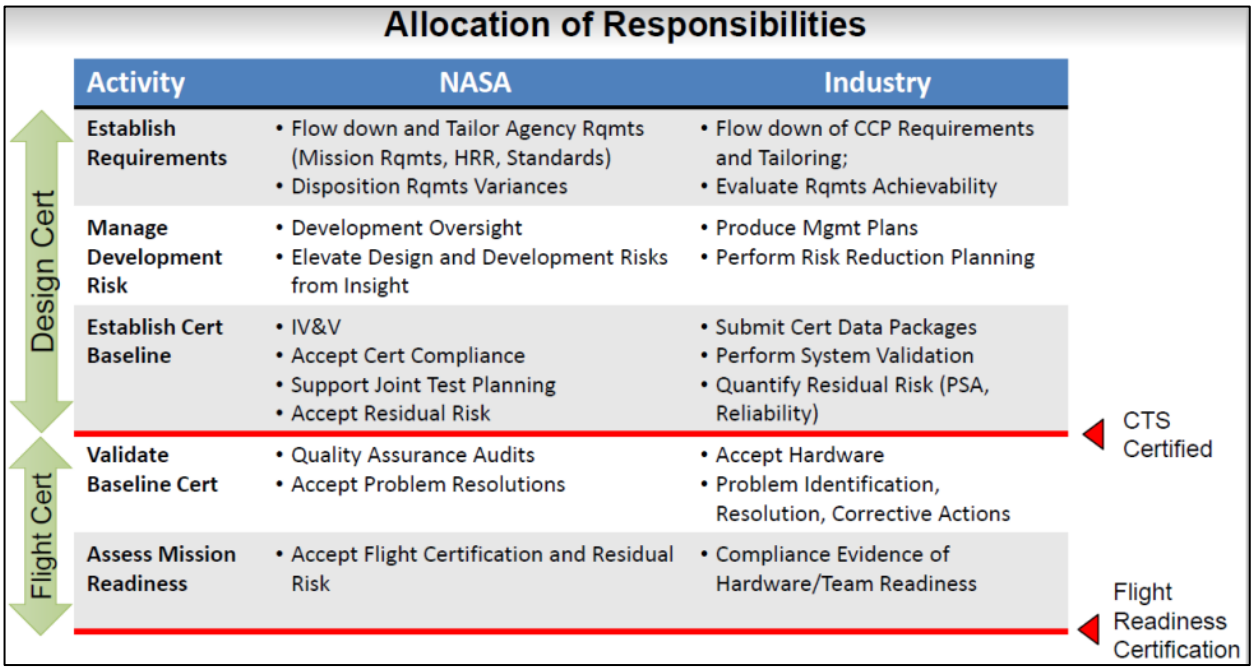


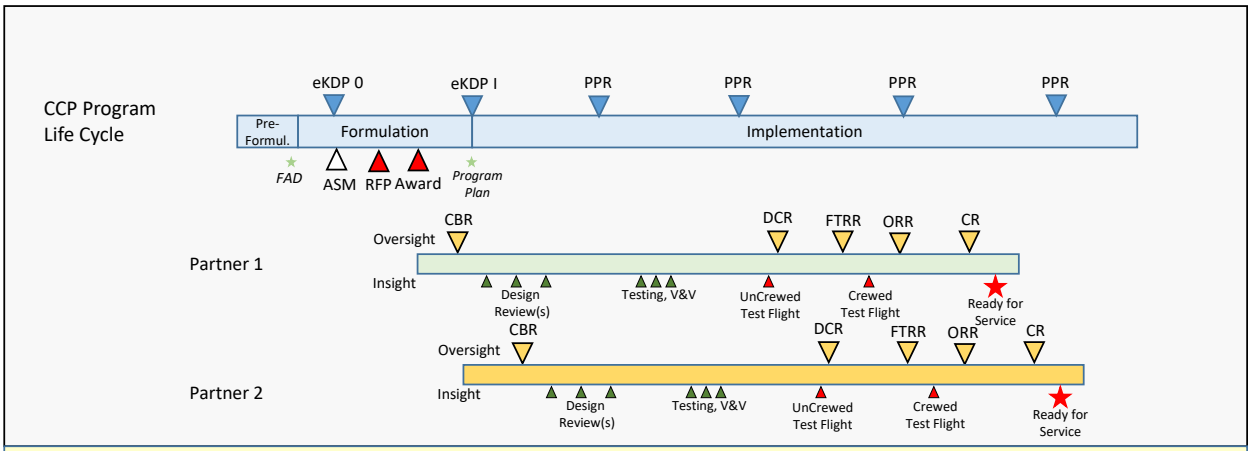
Figure G-4 Contract Activity and Allocation of Responsibilities

(Taken from "CCP Status to the NASA Advisory Council Human Exploration and Operations Committee" Briefing by Kathryn Lueders, November 2015)

The CCP balanced NASA's need to confirm that the commercial CTS was compliant with NASA's safety requirements with independence and flexibility for the commercial partners and contractors, thereby allowing for innovation and agility to meet the needs of multiple customers, including NASA.

To do this, NASA defined the scope of insight and clearly communicated its expectations to industry. As part of the acquisition documentation (e.g., SAAs and contracts), NASA requested that commercial partners and contractors propose an approach for accommodating NASA insight. In a change in thinking, NASA established proactive insight teams to communicate with the commercial partners and contractors rather than having the commercial partners and contractors establish a supporting role to NASA. Traditional project life-cycle reviews (LCRs) were replaced by the processes and milestones of the commercial partners and contractors, while program-level required reviews and boards allowed NASA approval and oversight of the work.

Figure G-5 shows a simplified life cycle representing the relationship of the CCP program-level life cycle to the project life cycles of the commercial contractors. Traditional NASA program-level decisional reviews after eKDP I become PPRs. The figure also shows the interplay of oversight and insight reviews.



ASM: Acquisition Strategy Meeting
CBR: Certification Baseline Review. Baseline requirements, current design, plans and schedule to complete DDT&E
CCP: Commercial Crew Program
CR: Certification Review. Provide evidence that the Crew Transportation System has met all requirements, provide documentation of crew safety and mission assurance risks
DCR: ISS Design Certification Review. Demonstrate Crew Transportation System and operations meet all applicable requirements, evidence of requirement compliance
DDT&E: Design, Development, Test and Evaluation
eKDP: Equivalent Key Decision Point
FAD: Formulation Authorization Document
FTRR: Flight Test Readiness Review. Demo readiness to conduct a crewed flight test
ORR: Ops Readiness Review. Demonstrate actual Crew Transportation System characteristics and procedures reflect deployed state, ensure all flight and ground systems meet req.
PPR: Program Progress Review
RFP: Request for Proposal
V&V: Verification and Validation

Figure G-5 CCP Reviews and NASA Insight/Oversight Model

Figure G-6 depicts the CCP insight/oversight model.

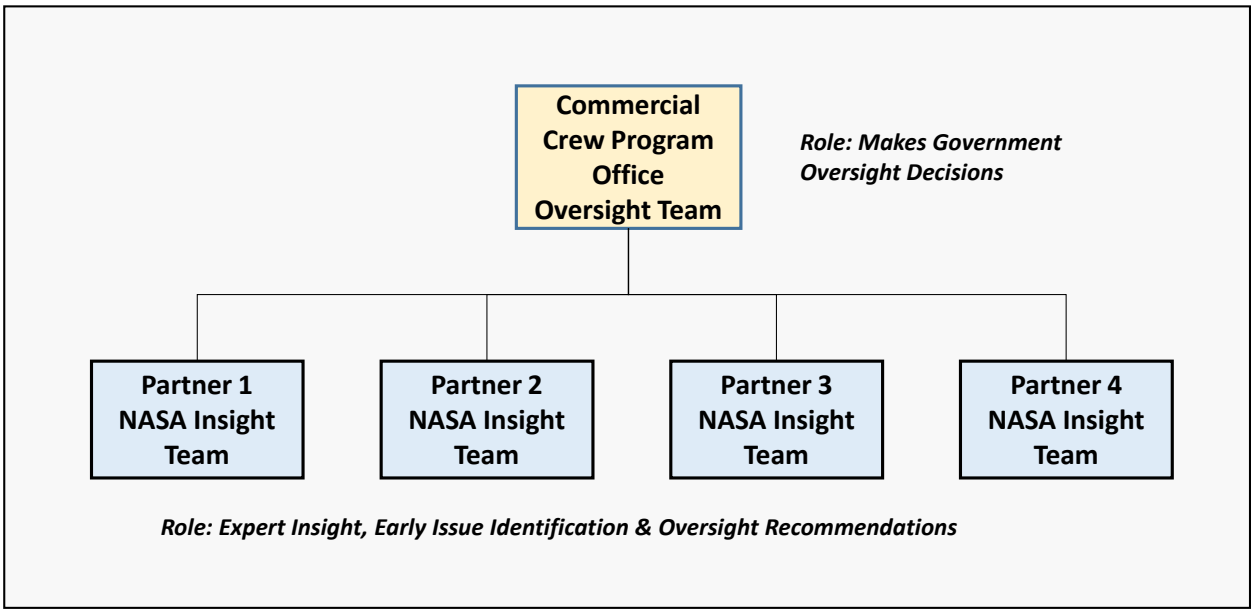


Figure G-6 Commercial Crew Insight/Oversight Model

(Based on information from "Commercial Crew Insight/Oversight Model Recommendations" by Frank Bauer, February 2011)

Insight/Oversight During Phase 1

For the CCP Phase 1 using SAAs, Partner NASA Insight Teams were comprised of the engineering, safety, and health/medical Technical Authorities as well as representatives from the CCP, ISS, an astronaut crew representative from the JSC Crew Office, and representatives from the U.S. Federal Aviation Administration (FAA), all of whom were matrixed from their home organizations.

The CCP ensured safety and requirements compliance for the integrated transportation system, including launch vehicle, spacecraft, ground operations systems, and mission operations systems. The ISS representative, along with the CCP, ensured ISS safety and requirements compliance. The JSC Crew Office representatives reviewed crew safety, vehicle compatibility with crew, and crew training approaches. The FAA and other U.S. Government regulatory authorities ensured compliance with their respective regulations.

Partners conducted major partner reviews with NASA, which enabled NASA review teams to gain insight and provide comments not decisions [3]. The NASA CCP, Technical Authority (TA), and others had frequent interactions with partners to maintain deep insight and access to all partner systems for the integrated capability.

Insight/Oversight During Phase 2

The CCP Phase 2 used contracts, control boards, including a Program Control Board (PCB), a Technical Review Board (TRB) and a Safety Technical Review Board (STRB), and provided approval for the completion of contract milestones and deliverables. The CCP integration and systems offices, along with the Technical Authorities, Flight Operations Directorate, ISS, and FAA, perform insight in regular interactions with the commercial contractors leading to certification.

The CCP established standard clauses for inclusion in CCtCap contracts:

- A GOVERNMENT INSIGHT CLAUSE (H.15) requires the Contractor to provide the Government with access to all data used in performance of this contract, including but not limited to data associated with areas of insight identified in CCT-PLN-1100; Commercial Crew Transportation Plan, Appendix C, Insight Areas, and supporting data/information, and administrative and management information. The following are considered exceptions: financial information, and any other information not used in performance of the contract related to the CTS design, production, and operations to include technical data, supporting data/information, and administrative and management information except for financial information.

- NASA revisits partner certification efforts for CCtCap missions, along with anomalies identified to ensure all certification requirements are mitigated and closed and anomalies and risks are mitigated or accepted. To that end, a MISHAP CLAUSE (H.26) requires the

[3] The NASA review teams consisted of the embedded civil servant systems engineers, relevant CCP subsystem experts, and cognizant FAA experts, and were augmented as needed with other independent experts from NASA, FAA, or industry as appropriate. The review products included key findings, concerns, actions, and recommendations.

Contractor to make available to NASA all data and resulting reports related to a mishap investigation conducted by the Contractor in the performance of activities not under the CCtCap contract but relevant to the design, production, and operations of the CTS.

- Finally, the ANOMALY INVESTIGATION AND CORRECTIVE ACTION CLAUSE (H.29) requires the Contractor to report to the Government information on an unexpected event; hardware or software damage; departure from established procedures or performance; or a deviation of system or subsystem, hardware or software, performance outside intended design or expected performance specification limits.

Fleet Following Activities

Under a CCtCap contract, NASA maintains access to and analyzes flight data for the performance of each provider's CTS, including all missions flown with NASA as a customer and with other Government and commercial customers (e.g., Inspiration4, Axiom private astronaut missions). In addition, NASA tracks performance anomalies of commercial missions that use similar launch vehicles.

This "Fleet Following" insight information and data allows NASA to understand how the as-built configurations of the flight hardware systems perform and whether they perform within the design margins planned for certifying NASA missions. If the hardware does not perform within such margins, NASA interacts with the provider to determine why the hardware did not perform as expected and what, if any, changes would be required for the NASA-certified CTSs.

Figure G-7 shows the insight/oversight interactions between the Government and industry.

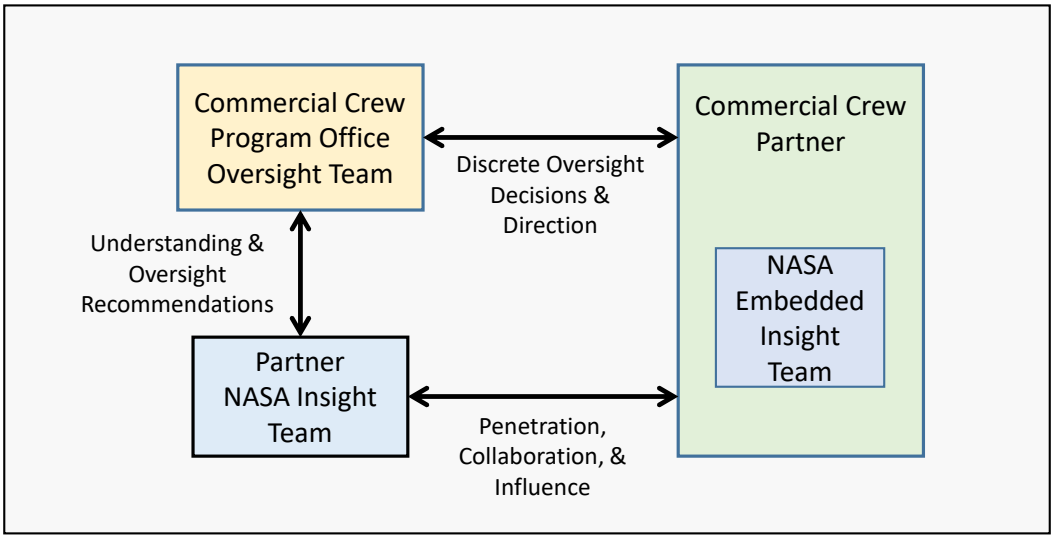
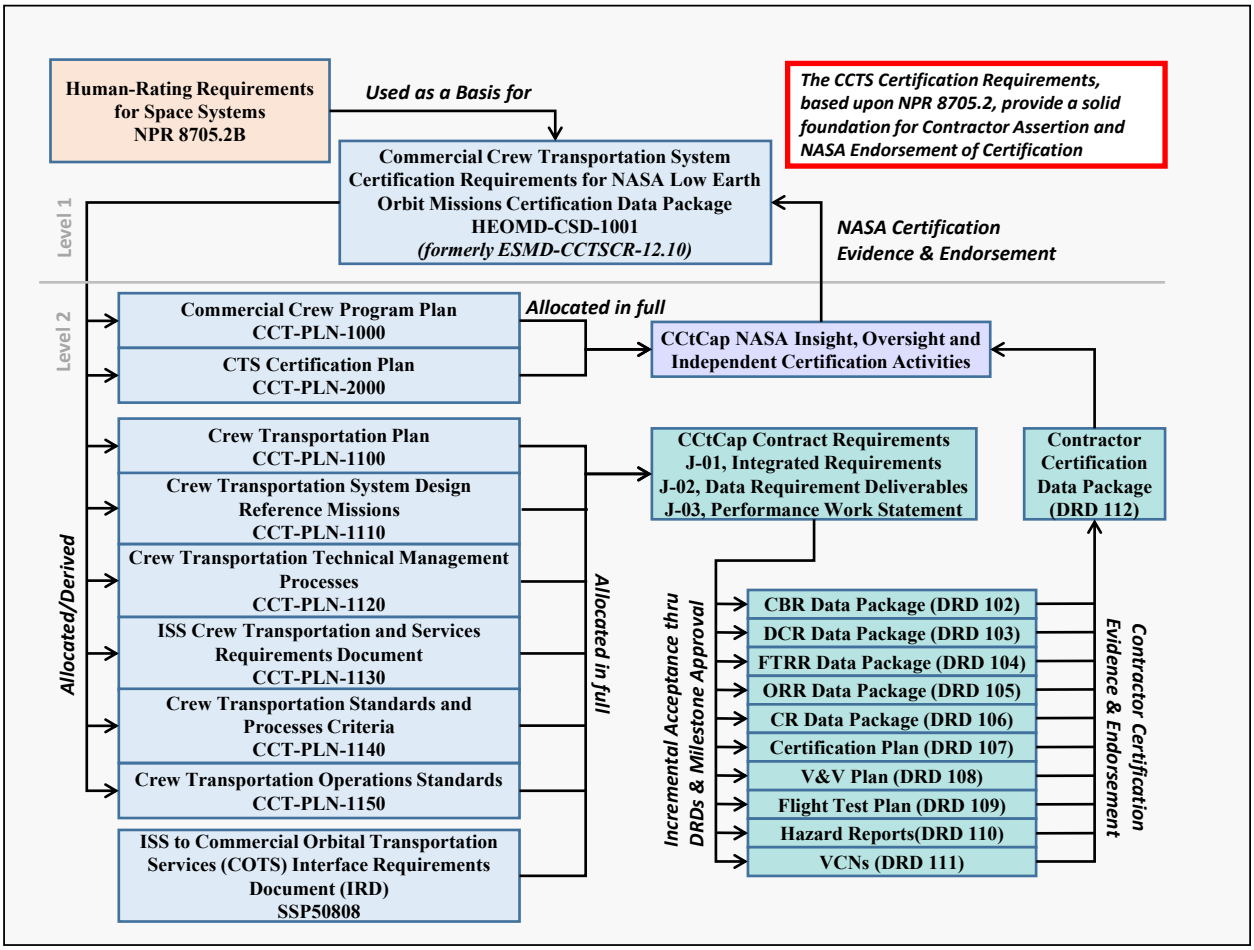


Figure G-7 Government-Commercial Insight/Oversight Interactions

(Based on information from "Commercial Crew Insight/Oversight Model Recommendations" by Frank Bauer, February 2011)

2.4 Documentation

NASA Headquarters (HQ) CTS certification requirements are defined in *HEOMD-CSD-10001, Commercial Crew Transportation System Certification Requirements for NASA Low Earth Orbit Missions Certification Data Package*, which includes requirements from *NPR 8705.2, Human-Rating Requirements for Space Systems* determined by the Agency Technical Authorities as being applicable to CCP. The CCP documented these requirements in the CCP series 1100 requirements documents, which were, in turn, flowed to CCP contractors through the CPC and CCtCap contracts as shown in Figure G-8. NASA also imposed the requirements contained in the ISS Interface Requirement Document describing the physical, electrical, and fluid interface requirements that would need to be met by the contractor to properly attach to the ISS on its contractors. (See *SSP 50808, ISS to Commercial Orbital Transportation Services (COTS) Interface Requirements Document*.)



CCTS=Commercial Crew Transportation System; CBR=Certification Baseline Review; ORR=Operational Readiness Review; CR=Certification Review; V&V=Verification and Validation; VCN=Verification Closure Notice

Figure G-8 Commercial Crew Documentation Flow Down

(Taken from "CCP Status to the NASA Advisory Council Human Exploration and Operations Committee" Briefing by Kathryn Lueders, November 2015)

These documents were placed on the CCtCap contract and its attachments (J-01 to J-03). As part of the contract, DRDs (shown on the bottom right corner of Figure G-8) were defined for each deliverable identifying title, description of use, submission frequency, distribution, contents, and format for each required deliverable. The commercial contractor uses these DRDs to construct the data packages for each of the oversight reviews (described in Section G.3) and to provide other required documentation, such as the Verification Closure Notices (VCNs) which provide evidence of compliance with NASA requirements.

The commercial contractor develops a final Certification Data Package (DRD 112) and provides it for NASA approval. This information, combined with the insight gathered from the embedded NASA teams and any other independent assessments, is used to determine if the contractor successfully meets all the certification requirements as expressed in the certification document. If the contractor meets the requirements and expectations, then CTS certification is granted, allowing NASA to contract with that contractor for transportation services to and from the ISS.

The suite of documentation described in Figure G-8 provides the means for NASA to identify a minimum set of requirements and expectations while allowing the commercial contractors to use their own processes and practices to deliver cost-effective solutions. The DRDs and the evaluations of the embedded insight teams provide NASA with enough information to evaluate a CTS for crew safety and permit the contractor to build and operate a CTS that is compliant with the certified design. Certification maintenance is the responsibility of the commercial contractor. NASA has oversight/approval through a process that requires the commercial contractor to bring to the CCP and ISS Program, as part of its operating plans, changes to the certification baseline with rationale for acceptability. When any change or set of changes are deemed to affect the baseline established at CTS Certification, NASA will assess the need for a new CTS Certification or, in cases of unacceptable risk, nullify the commercial contractor's NASA CTS Certification.

2.5 CTS Certification of Flight Readiness Process

CTS CoFR is the NASA endorsement that the commercial contractor's physical as-built CTS was produced, assembled, integrated, and tested within the approved production and operational constraints, that the mission specific requirements are enveloped within the certified CTS capabilities, that all personnel are trained and certified to support the mission, and that all aspects of the CTS are ready for the mission. CoFR is a recurring process that is completed for each orbital flight test, crewed flight test, or PCM. The supporting CoFR data is gathered incrementally throughout the execution of standard work. The actual CoFR process commences several months prior to flight and is completed at the Agency FTRR or Agency FRR.

The CCP CoFR process defines the endorsements, method of approving exceptions to the endorsements, roles and responsibilities, and the scope of the CoFR reviews. The NASA CoFR process consists of an ISS Program Stage Operations Readiness Review (SORR), a CCP FTRR/FRR, and an Agency FTRR/FRR with the commercial contractor that demonstrates the program's readiness to proceed with the flight test or mission. Each review encompasses the assessment of standard open work, non-standard open work, any open requirements, acceptance of risk, and any issues. Only associated open work (standard and nonstandard), open requirements, and issues from the previous review will be addressed at the next review. All open work (standard and non-standard) and issues that impact the integrated readiness of the flight test

or mission will be assessed for integrated risk to confirm readiness for proceeding to the next review. These CoFR reviews with the commercial contractor culminate in the Agency FTRR/FRR, where the Agency endorses the readiness of the commercial contractor's CTS and any Government Provided Services necessary to support the mission.

2.6 Commercial Transportation Pathfinder

In closing, NASA, through the CCP, has enabled development and demonstration of commercial crew transportation services that NASA continues to pursue. The CCP has demonstrated an innovative approach within commercial human space flight, from both the acquisition and programmatic perspectives. This approach includes the following:

- Defining the goal of an end-to-end crew transportation solution to ISS.
- Using SAAs and FFP contracts with competitive selection of partners and contractors for providing services.
- Using milestone-based agreements/contracts that support competition, development, testing, and demonstration of space flight systems.
- Encouraging commercial industry investment.
- Defining clearly stated high-level requirements early to allow technical trades to be accomplished without contract modifications.
- Judiciously applying design and construction standards.
- Rigorously assessing proposed requirements changes. Requirements changes were elevated to NASA HQ.
- Establishing true partnerships with contractors that allow for continuous deep insight into contractor efforts and help the contractor succeed.
- Efficiently and effectively governing insight/oversight.
- Using a lean and agile program management approach.

Chapter 3 Human Landing System Program Observations

3.1 Overview

In the Artemis lunar exploration initiative, the Human Landing System (HLS) is the mode of transportation that will take astronauts to the lunar surface. On early missions the HLS will also serve as a pressurized crew cabin for astronauts to live in for up to a week.

NASA seeks to develop the HLS using a public-private partnership model that will reduce the cost of development, reduce the time required for the development cycle, stimulate the economy, produce a stronger industrial base to facilitate the commercial space market, and enhance U.S. competitiveness in the global space industry.

To accomplish these goals, NASA will

- Specify the minimum NASA required capabilities for the HLS, allowing the contractor to tailor their design to best address their commercial interests.
- Launch on industry-procured, commercial launch vehicles.
- Allow standards tailoring to incorporate commercial practices, standards, specifications, and processes.
- Use a collaborative approach with NASA subject matter expertise, as requested by the contractors.
- Use insight and oversight.

This approach represents a notable change from the traditional NASA approach and promotes shared benefits between NASA and the commercial entities. The HLS contractors will be responsible for all activities associated with the design, development, manufacture, test, system verification, and system demonstration of the HLS lander. NASA will be responsible for issuing the CoFR and for any critical Go/No Go calls during on-orbit operations.

The HLS Program is a multi-mission single project program with upgrades from an Initial Capability to a Sustaining Capability as depicted in Figure H-1. (See Appendix C for descriptions of the diverse types of programs.)

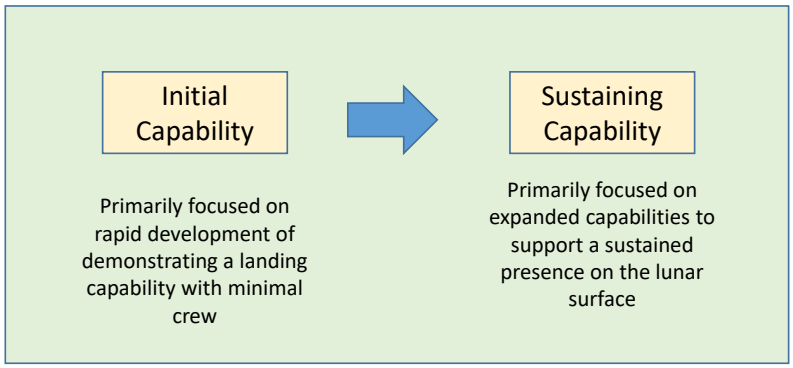


Figure H-1 HLS Initial and Sustaining Capabilities

(Based on Human Landing System Program Tailoring Proposal, May 2022)

3.2 HLS Acquisition Structure

The HLS is being procured through a Broad Agency Announcement (BAA) titled Next Space Technologies for Exploration Partnership (NextSTEP).

BAAs are used to obtain proposals for research and development to advance or evaluate innovative technologies that are not related to a specific system or hardware requirement. The NextSTEP BAA has been used to solicit studies, concept development, and technology maturation activities to demonstrate key exploration capabilities. Most efforts under the BAA require some level of corporate contribution and public-private partnership, the level of which is specified in each solicitation.

The first NextSTEP BAA was issued in 2014 to develop concepts for cross-cutting technologies that would provide new capabilities in four critical focus areas to enable a return to the Moon:

- Advanced Propulsion Systems
- Habitation Systems
- Environmental Control & Life Support Systems
- Small Satellite Missions (Artemis-1 secondary payloads)

NASA issued two to four FFP contracts with technical and payment milestones in each of these focus areas based on proposals from private-sector partners.

The second NextSTEP BAA, called NextSTEP-2, was issued in 2016 to refine concepts, develop ground prototypes, develop initial capabilities, and mature technologies to enable a sustained presence on the Moon and Mars. This omnibus BAA document contained general eligibility requirements, proposal instructions, and proposal review information for the specific research and development opportunities announced periodically as appendices to the BAA. The appendices contained details specific to the research being sought, such as funding levels, expected number/type of awards, and any proposal instructions that differ from or augment instructions provided in the omnibus BAA document.

The appendices related to HLS (i.e., E, H, N, and P) are highlighted in Table H-1 below. Note that these may be subject to change.

Table H-1 NextSTEP-2 Appendices Example

Appendix	Title
A	Habitat Systems
B	In-Space Manufacturing (ISM) Multi-Material Fabrication Laboratory (FabLab)
C	Power and Propulsion Element (PPE) Studies
D	In-Situ Resource Utilization (ISRU) Technology
E	Human Landing System (HLS) Studies, Risk Reduction, Development, and Demonstration
F	Logistics Reduction (LR) in Space by Trash Compaction and Processing System (TCPS)
G	Space Relay Partnership and Services Study
H	Human Landing System Integrated Lander
I	Commercial Destination Development in Low Earth Orbit using the International Space Station
J	Opportunities to Stimulate Demand in Low Earth Orbit through Applied Research
K	Cancelled
L	Lunar Terrain Vehicle (Reserved)
M	Foundation Surface Habitat (Reserved)
N	Sustainable Human Landing System Studies and Risk Reduction
O	Capability Studies for NASA Communications and Navigation Network Direct-to-Earth and Lunar Space Relay Commercialization Services
P	Human Landing System Sustaining Lunar Development

NextSTEP-2 BAAs allow greater flexibility in the development of new technologies and capabilities before their specific requirements are known. The intent of each of these activities is to use the flexibility of BAAs during development, eventually transitioning to a negotiated contract or procurement of a commercial sustaining service. The final procurement of the sustaining service will be performed under FAR part 12 or 15 procurement. Figure H-2 shows how the different NextSTEP-2 acquisitions progressively mature the HLS capability.

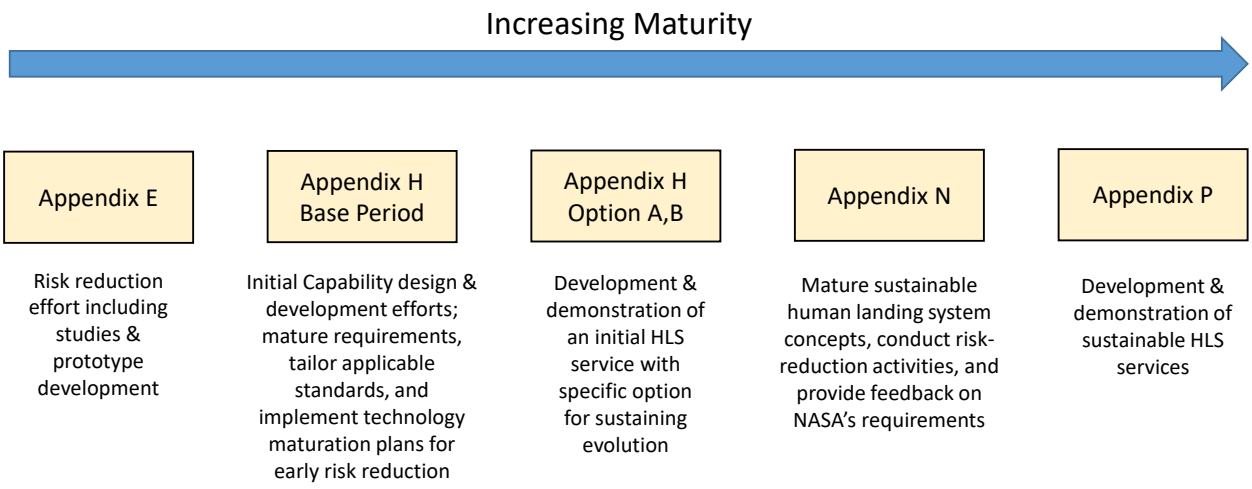


Figure H-2 Acquisition Progression of the HLS

(Based on Human Landing System Program Tailoring Proposal, May 2022)

Each of the HLS-related appendices represents a different phase of development leading to sustainable support of lunar transport.

Appendix E

Under Appendix E, the selected contractors performed early architecture and trade studies for the human lander. Contractors were able to understand the required capabilities, expectations, standards, ground rules, and assumptions for the HLS system and begin developing concepts for its development.

This acquisition was to minimize the number of top-level requirements, allowing industry to develop innovative concepts and employ or develop cost-effective processes for sustainable manufacturing. The top-level requirement set was carefully selected to indicate what was needed without stating or implying how the need should be met. The requirement set also included data and physical interface requirements with the launch vehicle (without identifying the type or provider of the launch vehicle), ground systems, the crew staging vehicle, extravehicular activity (EVA) suit systems, and other mission systems interfaces. Finally, NASA certification for human space flight imposes certain constraints, which were conveyed as ground rules and assumptions.

Appendix H

The architecture and trades of the design concepts were further refined in Appendix H, which was structured in three parts:

- The base period established a preliminary design for the HLS initial capability. NASA selected three contractors in a process that involved adjudication of design and other standards that could be used by industry partners and for system development through preliminary design.

- Option A provided for further development and demonstration of the HLS uncrewed and crewed lunar transport initial capability to the moon's surface. NASA down selected and

funded two contractors from the three base period contractors for the design, development, test, and evaluation (DDT&E) and the first flight.

- Option B provides for the development of a more robust HLS capability that will meet or exceed NASA's requirements for a sustained presence on the lunar surface. In Option B, one of the contractors selected for Option A will continue the engineering, design, and test of upgrades to the original designs and will conduct demonstrations of both an uncrewed and crewed capability to produce a lunar lander spacecraft that meets the Agency's requirements for recurring services.

Appendix N

Appendix N sought new commercial-led work to mature HLS designs and study risk reduction solutions. These are FFP, milestone-based contracts for each selected company to help the Agency fine-tune its approach. This effort helped NASA refine requirements for future contracts that will enable a regular cadence of crewed trips from Gateway lunar orbit to the lunar surface and back.

Appendix P

Appendix P includes the DDT&E, un-crewed demonstration, and crewed demonstration for the sustaining capability including transportation between Gateway and the lunar surface. This was an open call to U.S. companies other than the Appendix H contractor (SpaceX) for the purpose of bringing a second entrant to market for the development of a lunar lander in parallel with the Appendix H awardee. This effort is meant to maximize NASA's support for competition and to provide redundancy in services to help ensure NASA's ability to transport astronauts to the lunar surface. The sustaining capability will increase the number of crew members, the surface duration, and the amount of mass to and from the lunar surface and will add to the ability of the lander to survive lunar darkness.

3.3 Tailoring of NPR 7120.5 Requirements

The HLS Program tailored the NPR 7120.5 single-project program life-cycle model based on the CCP life-cycle tailoring. (See Appendix C.) The approach includes two decisional reviews (KDP A and KDP C) followed by informational Annual Synchronization Reviews (ASRs). No KDP B was required for the initial capability.

The ASRs include selected members from both the APMC and DPMC with minimal or no pre-briefs, reflecting the plan to have just one deep review of the program annually. In addition, the ASRs include Center Directors, TAs, and the OCFO.

Table H-2 summarizes the HLS Program NPR 7120.5 tailored approach.

Table H-2 Human Landing System Program Tailored Approach

(Based on "Gateway Presentation to the Public-Private Partnership (PPP) Guide Working Group, October 2021)

Topics	7120.5E requirements	HLS Proposed Tailored Approach
Program Life Cycle	• Transition from Phase D to E occurs following on-orbit checkout and initial operations	• Straightforward approach: Life cycle for purposes of ABC includes all DDT&E until entry into Phase E, Operations and Sustainment. Milestone for entry into Phase E is marked by the demonstration of the initial human lunar landing capability in 2024.
Program-level Design Reviews	• SRR/SDR, PDR, CDR, SIR reviews at Program level, followed by PIRs when in an operational state.	• Program design reviews negotiated with each NextSTEP-2 Appendix H awardee to enable efficiency/industry best practices. Program/awardee review plan to be captured in HLS Program Plan. Program reviews include reviews by independent technical and programmatic authorities.
Program KDPs	• For Single Project Programs, perform KDPs after key design reviews, including KDP A, B, C, D.	• Program-level "KDP C equivalent" review at transition from HLS Phase A to Phase B, currently estimated for 18 months after BAA award in October 2019. To include ABC for cost and schedule through entry into Phase E. • Contractors to involve the government in a design review milestone marking end of preliminary design. • Annual Synchronization Reviews thereafter.
Governing Council	• Agency Program Management Council for major milestone reviews.	• APMC for KDP C equivalent review. Informational briefings provided via quarterly Baseline Performance Review. • DPMC for Annual Synchronization Reviews, thereafter, including independent assessment out briefs.

Key Governing Documents	• Formulation Authorization Document (FAD) • Program Commitment Agreement • Program Plan • Decision Memorandum (DM) for all KDPs	• Initial FAD equivalent content for top-level LCR approach captured in Acquisition Strategy Meeting (ASM) presentation. • Draft Program Plan due prior to Appendix H award, to include tailoring (partially based on industry partner feedback). Final Program Plan due at KDP C equivalent review approximately 18 months after BAA award. Moon to Mars Enterprise Deputy AA to sign, • Single DM for KDP C.
Independent Assessments	• Standing review boards conduct independent assessments without any conflict of interest or inappropriate interference particularly from the organization being assessed (See Section H.4 Independent Assessment)	• HLS SRB to be comprised of a Chair, systems engineering SME, programmatic analyst (OCFO), crew office member, and one member each from the independent technical authorities (which may be either the program embedded TA or another SME who is current on the program). Independent assessments are provided continuously as well as during KDP and Annual Synchronization Reviews.
Program level ABC and Programmatic Analysis Req. (including JCL)	• Create ABC using JCL and programmatic analysis	• ABC for program to Phase E and demonstration of human lunar landing capability in 2024. Details (including making ABC at program- or contractor-level) to be documented in Program Plan. • Tailored, lean JCL/SRA using milestone summary schedule. Approach has agility to both inform ABC decision and regular program management risk identification/mitigation in a timely manner. • Contractors to provide basis of estimate for cost and schedule to enable ongoing NASA insight.

CDR=Critical Design Review, PDR=Preliminary Design Review, SIR=System Integration Review, SRR/SDR=System Requirements Review/System Definition Review

3.4 Independent Assessment

The HLS SRB operates interactively with the program and Agency leadership and provides continuous independent technical and program input. The HLS SRB has seven members including:

- Chair, jointly selected by the NASA AA and the SOMD AA
- Systems Engineering subject matter expert from the NASA Engineering and Safety Center (NESC)
- Programmatic Analyst from the OCFO
- TA representatives selected by TA Leadership (i.e., Chief Engineer, Chief Safety Officer, and Chief Medical Officer)
- Crew Member selected by the Crew Office
- Other subject matter experts for topics engaged as needed (i.e., not standing members)

Composition of the HLS SRB did not technically require tailoring of NPR 7120.5 requirements. Including TA representatives on the HLS SRB required approval due to their inherent positional Conflicts of Interest (COI). For additional information, see NASA/SP-20230001306, NASA Standing Review Board Handbook.

3.5 NASA Insight/Oversight

NASA oversight on the HLS Program is accomplished through KDP A and KDP C reviews and the ASRs. For insight, the HLS Program uses a risk-based approach that is commensurate with the acquisition of a service as opposed to a spacecraft. Insight is focused on ensuring that the NASA program office has enough data and confidence to sign the CoFR.

NASA interacts with the contractor teams for:

- Joint mission and operations planning,
- Insight into contractor activities required by NASA,
- Work under the responsibility of the contractor for which they request NASA collaboration.

NASA obtains insight by participating in the following contractor forums where decisions are made:

- Mission Design Working Group
- Mission Operations Planning Working Group

- Joint Loads Task Team
- Weekly Integrated Analysis Planning Meeting
- Contractor Updates
- Crew Systems
- Performance
- Risk Updates
- Requirement Interface and Verification
- Safety and Mission Assurance
- Avionics and Power
- Software
- Propulsion
- Structures and Mechanisms
- Mission Systems/Ground Systems Operation
- Health and Medical
- Thermal

Participation in these insight forums allows NASA to identify targeted areas that may need deeper penetration based on the associated risk. In some cases, NASA may choose to perform an independent verification and validation (IV&V) on higher risk areas as well as spot checks on lower-level verifications. This information informs the certification decisions.

Because the HLS has several dynamic mission phases (from launch to in-space transit, RPODU, landing, ascent, etc.), with multiple contractors, interactions with different Artemis programs (Gateway, Orion, EHP, etc.), and numerous technical disciplines (propulsion, power, communications, etc.), the insight space is viewed as three-dimensional. Insight responsibility is divided within the insight team to gain a better understanding of each contractor's design, performance, and ability to meet the expected capabilities within each phase of the mission. This understanding must cut across not only the mission segments (e.g., launch, landing, ascent) and technical disciplines (e.g., power, propulsion, avionics), but also address the unique capabilities and approaches of each contractor.

The entire insight space can be effectively covered by using insight teams with different viewpoints:

- The Mission Segment Leads concentrate on each segment of the mission across all disciplines needed for that segment.
- Lead Systems Engineers look across all disciplines of a contractor's efforts for all segments of the mission.
- Discipline Leads focus on their specific discipline to understand its use across all mission segments for all the contractors.

The three-dimensional insight space with insight roles in each dimension is illustrated in Figure H-3.

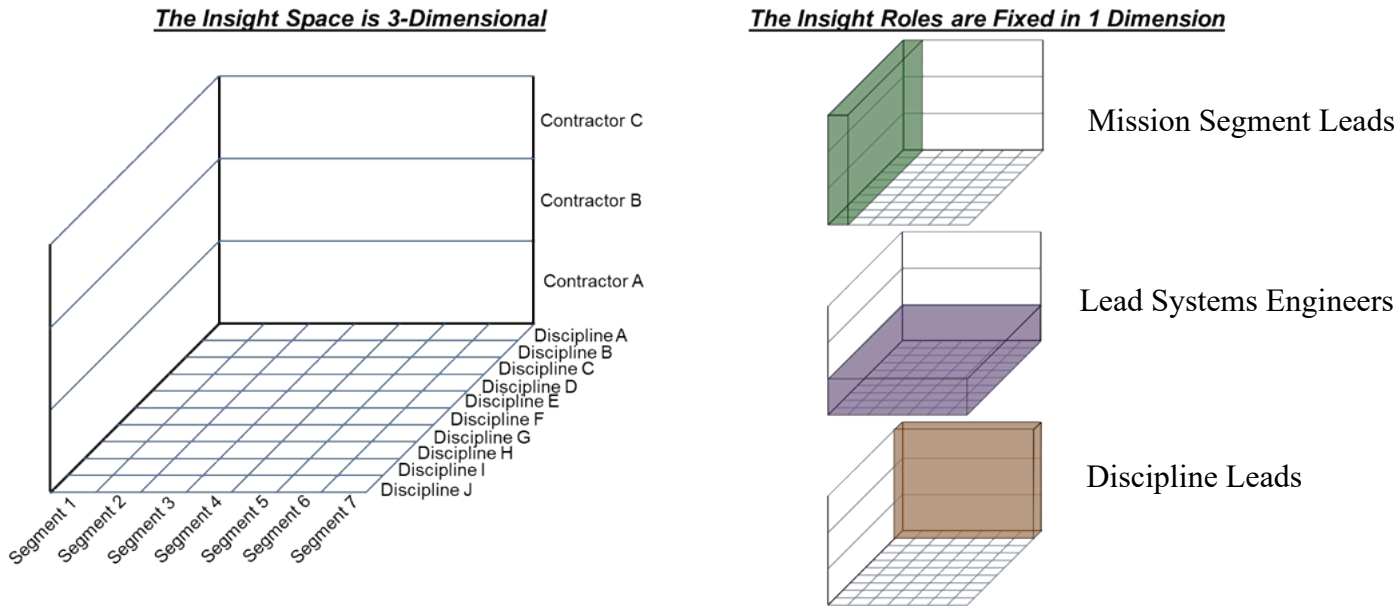


Figure H-3 The Three-Dimensional Insight Space

3.6 HLS Certification of Flight Readiness Process

Issuance of the CoFR is based on (1) design certification built on NASA-approved hazard control, verification objectives, and verification closures against the NASA-mandated requirements, (2) contractor compliance with NASA-approved design and certification standards, and (3) contractor processes and NASA process controls as identified by NASA risk-based insight.

Chapter 4 Summary Observations

This chapter summarizes observations provided in Chapter 3 and 4. These efforts developed and employed tailored life cycle and management structures that differ from those used by traditional acquisitions in areas such as life-cycle reviews, key decision points, independent assessments, the balance between NASA insight and oversight, intellectual property and data sharing, and program/project documentation.

Summary observations discussed in more detail in this chapter include the following actions:

1. Identify the appropriate acquisition strategy as early in the process as practicable in consultation with Office of Procurement and Office of General Counsel.

2. Revise the acquisition strategy as concepts and requirements are clarified.

3. Identify the necessary reviews and milestones based on the acquisition strategy, contract type, and selected life cycle.

4. Tailor the appropriate life cycle based on the acquisition strategy, what information the program or project will need to evaluate progress, how the products will be produced, or services will be procured, and how performance will be measured.

5. Make Agreement during acquisition negotiations on the insight and oversight needed to ensure NASA objectives are met while allowing sufficient flexibility for the contractor to efficiently provide the product or service.

6. Identify the documentation needed based on the type of acquisition and planned operational concepts.

4.1 Selecting the Acquisition Strategy

Program/Project Managers considering utilizing a commercial partnership approach should consult the Office of Procurement and Office of General Counsel to obtain advice on best and most current acquisition/agreement approaches and associated laws that best suit the program/project objectives.

Selecting an acquisition strategy for a program or project is highly dependent on several factors, including:

- The NASA need or objective being addressed

- The type of program or project needed (e.g., tightly coupled, loosely coupled)

- The specific and broader objectives of the program or project

- National and NASA strategic vision, priorities, and/or direction

- The commercial market and whether existing capabilities or products already exist or will soon likely exist within commercial or non-commercial entities
- Schedule or cost considerations
- The extent of NASA involvement desired
- The kind of life cycle and reviews needed
- The documentation needed by NASA.

The following sections discuss some of the considerations associated with these key factors.

4.1.1 Program or Project Need, Purpose, and Type

The first task is to determine the need for a capability, product, or service. The need may be driven by scientific discovery, exploration goals, national goals, or other factors. The objectives of acquiring the product or service will determine the possible acquisition strategies, the high-level requirements, whether a research or space flight program is needed, and the space flight program type (i.e., uncoupled, loosely coupled, tightly coupled, or single-project program).

The acquisition strategy is influenced by the overall objective and might vary for different program objectives, for example:

- Design, develop, test, and/or operate a new capability that will be "owned" by NASA. (See Appendix E.)
- Help develop and nurture commercial space capabilities.
- Procure services.
- Initiate research to develop a new technology or to bring promising research or technologies to a higher technology readiness level.

Table 4.1-1 Summarizes some of the key characteristics differentiating between traditional and commercial oriented approaches.

Table 4.1-1 Examples of Traditional and Commercially Oriented Acquisition Approaches

(Taken from "CCP Formulation Lessons Learned/Observations" by Phil McAlister, as presented to the Program and Project Management Board (PPMB) on 3/1/2023")

Program Characteristics	Traditional Approach	Commercially-Oriented Approach
Owner	NASA	Industry
Contract Type-Fee	Cost-Plus	Fixed Price
Contract Management	Prime Contractor	Public-Private Partnership
Customer(s)	NASA	Government and Non-Government
Funding for Capability Development	NASA procures capability	NASA provides investment via milestone payments
NASA's Role in Capability Development	NASA defines "what" and "how"	NASA defines "what" and industry defines "how"
Requirements Definition	NASA defines detailed requirements	NASA defines top-level requirements
Cost Structure	NASA incurs total cost	NASA and industry share costs

4.2 Purpose of the Contract or Agreement

Identify the key purpose of an acquisition, such as:

- Obtaining a certain product or service for NASA use?
- Helping the commercial work move quickly into the ability to provide spacecraft and space related services?
- Determining the number of contracts necessary to fulfill demand.

Decisions such as these will determine what type of contract(s) or agreement(s) needs to be used. For example, for a specific product such as a spacecraft to investigate an asteroid that will be owned and operated by NASA, the "negotiated contract" type available under FAR part 15 might be in order. These contracts are solicited through RFPs. Proposals are received and evaluated, and one or more companies are selected. These contracts allow for selections based on "best value" rather than lowest cost. "Best value" includes consideration of other criteria such as past performance, shortest schedule, technical merit, budget availability, etc.

If, on the other hand, NASA wants to purchase an existing capability or service, such as delivery of cargo to the ISS, contracts under FAR part 12 "commercial items" can be used. Performing a market survey supports the development of an effective strategy for the acquisition of commercial products and services and establishes the foundation for the Agency's description of need, solicitation, and resulting contract. For these types of contracts, the description of NASA's need must contain sufficient detail for potential offerors of commercial products or services to

determine which of their products or services are suitable and/or how they may need to be modified to meet the Agency's need. The description should therefore contain how the Agency intends to use the product or service in terms of function to be performed, performance requirement, environment for intended use, and other physical characteristics.

For cases where NASA is interested in preparing the scientific or commercial industrial base to enter the market or improve upon existing capabilities, the use of FAR part 35 "Broad Area Announcements" is useful. These contracts are used to advance scientific and technical knowledge and apply that knowledge to achieve Agency and national goals. Unlike FAR part 12 and FAR part 15 contracts, FAR part 35 contracts are directed toward objectives for which the work or methods cannot be precisely described in advance, the probabilities of success or required effort for technical approaches is difficult to judge, and/or there is little to no early assurance of full success. This contracting process is used to encourage the best sources from the scientific and industrial community to become involved in the program or project and must provide an environment in which the work may be pursued with reasonable flexibility and minimum administrative burden.

Recent program acquisition strategies have made increasing and effective use of funded SAAs to help develop and mature the ability of commercial entities to provide cost-effective products and services. SAAs have proven to be a valuable method for providing greater flexibility in the development of new technologies and capabilities before their specific requirements are known or developed and maturing these technologies and capabilities to the point that further development can be transitioned to a negotiated contract. (See Appendix E for more information on SAAs.)

4.3 Selecting an Acquisition Strategy

An essential tool for selecting an acquisition strategy is the Analysis of Alternatives (AoA), or trade study. An AoA should be performed as early in the life cycle as possible. The results of the AoA will identify how each major part of the program or project could be accomplished whether through in-house work (using the NASA workforce), contracts, or agreements. Consult the Office of Procurement and Office of General Counsel to obtain advice on the best and most current acquisition/agreement approaches and associated laws that best suit the program/project objectives.

Criteria for the AoA are based on the identified need and purpose, relative cost and available budget, schedule, ability to accomplish the technical capability, and other factors such as internal NASA needs for workforce training and external needs such as geopolitical issues. As many options as need to be consider so that the most cost effective and technically achievable acquisition strategy can be developed. Use of independent NASA reviewers and subject matter experts during the AoA is essential.

AoA results and recommendations should be presented to a Decision Framing Meeting or Pre-ASM, and an ASM for discussion and approval by NASA management. Some major procurements may also be required to conduct a Procurement Strategy Meeting (PSM) for contracts or Project Strategy Briefing (PSB) for SAAs. ASMs are described in more detail in the NASA Space Flight Program and Project Management Handbook; *NASA Policy Directive* (*NPD)*

1000.5, Policy for NASA Acquisition, *NAII 1000.1, Decision Framing Meeting (DFM and Pre-Acquisition Strategy Meeting Pre-ASM) Guide*, and *NAII 1000.2, Acquisition Strategy Meeting (ASM) Guide* in NODIS.

After performing an acquisition AoA and gaining approval of the acquisition strategy, the program or project will know how to divide up the work between in-house work, contracted work packages, and work to be accomplished under agreements. **Note that for most programs and projects, more than one set of contracts or agreements may be needed to accomplish the needs and goals**. In-house work can be planned and budgeted through internal Task Agreements or other means. Contracts or agreements are used for external work. Section 2.2 looks at the types of contracts or agreements that can be used depending on the desired purpose.

Use of Firm Fixed Price (FFP) Contracts

While the use of FFP contracts provides many conveniences, such as a constrained budget, they are best used when:

- Requirements are mature and stable. Changing requirements in an FFP contract can result in additional costs to NASA for each change.
- The required technology is well understood. This allows the offerors to estimate their costs and risks with high precision, reducing uncertainty related to costs.

NASA oversight for FFP contracts is kept to a minimum. This allows for innovation and cost-effectiveness, increasing companies' incentives for accepting FFP contracts.

Each project or work package will need to be individually assessed to determine the most effective contract or agreement type and implementation. For example, complex programs such as those involved in Artemis will be comprised of several complex projects, each of which may have several work packages requiring negotiated contracts, commercial contracts, BAAs, or SAAs to develop, mature, and procure the desired products and services as evidenced in the Commercial Crew Program and HLS Program examples.

4.4 Tailoring the Life Cycle, Key Decision Points, and Reviews

4.4.1 Tailoring Overview, Guidance, and Resources

The NASA Space Flight program and project management requirements are documented in NPR 7120.5. Programs and projects vary in scope and complexity and require varying levels of management requirements and Agency oversight to support mission success within acceptable risk. NASA policy recognizes the need to accommodate the unique aspects of each program and project to achieve mission success in a safe, efficient, and economical manner within acceptable risk. The application of the requirements should be commensurate with scope, scale and risk of the program and project. This is typically accomplished by tailoring (streamlined approach to deviations and waivers as noted in the NPRs and includes process to document approval of tailored requirements). Tailoring is both an expected and accepted part of establishing proper requirements. Additional details on how to tailor are documented in NPR 7120.5, Introduction to Appendix C

Program and project management requirements in NPR 7120.5 include the following:

- Specific life cycles based on the type of program or category of project,
- Specific reviews required at established points in the life cycle (i.e., LCRs and Independent Assessments),
- Key gates in the life cycle, known as Key Decision Points (KDPs), through which programs and projects must proceed to advance to the next phase,
- Governing Program Management Councils and Decision Authorities,
- Key governing documents,
- Specific methodologies for cost and schedule analyses (e.g., JCL), and
- Establishing technical, cost and schedule baselines including the Agency Baseline Commitment (ABC).

Guidance and resources to assist programs and projects in tailoring NPR 7120.5 requirements have been established and/or developed by the Agency, MDs, and Centers. These include compliance matrices, consultation and assistance for tailoring, and resources for developing the tailoring approach. NPR 7120.5, Appendix C provides guidance for the tailoring process and identifies resources available to programs and projects for developing a tailoring approach and obtaining approval for tailoring. These resources include:

- Compliance Matrix templates used for tailoring and Points-of-contact for Headquarters requirements owners and some MDs for consulting with and assisting programs and projects in developing their tailoring approach and in obtaining approval for tailoring.
- Programs, Category 1 projects, and projects of high importance or visibility to NASA coordinate with the NASA Chief Program Management Officer (CPMO) to determine their tailoring approach. The CPMO-coordinated tailoring approach may need to be presented by the program or project to the NASA PPMB, as determined by the CPMO.
- Assistance from the NASA Program and Project Management Board (PPMB) in tailoring requirements and providing guidance through the tailoring process. The PPMB may be engaged to determine whether to endorse the program or project's tailoring and resolve issues related to tailoring between requirement owners and programs and projects.
- An Agency Tailoring Web site that includes many tailoring resources, including the information identified above. The web site is available at Tailoring Web Site.

4.4.2 Developing the Program or Project's Tailoring Approach

Considerations in developing the tailoring approach may include but are not limited to:

- The acquisition strategy and agreement/contract type(s) to be used,

- Program or project goals (greater flexibility, streamlining activities),
- Key characteristics of the program (e.g., projects with different timelines),
- The need for adequate control at the program and Agency levels,
- Allowing for commercial partner practices,
- The insight/oversight model to be used,
- Key milestones and decision points,
- What information the program or project will need to evaluate progress, and
- How and when that information will be obtained (program-, project-, contract-level reviews, documentation, etc.).

Program and project managers should consult with the CPMO or NPR 7120.5 requirement owners to ensure their proposed tailoring approach aligns with agency expectations and external laws and regulations.

4.4.3 Tailoring Examples

The tailoring approaches used by the CCP and HLS Program and their constituent projects to tailor NPR 7120.5E requirements are provided in this document and may be useful to future programs and projects in developing their tailoring approach. Examples of tailoring discussed in Chapter 2 include the following:

- Tailoring the number of KDPs. (For example, the NASA AA as DA determined that no additional KDPs were required for the CCP after eKDP I since primary risks had been shifted from NASA to industry contractors through the CCP's approved acquisition strategy and use of FFP contracts, and that upcoming required contract milestones had considerable overlap with KDPs).
- Conducting periodic reviews or synchronization reviews instead of KDPs to assess program performance. (For example, the NASA AA held CCP Program Progress Reviews (PPRs) (also known as Annual Reviews) at the APMC to assess the program's progress and determine the program's ability to execute with acceptable risk within cost and schedule constraints.)
- Aligning the independent assessment engagements with the tailored review approach. (For example, the CCP SRB was established to support KDP I and the Program Progress Reviews (PPRs) (also known as Annual Reviews) which were conducted by the NASA AA at the APMC. The CCP SRB used the acceptance criteria for the contract milestones, and attended and observed the milestone reviews.)

4.5 NASA Interactions with Contractors and Partners

When NASA acquires products or services, either from in-house developments or through contracted efforts or efforts conducted under agreements, the appropriate level of monitoring, control, and acceptance is critical to ensure the product and/or service meets NASA's needs and objectives.

4.5.1 Risk and Insight/Oversight

The appropriate level of insight/oversight is tightly tied to the amount of risk NASA is willing to accept that the product or service will fail to meet NASA's needs and the resulting consequences. Acceptable risk can vary widely across the spectrum of programs and projects. It is important that programs and projects get agreement on the appropriate level of risk from the stakeholders early in the life cycle so the right mechanisms can be put in place to enable the appropriate level of insight/oversight.

Human space flight programs in general tolerate only low levels of risk, and therefore may need higher levels of insight and/or oversight. However, technology maturation projects may tolerate more risk, and therefore need less insight/oversight. Unnecessarily elevated levels of oversight can slow down an effort and run the risk of stifling innovative commercial techniques and processes. Inadequately low levels of oversight run the risk of NASA receiving an unacceptable product or service. Likewise, unnecessarily elevated levels of insight can slow things down on the manufacturing floor, but inadequately low levels of insight may result in a product with hidden flaws that might not be discovered until it is too late. Achieving the right balance of oversight and insight will be unique for each product or service acquired.

4.5.2 Maturity and Insight/Oversight

Another factor involved in determining the appropriate level of insight/oversight for contracted efforts and efforts conducted under agreements is the maturity of the capabilities and products offered by commercial firms. Purchasing a radio transponder from a company that has a history of providing space-suitable transponders may require a minimum amount of insight to track the status of the purchase and functional test when the transponder is received before integrating it into the system for further testing. Purchasing a ride for crew on a new spacecraft with little to no history of successful space missions requires a higher level of insight/oversight to ensure the safety of the crew.

4.5.3 Assessing NASA's Role in Insight/Oversight

In-house development efforts inherently entail elevated levels of oversight by NASA program or project managers and in-line leadership. Contracted products or services needing greater NASA oversight will typically be acquired through FAR part 15 negotiated contract type efforts. This allows the appropriate level of oversight and insight to be negotiated and accepted for the acceptable amount of risk. For example, insight can be obtained by embedding civil servants into the contractor's development activities to gather information on, but not provide direction to, how things are proceeding, what issues are arising, and other aspects of the project. Insight might also be obtained through periodic status reports and/or briefings. Oversight might be provided by NASA chairing the LCRs and providing direction to the contractor based on the results. Oversight may also be obtained through periodic reviews of the efforts with NASA direction

provided only at negotiated key decision points. For FAR part 15 negotiated contract types, the appropriate mix of oversight and insight methods will need to be negotiated.

For products and services acquired to help mature technologies or capabilities that might one day be used in space, FAR part 35's BAAs or private-public partnerships such as SAAs would typically be used. These acquisition methods usually have a much higher risk tolerance and therefore may allow lower levels of NASA oversight and/or insight. For public-private partnerships the agreement partner typically provides money and effort and NASA oversight (i.e., giving directions on how to use their money/effort) may not be appropriate. Only NASA insight through periodic status reviews may be needed.

4.6 Key Governing Documentation

Expected and required documentation is defined in NPR 7120.5 for space flight programs and projects. This documentation includes plans, concepts, requirements, designs, verification results, and other information to characterize and capture information about the program or project. Programs are always managed at a NASA level and not contracted out. Projects, however, can be managed as an in-house (NASA civil servant and/or Agency support contractors) effort, a contracted effort, an agreement, or a combination thereof. In any case, the proper amount of documentation (i.e., information captured, in what form—electronic files, hard copies, drawings, models, etc.) is needed to ensure key information is captured and communicated. For contracted or agreement efforts, this documentation needs to be part of the contract/agreement negotiations and clear expectations/requirements need to be set for:

- How the information is documented, including the required format,
- When the information is required, e.g., the milestones at which the information is due, and
- What the process will be for changes or updates.

The list that delineates the program/project minimum data needs is provided as a Contract Data Requirements List (CDRL) with Data Item Descriptions (DIDs) that define the data content, format, and intended use for each required document/information.

For FAR part 15 negotiated contacts with high oversight needs, the documentation required in NPR 7120.5 should be used. Some documentation will be provided by the contractor, and some may be provided by the NASA program or project. Identifying the parties responsible for various documentation is an important part of program or project planning. Depending on the unique aspects of the program or project, additional documentation may be needed while some documentation required by the NPR may not be needed. Tailoring may be required to remove documentation requirements. Approved tailoring is documented in the Compliance Matrix associated with the applicable NPR. The Compliance Matrix is attached to the Program or Project Plan.

For contracts or agreements that do not require elevated levels of oversight, the list of required documentation may be tailored significantly and/or NASA program or project manager

approvals on the documentation may not be needed. Documentation obtained and reviewed by NASA personnel needs to be sufficient to ensure the safety and capability of the product or service, commensurate with acceptable risk.

Chapter 5 Conclusions

This document presents observations on recent space flight programs that have implemented non-traditional acquisition approaches to information for new programs and projects considering the use of non-traditional acquisition approaches. The key is conducting a thorough Analysis of Alternatives to assess the risks, costs and market and technology maturity to determine the best acquisition method(s) appropriate.

The acquisition approach informs the life cycle and management structures needed by a program or project, beginning with the allocation of roles and responsibilities between NASA and the partner or contractor. The allocation of responsibilities shapes the life cycle model, the need for life-cycle reviews and key decisions, the frequency and timing of these reviews, and the need for data and documentation. This, in turn, establishes the need for tailoring NPR 7120.5 requirements. The allocation of responsibilities and management also shapes the insight/oversight approach which must provide sufficient visibility into the partner or contractor's effort and progress to support management of the program or project. The procurement documents then need to reflect decisions, to include intellectual property rights, ownership of hardware and software, and negotiated tailoring. The detailed performance statement of work with clear requirements must be codified in the contract documents through the procurement processes so NASA and the partners have clear and established deliverables with an agreed baseline.

Appendix A. Glossary

Acquisition. Obtaining, or advancing the development of, the systems, research, services, construction, and supplies to fulfill the Agency's mission and other activities which advance the Agency's statutory objectives. (The definition of acquisition in this document is used in a broader context than the FAR definition to encompass the spectrum of various NASA acquisition authorities and approaches to achieve the Agency's mission and activities).

Acquisition Strategy. The integrated strategy that enables a program or project to meet its mission objectives and provides the best value to NASA.

Acquisition Strategy Meeting. A decision-making forum where senior Agency management reviews and approves program and project acquisition strategies. The ASM focuses on considerations such as impacting the Agency workforce, maintaining core capabilities, make-or-buy decisions, supporting Center assignments, potential partnerships, and risk. (See *NPD 1000.5, Policy for NASA Acquisition,* and *NASA Advisory Implementing Instruction (NAII) 1000.2 Acquisition Strategy Meeting (ASM) Guide* for more information on ASMs.)

Agency Baseline Commitment. Establishes and documents an integrated set of project requirements, cost, schedule, technical content, and an agreed-to JCL that forms the basis for NASA's commitment to the external entities of the U.S. Office of Management and Budget (OMB) and the U.S. Congress. Only one official baseline exists for a NASA program or project, and it is the Agency Baseline Commitment.

Agreement. The statement (oral or written) of an exchange of promises. Parties to a binding agreement can be held accountable for its proper execution and a change to the agreement requires a mutual modification or amendment to the agreement or a new agreement.

Analysis of Alternatives. A formal analysis method that compares alternative approaches by estimating their ability to satisfy mission requirements through an effectiveness analysis and by estimating their life-cycle costs through cost analysis. The results of these two analyses are used together to produce a cost-effectiveness comparison that allows decision makers to assess the relative value or potential programmatic returns of the alternatives. An analysis of alternatives broadly examines multiple elements of program/project alternatives (including technical performance, risk, life-cycle cost (LCC) or initial capability cost, and programmatic aspects).

Announcement of Opportunity. An Announcement of Opportunity (AO) is one form of a NASA Broad Agency Announcement (BAA), which is a form of public/private competition. NASA solicits, accepts, and evaluates proposals submitted by all categories of proposers in response to an AO, including academia, industry, not-for-profits, Government laboratories, Federally Funded Research and Development Centers (FFRDC) (including the Jet Propulsion Laboratory (JPL)), and NASA Centers. Regulatory coverage of AOs appears in NASA Federal Acquisition Regulation (FAR) Supplement (NFS) Part 1872. NASA typically uses a one-step or a two-step AO process. In a one-step AO process, proposals for new projects are evaluated competitively and selected for Formulation in a single step. In two-step competitions, several proposals for new projects may be selected in Step 1 and given time to mature their concepts in a funded concept study before the Step 2 down-selection.

Broad Agency Announcement. A general announcement of an agency's research interest including criteria for selecting proposals and soliciting the participation of all offerors capable of satisfying the Government's needs. See FAR 6.102(d)(2).

Configuration Management. A technical and management process applying appropriate processes, resources, and controls to establish and maintain consistency between product configuration information and the product throughout the product life cycle.

Contract. A mutually binding legal relationship obligating the seller to furnish the supplies or services (including construction) and the buyer to pay for them. It includes all types of commitments that obligate the Government to an expenditure of appropriated funds and that, except as otherwise authorized, are in writing. In addition to bilateral instruments, contracts include (but are not limited to) awards and notices of awards; job orders or task letters issued under basic ordering agreements; letter contracts; orders, such as purchase orders, under which the contract becomes effective by written acceptance or performance; and bilateral contract modifications. Contracts do not include grants and cooperative agreements.

Deviation. A documented authorization releasing a program or project from meeting a requirement before the requirement is put under configuration control at the level the requirement will be implemented.

Formulation Agreement. The Formulation Agreement is prepared by the project to establish the technical and acquisition work that needs to be conducted during Formulation, defines the schedule, and funding requirements during Phase A and Phase B for that work.

Formulation Authorization Document. The document issued by the Mission Directorate AA to authorize the formulation of a program whose goals will fulfill part of the Agency's Strategic Plan and Mission Directorate strategies and establish the expectations and constraints for activity in the Formulation Phase. In addition, a FAD or equivalent is used to authorize the formulation of a project.

Formulation Phase. The first part of a program or project life cycle where Formulation activities are completed. The Formulation Phase begins at Approval for Formulation and ends at Approval for Implementation.

Implementation Phase. The second part of a program or project life cycle where Implementation activities are completed. The Implementation Phase begins at Approval for Implementation and continues through the end of the program or project.

Industrial Base. The capabilities residing in either the commercial or government sector required to design, develop, manufacture, launch, and service the program or project. This encompasses related manufacturing facilities, supply chain operations and management, a skilled workforce, launch infrastructure, research and development, and support services.

Information Technology. Any equipment or interconnected system or subsystem of equipment that is used in the automatic acquisition, storage, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information by an executive

Agency. Information technology also includes computers; ancillary equipment (including imaging peripherals, input, output, and storage devices necessary for security and surveillance); peripheral equipment designed to be controlled by the central processing unit of a computer; software; firmware; and similar procedures, services (including support services), and related resources. It does not include any equipment acquired by a federal contractor incidental to a federal contract.

Insight. The capacity to discern the true nature of the project's efforts to design, develop, test, and operate the system. It is accomplished through penetration (per contract agreement) into the contractor's processes and their design, development, test, and operations to improve the probability of program success.

Key Decision Point. The event at which the Decision Authority determines the readiness of a program/project to progress to the next phase of the life cycle (or to the next KDP).

Loosely Coupled Programs. These programs address specific objectives through multiple space flight projects of varied scope. While each project has an assigned set of mission objectives, architectural and technological synergies and strategies that benefit the program are explored during the Formulation process. For instance, Mars orbiters designed for more than one Mars year in orbit are required to carry a communication system to support present and future landers.

Oversight. The watchful and responsible care and management of the development, test, and operations efforts. This is accomplished through overseeing the performance of the provider's design, development, and test efforts and their ability to certify their system. The primary elements of oversight require government approval and/or direction.

Procurement Strategy Meeting. A forum where management reviews and approves the approach for the Agency's major and other selected procurements. Chaired by the Assistant Administrator for Procurement (or designee), the Procurement Strategy Meeting (PSM) addresses and documents information, activities, and decisions required by the FAR and NFS and incorporates NASA strategic guidance and decisions from the ASM strategic acquisition meeting to ensure the alignment of the individual procurement action with NASA's portfolio and mission. (See *NPD 1000.5, Policy for NASA Acquisition.)*

Program. A strategic investment by Mission Directorates or mission support offices that has a defined architecture and/or technical approach, requirements, funding level, and management structure that initiates and directs one or more projects. A program implements a strategic direction the Agency has identified as needed to accomplish Agency goals.

Project. A space flight project is 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 goals.

Risk. In the context of mission execution, risk is the potential for performance shortfalls, which may be realized in the future, with respect to achieving explicitly established and stated performance requirements. The performance shortfalls may be related to any one or more of the

following mission execution domains: (1) safety, (2) technical, (3) cost, and (4) schedule. (See *NPR 8000.4, Agency Risk Management Procedural Requirements*.)

Single-Project Programs. These programs tend to have long development and/or operational lifetimes, represent a large investment of Agency resources, and have contributions from multiple organizations/agencies. These programs frequently combine program and project management approaches, which they document through tailoring.

Tailoring. The process used to adjust or seek relief from a prescribed requirement to accommodate the needs of a specific task or activity (e.g., program or project). The tailoring process results in the generation of deviations and waivers depending on the timing of the request.

Technology Readiness Level. Provides a scale against which to measure the maturity of a technology. Technology Readiness Levels (TRLs) range from 1, Basic Technology Research, to 9, Systems Test, Launch, and Operations.

Tightly Coupled Programs. Programs with multiple projects that execute portions of a mission(s). No project can implement a complete mission. Typically, multiple NASA Centers contribute to the program. Individual projects may be managed at different Centers. The program may also include other agencies or international partner contributions.

Uncoupled Programs. Programs implemented under a broad theme and/or a common program implementation concept, such as providing frequent flight opportunities for cost-capped projects selected through AOs or NASA Research Announcements (NRAs). Each such project is independent of the other projects within the program.

Validation. The process of showing proof that the product accomplishes the intended purpose based on stakeholder expectations. May be determined by a combination of test, analysis, demonstration, and inspection. (Answers the question, "Am I building the right product?")

Verification. Proof of compliance with requirements. Verification may be determined by a combination of test, analysis, demonstration, and inspection. (Answers the question, "Did I build the product right?")

Waiver. A documented authorization releasing a program or project from meeting a requirement after the requirement is put under configuration control at the level the requirement will be implemented.

Appendix B. Acronyms

AA	(NASA) Associate Administrator
ABC	Agency Baseline Commitment
AI&T	Assembly, Integration, and Test
AoA	Analysis of Alternatives
AO	Announcement of Opportunity
APMC	Agency Program Management Council
ASAP	(NASA) Aerospace Safety Advisory Panel
ASM	Acquisition Strategy Meeting
ASP	Acquisition Strategy Planning
ASR	Annual Synchronization Review
BAA	Broad Agency Announcement
BPR	Baseline Performance Review
CAD	(NASA OCFO) Cost Analysis Division
CAS	Cost Accounting Standards
CBR	Certification Baseline Review
CCDev	Commercial Crew Development
CCiCap	Commercial Crew Integrated Capability
CCP	Commercial Crew Program
CCtCap	Commercial Crew Transportation Capability
CCTS	Commercial Crew Transportation System
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CFR	Code of Federal Regulations
CoFR	Certification of Flight Readiness

COTS	Commercial Orbital Transportation Services
CPAF	Cost Plus Award Fee
CPC	Certification Products Contracts
CPFF	Cost Plus Fixed Fee
CPIF	Cost Plus Incentive Fee
CPMO	(NASA) Chief Program Management Officer
CR	Cost Reimbursement or Certification Review
CRADA	Cooperative Research and Development Agreement
CS	Cost Sharing
CTS	Crew Transportation System
DA	Decision Authority
DCR	Design Certification Review
DDT&E	Design, Development, Test, and Evaluation
DID	Data Item Description
DM	Decision Memorandum
DPMC	Directorate Program Management Council
DR	Decommissioning Review
DRD	Data Requirements Description
DRR	Disposal Readiness Review
eKDP	Equivalent Key Decision Point
EHP	Extravehicular Activity (EVA) and Human Surface Mobility (HSM) Program
EVA	Extravehicular Activities
FAA	Federal Aviation Administration
FAD	Formulation Authorization Document
FAR	Federal Acquisition Regulation

FFP	Firm Fixed Price
FFRDC	Federally Funded Research and Development Centers
FP	Fixed Price
FPI	Fixed Price Incentive
FRR	Flight Readiness Review
FSAA	Funded Space Act Agreement
FTRR	Flight Test Readiness Review
GAO	(U.S.) Government Accountability Office
HEOMD	Human Exploration and Operations Mission Directorate
HLS	Human Landing System
HQ	Headquarters
HRR	Human Rating Requirements
IAA	Interagency Agreement
IDIQ	Indefinite Delivery Indefinite Quantity
IP	Intellectual Property or International Partner
IRAD	Internal Research and Development
ISM	In-Space Manufacturing
ISRU	In-Situ Resource Utilization
ISS	International Space Station
IV&V	Independent Verification and Validation
JCL	Joint Cost and Schedule Confidence Level
JPL	Jet Propulsion Laboratory
JSC	(NASA) Johnson Space Center
JWST	James Webb Space Telescope
KDP	Key Decision Point

LCC	Life-Cycle Cost
LCR	Life-Cycle Review
LEO	Low Earth Orbit
LR	Logistics Reduction
MCR	Mission Concept Review
MDR	Mission Definition Review
MOU	Memorandum of Understanding
MRR	Mission Readiness Review
NASA	National Aeronautics and Space Administration
NESC	NASA Engineering and Safety Center
NextSTEP	Next Space Technologies for Exploration Partnership
NFS	NASA FAR Supplement
NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
NRA	NASA Research Announcement
OCFO	Office of the Chief Financial Officer
OMB	Office of Management and Budget
OTA	Other Transaction Authority
ORR	Operational Readiness Review
PCB	Program Control Board
PCM	Post Certification Missions
PDR	Preliminary Design Review
PI	Principal Investigator
PIR	Program Implementation Review
PMC	Program Management Council

PPE	Power and Propulsion Element
PPMB	(NASA) Program and Project Management Board
PPP	Public-Private Partnership
PPR	Program Progress Review
PRR	Production Readiness Review
PSA	Probabilistic Safety Assessment
PSB	Project Strategy Briefing
PSM	Procurement Strategy Meeting
QRA	Quantitative Risk Analysis
R&D	Research and Development
RASM	Revised ASM
RFP	Request for Proposal
RPODU	Rendezvous, Proximity Operations, Docking, and Undocking
SAA	Space Act Agreement
SDR	System Definition Review
SIR	System Integration Review
SORR	(ISS Program) Stage Operations Readiness Review
SRA	Schedule Risk Analysis
SRB	Standing Review Board
SRR	System Requirements Review
STRB	Safety Technical Review Board
STS	Space Transportation System
TA	Technical Authority
T&M	Time and Materials
TCPS	Trash Compaction and Processing System

TRB	Technical Review Board
TRL	Technology Readiness Level
U.S.	United States
U.S.C.	United States Code
V&V	Verification and Validation
VCN	Verification Closure Notice

Appendix C. Types of Programs and Projects

Space flight programs and projects flow from the implementation of national priorities, defined in the Agency's Strategic Plan, through the Agency's Mission Directorates, as part of the Agency's general work breakdown hierarchy shown in Figure C-1.

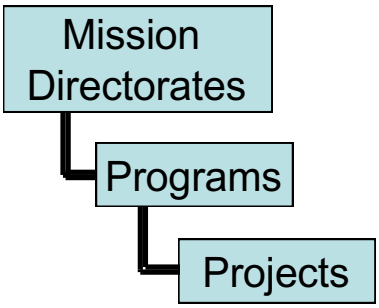


Figure C-1 Programmatic Authority Organizational Hierarchy

This hierarchical relationship of programs to projects shows that programs and projects are different, and their management involves different activities and focus.

C.1 Types of Programs

A program is a strategic investment by a Mission Directorate or mission support office with a defined architecture and/or technical approach, requirements, funding level, and a management structure that initiates and directs one or more projects. A program implements a strategic direction the Agency has identified as needed to accomplish Agency goals. NPR 7120.5 defines four types of programs:

- **Uncoupled programs** (e.g., Discovery Program) are implemented under a broad theme (like planetary science) and/or a common program implementation mechanism, such as providing flight opportunities for formally competed cost-capped projects or Principal Investigator (PI)-led missions and investigations. Each project in an uncoupled program is independent of the other projects within the program.

- **Loosely coupled programs** (e.g., Mars Exploration Program) address specific objectives through multiple space flight projects of varied scope. While each project has an independent set of mission objectives, the projects have architectural and technological synergies and strategies that benefit the program. For example, Mars orbiters designed for more than one Mars year in orbit are required to carry a communication system to support present and future landers.

- **Tightly coupled programs** (e.g., Gateway Program) have multiple projects that execute portions of a mission or missions. No project can implement a complete mission. Typically, multiple NASA Centers contribute to the program. Individual projects may be managed at different Centers. The program may also include other agencies or international partner contributions.

- **Single-project programs** (e.g., James Webb Space Telescope (JWST)) tend to have long development and operational lifetimes and represent a large investment of Agency resources. Multiple organizations or agencies contribute to them. Single-project programs have one project and implement their program objectives and requirements through one of two management approaches: (1) separate program and project structures or (2) a combined structure. The requirements for both programs and projects apply to single-project programs as described in NPR 7120.5.

C.2 Types of Projects

A project is 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 goals. Projects covered in this document are governed by NPR 7120.5 for space flight projects.

Projects vary in scope and complexity and require varying levels of management requirements and Agency attention and oversight. Project categorization defines Agency expectations of project managers by determining both the oversight council and the specific approval requirements. Projects are Category 1, 2, or 3. (See NPR 7120.5 for guidelines for determining a project's category.)

C.3 Program and Project Life Cycles

Life cycles define how the program or project will organize its activities as it moves through the conceptualization (pre-formulation), formulation, implementation, and closeout phases. The life cycle provides the foundation of the actions that are to be performed and is critical to the success of the program or project.

NPR 7120.5 provides life-cycle figures for programs and projects (see Figures C-2, C-3, C-4, and C-5). These life cycles execute in a serial manner and show the product moving in a straight line from the initial concepts, through design, development, test, delivery, operations, and closeout. This straight-line approach is useful for programs and projects when the product can be well defined with firm requirements developed early in the life cycle, and in which the tolerance for risk is low. An example would be human space flight projects. Negotiated contracts also often take this approach. Planning documents, work packages, and contracts/agreements are developed early in the life cycle based on these firm requirements and the program/project managers use them to monitor and control changes that might affect the scope, schedule, or budget. If requirements change later in the life cycle, the planning documents, designs, contracts, or other agreements may need to be modified, incurring additional cost and schedule delays.

Figures C-2, C-3 and C-4 provide the standard NPR 7120.5 life cycles for an Uncoupled or Loosely Coupled Program, a Tightly Coupled Program, and a Single-Project Program, respectively. Figure C-5 provides the standard NPR 7120.5 life cycle for a NASA project.

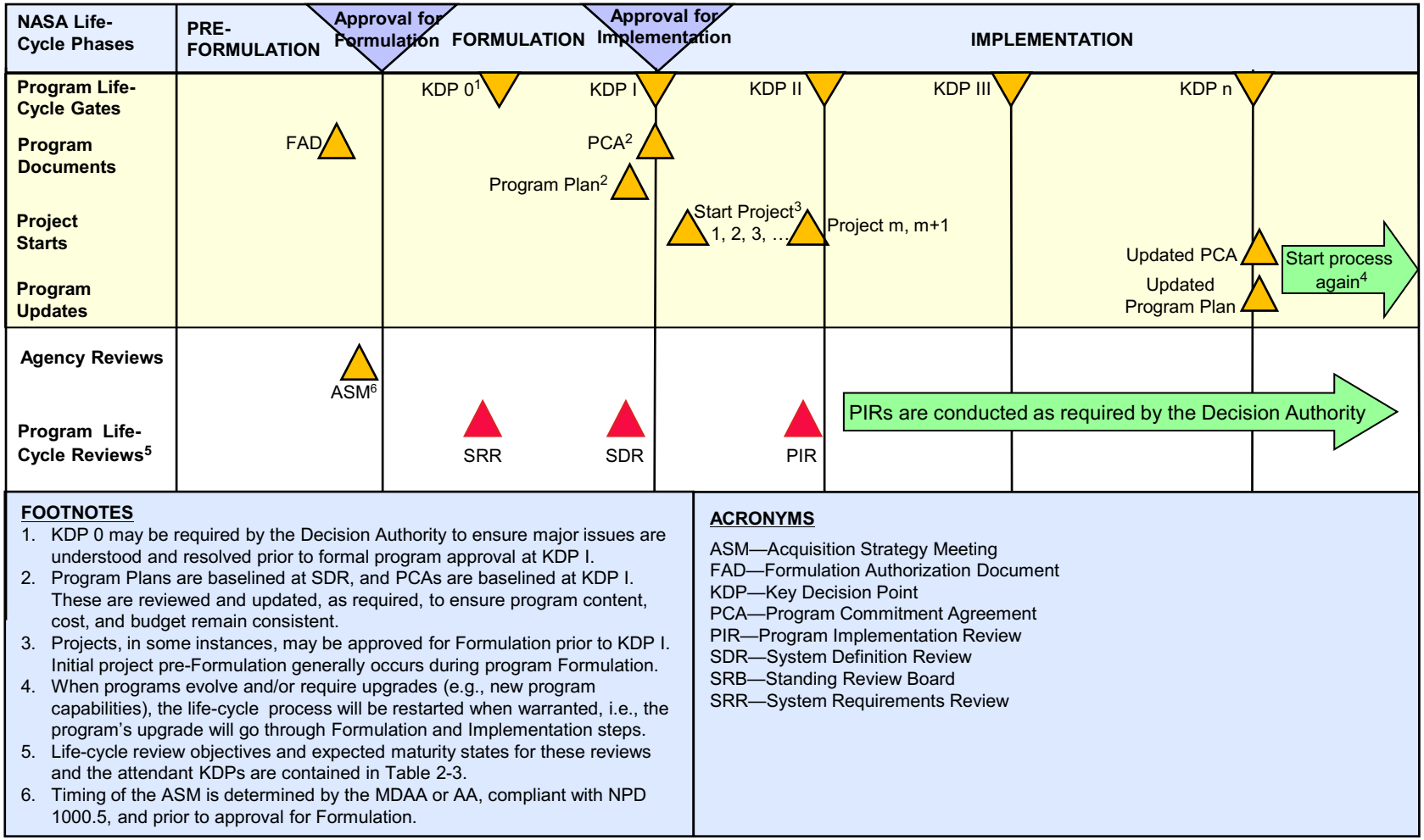
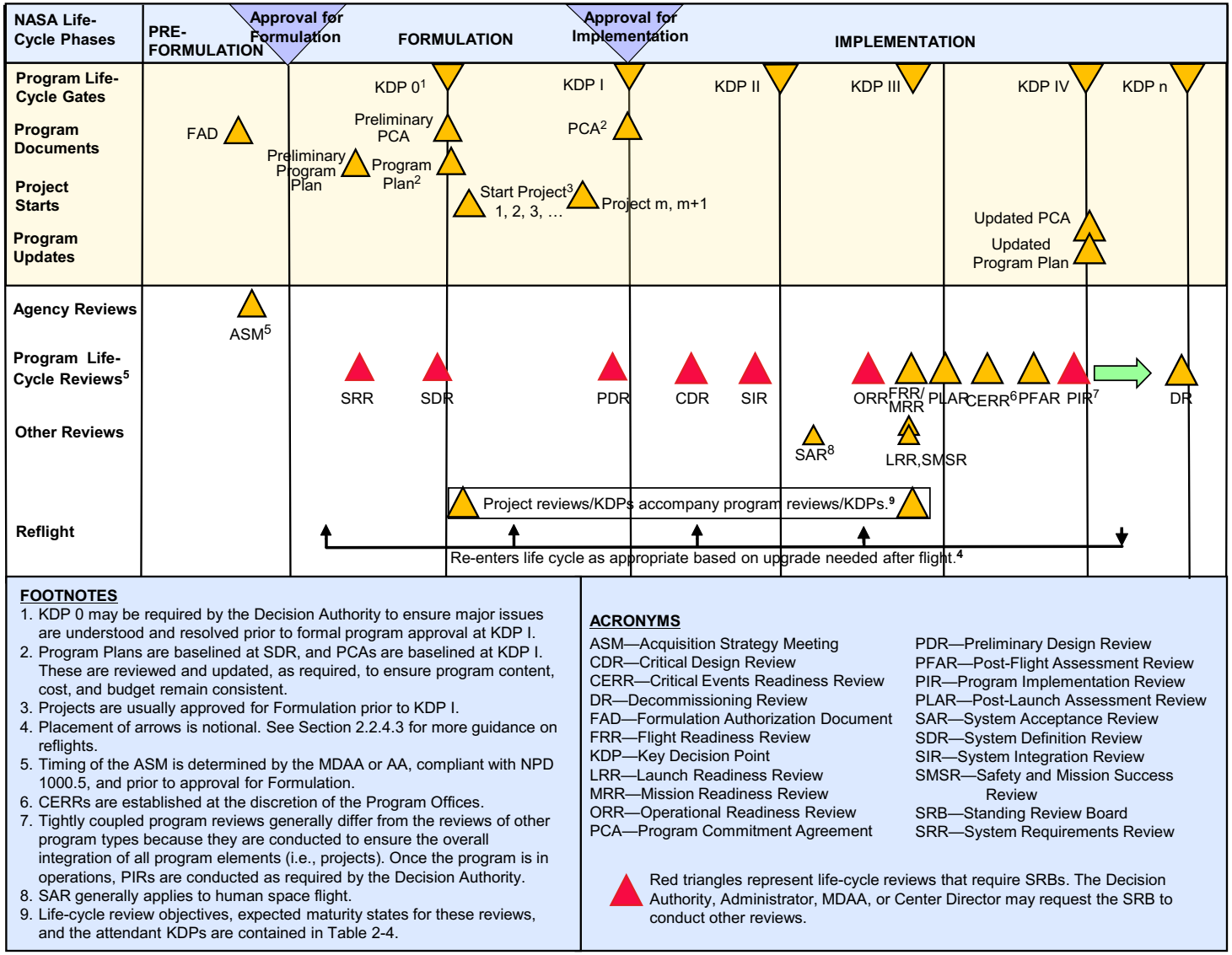


Figure C-2 NASA Uncoupled and Loosely Coupled Program Life Cycle

(Taken from NPR 7120.5F, Figure 2-2)



FOOTNOTES

1. KDP 0 may be required by the Decision Authority to ensure major issues are understood and resolved prior to formal program approval at KDP I.
2. Program Plans are baselined at SDR, and PCAs are baselined at KDP I. These are reviewed and updated, as required, to ensure program content, cost, and budget remain consistent.
3. Projects are usually approved for Formulation prior to KDP I.
4. Placement of arrows is notional. See Section 2.2.4.3 for more guidance on reflights.
5. Timing of the ASM is determined by the MDAA or AA, compliant with NPD 1000.5, and prior to approval for Formulation.
6. CERRs are established at the discretion of the Program Offices.
7. Tightly coupled program reviews generally differ from the reviews of other program types because they are conducted to ensure the overall integration of all program elements (i.e., projects). Once the program is in operations, PIRs are conducted as required by the Decision Authority.
8. SAR generally applies to human space flight.
9. Life-cycle review objectives, expected maturity states for these reviews, and the attendant KDPs are contained in Table 2-4.

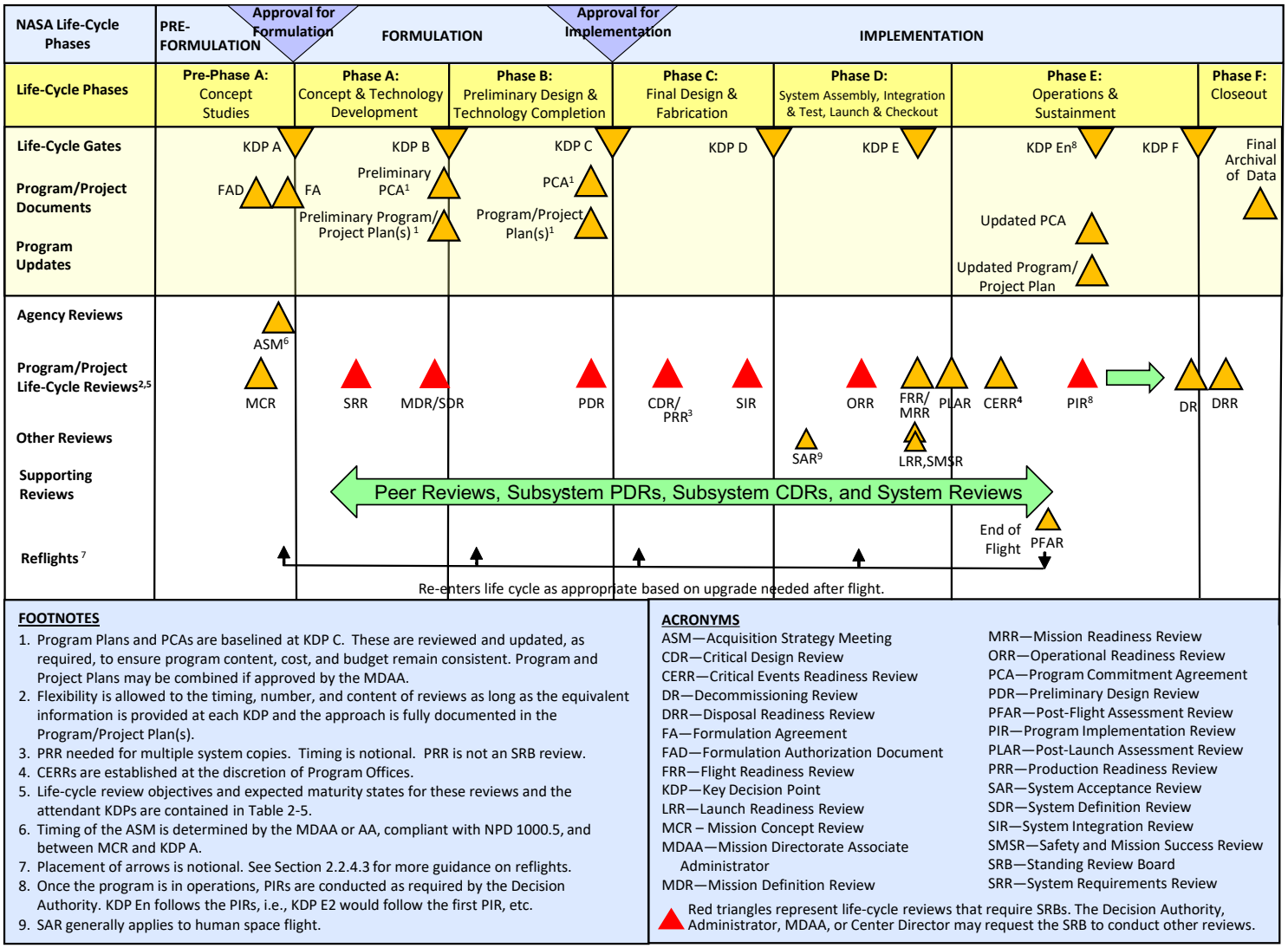
ACRONYMS

ASM—Acquisition Strategy Meeting
CDR—Critical Design Review
CERR—Critical Events Readiness Review
DR—Decommissioning Review
FAD—Formulation Authorization Document
FRR—Flight Readiness Review
KDP—Key Decision Point
LRR—Launch Readiness Review
MRR—Mission Readiness Review
ORR—Operational Readiness Review
PCA—Program Commitment Agreement
PDR—Preliminary Design Review
PFAR—Post-Flight Assessment Review
PIR—Program Implementation Review
PLAR—Post-Launch Assessment Review
SAR—System Acceptance Review
SDR—System Definition Review
SIR—System Integration Review
SMSR—Safety and Mission Success Review
SRB—Standing Review Board
SRR—System Requirements Review

Red triangles represent life-cycle reviews that require SRBs. The Decision Authority, Administrator, MDAA, or Center Director may request the SRB to conduct other reviews.

Figure C-3 NASA Tightly Coupled Program Life Cycle

(Taken from NPR 7120.5F, Figure 2-3)



FOOTNOTES

1. Program Plans and PCAs are baselined at KDP C. These are reviewed and updated, as required, to ensure program content, cost, and budget remain consistent. Program and Project Plans may be combined if approved by the MDAA.
2. Flexibility is allowed to the timing, number, and content of reviews as long as the equivalent information is provided at each KDP and the approach is fully documented in the Program/Project Plan(s).
3. PRR needed for multiple system copies. Timing is notional. PRR is not an SRB review.
4. CERRs are established at the discretion of Program Offices.
5. Life-cycle review objectives and expected maturity states for these reviews and the attendant KDPs are contained in Table 2-5.
6. Timing of the ASM is determined by the MDAA or AA, compliant with NPD 1000.5, and between MCR and KDP A.
7. Placement of arrows is notional. See Section 2.2.4.3 for more guidance on reflights.
8. Once the program is in operations, PIRs are conducted as required by the Decision Authority. KDP En follows the PIRs, i.e., KDP E2 would follow the first PIR, etc.
9. SAR generally applies to human space flight.

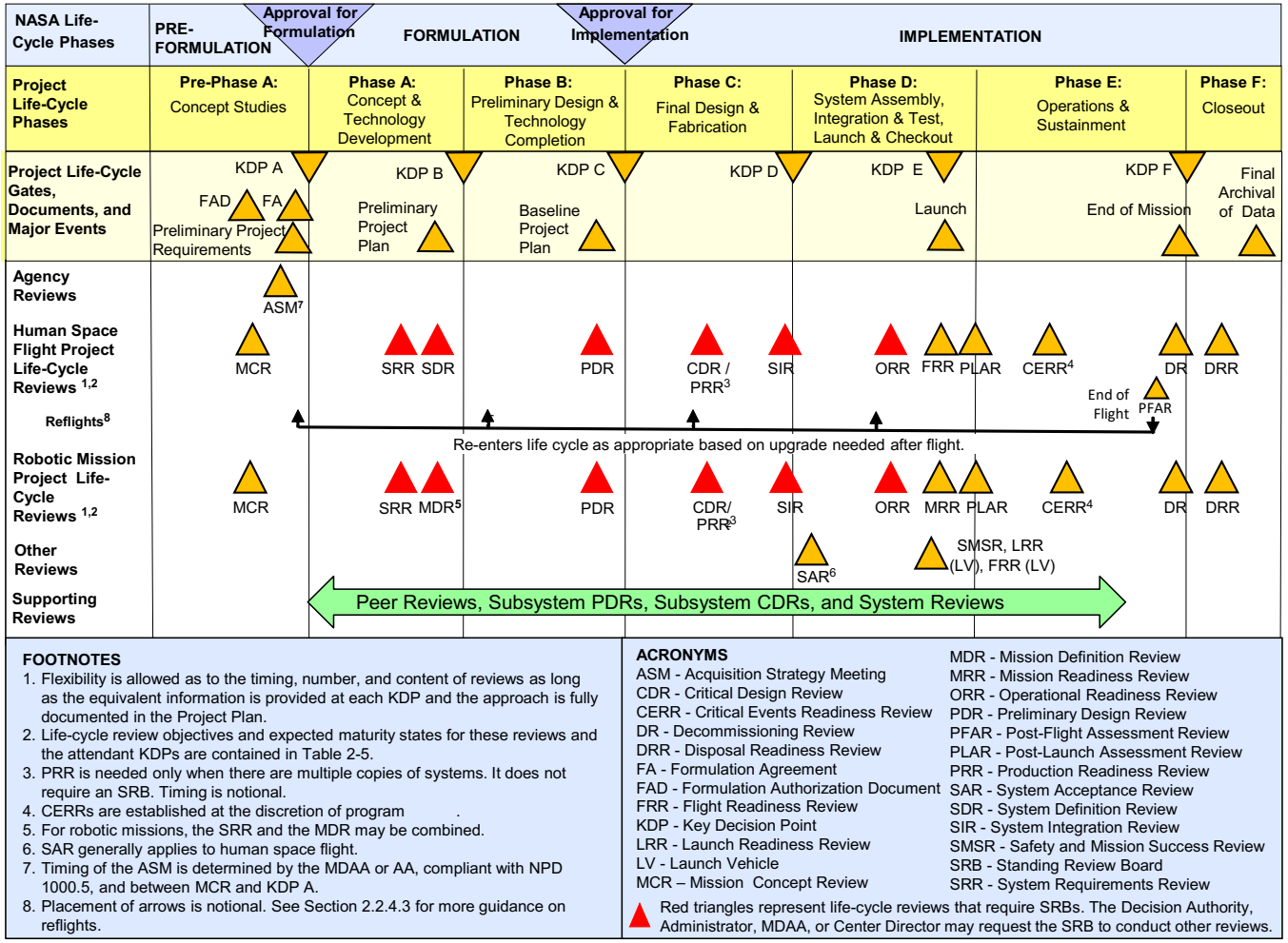
ACRONYMS

ASM—Acquisition Strategy Meeting
CDR—Critical Design Review
CERR—Critical Events Readiness Review
DR—Decommissioning Review
DRR—Disposal Readiness Review
FA—Formulation Agreement
FAD—Formulation Authorization Document
FRR—Flight Readiness Review
KDP—Key Decision Point
LRR—Launch Readiness Review
MCR – Mission Concept Review
MDAA—Mission Directorate Associate Administrator
MDR—Mission Definition Review
MRR—Mission Readiness Review
ORR—Operational Readiness Review
PCA—Program Commitment Agreement
PDR—Preliminary Design Review
PFAR—Post-Flight Assessment Review
PIR—Program Implementation Review
PLAR—Post-Launch Assessment Review
PRR—Production Readiness Review
SAR—System Acceptance Review
SDR—System Definition Review
SIR—System Integration Review
SMSR—Safety and Mission Success Review
SRB—Standing Review Board
SRR—System Requirements Review

▲ Red triangles represent life-cycle reviews that require SRBs. The Decision Authority, Administrator, MDAA, or Center Director may request the SRB to conduct other reviews.

Figure C-4 NASA Single-Project Program Life Cycle

(Taken from NPR 7120.5F, Figure 2-4)



FOOTNOTES

1. Flexibility is allowed as to the timing, number, and content of reviews as long as the equivalent information is provided at each KDP and the approach is fully documented in the Project Plan.
2. Life-cycle review objectives and expected maturity states for these reviews and the attendant KDPs are contained in Table 2-5.
3. PRR is needed only when there are multiple copies of systems. It does not require an SRB. Timing is notional.
4. CERRs are established at the discretion of program .
5. For robotic missions, the SRR and the MDR may be combined.
6. SAR generally applies to human space flight.
7. Timing of the ASM is determined by the MDAA or AA, compliant with NPD 1000.5, and between MCR and KDP A.
8. Placement of arrows is notional. See Section 2.2.4.3 for more guidance on reflights.

ACRONYMS

ASM - Acquisition Strategy Meeting
CDR - Critical Design Review
CERR - Critical Events Readiness Review
DR - Decommissioning Review
DRR - Disposal Readiness Review
FA - Formulation Agreement
FAD - Formulation Authorization Document
FRR - Flight Readiness Review
KDP - Key Decision Point
LRR - Launch Readiness Review
LV - Launch Vehicle
MCR – Mission Concept Review
MDR - Mission Definition Review
MRR - Mission Readiness Review
ORR - Operational Readiness Review
PDR - Preliminary Design Review
PFAR - Post-Flight Assessment Review
PLAR - Post-Launch Assessment Review
PRR - Production Readiness Review
SAR - System Acceptance Review
SDR - System Definition Review
SIR - System Integration Review
SMSR - Safety and Mission Success Review
SRB - Standing Review Board
SRR - System Requirements Review

Red triangles represent life-cycle reviews that require SRBs. The Decision Authority, Administrator, MDAA, or Center Director may request the SRB to conduct other reviews.

Figure C-5 NASA Space Flight Project Life Cycle

(Taken from NPR 7120.5F, Figure 2-5)

Appendix D. Types of Reviews

There are several distinct types of reviews conducted by programs and projects including life-cycle reviews (LCRs), key decision points (KDPs), independent reviews, internal reviews, peer reviews, and other special reviews. The sections below provide summary information on these reviews. For additional information see NPR 7120.5 and the NASA Space Flight Program and Project Management Handbook.

D.1 Life-Cycle Reviews

LCRs provide a periodic assessment of a program or project's technical and programmatic status and health at key points in the life cycle. Certain LCRs provide the basis for the Decision Authorities to approve or disapprove the transition of a program or project to the next life-cycle phase. Refer to Figure C-2 to C-5 for examples of LCRs and where they occur in the life cycle. Table D-1 provides a general description of the objectives of LCRs for projects and single-project programs. (For objectives for uncoupled and loosely coupled programs and tightly coupled programs, see NPR 7120.5F, Tables 2-3 and 2-4, respectively.)

Table D-1 Life-Cycle Review Objectives for Projects and Single-Project Programs

(Based on NPR 7120.5F, Table 2-5 Expected Maturity State Through the Life Cycle of Projects and Single-Project Programs)

Life-Cycle Review	Objectives
Mission Concept Review (MCR)	To evaluate the feasibility of the proposed mission concept(s) and its fulfillment of the program's needs and objectives. To determine if the concept's maturity and associated planning are enough to begin the concept and technology development phase (e.g., Phase A for space flight projects).
System Requirements Review (SRR)	To evaluate whether the functional and performance requirements defined for the system are responsive to the program's requirements on the project and represent achievable capabilities.
Mission Definition Review (MDR) or System Definition Review (SDR)	To evaluate the credibility and responsiveness of the proposed mission/system architecture to the program requirements and constraints, including available resources. To determine whether the maturity of the project's mission/system definition and associated plans are sufficient to begin preliminary design phase (e.g., Phase B for space flight projects).
Preliminary Design Review (PDR)	To evaluate the completeness/consistency of the planning, technical, cost, and schedule baselines developed during Formulation. To assess compliance of the preliminary design with applicable requirements and to determine if the project is sufficiently mature to begin final design and fabrication (e.g., Phase C for space flight projects).
Critical Design Review (CDR)	To evaluate the integrity of the project design and its ability to meet mission requirements with appropriate margins and acceptable risk within defined project constraints, including available resources. To determine if the design is appropriately mature to continue with the fabrication phase.

Life-Cycle Review	Objectives
Production Readiness Review (PRR)	To evaluate the readiness of system developer(s) to produce the required number of systems within defined project constraints for projects developing multiple similar flight or ground support systems. To evaluate the degree to which the production plans meet the system's operational support requirements.
System Integration Review (SIR)	To evaluate the readiness of the project and associated supporting infrastructure to begin system assembly, integration, and test (AI&T); evaluate whether the remaining project development can be completed within available resources; and determine if the project is sufficiently mature to begin AI&T (e.g., Phase D for space flight projects).
Operational Readiness Review (ORR)	To evaluate the project's readiness to operate the flight system and associated ground system(s) in compliance with defined project requirements and constraints during the operations/sustainment phase of the project life cycle.
Mission Readiness Review (MRR) or Flight Readiness Review (FRR)	To evaluate the readiness of the project and all project and supporting systems for a safe and successful launch and flight/mission.
Decommissioning Review (DR)	To evaluate the project's readiness to conduct closeout activities including final delivery of all remaining project deliverables and safe decommissioning of space flight systems and other project assets. To determine if the project is appropriately prepared to begin the closeout phase (e.g., Phase F for space flight projects).
Disposal Readiness Review (DRR)	To evaluate the project's readiness and flight system for execution of the spacecraft disposal event.

For LCR entrance and success criteria guidelines, refer to Appendix G of *NPR 7123.1, NASA Systems Engineering Processes and Requirements*.

To enhance comprehension and mitigate confusion with internal and external stakeholders, NASA's general policy/practice is for NASA programs and projects to maintain conformance with the names of the reviews consistent with policy (e.g., NPR 7120.5 KDP) and not enable unique renames (e.g., eKDP). However, when procuring services from a commercial company, the company names of LCRs may vary; for example, a contractor organization may call a PDR a 30% review and a CDR a 90% review. Regardless of its name, the review must accomplish the objectives for the review.

In some cases, NASA programs and projects may substitute an equivalent action for one of the reviews. For example, for competed projects, the concepts for how a proposer might accomplish the project are usually developed by the proposer and provided as part of the proposal to NASA. In many cases, the NASA process of reviewing the proposed concepts, selecting the winning proposal(s), and follow-on negotiations may fulfill all the expectations of a project-level MCR. In such cases, "credit" can be taken for accomplishing the project-level MCR and the project can move directly to the next phase. In some cases, especially for projects with a low tolerance for risk, the program may choose to hold a formal MCR after final negotiations with the winning

proposer are completed and the final concepts are refined. This type of planning needs to occur prior to and after contracts or agreements are awarded.

LCR formality needs to be consistent with the risk tolerance, size, and complexity of the program or project. Complex programs and projects with low tolerance for risk may need to have very formal LCRs with a large review board consisting of several key stakeholders and cross-Agency and independent reviewers providing formal comments and recommendations that need to be reviewed, dispositioned, and closed. Smaller programs or projects with a high tolerance for risk may only need reviews with a few key stakeholders, review comments gathered through emails or comment forms, and action items recorded to track the dispositions. If an LCR accomplishes the expectations for that type of review, "credit" can be taken for the review. Program and project managers need to identify and document the type and formality of the LCRs needed to accomplish the work as part of their planning activities. Certain changes to LCRs require tailoring NPR 7120.5 requirements for LCRs. For information on tailoring see NPR 7120.5, Appendix C, and the Agency Tailoring Website at https://appel.nasa.gov/npr-7120-5-tailoring-resources.

D.2 Key Decision Points

KDPs are reviews at which the Decision Authority determines the readiness of a program or project to progress to the next phase of the life cycle. Refer to Figures C-2, C-3, C-4, and C-5 for examples of KDPs and where they occur in the program and project life cycles. Table D-2 describes the overall expected maturity state for projects and single-project programs at key KDPs. (For maturity states for uncoupled and loosely coupled programs and tightly coupled programs, see NPR 7120.5F, Tables 2-3 and 2-4, respectively.)

Table D-2 Key Decision Point Expected Maturity State for Projects and Single-Project Programs

(Based on NPR 7120.5F, Table 2-5 Expected Maturity State Through the Life Cycle of Projects and Single-Project Programs)

KDP Review	Expected Maturity State
KDP A	Project addresses critical NASA need. Proposed mission concept(s) is feasible. Associated planning is sufficiently mature to begin Phase A, and the mission can be achieved as conceived.
KDP B	Proposed mission/system architecture is credible and responsive to program requirements and constraints, including resources. The maturity of the project's mission/system definition and associated plans is sufficient to begin Phase B, and the mission can be achieved within available resources with acceptable risk.
KDP C	Project's planning, technical, cost, and schedule baselines developed during Formulation are complete and consistent. The preliminary design complies with its requirements. The project is sufficiently mature to begin Phase C, and the cost and schedule are adequate to enable mission success with acceptable risk.

KDP D	Project is still on plan. The risk is commensurate with the project's payload classification, and the project is ready for assembly, integration, and test (AI&T) with acceptable risk within its ABC.
KDP E	Project and all supporting systems are ready for safe, successful launch and early operations with acceptable risk within ABC.
KDP F	Project decommissioning is consistent with program objectives and the project is ready for safe decommissioning of its assets and closeout of activities, including final delivery of all remaining project deliverables and disposal of its assets.

For additional information on KDPs, see NPR 7120.5 and the NASA Space Flight Program and Project Management Handbook.

Appendix E. Types of Contracts and Agreements

E.1 Overview

The information reflected in this appendix is based on a program/project perspective and analyses. Program/Project Managers considering utilizing commercial partnership approach should consult the Office of Procurement and Office of General Counsel to obtain advice on best and most current acquisition/agreement approaches, and associated laws that best suit the

There are many strategies available to NASA for the acquisition of goods and services to meet the Agency's strategic goals. Some of the key authorizations include:

- The Federal Acquisition Regulations (FAR) – Title 48, Code of Federal Regulations (CFR)
- The NASA FAR Supplement (NFS) – Chapter 18 of Title 48, CFR
- The National Aeronautics and Space Act of 1958

The CFR is the codification of the general and permanent rules published in the Federal Register by the departments and agencies of the Federal Government. It is divided into fifty titles that represent broad areas subject to Federal regulation. Figure E-1 depicts the breakdown of the CFR.

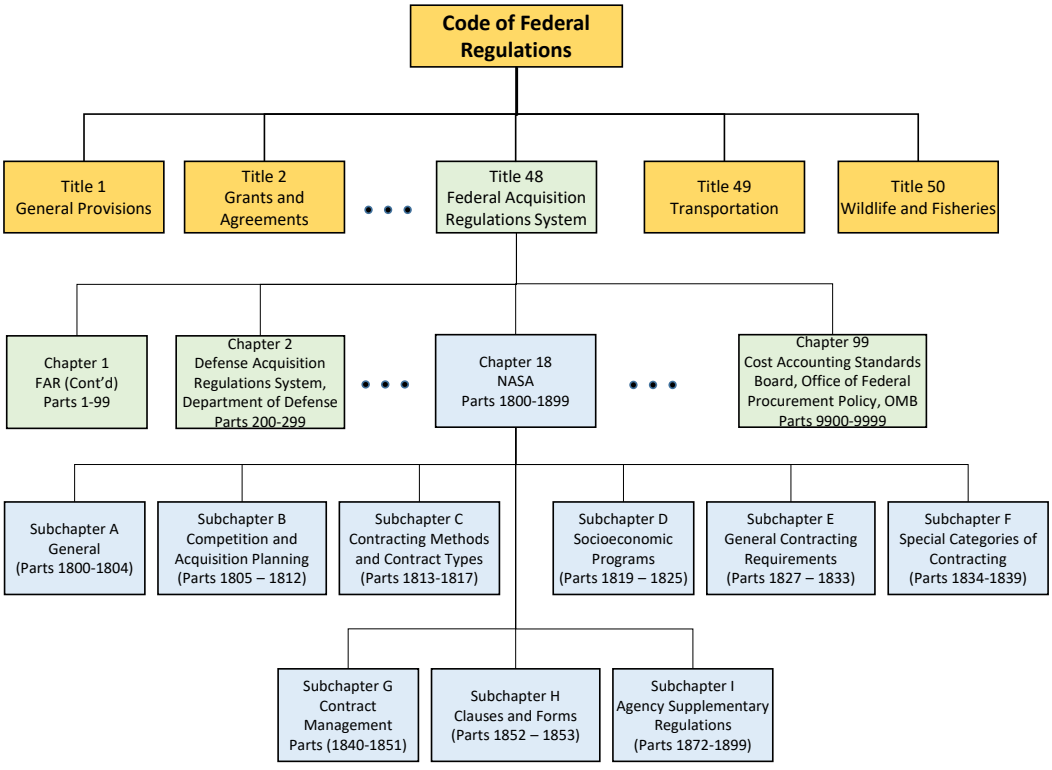


Figure E-1 U.S. Code of Federal Regulations

As can be seen in Figure E-1, Title 48 of the CFR is the FAR system that identifies the requirements for use by government agencies for the acquisition of goods and services when using appropriated funds. Chapter 18 of the FAR is the NASA FAR Supplement (NFS), which identifies the requirements specifically for NASA.

FAR-based contracts are required when the principal purpose of the activity is to acquire (by purchase, lease, or barter) property or services for the direct benefit or use of the U.S. Government. These contracts must comply with the FAR and the Armed Services Procurement Act (10 U.S.C Section 2302).

E.2 FAR-Based Contracts

Some of the key FAR-based contract types used by NASA are FAR part 12 (Commercial Items), FAR part 15 (Contracting by Negotiation), and FAR part 35 (Research and Development).

FAR part 12 is used to acquire any item, good or service, other than real property, that is of a type customarily used by the public or by non-governmental entities for purposes other than governmental purposes, and has been offered for sale, lease, or license to the public. This part prescribes policies and procedures unique to the acquisition of commercial products, including commercial components and commercial services.

FAR part 15 prescribes policies and procedures governing competitive and noncompetitive negotiated acquisitions. A contract awarded using other than sealed bidding procedures is a negotiated contract. FAR part 15 provides the rules and regulations for source selection, solicitation and receipt of proposals, contract pricing, proposal analysis, price negotiations, documentation, unsolicited proposals, notifications, and protests. These contracts are negotiated for "best value" rather than awarding to the lowest-price offeror. The government issues a Request for Proposal (RFP) with specific information on what is desired, requirements that must be met, and other information that characterizes what is desired. Private or public organizations that would like to be considered for the work submit a proposal on how they would accomplish the product or service and meet the requirements. The proposals are received by the government, evaluated to a pre-determined set of criteria that may include cost/price, past performance, schedule, technical performance, and other factors. The proposals are ranked as the best value and one or more are selected for an award.

FAR part 35 covers policies and procedures of special application to research and development (R&D) contracting. The primary purpose of contracted R&D programs is to advance scientific and technical knowledge and apply that knowledge to the extent necessary to achieve Agency and national goals. Unlike contracts for supplies and services, most R&D contracts are directed toward objectives for which the work or methods cannot be precisely described in advance. Broad Area Announcements (BAAs) fall under FAR part 35. A BAA is a notice from the government that requests basic or applied research proposals from private firms concerning certain areas of interest to the government. These are used for advancing the state-of-the-art or increasing knowledge and understanding rather than focusing on a specific system or hardware solution. Proposals submitted in response to FAR part 15 RFPs are intended to accomplish the same thing and are therefore compared against each other, and a winner is selected based on best value. In contrast, proposals submitted in response to FAR part 35 BAAs contain stand-alone

unique solutions and are evaluated independently for technical value, program relevance, and each offeror's capability and not compared to each other.

E.3 Non-FAR-Based Instruments

Other acquisition methods are available to NASA in addition to those described in the FAR. The National Aeronautics and Space Act of 1958 authorizes NASA "*to enter into and perform such contracts, leases, cooperative agreements, or other transactions as may be necessary in the conduct of its work…".* In addition to the FAR-based mechanisms, this allows NASA to enter into public-private partnerships, which represent collaborations between NASA and private industry where both parties realize a benefit from the result of a shared endeavor. Under the public-private partnership umbrella, several types of partnerships are available depending on the objectives and circumstances of the partnership:

- **Reimbursable** – Agreements where NASA's costs associated with the activity are reimbursed by the agreement partner (in full or in part). This type of agreement is made when NASA has unique goods, services, or facilities that are not currently being fully used and can be made available to others on a noninterference basis.

- **Non reimbursable** – Agreements that involve NASA and one or more partners working together on mutually beneficial activities that further the Agency's missions. Each partner bears the cost of its participation, and no funds are exchanged between the parties.

- **Funded agreements** – Agreements in which NASA transfers appropriated funds to a domestic partner to accomplish an Agency objective where the benefits to NASA may not be direct. Funded agreements may be used when the Agency cannot accomplish its objectives using a procurement contract, grant, or cooperative agreement, and only after full and open competition. Funded agreements have been used to facilitate commercial development of space transportation, communications systems, space-related technologies, aviation technologies, low-Earth orbit platforms, and for other uses. NASA does not use funded agreements for specific NASA requirements or to directly obtain hardware or services.

- **Unfunded agreements** – Agreements in which the Agency provides goods, services, facilities, or equipment on a no-exchange-of-funds basis to a domestic partner to accomplish an Agency objective where there is no direct benefit to NASA. NASA will enter into unfunded agreements only after full and open competition.

Two key types of public-private partnership agreements are Space Act Agreements (SAA) and Cooperative Research and Development Agreements (CRADA). Arrangements concluded under the "Other Transaction Authority" (OTA) of the Space Act are commonly referred to as SAAs. A CRADA is any agreement between NASA laboratories and one or more non-Federal parties under which NASA, through its laboratories, provides personnel, services, facilities, equipment, intellectual property, or other resources with or without reimbursement (but not funds to non-Federal parties). A CRADA does not include a procurement contract or cooperative agreement. CRADA agreements are not addressed in this document.

E.4 Usage

Table E-1 summarizes the purpose, terms and conditions, flexibility, and payment for the major types of contracts and agreements used by NASA.

Table E-1 Procurement Mechanism Summary

(Adapted from HEOMD-00-02 HEOMD Formulation Guide)

	FAR part 12	FAR part 15	FAR part 35	PPP	SAA
Purpose	Acquire goods or services for the direct benefit of NASA as commercial Items.	Acquire goods or services for the direct benefit or use of NASA.	Advance scientific or technical knowledge. Objectives known; work /methods not precisely described in advance.	Supports expanding mutually beneficial capabilities and opportunities in space.	NASA OTA. Funds and facilitates commercial development of technologies and capabilities relevant to NASA objectives
Terms & Conditions	FAR-based. Profit/Fee negotiable.	FAR-based. Cost-reimbursable or fixed price. Incentives are negotiable.	Allows BAAs (FAR-based, typically CR, but can be FP).	Typically, FP. Subject to FAR. Reimbursable or non-reimbursable.	FAR does not apply. Terms from Funded SAA (FSAA) template can be tailored.
Flexibility	Less reporting, often FFP. Cost Accounting Standards (CAS) not applicable. Fewer FAR clauses. Flexible IP rights.	Significant emphasis placed on delivery of results, product, or performance; frequent reporting requirements.	Work can be pursued with reasonable flexibility and minimum administrative burden.	Flexible IP rights. Data Rights/Patent Rights may be granted if both commercial and Government usage is demonstrated.	Flexible IP/data rights, liability, resource contribution, reporting. Not subject to CAS. Very limited protest options.
Payment	Based on milestone events. Frequency is flexible.	Based on milestone events. Frequency is flexible.	Based on milestone events. Frequency is flexible.	Milestones.	Based on milestone events. Frequency is flexible.

CR=Cost Reimbursement; FFP=Firm Fixed Price; FP=Fixed Price; IP=Intellectual Property; IRAD=Internal Research and Development; PPP=Public-Private Partnership

Tables E-2 and E-3 provide pros and cons for the major FAR-based and non-FAR-based contracts and agreements, respectively.

Table E-2 Procurement Mechanism Pro/Con (FAR-Based)

(Adapted from HEOMD-00-02 HEOMD Formulation Guide)

FAR part 12		FAR part 15		FAR part 35	
PRO	CON	PRO	CON	PRO	CON
Availability of commercial market pricing data reduces administrative cost and procurement lead time	Inability to tailor to unique government requirements reduces flexibility for complex acquisitions	Ability to uniquely negotiate terms and conditions, and pricing arrangements enables improved mission outcomes	Regimented processes traditionally have a longer procurement lead time to award and do not lend to quick delivery of product or service	Increases knowledge in areas of strategic importance and technical capability to programs	Limitations on use of BAAs increases burden on government to transition capability to acquisition programs
Ability to use streamlined procedures for commercial technologies provides opportunity for acquisition programs to deliver capability quickly	Limitation to firm-fixed-price (FFP), or time-and-materials (T&M) pricing arrangements may not be appropriate or suitable for complex requirements	Use of competitive range or multi-step process provides time saving mechanism to negotiate with only highest rated vendor offers	Selection of appropriate terms and conditions, including data rights increases burden on Government to ensure terms are explicitly set forth in the contract	Streamlined evaluation process based on technical merit increases flexibility to select innovative capability solutions	Intellectual property and data rights increase burden on government to ensure rights are explicitly set forth in the contract before any transition to acquisition programs
Streamlined commercial procedures and terms and conditions reduce procurement lead time	Standard commercial rights and licenses increase burden on government to ensure specialized rights are explicitly set	Use of change orders enables flexibility to adjust to urgent or unforeseen circumstances	Procedures require labor intensive and government resource support increasing administrative burden and costs	Allows partnerships and cost-sharing	Standard commercial rights and licenses increase burden on government to ensure any specialized rights are explicitly set

FAR part 12		FAR part 15		FAR part 35	
	forth in the contract				forth in the contract
Allows partnerships and cost-sharing	May require integration of commercial technologies into larger program technical baseline	Provides opportunity to design and negotiate solutions that meet mission requirements			

E.5 Contract Types

Table E-3 summarizes the different types of contracts. For additional information on each type, refer to FAR part 16 and NASA FAR Supplement (NFS), part 1816 Types of Contracts.

Table E-3 Contract Types

Contract Type	Description

Fixed-Price	• NASA agrees to pay a specific price for the successful delivery of the desired capability.
	• Favored in situations when a clear scope and a defined schedule is negotiated and accepted.
	  • Payments are often tied to the contractor's successful completion of pre-arranged milestones.
	• Uses change requests for changes to be made in scope or any other terms and conditions.
	  • There are provisions for economic price adjustments whereas a Firm Fixed-Price contract is not subject to adjustments based on the contractor's cost experience in fulfilling the contract.

Cost-Reimbursement	• NASA reimburses the contractor's actual costs. • Added to that is a fee that typically represents the contractor's profit. • Cost-reimbursable contracts often contain incentive structures in which the contractor will receive a bonus payment or incentive if they meet or exceed a series of pre-determined target objectives, such as meeting a particular schedule or keeping the activity below a certain cost
Broad Agency Announcements (BAA)	• A solicitation method for Research and Development efforts that provides for full and open competition. • Established under FAR part 35 • Authorized for the acquisition of basic and applied research not related to the development of a specific system or hardware procurement.

	• BAAs are appropriate when fulfilling requirements for scientific study and experimentation directed toward advancing the state-of-the-art, increasing knowledge, or understanding rather than focusing on a specific system or hardware solution
Indefinite Delivery Indefinite Quantity (IDIQ)	• Indefinite Delivery – used to acquire supplies and/or services when the exact times of future deliveries are not known at the time of contract award. • Indefinite Quantity – provides for an indefinite quantity, within stated limits, of supplies or services during a fixed period. • NASA issues individual delivery or task orders for the supplies and/or services as needed for a specified delivery date and quantity.
*Time and Materials	• Provides for acquiring supplies or services based on direct labor hours at specified fixed hourly rates and actual cost for materials.
*Labor-Hour	• A variation of the time-and-materials contract, differing only in that the contractor does not supply materials.
*Letter	• A letter contract is a written preliminary contractual instrument that authorizes the contractor to begin immediately manufacturing supplies or performing services. • May be used when (1) NASA's interests demand that the contractor be given a binding commitment so that work can start immediately and (2) negotiating a definitive contract is not possible in sufficient time to meet the requirement.

*This document does not discuss these contract types.

Figure E-2 shows how contract type selection affects the risks to the contractor and to NASA.

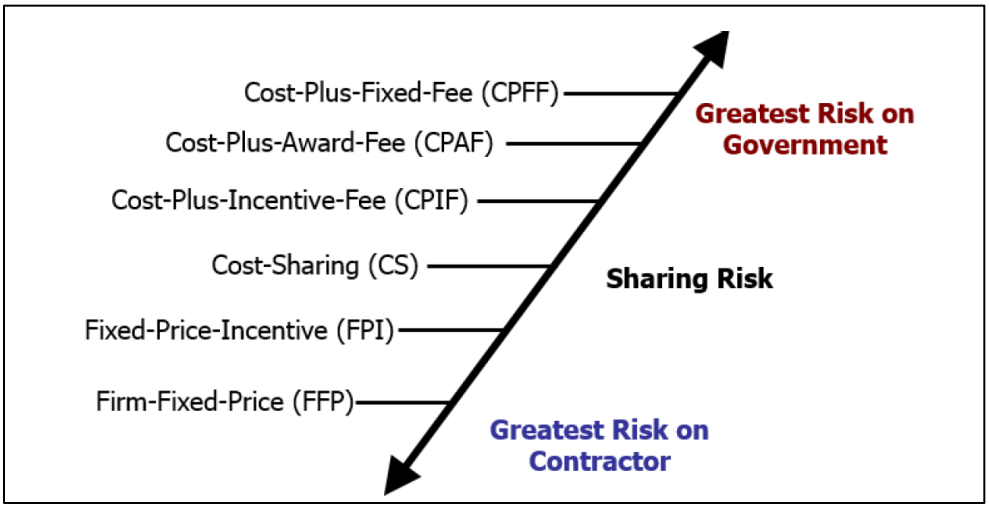


Figure E-2 Contract Type versus Cost Risk

(Taken from "Fixed Price and Risk Best Practices" presentation, November 2021)

Appendix F. Insight and Oversight Models

This document uses the following definitions:

- **Oversight** is the watchful and responsible care and management of the development, test, and operations efforts. This is accomplished through overseeing the performance of the provider's design, development, and test efforts and their ability to certify their system. The primary elements of oversight require government approval and/or direction.

- **Insight** is the capacity to discern the true nature of the project's efforts to design, develop, test, and operate the system. It is accomplished through penetration (via contract agreement) into the contractor's processes and their design, development, test, and operations to improve the probability of program success.

F.1 Oversight Models

Traditional NASA programs relied heavily on continuous government oversight with NASA making key decisions and providing directions to the prime contractors. As the commercial industrial base has become more experienced in the design and production of space systems, oversight decisions and directions can be targeted for key milestones and events using a discrete oversight model, allowing providers to perform the other activities within their own authority. These two oversight models are depicted in Figure F-1.

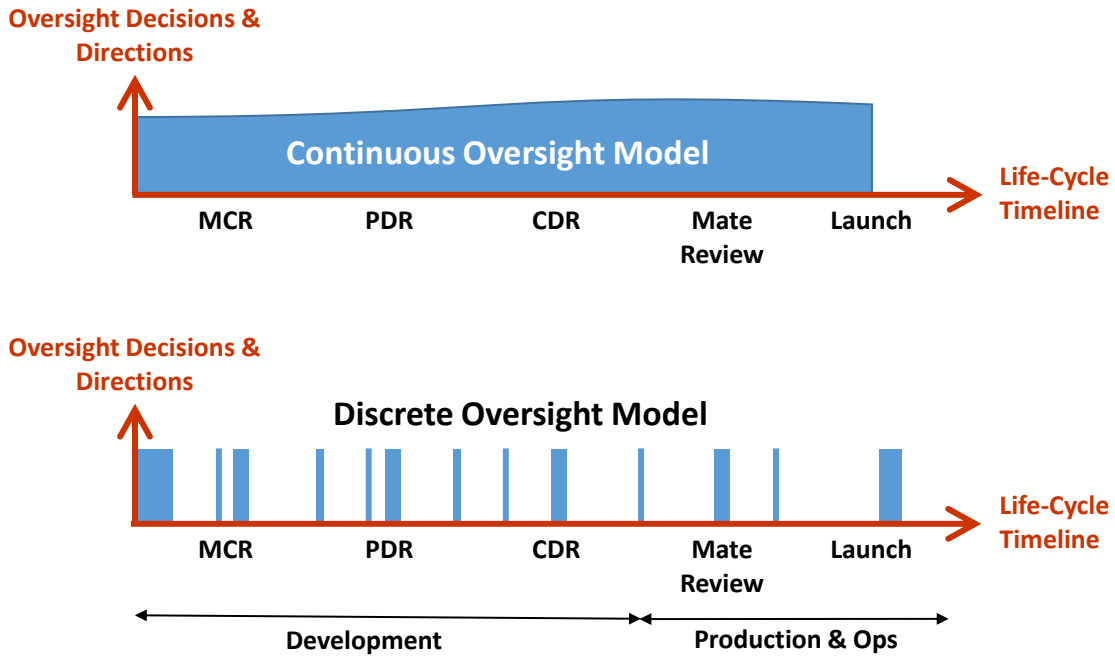


Figure F-1 Oversight Models

(Taken from the presentation "Commercial Crew Insight/Oversight Model Recommendations" by Frank H. Bauer presented at the Feb 2011 PM Challenge.)

As implied by the Discrete Oversight Model in Figure F-1, NASA oversight decisions and directions are performed only when necessary.

F.2 Insight Model

In contrast to the oversight models, NASA does not provide official decisions or directions to the provider during insight, but instead depends on the provider to make all decisions in the design, development, test, and/or operation of the system.

To gain confidence in the provided system so that it may be certified or approved for use, NASA gains insight into the provider's activities through technical engagement (Insight Teams). This engagement, as documented and agreed-to in the contract, may range from attending the provider's milestone reviews and providing suggestions and opinions (not directions) to the full-time presence of civil servants collocated with the contractor. These insight teams follow the design, development, test, and verification of the systems. More experts may be assigned to the more challenging high-risk areas and may be called to assist in problem resolution teams. Figure F-2 depicts an insight model that shows some level of sustaining insight with increased participation for problem resolutions.

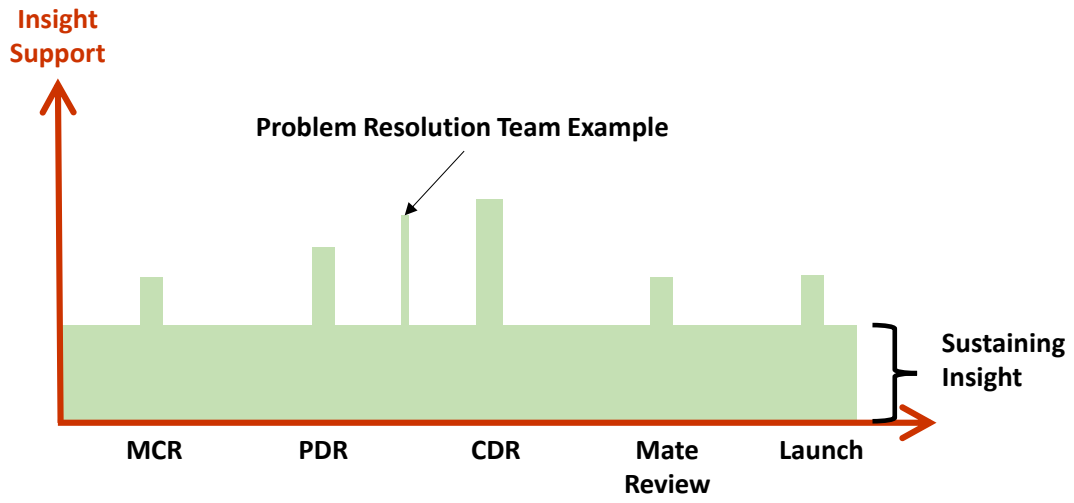


Figure F-2 Insight Model

(Taken from the presentation "Commercial Crew Insight/Oversight Model Recommendations" by Frank H. Bauer presented at the Feb 2011 PM Challenge.)

F.3 Developing an Appropriate Insight/Oversight Model

The key stakeholders of a program or project's insight/oversight model should be consulted in development of the model to ensure their buy-in. These stakeholders include, but are not limited to, program/project managers, system/subsystem managers, and Technical Authorities. Buy-in from key stakeholders is especially critical for programs and projects developing systems that require certification for flight and/or human rating.

Appendix G. References

Armed Services Procurement Act (10 United States Code (U.S.C.) Section 2302).

National Aeronautics and Space Act (51 U.S.C. § 20113(e)).

Federal Acquisition Regulation (FAR) (48 Code of Federal Regulations (CFR) Chapter 1).

NASA FAR Supplement (NFS) (48 CFR Chapter 18).

NAII 1000.1, Decision Framing Meeting (DFM and Pre-Acquisition Strategy Meeting Pre-ASM) Guide. (Accessible through front page of NPD 1000.5.)

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NAII 1050-1D, Space Act Agreements Guide. (Accessible through front page of NPD 1050.7.)

NAII 1050-3B, NASA Partnerships Guide. (Accessible through front page of NPD 1050.7.)

NPD 1000.5, Policy for NASA Acquisition.

NPD 1001.0, NASA Strategic Plan.

NPD 1050.7, Authority to Enter into Partnership Agreements.

NPR 7120.5, NASA Space Flight Program and Project Management Requirements.

NPR 7123.1, NASA Systems Engineering Processes and Requirements.

NPR 8000.4, Agency Risk Management Procedural Requirements.

NPR 8705.2, Human-Rating Requirements for Space Systems.

NASA/SP-2022-3705, NASA Space Flight Program and Project Management Handbook. https://ntrs.nasa.gov/citations/20220009501

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