National Aeronautics and Space Administration

Commercial Crew Program
John F. Kennedy Space Center

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NASA Commercial Crew Program
Crew Transportation System
Certification of Flight Readiness Plan

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Not Export Controlled

Record of Revision/Changes

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Rev B	Revised per CR-0417. Updates to CoFR process and readiness for mission return incorporating lessons learned from Demo-1, OFT, Demo-2, and Crew-1.	3/10/2021
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Basic	CR-0230: Baselines *Crew Transportation System Certification of Flight Readiness Plan*	11/17/2015

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1.0 Introduction

NASA Commercial Crew Program (CCP) Crew Transportation System (CTS) Certification of Flight Readiness (CoFR) is the authorization granted by the Agency that certifies the flight readiness of a Commercial Provider's CTS to conduct a flight test or mission to transport NASA Crew to and from the ISS. The Commercial Provider is responsible for developing and executing its plan for certifying the flight readiness of its CTS. The CCP with the International Space Station (ISS) Program must substantiate the Commercial Provider's CoFR assertion to ensure compliance with NASA requirements and NASA Crew safety.

NASA CCP CTS CoFR is the approval of the Commercial Provider's evidence that:

- The physical as-built CTS was produced, assembled, integrated, and tested within the approved production and operational constraints.
- The mission specific requirements are enveloped within the certified CTS capabilities.
- The CTS personnel are trained and certified to support the mission.
- All aspects of the CTS are ready for the mission.

1.1 Purpose

This NASA CCP CTS CoFR Plan defines the CCP CoFR process for NASA CCP activities and its interfaces with the related ISS Program CoFR processes. It also defines the CCP products and endorsement statements required to support the recommendation for CTS CoFR and describes the associated roles and responsibilities. This document also defines the requirements for the integrated packages required as part of the series of Program and Agency level reviews.

1.2 Scope

This plan is applicable to all NASA CCP organizations contributing to the recommendation of CTS CoFR by the CCP Manager. Each contributing organization will attest that the necessary tasks, activities, and data products associated with their endorsement statements have been accomplished. The ISS Program CoFR Endorsements and processes will be conducted per the *ISS Program Certification of Flight Readiness Process Document* (SSP 50108) that is standard for all ISS visiting vehicles, hardware/software (HW/SW), and operations.

The *NASA Crew Transportation System Certification Plan* (CCT-PLN-2000) will cover the CCP CTS Certification process and its interfaces with the ISS Program processes.

1.3 Precedence

Nothing in this document supersedes applicable laws and regulations, unless a specific exemption has been obtained.

1.4 Delegation of Authority

This document was prepared by NASA's CCP, and will be maintained in accordance with standards for CCP documentation. The CCP is responsible for assuring the definition, control, implementation, and verification of the requirements identified in this document.

2.0 Documents

2.1 Applicable Documents

Document Number	*Title*
CCT-PLN-1000	*Program Plan Commercial Crew Program*
CCT-PLN-1100	*Crew Transportation Plan*
CCT-DRM-1110	*Crew Transportation System Design Reference Missions*
CCT-PLN-1120	*Crew Transportation Technical Management Processes*
CCT-REQ-1130	*ISS Crew Transportation and Services Requirements*
CCT-STD-1140	*Crew Transportation Technical Standards and Design Evaluation*
CCT-STD-1150	*Crew Transportation Operations Standards*
CCT-PLN-2000	*NASA Crew Transportation System Certification Plan*
CCT-PLN-2110	*Commercial Crew Mission Implementation Plan*
CCT-PLN-3000	*Commercial Crew Program Surveillance Plan*
CCT-P-2101	*Commercial Crew Program Mission Management Team and Launch Support Team Charter*
CCT-P-4001	*Commercial Crew Program Control Board Charter and Process*
HEOMD-CSD-10001	*Commercial Crew Transportation System Certification requirements for NASA Low Earth Orbit Missions*
SharePoint File Plan	*Commercial Crew Program File Plan*
Memorandum of Agreement	*ISS Program/CCP MOA, 2013-09-06*
SSP 50108	*ISS Program Certification of Flight Readiness Process Document*
SSP 50808	*ISS to Commercial Orbital Transportation Services (COTS) Interface Requirements Document (IRD)*
SSP 50964	*Visiting Vehicle ISS Integration Plan*

2.2 Reference Documents

Document Number	*Title*
NPD 1000.0A	*NASA Governance and Strategic Management Handbook*
NPR 7120.5E	*NASA Space Flight Program and Project Management Requirements*
SSP 30599	*ISS Safety Review Process*

3.0 CTS Certification of Flight Readiness Philosophy

3.1 Shared Accountability Approach

NASA's CTS Certification of Flight Readiness (CoFR) is the flight-to-flight certification of four elements: programmatic, design, as-built, and operations (reference CCT-PLN-2000 Appendix C, for a description on the non-programmatic [aka Commercial Provider] elements) under a shared accountability model between NASA and the Commercial Provider. Under CoFR, the Commercial Provider is responsible for the flight-to-flight certification of any changes to the baseline CTS certification (programmatic, design, as-built, and operations) which supports their assertion of meeting the CTS requirements for the flight test or mission and NASA is responsible for approving the compliance evidence to NASA's requirements.

Figure 3.0: Mission Success

Under this shared accountability model, NASA CCP is accountable for assuring:

- Compliance to the ISS CTS requirements for the ISS Design Reference Mission (DRM) as documented in CCT-REQ-1130 and any mission specific requirements
- Compliance with the technical management processes requirements covered in CCT-PLN-1120
- Adherence to the technical standards in CCT-STD-1140 and the operational standards in CCT-STD-1150

NASA ISS Program is accountable for assuring:

- Compliance to the integrated technical requirements in CCT-REQ-1130 [i] requirements
- Compliance to the technical requirements in SSP 50808

Both the CCP and ISS Program will accomplish this through evaluation and approval of the Commercial Provider's compliance evidence and/or variances. After approval of the Commercial Provider's compliance evidence and any additional work associated with each of the CCP Offices CoFR Endorsements Statements (reference Appendix E) and applicable ISS Certification endorsements per SSP 50108, NASA CCP, jointly with the ISS Program and Technical Authority / Flight Operations Directorate management, will sign the CTS CoFR statements (reference Appendix D) and present a joint CoFR recommendation to the Agency. Upon Agency approval of the CTS CoFR, the Agency CoFR statements (reference Appendix C) will be signed and documented. Should the CTS fail to meet the requirements levied by the CCP and the ISS Program, NASA CTS CoFR will not be granted.

3.2 Shared Assurance Approach

CTS CoFR is not fundamentally different than any other NASA spaceflight program, as it consists of a combination of oversight and insight activities, as shown in Figure 3-2.1.

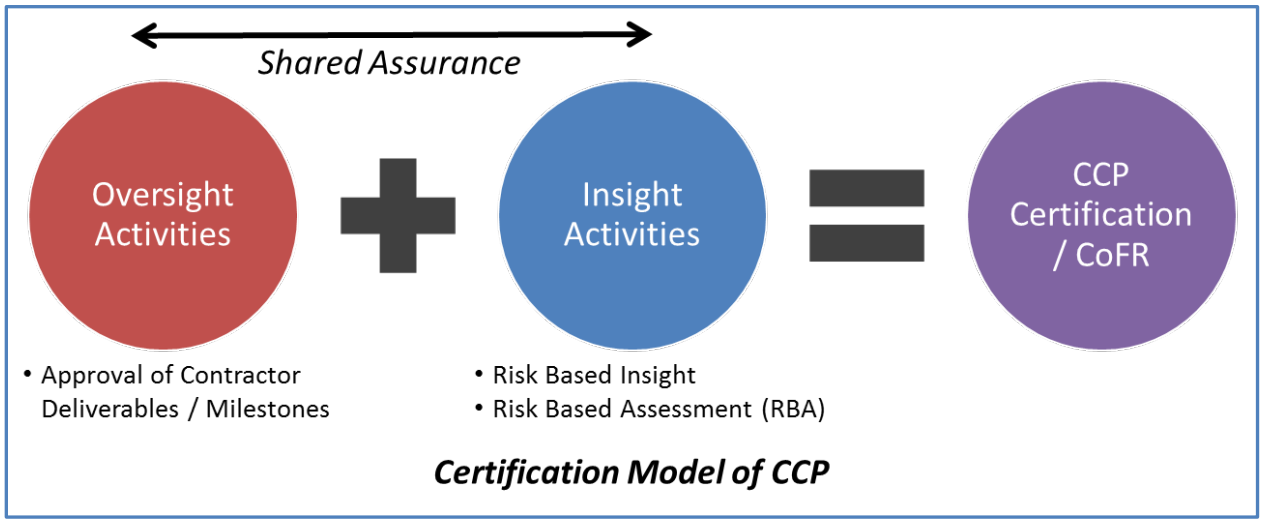


Figure 3-2.1: Certification and CoFR Model of CCP

To support the Commercial Crew CoFR Model, it is critically important for NASA to smartly engage in both oversight and insight activities related to flight-to-flight certification to minimize overlap of responsibility by utilizing the most knowledgeable skills throughout the Agency. This Shared Assurance approach is pictorialized in Figure 3-2.2.

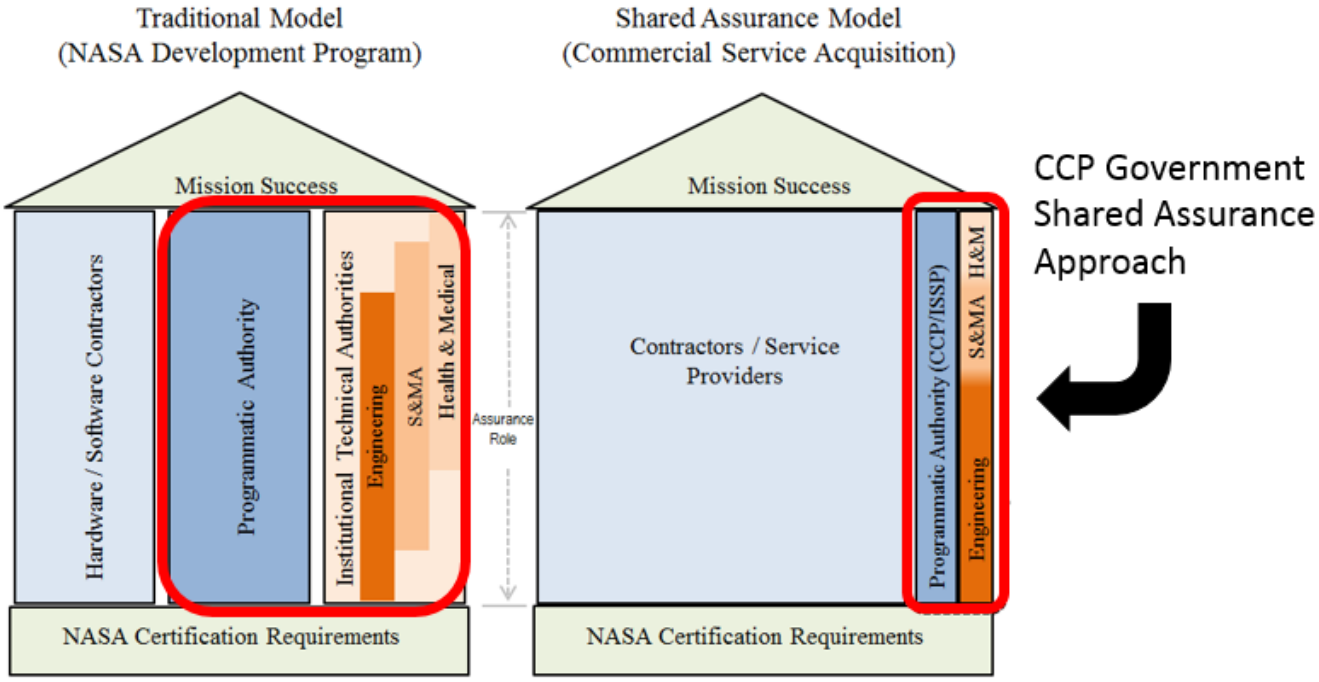


Figure 3-2.2: Shared Assurance Approach

3.2.1 Certification of Flight Readiness Oversight Approach

NASA implements the shared assurance model through the use of an office of primary responsibility (OPR) and stakeholders for all programmatic oversight activities. Oversight activities are defined as items over which NASA has the final approval authority and have been pre-declared through the CCtCap contract. These include review and approval of (or any revisions to) each Commercial Provider's:

- Management and Technical Plans
- Certification Plan
- V&V Plan
- Hazard Reports
- Verification Closure Notices (VCNs)
- Certification Data Package
- Post Flight Assessment Review

Details of the required content for each of the Commercial Provider products are contained within the specific CCtCap contract. In addition to the products, NASA oversight includes approval of both the Commercial Provider's interim milestones and CoFR reviews. The details of all milestones are contained within the specific CCtCap contract and a summary of key CoFR reviews is provided in Section 5.0.

VCNs are a prime example of how this oversight process works. All requirements have been assigned an OPR. Within each OPR, every requirement is then assigned to an individual designated as the requirement owner. Clear roles and responsibilities have also been established within the ISS Program for ISS Integration that include the designation of a Visiting Vehicle Integration Manager and various requirement owners within the ISS Program for each SSP 50808 requirement and ISS requirements in CCT-REQ-1130 [i] requirements.

Further, for all requirements, stakeholders have been designated from the CCP Offices, Technical Authorities, and matrixed Support Organizations. Stakeholders will participate in the review of intermediate products and requirement closures. Stakeholders may be matrixed support assigned to provide additional technical expertise, reviews, and risk assessments that will assist the CCP in generating and updating NASA assessments, closure reports, and closing the requirement once verifications are satisfied.

The requirement owner within the OPR and/or the ISS Program is responsible for managing all aspects of the requirement including closure of the verification for the requirement. This will be accomplished by presenting recommendations and rationale, along with any residual risk to the applicable ISS Program and/or CCP boards. The closure recommendation will be based on a culmination of insight gathered throughout Certification and may include reference to a NASA closure report as well as the Commercial Provider VCN. Note that the CCP and the ISS Program have established a Memorandum of Agreement (MOA), "*ISS Program/CCP MOA, 2013-09-06*" which includes details on the partnership managing the development of commercial systems for the ISS DRM.

A similar process to what was described for VCNs has been established for all other oversight activities.

3.2.2 Certification of Flight Readiness Insight Approach

3.2.2.1 Risk-Based Insight Philosophy and Approach

The CCP Offices are responsible for ensuring that the NASA insight engagement in the Commercial Provider CoFR reviews is balanced and commensurate with the assessed Commercial Provider risk. NASA

engages in Commercial Provider activities to gain insight into production of the flight articles and any changes to the Commercial Provider's design definition underlying the verification activities and to understand any changes to the boundaries and limitations of the system and its CoFR. NASA engagement enables the Commercial Provider and NASA to maintain a common basis of knowledge about the system and the background data from the verification closure activities.

The CCP Offices, with ISS Program participation, use the following guidelines to continuously assess the Commercial Provider management, design, productions, and operations factors for each of the individual functional disciplines of the CTS. On a case by case basis, the CCP Offices may identify other factors which may be considered before determining the NASA level of engagement.

Commercial Provider Management Risk Factors:

1. Is the Commercial Provider staff highly experienced in developing, operating, and maintaining the subject functional discipline of a crewed spaceflight system?
2. Does the Commercial Provider employ a robust peer review process?
3. Does the Commercial Provider employ a robust independent review process as evidenced by established meetings, outside expert participation, and cross discipline evaluations which ensures checks and balances?
4. Does the Commercial Provider's organizational structure provide healthy tension between organizational elements?
5. Are the Commercial Provider's standards, technical management processes, and operations mature, strong, and controlled?

Unique Design, As Built, and Operation Factors:

1. Is the system a low contributor to the total risk or is it a critical system that is a high contributor?
2. Is the design of the system mature and demonstrated reliable in the relevant environments or is it assessed as a low technology readiness level, first time use, or no experience with the design or operation?
3. Is the complexity of the system design and interfaces simple and well understood or are they complex or have high uncertainties?
4. Are the hazards associated with the system design low or high in terms of likelihood and consequence?
5. Are the system design margins high with low uncertainties, low with high uncertainties, or high with high uncertainties?
6. Has the design demonstrated high reliability with no prior failures or adverse trends or has the design exhibited unexpected failures in previous uses or in development?

This is not a static ranking of the system design risk but will be the starting point for setting the level of engagement by the CCP, as shown in Figure 3-2.2.1.

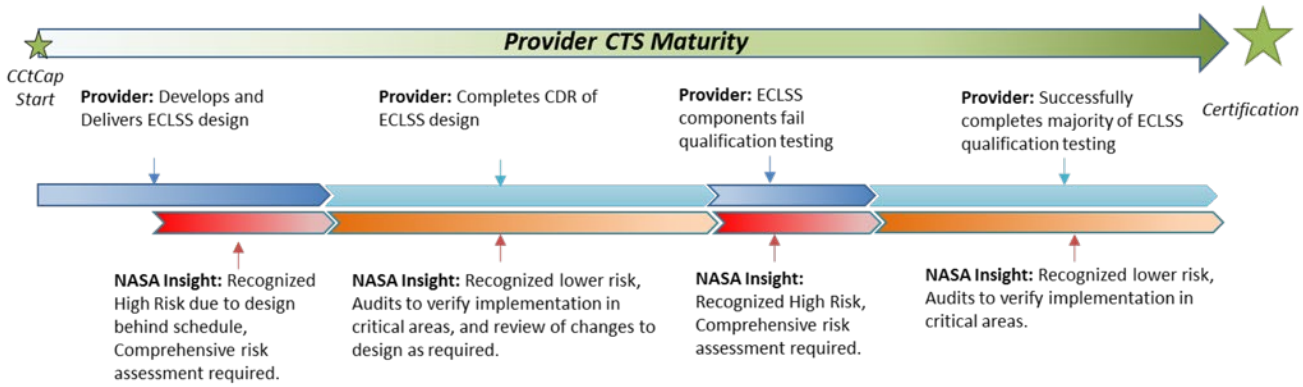


Figure 3-2.2.1: Notional Risk Based Insight Approach

Changes in any of the engagement factors over time may increase or reduce the need to engage with the Commercial Provider and will be managed by the responsible CCP Offices. Using these guidelines for Commercial Provider and unique design risk factors the CCP Offices can make a technical judgment as to the level of risk associated with the functional discipline.

3.2.3 Levels of Engagement

There are three approaches for NASA engagement in the Commercial Provider's CoFR activities:

1. Engage in insight activities with the Commercial Provider in preparation for reviewing and approving deliverables through oversight.
2. Conduct joint analysis with the Commercial Provider where NASA has unique analysis capabilities in addition to insight and oversight activities.
3. Perform independent verification and validation in addition to insight and oversight activities. These analyses and assessments require more detailed data from the Commercial Provider to support independent modeling and simulation efforts. Typically, this also drives more technical collaboration with the Commercial Provider.

These approaches represent increasing levels of NASA effort and integration with the Commercial Provider. Requirements evaluated as lower risk will be addressed using the first approach. Approaches 2 and 3 will be applied in higher risk areas.

3.2.3.1 Insight

NASA will use a proactive approach to assess critical elements of the as-built flight articles and operational phases by maintaining insight into the Commercial Provider's day-to-day activities. NASA is involved in informal data exchange throughout the CoFR process in order to enable NASA's timely recognition of issues involving safety features and reliability concerns that may warrant changes to the baseline design.

The insight assessment will be a continuous activity and will be adjusted, as necessary, to fit the observations of the CCP Offices and ISS Program. As technical issues and challenges arise, adjustments will be accomplished through collaboration between the appropriate program, technical authority, crew, and operations representatives.

In addition to the continuous insight assessment, insight strategies are developed by the OPR of an oversight activity to guide NASA insight personnel in insight engagement to support eventual CoFR approval. For Hazard Reports, as an example, the CCP will use a documented risk-based analysis (RBA) to determine the appropriate places to provide Government surveillance to support required safety critical attribute verification and validation, as documented in the *CCP Surveillance Plan* (CCT-PLN-3000). The outcome of the RBA is a discreet set of Product Assurance Actions (PAAs) that are executed as part of NASA's insight to assure that the selected hazard control verifications have been performed. For VCNs, as another example, NASA has developed insight strategies to determine which testing, analysis, and/or demonstration activities NASA requires insight into for the ability to later sign off on the actual VCNs. These strategies are maintained by the OPR, will continue to change and mature over-time, and are dependent on the Commercial Provider management and unique factors previously described in Section 3.2.2.1.

3.2.3.2 Independent Verification and Validation (IV&V), Joint Analysis, and Other NASA Technical Assessments

Technical assessment and IV&V tasks performed by NASA will be planned and focused using known areas of high risk and the verification logic networks in the NASA database and in each Commercial Provider's V&V Plan. Each CCtCap contract has defined an initial set of IV&V focus areas, along with the supporting data required by the Commercial Provider for NASA to conduct IV&V. Specific joint analyses required by the ISS Program are defined in the Commercial Provider specific ISS Visiting Vehicle Joint Integration, Verification, and Test Plan.

3.3 Certification Maintenance Approach

Certification maintenance is the responsibility of the Commercial Provider into which NASA has oversight/approval. As such, the Commercial Provider will bring to the CCP and ISS Program, as part of its operating plans, changes to the certification baseline with rationale for the 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 Provider's NASA CTS Certification.

4.0 CTS Certification of Flight Readiness Process

CTS CoFR is the NASA endorsement that the Commercial Provider'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. This 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 Flight Test Readiness Review (FTRR) or Agency Flight Readiness Review (FRR).

Prior to the Certification milestone, completion of the Design Certification Review (DCR) for the specific flight test configuration is a prerequisite to initiating the CCP CoFR process for that flight test. After the specific CTS is certified at the DCR, the CCP CoFR process will assess the Commercial Provider's physical as-built CTS for flight readiness and if any design, production, or operational changes to the CTS have occurred since the DCR. A detailed CoFR letter with applicable requirements will be provided by the Program to document the mission baseline and the specific requirements that are applicable to certify for flight this specific mission.

Leading into the PCM missions the Commercial Provider CTS will undergo certification as outlined in the CCP Certification plan CTS-PLN-2000. Once the CTS certification has been granted at the Agency Certification Review (CR), the Mission Certification Review (MCR) will be the prerequisite review to initiating the CCP CoFR process for missions. The MCR will allow NASA to assess if the Commercial Provider has completed certification of any new or open requirements and mission unique designs, completed ISS Integration, and that all of their infrastructure, facilities, personnel, and services are in place and will be ready for the mission and for crewed operations. For CoFR all the requirements and objective evidence will be documented electronically in the CoFR/Certification Evidence List and Log (CELL). The CoFR CELL will concentrate on deltas from certification and specific mission requirements. The majority of certification requirements are not expected to be reopened as part of CoFR. CoFR will build on the previous flight, post flight assessment, and lessons learned, and capture any changes that have been identified to certification or any mission unique requirements. The CoFR process will verify that there have not been any changes since certification and the last flight's CoFR.

4.1 Certification of Flight Readiness Process Overview

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 Provider 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 non-standard), 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 Provider culminate in the Agency FTRR/FRR, where the Agency endorses the readiness of the Commercial Provider's CTS and any Government Provided Services necessary

to support the mission. Figure 4.3, Completion of Standard Work and the CoFR Endorsement Process, illustrates this concept.

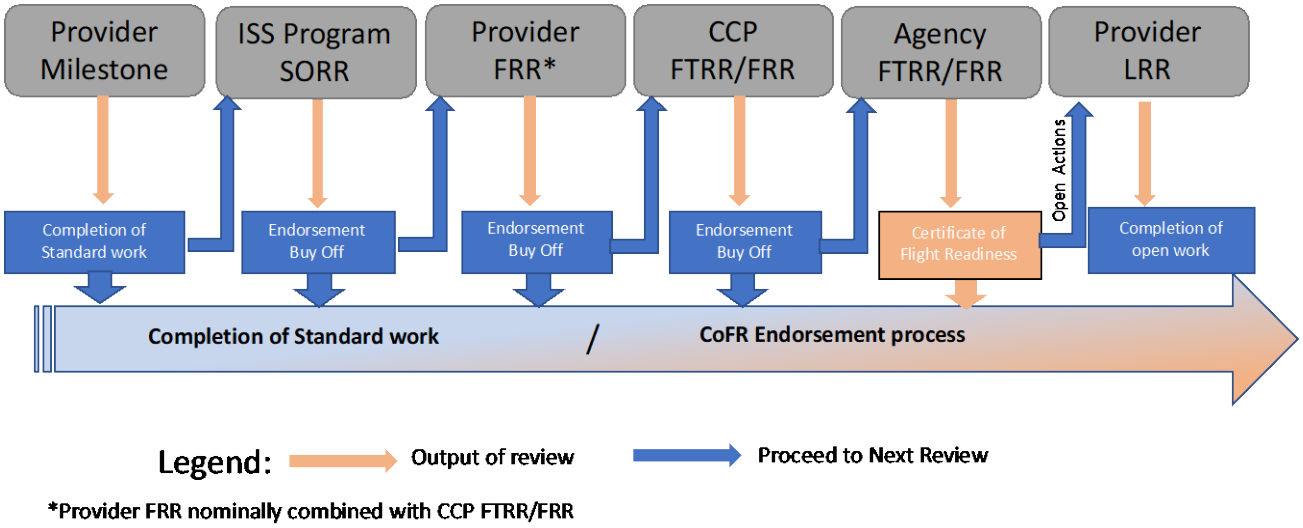


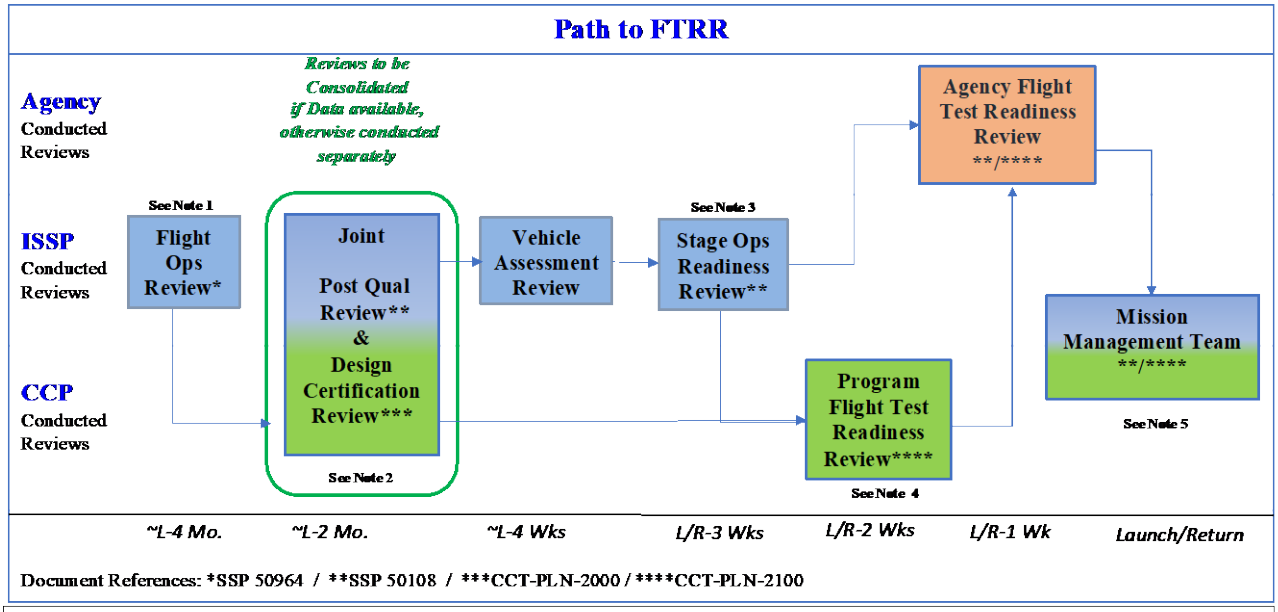
Figure 4.3: Completion of Standard Work and the CoFR Endorsement Process

4.2 Flight Test Readiness Process

The CTS CoFR process for flight tests includes a series of required ISS and CCP reviews that lead up to the Agency FTRR. The required reviews for the orbital flight test and crewed flight test are as follows:

- ISS Flight Operations Review (FOR)
- ISS Post Qualification Review (PQR)
- CCP Design Certification Review (DCR)
- ISS Vehicle Assessment Review (VAR)
- ISS Stage Operations Readiness Review (SORR)
- CCP Flight Test Readiness Review (CCP FTRR)
- Agency Flight Test Readiness Review (FTRR)
- Mission Management Teams (MMT)

Figure 4.4, Path to FTRR, illustrates the flow of the required integration, design, and flight readiness reviews and the interaction points between the CCP and ISS Program that lead to the Program's and the Agency's integrated CoFR for the flight test. Prior to the mission return for crewed flight test, a Program and Agency Return FTRR will be conducted, focusing on any deltas from the pre-launch FTRR and ensuring readiness for return, as described in Section 5.3.



Notes:
L=Launch. R=Return. Launch Minus (L-) and Return Minus (R-) dates are approximations for planning purposes only
1. ISS FOR are required for first flight of ISS Visiting Vehicles –*OR*- if significant changes to the certified CTS occur. ISS will determine if required. This content is not similar to PQR/DCR and is a different audience. Should not be combined.
2. The timing of the DCR varies (L-5 to L-2 Mo.) depending on Commercial Provider, shown here as late as ~ L-2 Months. The ISS Integration Reviews from SSP 50964 and the DCR may be combined on a case by case basis if content is ready.
3. ISS CoFR completed at SORR. ISS CoFR cannot be completed without FTRR content. SORR will have remaining open actions to be closed at Program FTRR. Remaining open work and any changes responsibility of ISS Mission Management Team (IMMT). Return SORR only for crewed flights.
4. CCP and Commercial Provider CoFR is completed at Program FTRR. Return FTRR only for crewed flights. Mission Management Team (IMMT) will convene after Agency FRR and continue post launch through mission as needed.
5. Post-Agency FTRR, an IMMT will be conducted for a GO/NO Go decision for launch and/or return. Depending on the provider, a DMMT or SMMT will be conducted to support launch and return as required, the CCP MMT will operate as a subset of the Commercial Provider MMTs as documented in the DMMT and SMMT charters.

Figure 4.1: Path to FTRR

For the DCR, the actual timing of the review will vary. Depending on the Commercial Provider's approach to achieving CTS certification, the DCR may occur as early as L-5 Months to as late as L-2 Months prior to their initial flight test. For the all flight tests of CCP visiting vehicles, the ISS Program requires the Commercial Provider to participate in a FOR, PQR, and VAR Flight Readiness Process

4.3 Flight Readiness Process

For PCMs, the series of required ISS Program and CCP reviews is streamlined. Due to the fact that the PCMs are intended to be service flights to the ISS with a certified CTS, the set of CCP and ISS reviews are consolidated unless significant changes to the certified CTS occur. The required reviews for the PCMs are as follows.

Reviews conducted prior to launch:

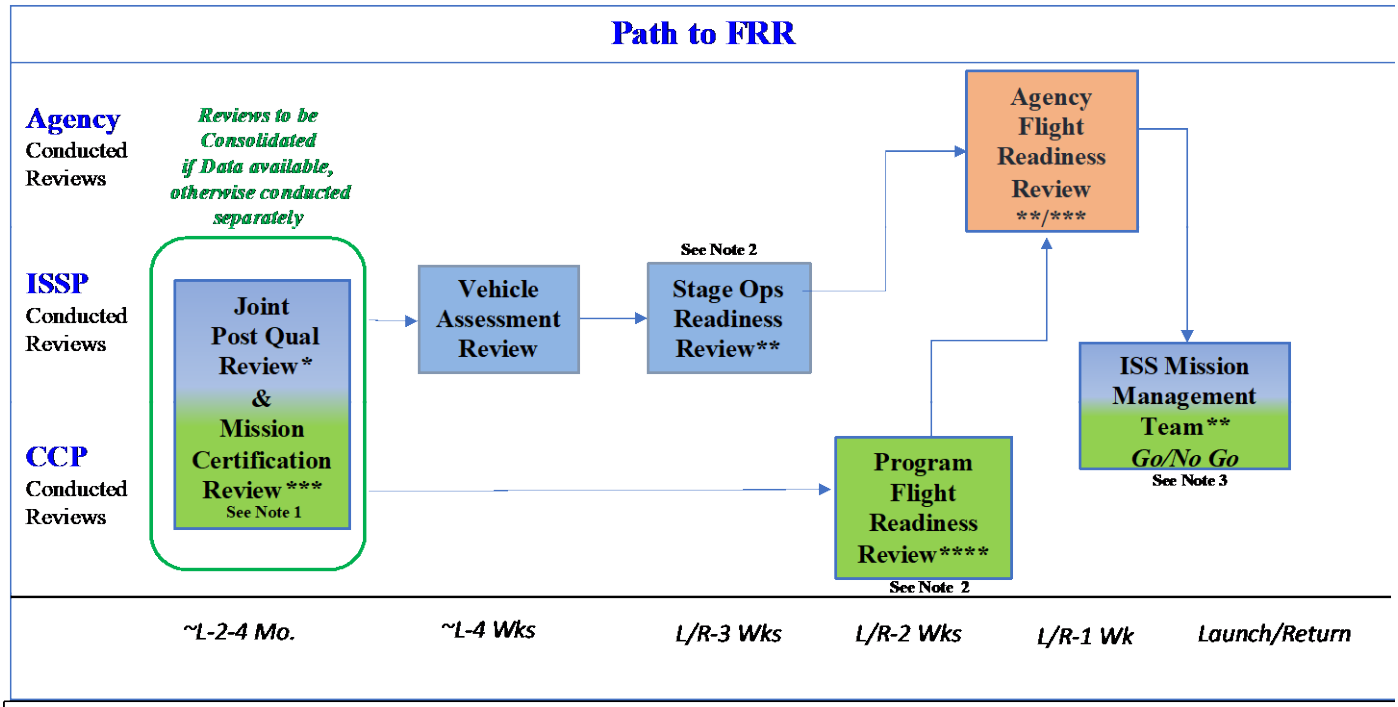
- Joint ISS PQR and CCP MCR
- ISS SORR
- CCP FRR
- Agency FRR
- Pre-launch MMTs

Reviews conducted during mission, prior to landing:

- ISS Return SORR
- CCP Return FRR
- Agency Return FRR
- Post-launch, docked operations, and pre-landing MMTs

If two PCMs are being flown in close proximity (direct handover, e.g.) the Program may decide to consolidate the pre-landing reviews of one mission with the pre-launch reviews of the next.

Figure 4.5, Path to Flight Readiness Review, illustrates the streamlined end state flow of the required reviews and the interaction points between the CCP and ISS Program that lead to the Program's and the Agency's integrated CoFR for the PCM.



Notes:
L=Launch. R=Return. Launch Minus (L-) and Return Minus (R-) dates are approximations for planning purposes only
1. If significant changes to the certified CTS occur, and ISS FOR will be required prior to the Joint PQR & MCR. The ISS Integration Reviews PQR from SSP 50964 and the MCR may be combined on a case-by-case basis if content is ready.
2. ISS CoFR is completed at SORR, while CCP and Commercial Provider CoFR is completed at the Program FRR
3. Post-Agency FRR, an IMMT will be conducted for a GO/NO Go decision for launch and/or return. Depending on the provider, a DMMT or SMMT will be conducted to support launch and return as required, the CCP MMT will operate as a subset of the Commercial Provider MMTs as documented in the DMMT and SMMT charters.

Figure 4.2: Path to Flight Readiness Review

Given that one of the purposes of the ISS PQR and the CCP MCR is to evaluate new or open requirements verifications, these reviews may be consolidated for PCMs. The VAR is conducted prior to the SORR with the primary emphasis to communicate the readiness of the Commercial Provider to proceed to final launch operations and to status the remaining open work. For steady state missions, ISS may evaluate the need for a VAR on a flight to flight basis.

5.0 Certification of Flight Readiness Reviews

The CCP, with ISS Program representation, will conduct CoFR Reviews as specified in this plan. The Commercial Provider will conduct CoFR Reviews as specified in their internal processes. For each required CCP CoFR review, the purpose, the review requirements, and the NASA review board membership are defined below. For the required ISS Program CoFR reviews, the review requirements are defined in SSP 50108.

Supporting organizations may conduct internal assessment reviews prior to these CCP and ISS Program reviews as needed to evaluate the status of their readiness and finalize positions on special topics.

5.1 Flight Test Readiness Reviews

5.1.1 Program FTRR

The CCP, with ISS Program representation, and the Commercial Provider will conduct an FTRR for each flight test to the ISS. The Program FTRR will be held in accordance with the review requirements specified in this plan.

The purpose of the Program FTRR is to evaluate readiness of all CTS/NASA personnel, elements, and assets to support the launch and execution of the flight test and return readiness. A Program Return FTRR will be conducted for the crew return test flight only (Section 5.3), which may be combined with subsequent mission launch FTRR/FRR depending on the planned return date. This review will request approval from the CCP and ISS Program Managers to proceed to launch countdown for the test that transports NASA Crew and/or cargo and will document the formal acceptance of risk by the Program and the Commercial Provider. Typically, prior to conducting the Program FTRR, the ISS Program SORR is completed. However, on occasion, the SORR may be conducted in a different sequence. The review requirements for the SORR are documented in SSP 50108. Upon successful conclusion of the Program FTRR and closure of open work, the CCP will develop the CTS CoFR Recommendation to be presented for approval at the Agency FTRR, chaired by the NASA Associate Administrator, Space Operations Mission Directorate (AA SOMD).

The Center Directors (CDs) for KSC, JSC, and MSFC (CDs) will be supporting the Program FTRR and they are part of the membership board in the Agency Flight Test Readiness Review. Each center Technical Authorities will conduct a review with MSFC and JSC Center Directions prior to the FTRR. If required a standalone CD Pre brief will be scheduled by the technical authorities prior to the Agency FTRR to discuss any specific issues or risk that follow up from the Program FTRR.

5.1.2 Program FTRR Requirements

The review agenda will include presentations from the Commercial Provider, the CCP, the ISS Program, and the Flight Operations Directorate (FOD) addressing the following:

1. The Commercial Provider will present a summary of the FTRR Data Package, demonstrating readiness to conduct a flight test. Additionally, the Commercial Provider will present the following:
    a. All critical items required to proceed into final launch countdown are ready

b. All CTS systems have been verified for the launch and flight test
c. All previously held Commercial Provider readiness review actions have been closed or resolved
d. Launch Site, Range, FAA, and recovery Support Organizations, as applicable, have committed to the launch and flight test
e. Tracking and data support resources have committed to the launch and flight test
f. Any standard open work or constraints to the launch and flight test are identified and closeout plans and schedules are in place and supportable
g. Residual mission risks are known, documented, and presented for acceptance
h. Operational elements are ready to support all phases of the mission
i. Cargo processing is complete and ready to support (as applicable)
j. NASA Crew is trained and ready to support (as applicable)

2. CCP Mission Management and Integration (MM&I) shall present:
    a. Integrated summary of CCP's review and assessment of the mission: emphasis shall be placed on the mission planning, mission manifest, and mission specific requirements execution
    b. Status summary of previous review action item closure
    c. Status summary of CoFR Endorsement activities and any exceptions
3. CCP Systems Engineering and Integration (SE&I) shall present:
    a. Status summary of Standard and non-standard open work related to CoFR Endorsement activities, any exceptions and formal dissents.
    b. Status summary of CCP's review and assessment of the CTS Design Certification: emphasis shall be placed on requirements compliance, delta certification activities, changes to integrated hazard reports, status of the safety review process and Safety Verification closures, any integrated in-flight anomalies, areas where risk has been accepted by NASA, and areas where significant open issues remain
4. CCP System Offices shall present:
    a. Status summary of Standard and non-standard open work related to CoFR Endorsement activities, any exceptions and Formal dissents.
    b. Status summary of any in-flight anomalies, any significant non-conformances, areas where risk has been accepted by NASA, and special topic.
    c. Status of any tasked Support Organizations to support the flight test
        i. GMO will include status readiness of NASA Launch Recovery Team
5. FOD shall present:
    a. Status summary of Standard and non-standard open work related to CoFR Endorsement activities, any exceptions and formal dissents.
    b. Mission overview including mission objectives, launch opportunities, and summary of the NASA Crew training and readiness of the NASA Crew to execute the flight test
6. ISS Program Transportation Integration Office (TIO) shall present:
    a. Status summary of results from the SORR
    b. Status summary of ISS Program CoFR Endorsement activities, any exceptions, and special topics
7. The Technical Authorities shall present:
    a. Status summary of Standard and non-standard open work related to CoFR Endorsement activities and any exceptions
    b. Status summary of any in-flight anomalies, any significant non-conformances, areas where risk has been accepted by NASA, and special topics

Prior to adjourning the review, the Chair shall review any open work and action items, and conduct a poll requesting concurrence and discussion on any Formal dissents.

Upon review completion, any CoFR Exceptions will be noted and a record of all open work, actions, and minutes will be maintained by the secretariat and stored in the CCP SharePoint data repository.

5.1.3 Program FTRR Board Membership

Program FTRR Board
Chair Manager, Commercial Crew Program
Secretariat Manager, Program Control and Integration Office, Commercial Crew Program
Members Manager, ISS Program Manager, Commercial Provider CCP Program Control Board Membership ISS Program organizational support, as required ISS International Partner support, as required

5.1.4 Agency FTRR

The Agency will conduct an FTRR for each flight test to the ISS. This Agency review will be a combined CCP and ISS Program review. The CCP portion of the Agency FTRR will be held in accordance with the review requirements specified in this plan. The review requirements for the ISS Program portion of this review are documented in SSP 50108.

The purpose of the Agency FTRR is to request approval from the NASA AA SOMD to proceed to Launch Countdown and/or Return for a flight test that transports NASA Crew and/or cargo, and to document the formal acceptance of risk by NASA and the Commercial Provider.

Prior to conducting the Agency FTRR, completion of the ISS Program SORR and the CCP FTRR is required. CCP will support the ISS Program SORR per SSP 50108 and will present a status of the mission readiness, verification status, any variances to requirements since VAR, risk summary and any significant open work.

Upon successful completion of the Agency FTRR and closure of open work, NASA will attest CTS CoFR for the flight test authorizing the Commercial Provider to proceed into launch countdown and flight test execution. Open items resulting from the Agency FTRR will be officially closed and documented by the CMMT prior to launch.

5.1.4.1 Agency FTRR Requirements

The review agenda will include presentations from the Commercial Provider, the CCP, and the ISS Program addressing the following:

1. The Commercial Provider will present a high-level summary of the material presented at the Program FTRR, demonstrating readiness to conduct a flight test.
2. CCP MM&I shall present:
    a. Integrated, high level, summary of the mission overview presented at the Program FTRR
    b. Status summary of FTRR action item closure
    c. Status summary of Program FTRR CoFR Endorsement activities, standard and non-standard open work, any exceptions, formal dissents and items of interest
    d. Summary of Program top risks
3. The CCP Technical Authorities shall present a summary of Standard and non-standard open work related to CoFR Endorsement activities, any exceptions, and formal dissents
4. CCP Manager shall present:
    a. CTS CoFR Recommendation to proceed with the flight test
5. Chair shall review any open work and action items.
6. Chair shall conduct a poll requesting concurrence and discussion on any formal dissents.

Upon review completion, any CoFR Exceptions will be noted and a record of all open work, actions, and minutes will be maintained by the secretariat and stored in the CCP SharePoint data repository.

5.1.4.2 Agency FTRR Board Membership

The review board membership requirements stated herein are applicable to the CCP portion of the Agency FTRR.

Agency FTRR Board
Chair Associate Administrator, Space Operations Mission Directorate, NASA
Secretariat Manager, Program Control and Integration Office, Commercial Crew Program, NASA
Members Manager, CCP, NASA Manager, ISS Program, NASA Manager, Commercial Provider Chief Engineer, NASA Chief Health and Medical Officer, NASA Chief Safety and Mission Assurance Officer, NASA Director for Commercial Spaceflight Development, NASA Director, Kennedy Space Center, NASA Director, Johnson Space Center, NASA Director, Marshall Space Flight Center, NASA
Note: Review Board Membership requirements above for CCP portion of Agency review may be duplicative to additional review board requirements for the ISS portion that are specified in SSP 50108.

5.2 Flight Readiness Reviews

5.2.1 Mission Certification Review

The CCP, with ISS Program representation, and the Commercial Provider will conduct an MCR for all PCMs to the ISS. The MCR will be held in accordance the review requirements specified in this plan.

The purpose of the MCR is to assess if the Commercial Provider has completed certification of any new requirements (including inherent capabilities that are specified for the mission), any open requirements, and mission unique designs, completed ISS Integration, and that all of their infrastructure, facilities, personnel, and services are in place and will be ready for the mission and for crewed operations, including agreement on cargo turnover and crew handover.

The timing of the MCR milestone is no later than Launch – 4 months. This timing was selected to baseline any final certification changes required to meet the mission content or changes proposed by the Contractor that could affect the scheduled launch date for the mission. Normally, significant changes to the mission would be proposed at VBR or MIR, but there are some changes that could be a result of new findings (post flight review, etc.) that could result in changes later in the flow. MCR is intended to capture those changes as well as status/closure on other certification products. It is intended coming out of MCR that open work is scoped such that a 30-day launch window can be set shortly after MCR. The MCR milestone serves as kick-off point for evaluation of activities that lead to the endorsement of CoFR.

Additionally, if significant changes to the certified CTS occur prior to conducting an MCR, completion of the ISS Program FOR and VAR may be required. The review requirements for the FOR and VAR are documented in *Visiting Vehicle ISS Integration Plan* (SSP 50964).

5.2.1.1 MCR Requirements

The Commercial Provider will present a summary of the certification of any new or open mission requirements, ISS integration, all unique design qualification and acceptance testing, and status of the CTS demonstrating readiness to conduct the mission including a status summary of mission unique:

1. Verification Closure Notices
2. Certification Data Package
3. Range Safety Data Documentation
4. Mission Resources Allocation
5. Integrated Cargo Phase III Hazard Reports
6. Status of Anomalies and all corrective actions

Prior to adjourning the review, any open work and action items will be addressed, and minutes will be maintained by the secretariat and stored in the CCP SharePoint data repository. Upon review completion, a review summary is brought to PCB to highlight any significant findings and document actions as part of closing out the milestone review.

5.2.2 Program Flight Readiness Review

The CCP, with ISS Program representation, and the Commercial Provider will conduct an FRR for each PCM. The FRR will be held in accordance with the review requirements specified in this plan.

The purpose of the Program FRR is to evaluate the readiness of all CTS/NASA personnel, elements, and assets to support the launch, execution, and return of the mission. Further, the process will verify that all risks, including past in-flight anomalies, have been identified, credibly assessed, and characterized, and that mitigation efforts have been implemented or residual risks have been accepted prior to proceeding to the next phase. Typically, prior to conducting the Program FRR, the ISS Program SORR is completed. However, on occasion, the SORR may be conducted in a different sequence. The review requirements for the SORR are documented in SSP 50108. Upon successful conclusion of the Program FRR and closure of open work, the CCP will develop the CTS CoFR Recommendation to be presented for approval at the Agency FRR, chaired by the NASA AA SOMD.

The Center Directors (CDs) for KSC, JSC, and MSFC (CDs) will be supporting the Program FRR and they are part of the membership board in the Agency Flight Readiness Review. Each center Technical Authority will conduct a review with MSFC and JSC Center Directors prior to the Program FRR. Any specific issues/risks that follow up from the Program FRR will be pre-briefed to the CDs prior to Agency FRR per their request.

5.2.2.1 Program FRR Requirements

Review agenda will include presentations from the Commercial Provider, the CCP, and the ISS Program addressing the following:

1. The Commercial Provider will present a summary of the Flight Readiness Review Data Package, demonstrating readiness to conduct a mission. Additionally, the Commercial Provider will present the following:
    a. All critical items required to proceed into final launch countdown are ready
    b. All CTS systems have been verified for the launch and mission
    c. All previously held Commercial Provider readiness review actions have been closed or resolved
    d. Launch Site, Range, FAA, and recovery Support Organizations, have committed to the launch and mission
    e. Tracking and data support resources have committed to the launch and mission
    f. Any standard open work or constraints to the launch and mission are identified and closeout plans and schedules are in place and supportable
    g. Residual mission risks are known, documented, and presented for acceptance
    h. Operational elements are ready to support all phases of the mission
    i. Cargo processing is complete and ready to support (as applicable)
    j. NASA Crew is trained and ready to support (as applicable)
2. CCP MM&I shall present:
    a. Integrated summary of CCP's review and assessment of the mission: emphasis shall be placed on the mission planning, mission manifest, and mission specific requirements execution

   b. Status summary of previous review action item closure
   c. Status summary of CoFR Endorsement activities and any exceptions
3. CCP SE&I shall present:
   a. Status summary of Standard and non-standard open work related to CoFR Endorsement activities, any exceptions and formal dissents.
   b. Status summary of CCP's review and assessment of the CTS delta Design Certification: emphasis shall be placed on requirements compliance, delta certification activities, changes to integrated hazard reports, any integrated in-flight anomalies, areas where risk has been accepted by NASA, and areas where significant open issues remain
4. CCP System Offices shall present:
   a. Status summary of Standard and non-standard open work related to CoFR Endorsement activities, any exceptions and formal dissents.
   b. Status summary of any in-flight anomalies, any significant non-conformances, areas where risk has been accepted by NASA, and special topics
   c. Status of tasked Support Organizations to support the mission
      i. GMO will include status readiness of NASA Launch Recovery Team
5. The Technical Authorities shall present:
   a. Status summary of Standard and non-standard open work related to CoFR Endorsement activities, any exceptions and formal dissents.
   b. Status summary of any in-flight anomalies, any significant non-conformances, areas where risk has been accepted by NASA, and special topics
6. FOD shall present:
   a. Status summary of Standard and non-standard open work related to CoFR Endorsement activities, any exceptions and formal dissents.
   b. Mission overview including mission objectives, launch opportunities, and summary of the NASA Crew training and readiness of the NASA Crew to execute the mission
7. ISS Program TIO shall present:
   a. Status summary of results from the SORR
   b. Status summary of ISS Program CoFR Endorsement activities, any exceptions, and special topics
8. Chair shall review any open work and action items.
9. Chair shall conduct a poll requesting concurrence and discussion on any formal dissents.

Prior to adjourning the review, the chair shall review any open work and action items, and conduct a poll requesting concurrence and discussion on any formal dissents.

Upon review completion, any CoFR Exceptions will be noted and a record of all open work, actions, and minutes will be maintained by the secretariat and stored in the CCP SharePoint data repository.

5.2.2.2 Program FRR Board Membership

Program FRR Board
Chair Manager, Commercial Crew Program
Secretariat Manager, Program Control and Integration Office, Commercial Crew Program
Members

Manager, ISS Program
Manager, Commercial Provider
CCP Program Control Board Membership
ISS Program organizational support, as required
ISS International Partner support, as required

5.2.3 Agency Flight Readiness Review

The Agency will conduct an FRR for each mission to the ISS. This Agency review will be a combined CCP and ISS Program review. The CCP portion of the Agency FRR will be held in accordance with the review requirements specified in this plan. The review requirements for the ISS Program portion of this review are documented in SSP 50108.

The purpose of the Agency FRR is to request approval from the NASA AA SOMD to proceed to launch countdown and/or Return for a mission that transports NASA Crew and cargo and to document the formal acceptance of risk by NASA and the Commercial Provider. For direct handovers, the Agency Flight Readiness Review may be combined with the Agency Return Readiness Review from the previous mission depending on planned return date and the Commercial Provider for each mission.

Prior to conducting the Agency FRR, completion of the ISS Program SORR and CCP FRR is required. CCP will support the ISS Program SORR per SSP 50108 and will present as part of this review the status of the mission readiness, verification status, any variances to requirements since VAR, risk summary and any significant open work.

Upon successful completion of the Agency FRR and closure of open work, NASA will attest CTS CoFR for the mission. Open items resulting from the Agency FRR will be officially closed and documented by the Mission Management Team (MMT) or PCB prior to launch.

5.2.3.1 Agency FRR Requirements

Review agenda will include presentations from the Commercial Provider, the CCP, and the ISS Program addressing the following:

1. The Commercial Provider will present a high-level summary of the material presented at the Program FRR, demonstrating readiness to conduct a mission.
2. FOD will present a Mission Operations Overview
3. CCP MM&I shall present:
    a. Integrated, high level, summary of the mission overview presented at the Program FRR.
    b. Status summary of Program FRR action item closure
    c. Status summary of Program FRR CoFR Endorsement activities, any exceptions, and items of note
4. CCP Manager shall present:
    a. CTS CoFR Recommendation to proceed with the mission
5. Chair shall review any open work and action items.
6. Chair shall conduct a poll requesting concurrence and discussion on any formal dissents.

Upon review completion, any CoFR Exceptions will be noted and a record of all open work, actions, and minutes will be maintained by the secretariat and stored in the CCP SharePoint data repository.

5.2.3.2 Agency FRR Board Membership

The review board membership requirements stated herein are applicable to the CCP portion of the Agency FRR.

Agency FRR Board
Chair Associate Administrator, Space Operations Mission Directorate, NASA
Secretariat Manager, Program Control and Integration Office, Commercial Crew Program, NASA
Members Manager, CCP, NASA Manager, ISS Program, NASA Manager, Commercial Provider Chief Engineer, NASA Chief Health and Medical Officer, NASA Chief Safety and Mission Assurance Officer, NASA Director for Commercial Spaceflight Development, NASA Director, Kennedy Space Center, NASA Director, Johnson Space Center, NASA Director, Marshall Space Flight Center, NASA
Note: Review Board Membership requirements above for CCP portion of Agency review may be duplicative to additional review board requirements for the ISS portion that are specified in SSP 50108.

5.3 Return Readiness Reviews

5.3.1 Program Return Readiness Review

A Return Readiness Return will be conducted for a crewed flight test and PCM missions. For a Crewed Flight Test, the Return FTRR will follow the same process and board structure as Return FRR. The purpose of the Program Return Readiness Review is for the CCP System offices and Technical Authorities to provide a status to the Program of their readiness of all CTS/NASA personnel, elements, and assets to support the mission return. Further, the process will verify that all risks, including past in-flight anomalies, have been identified, credibly assessed, and characterized, and provide the status of any CoFR endorsements updates. It will also identify any open work and that residual risks have been accepted prior to proceeding to the next phase. Typically, prior to conducting the Program Return Readiness Review, the ISS Program will conduct a Return SORR. The review requirements for the SORR are documented in SSP 50108.

Upon successful conclusion of the Program Return Readiness Review, the CCP will develop the CTS CoFR Recommendation to be presented for approval at the Agency Return FRR, chaired by the NASA AA SOMD.

5.3.1.1 Program Return Readiness Review Requirements

The following items need to be addressed either combined with flight readiness review (for direct handover missions) or standalone review depending on return date and Commercial Provider. Review agenda will include presentations from the Commercial Provider, each of the CCP offices and Technical Authorities addressing the following:

1. The Commercial Provider will present a high-level summary demonstrating their readiness to conduct a mission return. This will include the review of planned landing windows, available back up opportunities, weather reports, cargo to be returned, and CTS resources margins
2. CCP MM&I shall present:
    a. Any CoFR endorsement changes/updates since the Pre-launch FTRR/FRR and applicable to the mission Return.
    b. Status summary of Standard and non-standard open work related to CoFR Endorsement activities, any exceptions and formal dissents.
3. CCP SE&I shall present:
    a. Any CoFR endorsement changes/updates since the Pre-launch FTRR/FRR and applicable to the mission Return.
    b. Identify any changes/updates to cert products (VCN's, Variances, Hazard Reports, etc.) for future flights that changed the mission baseline and resulted in a change to the risk posture
    c. Status summary of Standard and non-standard open work related to CoFR Endorsement activities, any exceptions and formal dissents.
4. CCP System Offices (Except Launch Vehicle) shall present:
    a. Any CoFR endorsement changes/updates since the Pre-launch FTRR/FRR and applicable to the mission Return.
    b. Status summary of Standard and non-standard open work related to CoFR Endorsement activities, any exceptions and formal dissents.
    c. Assessment of system performance and any in-flight anomalies, any significant non-conformances during the mission, and areas where risk has been accepted by NASA ensuring that appropriate mitigations are in place
    d. Any special topics issues/risks uncovered during the mission that will be dispositioned for return
    e. Status of tasked Support Organizations to support the mission
        i. GMO will include status readiness of NASA recovery team to support return
5. The Technical Authorities shall present:
    a. Status summary of Standard and non-standard open work related to CoFR Endorsement activities, any exceptions and formal dissents applicable to mission return.
    b. Status summary of any in-flight anomalies, any significant non-conformances, areas where risk has been accepted by NASA, and special topics
6. FOD shall present:
    a. Status summary of Standard and non-standard open work related to CoFR Endorsement activities, any exceptions and formal dissents.
    b. Status summary of any in-flight anomalies, any significant non-conformances, areas where risk has been accepted by NASA, and special topics
7. Chair shall review any open work and action items.
8. Chair shall conduct a poll requesting concurrence and discussion on any formal dissents.

Upon review completion, any CoFR Exceptions will be noted and a record of all open work, actions, and minutes will be maintained by the secretariat and stored in the CCP SharePoint data repository.

5.3.1.2 Program Return Readiness Review Board Membership

Program Return FRR Board
Chair Manager, Commercial Crew Program
Secretariat Manager, Program Control and Integration Office, Commercial Crew Program
Members Manager, ISS Program Manager, Commercial Provider CCP Program Control Board Membership ISS Program organizational support, as required ISS International Partner support, as required

5.3.2 Agency Return Readiness Review

The Agency will conduct a Return Readiness Review for each crewed flight test and PCM missions to the ISS. This Agency review will be a combined CCP and ISS Program review. The CCP portion of the Agency Return FRR will be held in accordance with the review requirements specified in this plan. The review requirements for the ISS Program portion of this review are documented in SSP 50108.

The purpose of the Agency Return FRR is to request approval from the NASA AA SOMD to proceed with undock and mission return activities, and to document the formal acceptance of risk by NASA and the Commercial Provider prior to proceeding with the mission return. Prior to conducting the Agency Return FRR, the ISS Program Return SORR is completed. The review requirements for the Return SORR are documented in SSP 50108.

5.3.2.1 Agency Return Readiness Review Requirements

For crew return for test flights and PCM Missions the following items need to be addressed either combined with Agency FRR (for direct handover missions) or standalone review depending on return date and CTS Commercial Provider. The review agenda will include presentations from the Commercial Provider, the CCP and the ISS Program addressing the following:

1. The Commercial Provider will present a high-level summary demonstrating their readiness to conduct a mission return. This will include the review of planned landing windows, available back up opportunities, weather reports, cargo to be returned, and CTS resources margins.
2. FOD will present a Mission Operations overview.
3. CCP MM&I shall present:
    a. Status summary of changes to any CoFR endorsements and readiness that were affected since launch
    b. Integrated, high level, summary of the material presented at the Program Return FTRR/FRR. Emphasis shall be placed on resolution of major programmatic and technical issues, areas

where risk has been accepted by the Program, and areas where significant open issues remain.
c. Review of significant issues and anomalies during the mission
d. Any special topics issues/risks uncovered during the mission that will be dispositioned for return
e. Non-standard open work
f. Actions, exceptions and formal dissents

4. CCP Manager shall present the CTS CoFR Recommendation to proceed with the mission return
5. Prior to adjourning the review, the Chair shall review any open work and action items, and conduct a poll requesting concurrence and discussion on any formal dissents.

Upon review completion, any CoFR Exceptions will be noted and a record of all open work, actions, and minutes will be maintained by the secretariat and stored in the CCP SharePoint data repository.

5.3.2.2 Agency Return FRR Board Membership

The review board membership requirements stated herein are applicable to the CCP portion of the Agency Return FRR.

Agency Return FRR Board
Chair **Associate Administrator, Space Operations Mission Directorate, NASA**
Secretariat **Manager, Program Control and Integration Office, Commercial Crew Program, NASA**
Members **Manager, CCP, NASA** **Manager, ISS Program, NASA** **Manager, Commercial Provider** **Chief Engineer, NASA** **Chief Health and Medical Officer, NASA** **Chief Safety and Mission Assurance Officer, NASA** **Director for Commercial Spaceflight Development, NASA** **Director, Kennedy Space Center, NASA** **Director, Johnson Space Center, NASA** **Director, Marshall Space Flight Center, NASA**
Note: Review Board Membership requirements above for CCP portion of Agency review may be duplicative to additional review board requirements for the ISS portion that are specified in SSP 50108.

5.4 Post Agency FRR Reviews

After Agency FRR, as required a special PCB meeting will be held to close any items from approved CoFR exceptions. The purpose of this PCB is also to report on the status of any open work and actions from the Agency FRR and prior to the Commercial Provider's Launch Readiness Review (LRR). For a direct handover, the Commercial Provider is expected to conduct an Undock Readiness Review (URR) after

Agency FRR and prior to LRR to ensure Commercial Provider readiness for undock before the launch campaign commences.

The Provider-led LRR is a critical review that occurs after Agency FRR. As part of this review the Commercial Provider and NASA program management make a joint decision of whether or not to proceed with launch. The review assesses closure of all constrains, open work and open actions noted during the FRR. The schedule for all standard and non-standard open work is reviewed and readiness of all support needed for launch.

After the LRR, each of the Commercial Providers Mission Management team, the Dragon MMT (DMMT) chaired by SpaceX; and Starliner MMT (SMMT) chaired by Boeing are established and operate until after crew handover to NASA post-landing. Any open items from the Commercial Provider LRR will be addressed at the SMMT/DMMT and elevated to the agency if required. Any ISS open work or action items are statused at the IMMT, and they provide the NASA ISS Program GO/NO-GO for risk acceptance for launch and integrated operations.

Actions will be tracked on the CCP SharePoint site for that meeting.

5.5 Commercial Crew Program Mission Management Team

The Commercial Crew Program Mission Management Team (CMMT) is the Program's decision-making body that is responsible for making programmatic trades and decisions associated with maintaining NASA Crew safety and ensuring mission success. The CCP MMT is led by the NASA CCP Manager, or delegate, and includes NASA technical experts.

In general, the CCP MMT will not meet independently and will operate as a subset of the Commercial Provider MMTs. The Commercial Crew Program has delegated authority for real-time decision making to the Commercial Provider and will participate in the Commercial Provider's processes in order to maintain appropriate insight into areas of risk to the crew, vehicle, and mission success. Each Commercial Provider has instituted a Mission Management Team structure of their own to address near real-time decision-making pre-launch and during the missions. The Dragon MMT (DMMT), chaired by SpaceX, and Starliner MMT (SMMT), chaired by Boeing, will be the Commercial Crew Program's decision-making bodies responsible for programmatic trades and decisions associated with launch countdown, in-flight activities, and landing. NASA, represented on both teams, maintains its authority to approve acceptance of any risk to crew safety, vehicle safety, and mission success above the nominal baseline as defined by the flight plan. Any deviation from the Agency FRR accepted levels of risk to the NASA Crew or mission require the concurrence of the MMT. The MMT will approve all real-time changes, deviations or waivers to Launch Commit Criteria or Flight Rules. Approval to exceed certification limits or deviate from mission plans sufficiently to constitute a change in risk acceptance requires concurrence from the MMT.

The Commercial Crew Program Mission Management Team responsibilities are documented in CCT-P 2101, Commercial Crew Program Mission Management Team and Launch Support Team Charter. The details for the MMT implementation are documented in CCT-PLN-2110, Commercial Crew Mission Implementation Plan.

6.0 Roles and Responsibilities for CoFR

This section describes the CoFR roles and responsibilities, and method for delegation of authority for CCP management, the CCP System Offices, and any applicable supporting organizations tasked to support the flight test or mission.

6.1 NASA CCP

The following sections address the NASA CCP organization roles and responsibilities for the CoFR process and an overview of its roles and responsibilities. The Program is comprised of multiple integration and system offices and receives matrixed support from across the Agency.

The following are CCP Integration Offices participating in the CCP CoFR process:

- Mission Management & Integration
- Program Control & Integration
- Systems Engineering & Integration

The following are CCP System Offices participating in the CCP CoFR process:

- Spacecraft Office
- Launch Vehicle Office
- Integrated Performance Office
- Ground and Mission Operations Office

6.1.1 NASA CCP Manager

The NASA CCP Manager is responsible for establishing the Program CoFR process; ensuring the successful completion of CCP requirements, tasks, and activities; and providing CCP Program approval of flight readiness. The NASA CCP Manager manages the CCP CoFR process through the Program Control Board (PCB), the top-level executive board with ISS Program membership; co-chairs the MCR; participates in the ISS SORR; chairs the Program FTRR/FRR; and represents the CCP at the Agency FTRR/FRR.

6.1.1.1 Mission Management and Integration

The MM&I Office is responsible for leading and coordinating both the technical and process integration of the CCP CoFR effort. MM&I will integrate and coordinate within the CCP and with the ISS Program to integrate an Agency level NASA CTS CoFR Package. MM&I will present the CCP recommendation of CoFR to the CCP Manager at the Program FTRR/FRR. MM&I will lead and coordinate the integration of the final agreed to CoFR package for the Agency FTRR/FRR to request NASA CTS CoFR approval. MM&I will coordinate export control review of all CCP chart packages and ensure correct markings are included on all charts.

In preparation for the Program and Agency FTRR/FRR, MM&I will facilitate coordination meeting(s) as required with representatives from all the CCP Offices, Technical Authorities (TAs), and Support

Organizations, to ensure that the appropriate technical issues and special topics are identified as specific agenda items to be presented. MM&I will coordinate flight specific issues and special topics as applicable with the CCP organizations that cross organizational lines, to be integrated in their section of the FTRR/FRR presentation.

For the As-Built and Operations endorsement and sub-endorsement statements in Appendix E that are shared between organizations, MM&I will coordinate among the organizations sharing responsibilities for the particular endorsement statement to ensure the statement is planned to be satisfied, integrated across the organizations, and closed out. MM&I will provide an As-Built and Operations endorsement recommendation to the CCP Manager once all shared sub-endorsements have been completed.

6.1.1.2 Systems Engineering and Integration

The SE&I Office is responsible for leading and coordinating both the technical and process integration to maintain the Program's CTS Certification. The CCP SE&I Office will integrate and coordinate within the CCP and with the ISS Program on changes to the certified design, production, manufacturing and operations process that impact the design certification of the CTS. SE&I will support MM&I in the integration of an Agency level NASA CTS CoFR Package (including all requirements from the CCT-1100 series and SSP 50808).

In preparation for FTRR and FRR, SE&I will facilitate coordination meeting(s) as required with representatives from all the CCP Offices, TAs, and Support Organizations, to ensure that the appropriate changes to the original design certification are identified as specific agenda items to be presented. SE&I shall coordinate and disposition changes to the design certification with the CCP organizations that cross organizational lines.

For the Programmatic and Design Modifications endorsement and sub-endorsement statements in Appendix E that are shared between organizations, SE&I will coordinate among the organizations sharing responsibilities for the particular endorsement statement to ensure the statement is planned to be satisfied, integrated across the organizations, and closed out. SE&I will provide a Programmatic and Design Modification endorsement recommendation to the CCP Manager once all shared sub-endorsements have been completed.

6.1.1.3 Program Control and Integration

The Program Control and Integration (PC&I) Office is responsible for the coordination and logistics of each review for the CCP CoFR effort. PC&I will function as the review secretariat for all CCP CoFR reviews. Additionally, PC&I will maintain the official review documentation of each CCP Program FTRR/FRR and Agency FTRR/FRR and is the administrator of the Certification/CoFR Evidence List and Log (CELL) electronic data management system. The review documentation requirements are described in Section 6.5.

6.1.1.4 CCP Offices

All CCP Offices (Integration and Systems) lead both oversight activities and insight engagement within their area of responsibility, including tasking stakeholders and other Support Organizations as necessary. Each office is responsible for ensuring that all tasks required for CoFR are complete and in accordance with the Shared Assurance model of CCP. This means, where appropriate, the CCP Office may not be doing the work specifically, but will rely upon other offices and stakeholders to perform the actual tasks to support

CoFR. Ultimately, the CCP Office must attest to the completion of the task whether it was performed by their office or not. To facilitate this process, each CCP Office will develop, disseminate, and mature insight strategies related to their oversight activities.

At each specified CoFR review, the managers of the CCP Offices shall endorse the completion of tasks and activities for which they are responsible, including the completion of tasks required to support the flight test or mission. These tasks are listed and maintained in the CELL and form the basis of the tasks performed by each CCP Office to substantiate the Commercial Provider's assertion of readiness. The CELL database is described in Section 7.5.1.

Each CCP Office is responsible for the development and maintenance of their CELL that defines the unique activities that the office performs to satisfy their applicable CoFR Endorsement and sub-endorsements statements defined in Appendix E. Prior to beginning their flight preparations, each CCP Office shall review their CELL to ensure that it accurately reflects their current roles and responsibilities for the mission unique requirements, that any changes to Risk Based Analysis and insight are incorporated, and the CELL is consistent with the requirements specified in this plan.

6.2 Technical Authorities

The TAs are responsible for assessing the technical adequacy of the products and services produced from both within the NASA Center Directorates, as well as those developed by the Commercial Provider. The TAs also provide an independent assessment and reporting path on flight readiness and risk issues pertaining to Engineering, Safety and Mission Assurance, and Health and Medical Technical Authority. Although FOD Crew Office is not an Agency TA, their CoFR role is similar to that of a TA since FOD represents the NASA Crew that will fly on board. Any reference to a TA within this document includes FOD.

The TAs will provide matrixed personnel to the CCP Offices with the required systems or discipline expertise to support all CCP Office CoFR activities and reviews as specified in this plan. The TAs are board members of each CoFR review through which CoFR decisions are processed. Technical Authorities may have Operational Readiness Reviews to evaluate their readiness to support launch and return activities, any issues identified during those reviews will be identified at the CCP FRR/FTRR i.e. the Medical Operations Readiness Reviews.

6.3 Support Organizations

To support CCP CTS CoFR activities, the CCP tasks various support organizations to perform Government Furnished Services, tasks, or activities. These Support Organizations include but are not limited to:

- Federal Aviation Administration
- KSC Information and Technology and Communications Services
- KSC Spaceport Integration and Services
- NASA Space Communications And Navigation (SCAN)
- NASA Public Affairs Office (PAO)
- USAF 45th Operations Group Detachment-3
- US Strategic Command (USSTRATCOM)

Each Support Organization is tasked from the CCP via a System Office, PC&I, or its contract specified as a Government Furnished Service. At each specified CoFR review, the tasking CCP office shall certify the completion of tasks and activities for which the Support Organizations are responsible, including the completion of tasks required to support the flight test or mission as applicable.

The tasking CCP office shall satisfy the applicable CoFR Endorsement and sub-endorsements statements defined in Appendix E verifying that the Support Organization is ready to support the flight test or mission.

6.4 NASA ISS Program

The NASA ISS Program will support the CCP CoFR reviews to the extent as specified in this plan. ISS CoFR responsibilities are specified in SSP 50108.

7.0 Certification of Flight Readiness Endorsement and Approval

7.1 Certification of Flight Readiness Endorsement

NASA CCP CTS CoFR Endorsements encompasses programmatic, design, as-built, and operational elements. For each CoFR Endorsement, a set of endorsement and sub-endorsement statements define the scope of the endorsement and enable the tracking of CoFR status and progress (reference Appendix E). Figure 7.1 below graphically depicts the CoFR elements and supporting themes.

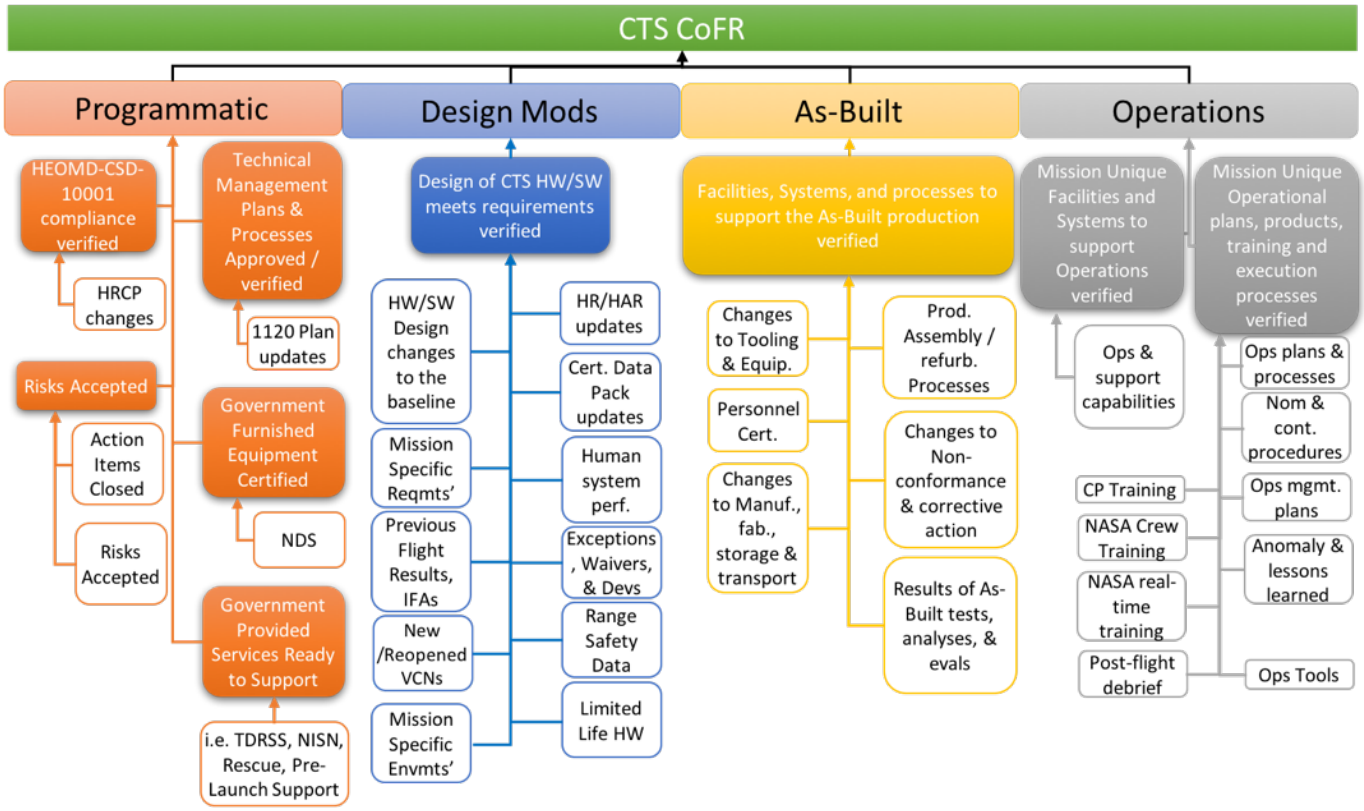


Figure 7.1: CoFR Theme/Statement Overview

Each CCP Office participating in the CCP CoFR process confirms that its CoFR activities and responsibilities are complete and meet the applicable endorsement statements. Of note, As-Built certification is related to the work for hardware production of the spacecraft and launch vehicle at the production facilities, and Operations certification includes the work related to the final assembly, integration, test and check out at the launch site, final preparations for landing and recovery, in addition to training development of the launch and mission support personnel. At each review, each CCP Office shall present the results of their CoFR assessment, including any CoFR Exceptions that have been identified. When the criteria for an Endorsement Statement cannot be completely met, it shall be documented as a CoFR Exception. The CoFR Exception process is described in Section 7.3.

7.1.1 Certification of Flight Readiness Endorsement Supporting Evidence

The work performed by NASA CCP in support of the CoFR Endorsement process is tracked in the CELL. The CELL database is described in Section 7.5.1. Commercial Provider-specific lists are located in CELL that link the supporting evidence necessary to meet the criteria to endorse the CoFR Certificate.

The supporting evidence for CoFR will be comprised of approval of Commercial Provider plans and evaluation of the Commercial Provider's data packages. Figure 7.2 is an overview of the types of evidence that could support CoFR statements. NASA's efforts for verification and validation of CCT-REQ-1130 and SSP 50808 requirements and certification statements of CCT-PLN-1120 technical management and process requirements are comprised of NASA approved Commercial Provider Certification products including: Alternate Standards and Variances to NASA's certification requirements; Safety and Reliability analysis products and Hazard Analysis Reports; V&V Plan and subsequent VCNs (including joint analyses and tests) and targeted independent assessment efforts; Certification Plan and subsequent Certification Data Package; and technical management plans and processes with subsequent audit/surveillance of compliance to the established processes. These efforts are conducted per the established CCP CoFR review and approval processes, including key board approvals leading to and contributing to CoFR confidence, referenced in Section 5.0.

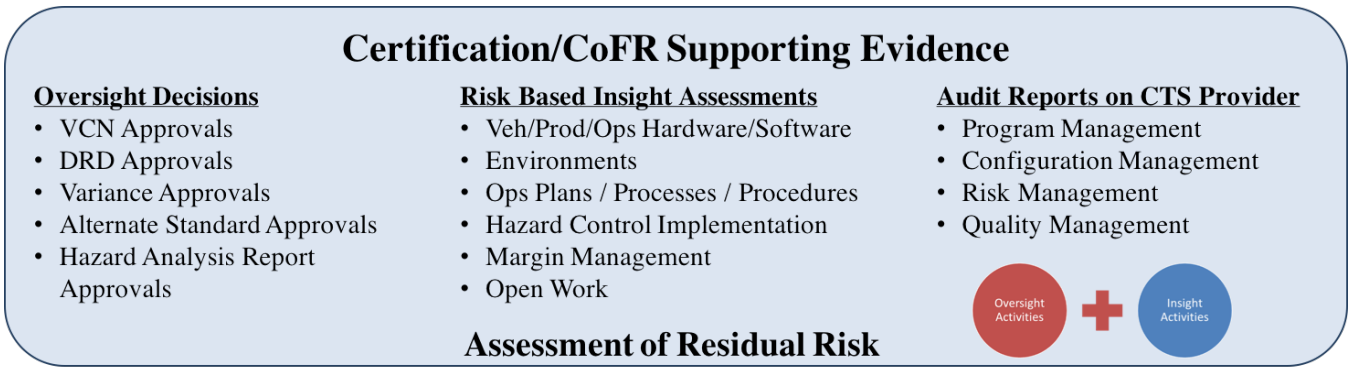
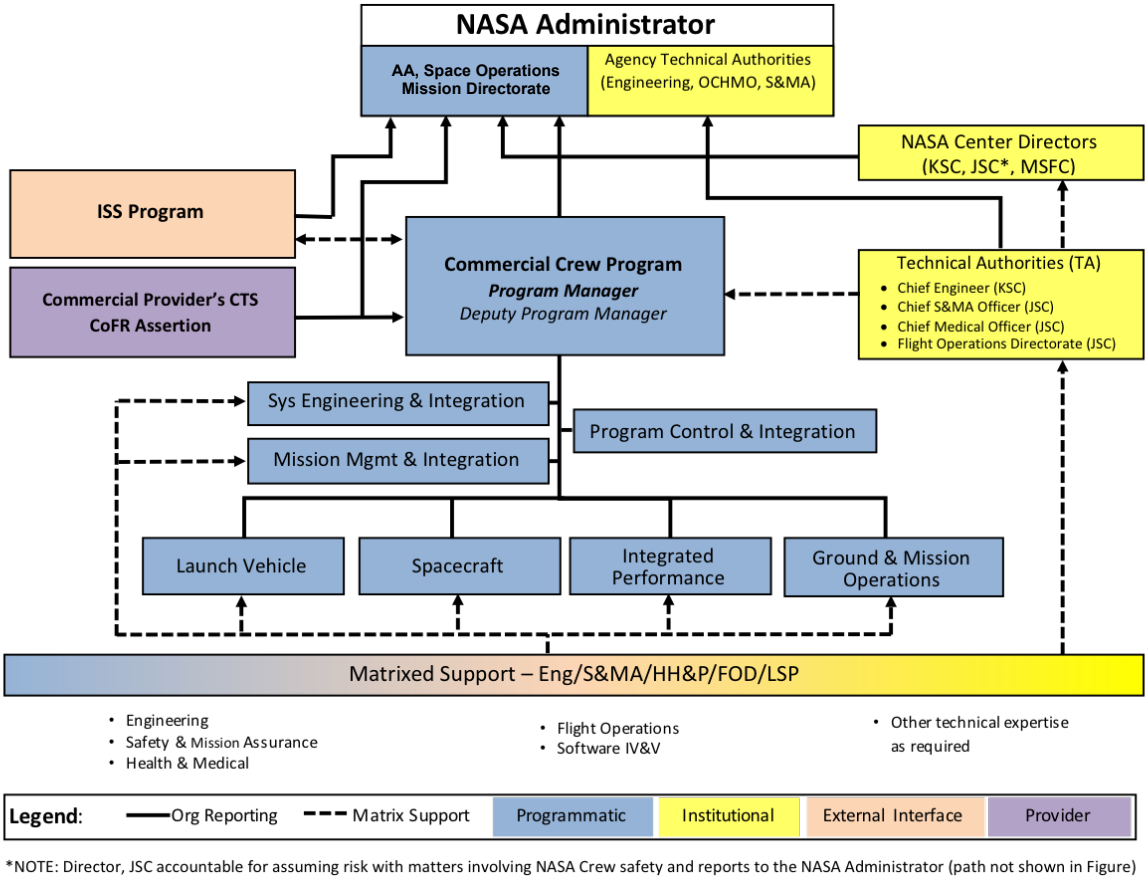


Figure 7.2: Certification/CoFR Supporting Evidence

7.2 Certification of Flight Readiness Approval

The NASA CTS CoFR is incrementally approved via an ISS Program SORR and a CCP FTRR/FRR with the Commercial Provider. These CoFR reviews with the Commercial Providers culminate in the Agency FTRR/FRR, where the Agency attests CTS CoFR for the mission. The Program FRR and Agency FRR Board members will endorse (sign) the CoFR Certificate. The CTS CoFR Certificate is considered endorsed when all signatures have been obtained. Figure 7.3, Agency CoFR Approval, illustrates the hierarchy of the CoFR approval process leading up to the NASA AA SOMD.



*NOTE: Director, JSC accountable for assuming risk with matters involving NASA Crew safety and reports to the NASA Administrator (path not shown in Figure)

Figure 7.3: Agency CoFR Approval

The Program and Agency reviews will be polled for CoFR concurrence, stating that all open items have been dispositioned or have been identified as standard open work and the body of evidence is ready to proceed to the next level review. The Readiness Poll process is described in Section 7.2.1.

7.2.1 Readiness Poll

A readiness poll of all Board members shall be conducted at the conclusion of each CoFR Review specified in this plan. When polled, the members are expected to state their recommendation from their perspective as a senior manager of their area of responsibility. Members are also expected to provide comments and recommendations on issues outside of their area of primary responsibility. When an issue is not in a member's primary area of expertise, members are expected to use their engineering and operational experience to ensure that a thorough exploration of relevant facts has been completed and that the meeting process has produced a logical conclusion. The Review Chair shall consider the poll results when formulating the final decision. The readiness poll shall be performed per a checklist, which shall be maintained as a CoFR record by the board secretariat and stored in the CCP SharePoint data repository.

7.3 Certification of Flight Readiness Endorsement Exception Process

When any of the criteria for a CoFR Endorsement Statement cannot be met due to non-standard open work a CoFR Exception is required, if so determined by the endorsing organization. Generally, a CoFR exception is used during the Program FRR and Agency FRR timeframes when CoFR Endorsements cannot be met. CoFR Exceptions may be granted against a specific or set of specific review success criteria statements or endorsement statements listed in Appendix E.

A CoFR Exception is used to document when the criteria for an Endorsement Statement cannot be completely met, or the non-standard open work will remain open at the Agency FRR or later. If there is non-standard open work that is open for CCP FRR but is expected to close prior to Agency FRR, a CoFR exception will not be required. CoFR Exceptions are required for any unsatisfied endorsement unless:

- An approved waiver or deviation exists for mandatory requirements that must be met to satisfy the completion of the CCP CoFR Endorsement statement.
- The completion of criteria for a specific Endorsement Statement is dependent upon the completion of standard work that is scheduled to occur after the Review.

A CoFR Exception follows the same general process regardless of which CoFR review at which it is generated. All paperwork must be filed prior to its presentation at the CoFR review, unless the exception is identified during the CoFR review.

A CoFR Exception shall be initiated and filed by the responsible endorsing organization prior to the submittal of their Review presentation charts. All exceptions and non-standard open work are to be listed within the Office's CoFR endorsement package, with a brief description of the activity, and the risk to flight (technical / schedule), with associated Estimated Completion Date (ECD) to support flight. Non-standard open work that presents potential exception at Agency FRR will be noted. All initiated CoFR Exceptions shall be included in the Review presentation charts submitted in accordance with the Review Announcement Memorandum.

In the event that a system office identifies a CoFR exception, the CoFR exception form CCT-T-2101 must be filled out and submitted prior to the next applicable mission CoFR review. All CoFR Exceptions must be dispositioned prior to flight. Closure is defined when the completion of identified actions which results in no longer having a CoFR exception or the CoFR exception, and any risk acceptance, has been dispositioned and approved by the CoFR board chair (either the CCP Program Manager and or the AA SOMD)

A CoFR Exception shall indicate the specific Endorsement Statement(s) that cannot be met. Exceptions are applicable only against the mission for which they are generated. Effectivity for multiple-mission exceptions will be considered on a case-by-case basis.

A CoFR Exception is generated at a specific CoFR review and will be assigned an action and actionee. The actionee is responsible for ensuring the completion of the action, collecting the required signatures, and presenting to the next higher-level review for approval. Figure 7.4, CoFR Exception Process, illustrates this concept.

At CCP FRR/FTRR/Return FRR-2 days, the final CoFR package for that flight will be under configuration control by MM&I. Any updates to the standard, non-standard open work or CoFR exceptions must be worked through MM&I.

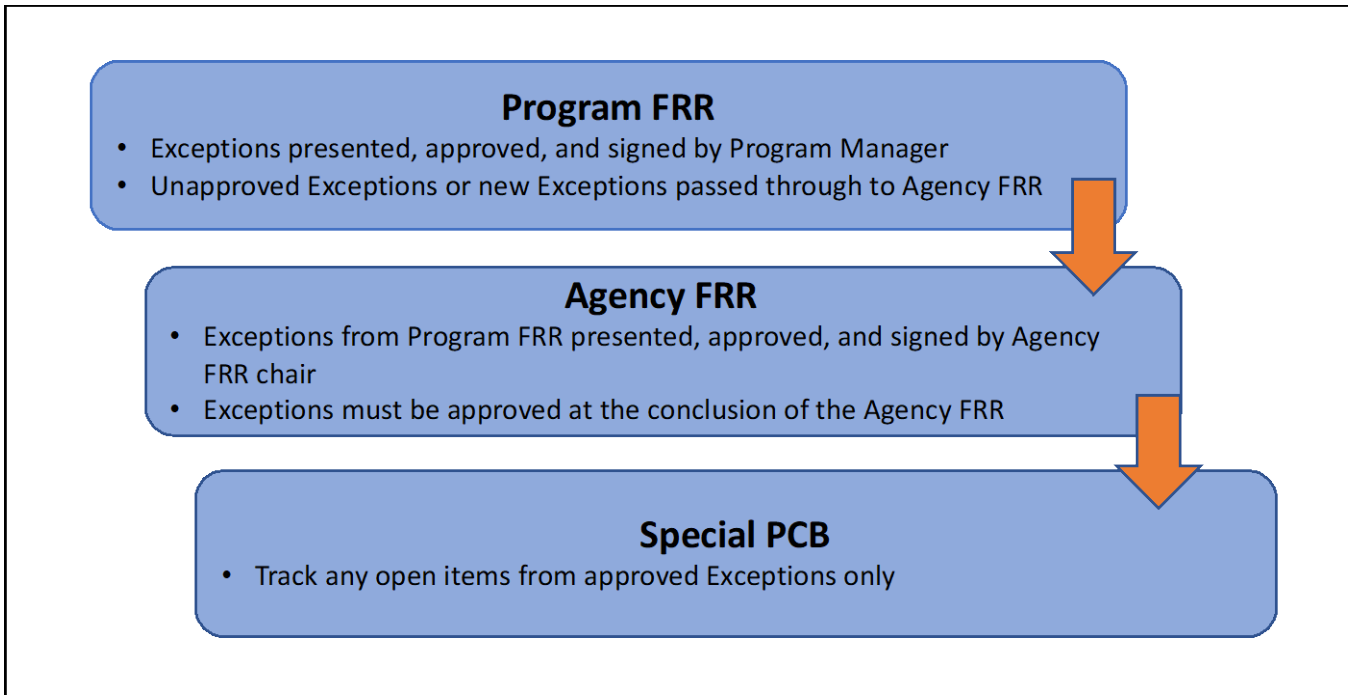


Figure 7.4: CoFR Exception Process

The CCP Manager, or designee, shall disposition and track all CoFR Exceptions. Each endorsing organization is responsible for ensuring a satisfactory closeout of their respective CoFR Exceptions.

The progress of the closeout activities shall be statused by MMI regularly to ensure closure of the CoFR Exception before the event with which it is associated.

7.4 Formal Dissents

Per NPD 1000.0, NASA Governance and Strategic Management Handbook, in assessing a decision or action, a member has three choices: agree, disagree but be willing to fully support the decision, or disagree and raise a formal dissent. Formal dissents shall be addressed using the process set forth in *Commercial Crew Program Control Board Charter and Process*, Section VI, (CCT-P-4001, Latest Issue), and a reclama may proceed all the way to the NASA Administrator as required. Formal dissents will also be documented in accordance with, *Program Plan Commercial Crew Program* (CCT-PLN-1000) Appendix C, 7120.5E Compliance Matrix.

Anyone at any level within the CCP will be able to raise a formal dissent. It is the responsibility of every board member of a CoFR review, whether within the Program or part of the TA, to ensure the review board is aware of formal dissents, that the formal dissents are discussed, and that the dissenter is advised of the disposition. The CoFR Review Board Chair (CCP Manager or delegate) will elevate, to the Center Management or Agency Management as appropriate, all decisions that have a formal dissent. The CoFR Review Board Chair (CCP Manager or delegate) and the representative of the dissenter's organization will jointly present the agreed upon facts and the respective positions, rationale, and recommendations.

Formal dissents that are elevated to Program and Agency reviews and/or are the result of being reclama-ed from the CCP PCB will be briefed as special topics at the Program FRR and/or Agency FRR. If the respective CoFR review chair decides to proceed and accept the risk posed by the formal dissent, the formal dissent will be documented and recorded. For CoFR reviews, formal dissents shall be logged against a specific endorsement. Formal dissents for each CoFR review may be logged at any time prior to, or during, the CoFR review.

If the dissenter is not satisfied with the process or outcome, the dissenter may appeal to the next higher level of management. As required, a reclama may proceed all the way to the NASA Administrator using the process set forth in CCT-P-4001.

7.5 Review Documentation

The CCP PC&I Office shall maintain the following official documentation of each CCP FTRR/FRR and Agency FTRR/FRR as Agency retention records in accordance with the *CCP File Plan* (KSC-R-2501, Latest Issue). The official documentation shall be stored in the CCP SharePoint data repository.

1. Action item log
2. Reference to applicable ISS Program CoFR Certificates in ISS Program data repository - signed
3. Reference to ISS Program CoFR Exceptions in ISS Program data repository
4. CCP CoFR Certificates - signed
5. CCP CoFR Exceptions
6. Agency CoFR Certificates - signed
7. Listing of Standard Open Work which is a constraint to an event
8. Signed Statements of Readiness for each organization
9. Review briefing materials
10. Delegation of authority letters
11. Readiness poll checklist – Signed
12. Approved review minutes (Records of the reviews will be detailed enough to review discussions and decision logic. Formal dissents will also be documented in accordance CCT-PLN-1000, Appendix C, 7120.5E Compliance Matrix.
13. Meeting audio recording

7.5.1 Certification/CoFR Evidence List and Log

The work performed by each CCP Office in support of the CoFR Endorsement buy off is tracked in the CELL. The CELL is a CCP generated, Commercial Provider-specific, database that links the specific list of tasks required to satisfy the CCP Office endorsements, defined in Appendix E, with the objective evidence of task performance.

The CELL is the CCP Office specific implementation plan of both Certification and CoFR. As tasks are completed within the CELL, the completion, as well as the evidence information and location (e.g. CCP SharePoint, CRADLE database, or Commercial Provider database) is logged into the CELL database.

Each CELL shall be under configuration control, maintained by the endorsing CCP Office, and available for review. At a minimum, the contents of the CELL shall:

1. Identify the task and the responsible CCP Office(s)
2. The completion status
3. Identify data products, tasks, and activities used to arrive at an endorsement decision, and the location of the data (e.g. CCP SharePoint, CRADLE database, or Commercial Provider database, etc.)

The **Mission Specific CoFR CELL** is maintained by MM&I for each Mission. Each CELL is Commercial Provider dependent, and contains any additional specifics required by each CCP Office to further define their overall CoFR implementation expectations between their stakeholders and the Commercial Providers. This includes:

- Definition of data products, tasks, and activities used to arrive at a certification decision
- Reconciliation of expectations with the system office stakeholders
- Identification of the person(s) accountable for the task to be completed

Appendix A: Acronyms

Acronym	Phrase
AA	Associate Administrator
AE	Approach Ellipsoid
AI	Approach Initiation
CCP	Commercial Crew Program
CELL	Certification / CoFR Evidence List/Log
CMMT	Commercial Crew Program Mission Management Team
CoFR	Certification of Flight Readiness
CoFTR	Certification of Flight Test Readiness
CR	Certification Review
CTS	Crew Transportation System
DCR	Design Certification Review
DPMC	Directorate Program Management Council
ECDs	Estimated Completion Dates
FAA	Federal Aviation Administration
FOD	Flight Operations Directorate
FOR	Flight Operations Review
FRR	Flight Readiness Review
FTRR	Flight Test Readiness Review
GFE	Government Furnished Equipment
HD/SW	Hardware/Software
HEA	Human Error Analysis
HEOMD	Human Exploration and Operations Mission Directorate
HH&P	Human Health and Performance
ICA	Interface Control Agreement
ICMC	Integrated Center Management Council
IMMT	International Space Station Program Mission Management Team
ISS	International Space Station
ISS TIO	International Space Station Transportation Integration Office
JSC	Johnson Space Center
KSC	Kennedy Space Center
MCR	Mission Certification Review
LOC/LOM	Loss of Crew/Loss of Mission
MIR	Mission Integration Review
MM&I	Mission Management and Integration
MRB	Material Review Board
MSFC	Marshall Space Flight Center
MOA	Memorandum of Agreement
MUA	Material Usage Agreement
OPR	Office of Primary Responsibility
ORR	Operational Readiness Review
PAA	Product Assurance Action

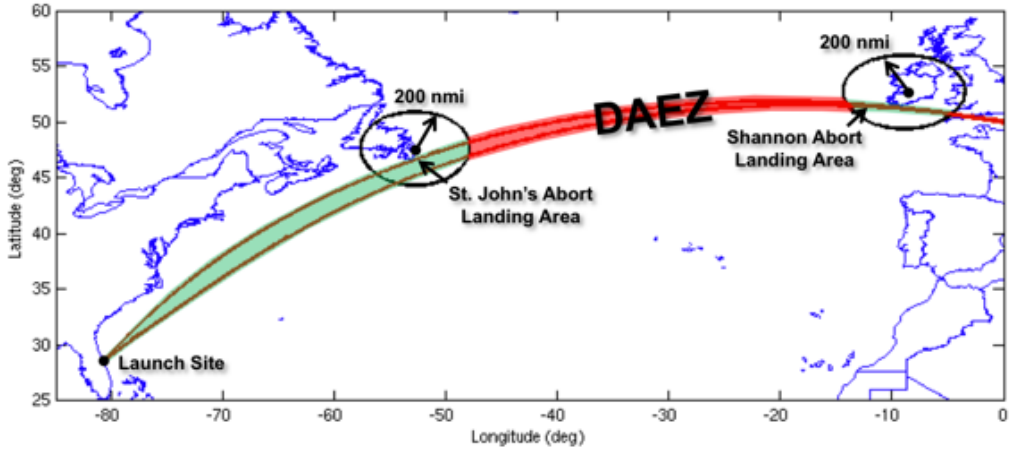
Acronym	Phrase
PAO	Public Affairs Office
PC&I	Program Control and Integration
PCM	Post Certification Mission
PQR	Post Qualification Review
SCAN	Space Communications And Navigation
SOMD	Space Operations Mission Directorate
rBA	Risk Based Insight Approach
RBA	Risk Based Analysis
SE&I	Systems Engineering and Integration
SORR	Stage Operations Readiness Review
SRP	Safety Review Panel
USSTRATCOM	United States Strategic Command
TA	Technical Authority
TBD	To Be Determined
URR	Undocking Readiness Review
VAR	Vehicle Assessment Review
VCN	Verification Closure Notice
VIDD	Vehicle Interface Definition Document

Appendix B: Definitions

Term	Definition
Abort	The forced early return of the crew when failures or the existence of uncontrolled catastrophic hazards prevent continuation of the mission profile and a return is required for crew survival.
Ambient Light	Any surrounding light source (existing lighting conditions). This could be a combination of natural lighting (e.g., sunlight, moonlight) and any artificial light source provided. For example, in an office there would be ambient light sources of both the natural sunlight and the fluorescent lights above (general office lighting).
Analysis	A verification method utilizing techniques and tools, such as math models, prior test data, simulations, analytical assessments, etc. Analysis may be used in lieu of, or in addition to, other methods to ensure compliance to specification requirements. The selected techniques may include, but not be limited to, task analysis, engineering analysis, statistics and qualitative analysis, computer and hardware simulations, and analog modeling. Analysis may be used when it can be determined that rigorous and accurate analysis is possible, test is not cost effective, and verification by inspection is not adequate.
Annunciate	To provide a visual, tactile, or audible indication.
Approach Ellipsoid	A 4 x 2 x 2 km ellipsoid, centered at the ISS center of mass, with the long axis aligned with the V-Bar.
Approach Initiation	The approach initiation is the first rendezvous maneuver during a nominal approach that is targeted to bring the vehicle inside the ISS approach ellipsoid (AE).
Ascent	The period of time from initial motion away from the launch pad until orbit insertion during a nominal flight or ascent abort initiation during an abort.
Ascent Abort	An abort performed during ascent, where the crewed spacecraft is separated from the launch vehicle without the capability to achieve the desired orbit. The crew is safely returned to a landing site in a portion of the spacecraft nominally used for entry and landing/touchdown.
Audit	A documented systematic, independent, official, examination, analysis, verification and validation of: records and other objective evidence of work performed; the requirements; the process or process requirements to determine compliance with requirements; and to assess the effectiveness of implementation and identify potential improvements.
Automated	Automatic (as opposed to human) control of a system or operation.
Autonomous	Ability of a space system to perform operations independent from any ground-based systems. This includes no communication with, or real-time support from, mission control or other ground systems.
Backout	During mission execution, the coordinated cessation of a current activity or procedure and careful return to a known, safe state.
Breakout	Any action that interrupts the nominally planned free flight operations that are intended to place the spacecraft outside of a threatening location to the cooperative vehicle. This may be an automated or manually executed action. For the ISS, the area within which a vehicle poses a threat to ISS is called the Approach Ellipse.

Term	Definition
Cargo	An item (or items) required to maintain the operability of the ISS and/or the health of its crew, and that must be launched and/or returned.
Catastrophic Event	An event resulting in the death or permanent disability of a ground closeout or flight crewmember, or an event resulting in the unplanned loss/destruction of a major element of the CTS or ISS during the mission that could potentially result in the death or permanent disability of a flight crewmember.
Catastrophic Hazard	A condition that could result in the death or permanent disability of a ground closeout or flight crewmember, or in the unplanned loss/destruction of a major element of the CTS during the mission that could potentially result in the death or permanent disability of a flight crewmember.
Certificate of Flight Readiness	A certificate containing a set of signed endorsements (wet ink or electronically) attesting to the readiness of flight systems, ground systems/facilities, software, personnel, flight products, and external Support Organizations to support all mission phases within acceptable levels of risk.
CoFR Endorsement	Statements certifying (attesting to) readiness for continuing towards launch/flight operations which are collected at the appropriate level for the review in which they are signed.
CoFR Exception	A CoFR Exception is used to document when the criteria for an Endorsement Statement cannot be completely met, or the non-standard open work will remain open at the Agency FRR or later.
CoFR Record	Any record retained as evidence of a successful CoFR process for each mission.
Command	Directive to a processor or system to perform a particular action or function.
Communications Coverage	Communication coverage is defined as successful link availability for nominal ascent and entry trajectories.
Communications Link	A communication link is established, whereas the received commands and voice from the CVCC to the spacecraft and the transmitted health and status data, crew health and medical related data, voice, telemetry, and transmitted launch vehicle and spacecraft engineering data are received.
Consumable	Resource that is consumed in the course of conducting a given mission. Examples include propellant, power, habitability items (e.g., gaseous oxygen), and crew supplies.
Continental U.S. Airport	An airport within the continental United States capable of accommodating executive jet aircraft similar to the Gulfstream series aircraft.
Contingency	Provisioning for an event or circumstance that is possible but cannot be predicted with certainty.
Contingency Spacecraft Crew Support (CSCS)	CSCS is declared when the spacecraft crew takes shelter on the ISS because the spacecraft has been determined to be unsafe for reentry. In this case, a rescue mission is required to return the spacecraft crew safely.
Crew	Any human onboard the spacecraft after the hatch is closed for flight or onboard the spacecraft during flight.

Term	Definition
Crew Transportation System (CTS)	The collection of all space-based and ground-based systems (encompassing hardware and software) used to conduct space missions or support activity in space, including, but not limited to, the integrated space vehicle, space-based communication and navigation systems, launch systems, and mission/launch control.
Critical	[1] The condition where failure to comply with prescribed contract requirements can potentially result in loss of life, serious personal injury, loss of mission, or loss of a significant mission resource. Common uses of the term include critical work, critical processes, critical attributes, and critical items. [2] A condition that may cause severe injury or occupational illness, or major property damage to facilities, systems, or flight hardware.
Critical Decision	Those technical decisions related to design, development, manufacturing, ground, or flight operations that may impact human safety or mission success, as measured by defined criteria.
Critical Fault	Any identified fault of software whose effect would result in a catastrophic event or abort.
Critical Function	Mission capabilities or system functions that, if lost, would result in a catastrophic event or an abort.
Critical Hazard	A condition that may cause a severe injury or occupational illness.
Critical Software	Any software component whose behavior or performance could lead to a catastrophic event or abort. This includes the flight software, as well as ground-control software.
Critical Software/Firmware	Software/Firmware that resides in a safety-critical system that is a potential hazard cause or contributor, supports a hazard control or mitigation, controls safety-critical functions, or detects and reports 1) fault trends that indicate a potential hazard and/or 2) failures which lead to a hazardous condition.
Critical (sub)System	A (sub)system is assessed as critical if loss of overall (sub)system function, or improper performance of a (sub)system function, could result in a catastrophic event or abort.
CTS Certification	CTS certification is the documented authorization granted by the NASA Associate Administrator that allows the use of the CTS within its prescribed parameters for its defined reference missions. CTS certification is obtained prior to the first crewed flight (for flight elements) or operational use (for other systems).
CTS Element	One component part of the overall Crew Transportation System. For example, the spacecraft is an element of the CTS.
Deconditioned	"Deconditioned" defines a space crewmember whose physiological capabilities, including musculoskeletal, cardiopulmonary, and neurovestibular, have deteriorated as a result of exposure to micro-gravity and the space environment. It results in degraded crewmember performance for nominal and off-nominal mission tasks.
Definitive Medical Care	An inpatient medical care facility capable of comprehensive diagnosis and treatment of a crewmember's injuries or illness without outside assistance—capable of care of Category I, II, and III trauma patients. Usually a Level I trauma center, as defined by the American College of Surgeons.

Term	Definition
Demonstration	A method of verification that consists of a qualitative determination of the properties of a test article. This qualitative determination is made through observation, with or without special test equipment or instrumentation, which verifies characteristics, such as human engineering features, services, access features, and transportability. Human-in-the-loop demonstration is performed for complex interfaces or operations that are difficult to verify through modeling analysis, such as physical accommodation for crew ingress and egress. Demonstration requirements are normally implemented within a test plan, operations plan, or test procedure.
Direct Handover	Handover of crew in ISS, where a new crew launches before the old crew departs, and the crew of both vehicles are temporarily abroad ISS at the same time.
Dissenting Opinion	A disagreement with a decision or action that an individual judges is of sufficient importance that it warrants a specific review and decision by higher level management and the individual specifically requests that the dissent be recorded and resolved by the dissenting opinion process.
Docking	Mating of two independently operating spacecraft or other systems in space using independent control of the two vehicles' flight paths and attitudes during contact and capture. Docking begins at the time of initial contact of the vehicles' docking mechanisms and concludes when full rigidization of the interface is achieved.
Downrange Abort Exclusion Zone	A geographical region of the North Atlantic Ocean to be avoided for water landings during ascent aborts for ISS missions due to rough seas and cold water temperatures. The region is depicted in Figure B-1. The St. John's abort landing area includes the waters within 200 nmi range to St John's International Airport (47° 37' N, 52° 45' W). The Shannon abort landing area includes the waters within 200 nmi range to Shannon International Airport (52° 42' N, 8° 55' W). Note: The northern and southern bounds of the DAEZ in the ISS Mission DAEZ figure are notional, as these bounds are limited only by steering and cross-range performance along the ascent trajectory and are not formally constrained.
Downrange Abort Exclusion Zone Figure	 **Figure B-1 Ascent Downrange Abort Exclusion Zone**

Term	Definition
Emergency	An unexpected event or events during a mission that requires immediate action to keep the crew alive or serious injury from occurring.
Emergency Egress	Capability for a crew to exit the vehicle and leave the hazardous situation or catastrophic event within the specified time. Flight crew emergency egress can be unassisted or assisted by ground personnel.
Emergency Equipment and Systems	Systems (ground or flight) that exist solely to prevent loss of life in the presence of imminent catastrophic conditions. Examples include fire suppression systems and extinguishers, emergency breathing devices, Personal Protective Equipment (PPE) and crew escape systems. Emergency systems are not considered a leg of failure tolerance for the nominal, operational equipment and systems, and do not serve as a design control to prevent the occurrence of a catastrophic condition.
Emergency Medical Services	Services required to provide the crewmembers with immediate medical care to prevent loss of life or aggravated physical or psychological conditions.
End of Mission	The planned landing time for the entire mission, including the nominal pre-flight agreed to docked mission duration.
Entry	The period of time that begins with the final commitment to enter the atmosphere from orbit or from an ascent abort, and ending when the velocity of the spacecraft is zero relative to the landing surface.
Entry Interface	The point in the entry phase where the spacecraft contacts the atmosphere (typically at a geodetic altitude of 400,000 feet), resulting in increased heating to the thermal protection system and remainder of the spacecraft exterior surfaces.
External Launch Constraint	Conditions outside the CTS Commercial Provider's control, such as range weather constraints or faults with range or ISS assets, or weather constraints affecting abort rescue forces capabilities. Range weather examples include ability to visually monitor the initial phases of the launch for range safety, etc. Non-weather range constraints include range safety radar and telemetry systems availability, flight termination systems readiness, clearance of air, land, sea, etc.
Failure	Inability of a system, subsystem, component, or part to perform its required function within specified limits.
Failure Tolerance	The ability to sustain a certain number of failures and still retain capability. A component, subsystem, or system that cannot sustain at least one failure is not considered to be failure tolerant.
Fault	An undesired system state and/or the immediate cause of failure (e.g., maladjustment, misalignment, defect, or other). The definition of the term “fault” envelopes the word “failure,” since faults include other undesired events, such as software anomalies and operational anomalies. Faults at a lower level could lead to failures at the higher subsystem or system level.
Flight Configuration	The arrangement, orientation and operational state of system elements and cargo, vehicle cabin layout, flight software mode, and crew complement, clothing and equipment in the applicable mission or ground phase necessary in verification to evaluate the attributes called out in the requirement.
Flight Hardware	All components and systems that comprise the internal and external portions of the spacecraft, launch vehicle, launch abort system, and crew worn equipment.

Term	Definition
Flight Operations	All operations of the integrated space vehicle and the crew and ground teams supporting the integrated space vehicle from liftoff until landing.
Flight Phase	A particular phase or timeframe during a mission is referred to as a flight phase. The term "all flight phases" is defined as the following flight phases: pre-launch, ascent, onorbit free-flight, docked operations, deorbit/entry, landing, and post-landing.
Flight Representative	Description of a test-article used in verifications in which the attributes under evaluation are equivalent to the flight article. Example: Human-in-the-loop tests for spacecraft egress must use an equivalent cabin layout, seats and restraints, and hatch configuration and masses. However, the propulsion system does not need to be functional, as it is not under evaluation.
Flight Rules	Established redline limits for critical flight parameters. Each has pre-planned troubleshooting procedures with pre-approved decisions for expected troubleshooting results.
Flight Systems	Any equipment, system, subsystem or component that is part of the integrated space system.
Flight Termination	An emergency action taken by range safety when a vehicle violates established safety criteria for the protection of life and property. This action circumvents the vehicles' normal control modes and ends its powered and/or controlled flight.
Free Flight Operations	Onorbit operations that occur when the spacecraft is not in contact with any part of the ISS.
Ground Crew	Operations personnel that assist the NASA Crew in entering the spacecraft, closing the hatch, performing leak checks, and working on the integrated space vehicle at the pad during launch operations.
Ground Hardware	All components and systems that reside on the ground in support of the mission, including the Commercial Vehicle Control Center, launch pad, ground support equipment, recovery equipment, facilities, and communications, network, and tracking equipment.
Ground Processing	The work required to prepare the launch vehicle and spacecraft for mission from final assembly/integration/test through launch and resumes after landing for recovery of crew and cargo.
Ground Support Equipment	Any non-flight equipment, system(s), ground system(s), or devices specifically designed and developed for a direct physical or functional interface with flight hardware to support the execution of ground production or processing. The following are not considered to be GSE: • Tools designed for general use and not specifically for use on flight hardware. • Ground Support Systems that interface with GSE Facilities.
Habitable	The environment that is necessary to sustain the life of the crew and to allow the crew to perform their functions in an efficient manner.
Hazard	A state or a set of conditions, internal or external to a system, that has the potential to cause harm.

Term	Definition
Hazard Analysis	The process of identifying hazards and their potential causal factors.
Health and Status Data	Data, including emergency, caution, and warning data, that can be analyzed or monitored describing the ability of the system or system components to meet their performance requirements.
Human Error	Either an action that is not intended or desired by the human or a failure on the part of the human to perform a prescribed action within specified limits of accuracy, sequence, or time that fails to produce the expected result and has led or has the potential to lead to an unwanted consequence.
Human Error Analysis (HEA)	A systematic approach used to evaluate human actions, identify potential human error, model human performance, and qualitatively characterize how human error affects a system. HEA provides an evaluation of human actions and error in an effort to generate system improvements that reduce the frequency of error and minimize the negative effects on the system. HEA is the first step in Human Risk Assessment and is often referred to as qualitative Human Risk Assessment.
Human-in-the-Loop Evaluation	Human-in-the-loop evaluations involve having human subjects, which include NASA crewmembers as a subset of the test subject population, perform identified tasks in a representative mockup, prototype, engineering, or flight unit. The fidelity of mockups used for human-in-the-loop evaluations may range from low-fidelity, minimal representation, to high-fidelity, complete physical and/or functional representation, relevant to the evaluation. Ideally, the fidelity of human-in-the-loop mockups and tests increases as designs mature for more comprehensive evaluations. Further information on human-in-the-loop evaluations throughout system design can be found in JSC 65995 CHSIP.
Human-System Integration	The process of integrating human operations into the system design through analysis, testing, and modeling of human performance, interface controls/displays, and human-automation interaction to improve safety, efficiency, and mission success.
Ill or Injured	Refers to a crewmember whose physiological and/or psychological well-being and health has deteriorated as a result of an illness (e.g., appendicitis) or injury (e.g., trauma, toxic exposure) and requires medical capabilities exceeding those available on the ISS and transportation to ground-based definitive medical care. Ill or injured crewmember performance for nominal and off-nominal mission tasks will be degraded.
Inspection	A method of verification that determines conformance to requirements by the use of standard quality control methods to ensure compliance by review of drawings and data. This method is used wherever documents or data can be visually used to verify the physical characteristics of the product instead of the performance of the product.
Integrated Operations	All operations starting at 90 minutes prior to the ISS Approach Initiation and lasting until the vehicle leaves the ISS Approach Ellipsoid on a non-return trajectory.
Integrated Space Vehicle	The integrated space vehicle includes all flight elements physically connected for the phase of flight from post lift-off until spacecraft separation.
Landing	The final phase or region of flight consisting of transition from descent to an approach, touchdown, and coming to rest.

Term	Definition
Landing Site	**Supported Landing Sites:** A fully supported site on a Continental U.S. land mass or waters directly extending from the coast with CTS recovery forces on station at the time of landing. The landing site zone extends through nominally expected dispersions from the landing site point. Designated Primary Landing Site – A supported landing site-intended for landing at the time of spacecraft undock. Alternate Landing Site – A supported landing site to which the spacecraft landing can be diverted in the event the deorbit burn is delayed. **Unsupported Landing Sites:** Emergency Landing – Any unsupported site (land or water) arrived at due to critical failures that force immediate return and preclude landing at a designated primary or alternate landing sites.
Launch Commit Criteria	Established redline limits for critical launch parameters. Each has pre-planned troubleshooting procedures with pre-approved decisions for expected troubleshooting results.
Launch Opportunity	The period of time during which the relative position of the launch site, the ISS orbital plane, and ISS phase angle permit the launch vehicle to insert the spacecraft into a rendezvous trajectory with the ISS (northerly launches only due to range constraints). The ISS is in-plane with the Eastern Range approximately every 23 hours and 36 minutes.
Launch Probability	The probability that the system will successfully complete a scheduled launch event. The launch opportunity will be considered scheduled at 24 hours prior to the opening of the launch window.
Launch Vehicle	The vehicle that contains the propulsion system necessary to deliver the energy required to insert the spacecraft into orbit.
Life-Cycle	The totality of a program or project extending from formulation through implementation, encompassing the elements of design, development, verification, production, operation, maintenance, support, and disposal.
Loss of Crew	Death or permanently debilitating injury to one or more crewmembers.
Loss of Mission	Loss of, or the inability to complete enough of, the primary mission objectives, such that a repeat mission must be flown.
Maintenance	The function of keeping items or equipment in, or restoring them to, a specified operational condition. It includes servicing, test, inspection, adjustment/alignment, removal, replacement, access, assembly/disassembly, lubrication, operation, decontamination, installation, fault location, calibration, condition determination, repair, modification, overhaul, rebuilding, and reclamation.
Manual Control	The crew's ability to bypass automation in order to exert direct control over a space system or operation. For control of a spacecraft's flight path, manual control is the ability for the crew to affect any flight path within the capability of the flight control system. Similarly, for control of a spacecraft's attitude, manual control is the ability for the crew to affect any attitude within the capability of the flight/attitude control system.

Term	Definition
MCC-H Mission Authority	• MCC-H has authority to make final decisions regarding spacecraft operations, including but not limited to Go/No-Go decisions and safety of flight and crew(s). • Beginning with either ISS integrated operations, or 30 minutes before the first required ISS configuration or crew activity in support of the spacecraft on rendezvous (e.g., ISS attitude maneuver, appendage configuration, USOS GPS configuration), whichever comes first. • Ending with either the end of ISS integrated operations, or when ISS is not required to maintain its configuration (e.g., ISS attitude, USOS GPS configuration, or appendages in a configuration) to support the spacecraft, whichever comes later. • Applies anytime the spacecraft free-drift trajectory, including dispersions, is predicted to enter the ISS AE within the next 24 hours.
Mission	The mission begins with entry of the crew into the spacecraft, includes delivery of the crew to/from ISS, and ends with successful delivery of the crew to NASA after landing.
Mission Critical	Item or function that must retain its operational capability to assure no mission failure (i.e., for mission success).
NASA Crew	The NASA crewmembers or the NASA sponsored crewmembers. These include international partner crewmembers.
Operations Personnel	All persons supporting ground operations or flight operations functions of the CTS. Examples of these personnel are listed below: Persons responsible for the production, assembly/integration/test, validation, and maintenance of flight hardware, production facilities, launch site facilities, operations facilities, or ground support equipment (GSE). Persons involved with supporting or managing the launch countdown, crew training, or mission during flight. Persons involved in post-flight recovery.
Orbit	This flight phase starts just after final orbit insertion and ends at the completion of the first deorbit burn.
Non-Standard Open Work	Work that is not a part of the normal standard work process.
Override	To take precedence over system control functions.
Pad Abort	An abort performed where the crewed spacecraft is separated from the launch vehicle while the launch vehicle remains on the launch pad. As a result, the crewed spacecraft is safely transported to an area which is not susceptible to the dangers associated with the hazardous environment at the launch pad.
Permanent Disability	A non-fatal occupational injury or illness resulting in permanent impairment through loss of, or compromised use of, a critical part of the body, to include major limbs (e.g., arm, leg), critical sensory organs (e.g., eye), critical life-supporting organs (e.g., heart, lungs, brain), and/or body parts controlling major motor functions (e.g., spine, neck). Therefore, permanent disability includes a non-fatal injury or occupational illness that permanently incapacitates a person to the extent that he or she cannot be rehabilitated to achieve gainful employment in their trained occupation and results in a medical discharge from duties or civilian equivalent.

Term	Definition
Portable Fire Suppression System	A system comprised of one or more portable handheld fire extinguishers and access ports. These access ports allow the user to discharge fire suppressant into enclosed areas with potential ignition sources. See also 3.10.12.2 Use of Hazardous Chemicals.
Post-Landing	The mission phase beginning with the actual landing event when the vehicle has no horizontal or vertical motion relative to the surface and ending when the last crewmember is loaded on the aircraft for return to JSC.
Process Witnessing	A physical observation of each Commercial Provider's work processes or demonstrations (including tests) to ensure compliance with documented procedure(s) and contract requirements. Includes processes related to manufacturing, fabrication, assembly, integration, repair, maintenance, refurbishment, test, and inspection.
Product Assurance Action (PAA)	A mandatory Government surveillance activity focusing on a particular aspect of the Commercial Provider's integrated Crew Transportation System where the government assures the product or service being delivered meets the requirements as defined by Commercial Crew Program. A PAA can be accomplished by performing one of the following - audit, process witness, product examination, or record review.
Product Examination	A physical inspection, measurement, or test to ensure product conformity to prescribed technical and contract requirements. This method may also include Engineering's independent Verification and Validation of an analysis, model, simulation, or test results.
Proximity Operations	The flight phase including all times during which the vehicle is in free flight beginning just prior to Approach Initiation (AI) execution and ending when the vehicle leaves the Approach Ellipsoid (AE).
Quiescent Docked Operations	The state of the CTS spacecraft while it is docked to the ISS with hatches open and ISS services, as called out in SSP 50808, connected and operational. From this state, the vehicle can support immediate ingress and transition into safe haven in the case of an emergency.
Record Review	A review and verification that recorded data properly evidences conformance to contract requirements (e.g., invoked drawings, specifications). Recorded data, including contractually required data deliverables, may document work performance, product attributes, product configuration, product performance, or quality assurance actions performed by each Commercial Provider.
Recovery	The process of proceeding to a designated nominal landing site, and retrieving crew, flight crew equipment, cargo, and payloads after a planned nominal landing.
Reliability	The probability that a system of hardware, software, and human elements will function as intended over a specified period of time under specified environmental conditions.
Rendezvous	The flight phase of executing a series of onorbit maneuvers to move the spacecraft into the proximity of its target. This phase starts with orbit insertion and ends just prior to the approach initiation.

Term	Definition
Risk Based Analysis (RBA)	A risk tool, whose application for CCP, is to independently assess all Commercial Providers' safety-critical attributes (areas, processes) for completeness, and adequate residual risk mitigation for all Program phases. It assigns *Government Quality Assurance* functions to any attribute (process, area) determined by the analysis to have residual risk which requires additional mitigation. It is an iterative analysis, updated as the Commercial Provider -specific risk changes, and is based on a comprehensive understanding of the design, development, test, critical manufacturing / assembly processes, and operations.
Safe Haven	A functional association of capabilities and environments that is initiated and activated in the event of a potentially life-threatening anomaly and allows human survival until rescue, the event ends, or repair can be affected. It is a location at a safe distance from or closed off from the life-threatening anomaly.
Safety	The absence from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment.
Safety Critical	A condition, event, operation, process, function, equipment or system (including software and firmware) with potential for personnel injury or loss, or with potential for loss or damage to vehicles, equipment or facilities, loss or excessive degradation of the function of critical equipment, or which is necessary to control a hazard.
Search and Rescue	The process of locating the crew, proceeding to their position, and providing assistance.
Software	Computer instructions or data stored electronically. Systems software includes the operating system and all the utilities that enable the computer to function. Applications software includes programs that do real work for users, such as word processors, spreadsheets, data management systems, and analysis tools. Software can be Commercial Off-The-Shelf (COTS), contractor developed, Government furnished, or combinations thereof.
Spacecraft	All system elements that are occupied by the crew during the space mission and provide life support functions for the crew. The crewed element includes all the subsystems that provide life support functions for the crew.
Space System	The collection of all space-based and ground-based systems (encompassing hardware and software) used to conduct space missions or support activity in space, including, but not limited to, the integrated space vehicle, space-based communication and navigation systems, launch systems, and mission/launch control.
Standard Open Work	Open work that is known in advance and which cannot be completed until some planned future event.
Standard Work	Work that occurs at part of the normal planned process.
Stowage	The accommodation of physical items in a safe and secure manner in the spacecraft. This does not imply that resources other than physical accommodations (e.g., power, thermal, etc.) are supplied.

Term	Definition
Subsystem	A secondary or subordinate system within a system (such as the spacecraft) that performs a specific function or functions. Examples include electrical power, guidance and navigation, attitude control, telemetry, thermal control, propulsion, structures subsystems. A subsystem may consist of several components (hardware and software) and may include interconnection items such as cables or tubing and the support structure to which they are mounted.
System	The aggregate of the ground segment, flight segment, and workforce required for crew rescue and crew transport.
Task Analysis	Task analysis is an iterative human-centered design process through which user tasks are identified and analyzed. It involves 1) the identification of the tasks and subtasks involved in a process or system, and 2) analysis of those tasks (e.g., who performs them, what equipment is used, under what conditions, the priority of the task, dependence on other tasks). The focus is on the human and how they perform the task, rather than the system. Results can help determine the hardware or software that should be developed/used for a particular task, the ideal allocation of tasks to humans vs. automation, and the criticality of tasks, which drive design decisions. Further information on task analysis can be found in JSC 65995 CHSIP, Section 4.1.
Test	A method of verification in which technical means, such as the use of special equipment, instrumentation, simulation techniques, and the application of established principles and procedures, are used for the evaluation of components, subsystems, and systems to determine compliance with requirements. Test will be selected as the primary method when analytical techniques do not produce adequate results; failure modes exist, which could compromise personnel safety, adversely affect flight systems or payload operation, or result in a loss of mission objectives. The analysis of data derived from tests is an integral part of the test program and should not be confused with analysis as defined above. Tests will be used to determine quantitative compliance to requirements and produce quantitative results.
Time-Critical Cargo	Cargo that requires late stowage pre-launch (within 24 hours of launch) and early removal post-landing (within 1 hour of crew egress).
Transport	Launch of crew and cargo to and return from the ISS.
Validation	Proof that the product accomplishes the intended purpose. May be determined by a combination of test, analysis, and demonstration.
Verification	Proof of compliance with a requirement or specifications based on a combination of test, analysis, demonstration, and inspection.

Appendix C: Agency, Center, and Technical Authority Endorsement Statements

Consistent with the Agency governance framework defined in NPD 1000.0 and the NASA CTS certification philosophy defined in HEOMD-CSD-10001, this Appendix defines the Agency CTS Certification of Flight Readiness Approval statement and the supporting Concurrence statements from the Center Directors and the Technical Authorities.

Approval	
NASA Associate Administrator for Space Operations Mission Directorate	The Flight Readiness Review Board has conducted a comprehensive assessment of the readiness of the Commercial Provider's CoFR assertion of the CTS flight and ground systems and supporting personnel. The FRR Board has also conducted a comprehensive assessment of the readiness of the integrated CTS, including the certification of the launch vehicle, spacecraft, ground, and mission operations to NASA's CTS requirements documented in HEOMD-CSD-10001. The CoFR assertion of the CTS has been endorsed by both the CCP and ISS Program. I have concluded, with the concurrence of the Flight Readiness Review Board that pending satisfactory completion of standard open work, the CTS is ready to execute the mission, as briefed, and the ISS Program is ready for on-orbit operations, as briefed, and that based on the flight readiness certification and residual risk posture, I authorize NASA Crew to fly on the Commercial Provider's CTS for this mission.
Concurrence	
Director, JSC	I have determined, with inputs from the Technical Authorities, that the technical management processes and requirements documented in CCT-PLN-1120, CCT-REQ-1130, and SSP 50808 have been adhered to and that technical requirement variances to NASA's CTS requirements, documented in the aforementioned documents, have been satisfactorily dispositioned, and that residual technical risk due to hazards, waivers, non-compliances, etc. have been appropriately characterized and assessed as reasonable by the technical authorities in support of the Program's risk acceptance decision. I have also determined, with inputs from the Technical Authorities, including Flight Operations, serving as the technical authority for the NASA Crew, that the Commercial Provider's readiness for flight is acceptable for NASA Crew based on adherence to technical management processes and requirements, approved variances, and appropriately characterized residual technical risk. I have also determined, with input from Flight Operations, serving as the technical authority for the NASA Crew, that the NASA Crew have been trained on the CTS operations by the Commercial Provider and are ready to support this mission. As a member of the FRR Board, and consistent with my assigned technical responsibility and cognizance of my Center for independent technical authority, and safety and mission assurance, I have determined that the CCP and ISS Program have substantiated the Commercial Provider's CoFR assertion to ensure compliance with NASA requirements and NASA Crew safety. Pending satisfactory completion of standard open work, I concur with proceeding with this mission.

Director, KSC	I have determined, with inputs from the Technical Authorities, that the technical management processes and requirements documented in CCT-PLN-1120, CCT-REQ-1130, and SSP 50808 have been adhered to and that technical requirement variances to NASA's CTS requirements, documented in the aforementioned documents, have been satisfactorily dispositioned, and that residual technical risk due to hazards, waivers, non-compliances, etc. have been appropriately characterized and assessed as reasonable by the technical authorities in support of the Program's risk acceptance decision. As a member of the FRR Board, and consistent with my assigned technical responsibility and cognizance of my Center for independent technical authority, and safety and mission assurance, I have determined that the CCP and ISSP have substantiated the Commercial Provider's CoFR assertion to ensure compliance with NASA requirements and NASA Crew safety. Pending satisfactory completion of standard open work, I concur with proceeding with this mission.
Director, MSFC	I have determined, based on my Center's focused evaluation of the Commercial Provider's flight system readiness assessments, that the Commercial Provider has provided adequate evidence under the shared assurance operational model of meeting the technical management processes and requirements documented in CCT-PLN-1120, CCT-REQ-1130, and SSP 50808 and that alternate standards and technical requirement variances to NASA's CTS requirements, documented in the aforementioned documents, have been satisfactorily implemented and dispositioned. I have also determined that residual technical risk due to hazards, waivers, non-compliances from pertinent review areas have been appropriately characterized and assessed in support of the Program's risk acceptance decision. As a member of the FRR Board, and consistent with the assigned technical responsibility and cognizance of my Center for independent technical authority, and safety and mission assurance, I have determined that the CCP and ISSP have substantiated for the content above that the Commercial Provider's CoFR assertion to ensure compliance with NASA requirements and NASA Crew safety. Pending satisfactory completion of standard open work, I concur with proceeding with this mission.
Agency Chief Engineer	I have determined that the Engineering technical requirements and applicable standards/specifications related to Flight Safety documented in CCT-PLN-1120, CCT-REQ-1130, and SSP 50808 have been adhered to and that technical requirement variances to NASA's CTS requirements related to Engineering, documented in the aforementioned documents, have been satisfactorily reviewed and dispositioned, and that residual safety of flight technical risk due to hazards, waivers, non-compliances, etc. have been appropriately characterized and assessed as reasonable by the Engineering technical authority in support of the Program's risk acceptance decision. I have reviewed the CCP and Center Engineering organizations' status of preparations for this mission, as briefed. I concur with proceeding with this mission.

Agency Chief Safety Officer	I have determined that the technical management processes and requirements documented in CCT-PLN-1120, CCT-REQ-1130, and SSP 50808 have been adhered to and that technical requirement variances to NASA's CTS requirements related to Safety and Mission Assurance, documented in the aforementioned documents have been satisfactorily reviewed and dispositioned, and that residual technical risk due to hazards, waivers, non-compliances, etc. have been appropriately characterized and assessed as reasonable by the Safety and Mission Assurance technical authority in support of the Program's risk acceptance decision. I have reviewed the CCP and Center S&MA organizations' status of preparations for this mission, as briefed. I concur with proceeding with this mission.
Agency Chief Health and Medical Officer	I have determined that the technical management processes and requirements documented in CCT-PLN-1120, CCT-REQ-1130, and SSP 50808 have been adhered to and that technical requirement variances to NASA's CTS requirements related to CTS Human Health and Performance, documented in the aforementioned documents have been satisfactorily reviewed and dispositioned, and that residual technical risk due to hazards, waivers, non-compliances, etc. have been appropriately characterized and assessed as reasonable by the Health and Medical technical authority in support of the Program's risk acceptance decision. I have reviewed the CCP and Center HH&P organizations' status of preparations for this mission, including those identified by Risk Based Analysis, as briefed. I concur with proceeding with this mission.

Appendix D: CCP CoFR Approval and Commercial Provider CoFR Substantiation

This Appendix defines the CCP CTS Certification of Flight Readiness Approval statement, the Concurrence statements from the participating NASA Organizations and the Technical Authorities, and the Commercial Provider's Substantiation statement.

Approval	
Manager, CCP	The Commercial Provider has certified the Crew Transportation System (CTS) for this mission. NASA has approved all Verification Closure Notices and Hazard Reports. All required NASA approved Commercial Provider plans are in place and implemented in accordance with CCT-PLN-1120. Deviations, exceptions, or waivers to CCP's requirements (CCT-REQ-1130) for the *ISS Design Reference Mission* (CCT-DRM-1110) have been approved and will be dispositioned by the MMT L-1 Day Review for this mission. The Commercial Crew Program is ready to proceed with this mission.
Concurrence	
NASA Organizations	The Certification of Flight Readiness Process documented in CCT-PLN-2100, NASA CTS Certification of Flight Readiness Plan, has been satisfied. Review of required products and verifications, including those areas identified by a Risk Based Analysis, for each organization have been or will be produced or completed. The following NASA organizations have completed or plan to complete audit, insight, and approval of the applicable Commercial Provider activities and deliverables, and have resolved all discrepancies. Government Furnished Services tasked by my organization are ready to support the Commercial Provider mission activities, as applicable. CCP Ground and Mission Operations CCP Integrated Performance Office CCP Launch Vehicle Office CCP Mission Management and Integration Office CCP Program Control and Integration Office CCP Spacecraft Office CCP Systems Engineering and Integration Office CCP Chief Engineer CCP Chief Safety and Mission Assurance Officer HMTA Delegate for Commercial Crew Program Flight Operations Directorate Based on the satisfaction of the review requirements applicable to my organization, I concur to proceed with this mission.
Commercial Provider Substantiation	
Manager, Commercial Provider	The NASA approved Commercial Provider Crew Transportation System Certification and Verification and Validation Plan, have been satisfied. All anomalous conditions impacting CTS Certification have been identified and resolved with NASA. The CTS has been designed, produced, manufactured, and certified in accordance with NASA's requirements (CCT-REQ-1130 and SSP 50808) for the CCT-DRM-1110 and the requirements defined in CCT-PLN-1120.

Appendix E: CCP Return CoFR Approval and Commercial Provider CoFR Substantiation

This Appendix defines the CCP CTS Certification of Flight Readiness Approval statement ,the concurrence statements from participating NASA Organizations and the Technical Authorities, and the Commercial Provider's Substantiation statement. These statements are used when the Program Return FRR is a standalone review and not combined with the launch FRR/FTRR.

Approval	
Manager, CCP	The Commercial Provider has certified the Crew Transportation System (CTS) for this mission. NASA has approved all Verification Closure Notices and Hazard Reports. All required NASA approved Commercial Provider plans are in place an implemented in accordance with CCT-PLN-1120. Post-launch, on-orbit real-time activities/anomalies have been evaluated and any changes to original Certification of Flight Readiness affecting the vehicle return has been reviewed and assessed. Deviations, exceptions or waivers to CCP's requirements (CCT-REQ-1130) for the ISS Design Reference Mission (CCT-DRM-1110) have been approved and will be dispositioned by the MMT R-2 Day Review for the mission. The Commercial Crew Program is ready to proceed with crew return for this mission.
Concurrence	
NASA Organizations	The Certification of Flight Readiness Process documented in CCT-PLN-2100, NASA CTS Certification of Flight Readiness Plan, was satisfied at Agency FRR on XXX. Post-launch, on-orbit real-time activities/anomalies have been evaluated and any changes to original Certification of Flight Readiness affecting the vehicle return has been reviewed and assessed. Any updates to required products and verifications, including those areas identified by a Risk Based Analysis, for [System Office or TA] have been or will be produced or completed. The <System Office or TA> has completed or plan to complete audit, insight, and approval of any updated Commercial Provider activities and deliverables affecting return mission activities, and have resolved all discrepancies. Government Furnished Services tasked by my organization are ready to support the Commercial Provider return mission activities, as applicable. CCP Ground and Mission Operations CCP Integrated Performance Office CCP Launch Vehicle Office CCP Mission Management and Integration Office CCP Program Control and Integration Office CCP Spacecraft Office CCP Systems Engineering and Integration Office CCP Chief Engineer CCP Chief Safety and Mission Assurance Officer HMTA Delegate for Commercial Crew Program Flight Operations Directorate Based on the satisfaction of the review requirements applicable to my organization, I concur to proceed with the vehicle return mission activities.

Appendix F: CCP Office CoFR Endorsement Statements

This Appendix identifies the CoFR Endorsement Statements that must be satisfied by the NASA CCP Offices to assure the Commercial Provider's CTS CoFR. This list also provides an organizational cross-reference matrix between the CoFR Endorsements and the endorsing CCP Office. Each Office endorses their applicable endorsement statements. CCP MM&I is responsible for ensuring the overall CoFR endorsement is met.

Endorsement Statements	Sub-Endorsement Statement	Final Sign off	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
Programmatic									
a. NASA has performed a compliance assessment to the HEOMD-CSD-10001 requirements. All waivers, deviations, or exceptions from the requirements have been dispositioned and accepted.	a.1 Changes to the Human Rating Certification Data Package have been developed and submitted for approval to the Associate Administrator of the Space Operations Mission Directorate (SOMD).	SE&I	X	N/A	N/A	N/A	N/A	N/A	N/A
b. All technical management plans and processes required in CCT-PLN-1120 are being implemented.	b.1 Commercial Provider Management Plans are approved and all adverse implementation and control processes items identified by NASA Insight have been resolved.	SE&I	X	X	X	X	X	X	X
c. The Commercial Provider, its subcontractors, suppliers, and team members have provided flight readiness	c.1 NASA has reviewed and accepted the Commercial Provider Flight Readiness Endorsements demonstrating that they have met	MM&I	N/A	X	N/A	N/A	N/A	N/A	N/A

Endorsement Statements	Sub-Endorsement Statement	Final Sign off	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
endorsements demonstrating that they have met requirements in accordance with the Commercial Provider's management processes.	requirements in accordance with the Commercial Provider's management processes.								
d. All risk management activities associated with operations have been completed or open risks have been documented as acceptable. All open risks have been reviewed for flight applicability. Flight effectivity rationale has been documented and acceptance rationale has been provided for each applicable open risk.	d.1 All open items and actions from the major mission reviews (including VBR, MIR, MCR, SORR, FTRR/FRR) have been resolved and closed	SE&I	X	X	X	X	X	X	X
	d.2 The Commercial Provider's risks applicable to the mission have been reviewed and they have been closed or accepted.	SE&I	X	X	X	X	X	X	X
e. International Space Station (ISS) Program Stage Operations Readiness Review (SORR) has been completed and the ISS is ready to accept the Visiting Vehicle and NASA Crew for flights to the ISS.	e.1 The CCP and the Commercial Provider supported the ISS Program SORR and any open items are tracked as open work with ECDs to support flight.	MM&I	N/A	X	N/A	N/A	N/A	X	N/A

Endorsement Statements	Sub-Endorsement Statement	Final Sign off	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
f. All Government Furnished Equipment / Government Provided Services have been verified to meet the functional and performance requirements.	f.1 All Government Furnished Equipment has been delivered to the Commercial Provider and verified to meet the functional and performance requirements (prior to delivery by NASA and post-delivery by the Commercial Provider included with, or interfaced with, its CTS). Any exceptions, waivers, or deviations from the requirements have been approved.	MM&I	N/A	X	N/A	N/A	N/A	N/A	N/A
	f.2 All Government Provided Services are ready to support. Any exceptions, waivers, or deviations from the requirements have been approved.	MM&I	N/A	X	X	N/A	N/A	X	N/A
Design Modifications									
g. The baseline design has been established for flight. All changes, modifications and anomalies since the design baseline was set have been resolved and resolutions have been accepted by NASA and will not impact the CTS ability to perform the	g.1 All vehicle HW/SW changes to the baseline design have been reviewed for compliance to the functional and performance requirements for crew and cargo transportation to ISS and the corresponding new/modified Verification Closure Notices (VCNs) have been approved or any open	SE&I	X	N/A	N/A	X	X	X	X

Endorsement Statements	Sub-Endorsement Statement	Final Sign off	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
flight. Any waivers, deviations, or changes from the requirements have been approved.	items are tracked as open work with ECDs to support flight.								
	g.2 The Flight Test Readiness Review / Flight Readiness Review Data Package has been reviewed and accepted and any open items are tracked as open work with ECDs to support flight.	SE&I	X	N/A	N/A	X	X	X	X
	g.3 New/Modified Hazard Reports have been approved or any open items are tracked as open work with ECDs to support flight.	SE&I	X	N/A	N/A	X	X	X	X
	g.4 Changes to the Certification Data Package have been approved or any open items are tracked as open work with ECDs to support flight.	SE&I	X	N/A	X	X	X	X	X
	g.5 NASA Crew and Ground Crew usability and human system performance, NASA Crew workload, and human error analyses have been reviewed and accepted for the mission.	SE&I	X	N/A	N/A	X	N/A	N/A	N/A
	g.6 NASA has reviewed and accepted the Commercial Provider's assessment of the	SE&I	X	N/A	N/A	N/A	N/A	N/A	N/A

Endorsement Statements	Sub-Endorsement Statement	Final Sign off	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
	risk of Loss of Crew/Loss of Mission (LOC/LOM) and associated level of uncertainty.								
	g.7 NASA Insight indicates that the Commercial Provider's anomalies, data review, and open work from the previous flight test/missions (including non-CTS flights) that affect the CTS certification have been resolved and any open items are tracked as open work with ECDs to support flight.	SE&I	X	X	N/A	X	X	X	X
	g.8 All waivers, deviations, or exceptions from the requirements have been dispositioned and any open items are tracked as open work with ECDs to support flight.	SE&I	X	N/A	N/A	X	X	X	X
	g.9 Range Safety Documentation has been reviewed and accepted for the mission.	SE&I	N/A	N/A	N/A	N/A	N/A	X	N/A
h. Flight Test/Mission Specific requirements, design, and configuration changes have been dispositioned, and the resulting HW/SW is ready to support the flight and on-orbit operations.	h.1 NASA Insight indicates that the Commercial Provider's design is compatible with the mission specific requirements.	SE&I	N/A	X	N/A	X	N/A	X	X

Endorsement Statements	Sub-Endorsement Statement	Final Sign off	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
	h.2 NASA Insight indicates that the Commercial Provider's limited-life hardware (time, cycle) has been identified and the logistics and maintenance planning has been accomplished that will support the CTS Mission.	SE&I	N/A	N/A	N/A	X	X	X	N/A
	h.3 NASA Insight indicates that the Commercial Provider's mission-specific hardware has been assessed as acceptable for ground handling and transportation, launch, flight and on-orbit environments, or appropriate protective measures have been identified and /or implemented to prevent exposure to the environments.	SE&I	N/A	N/A	N/A	X	X	N/A	N/A
As-Built									
i. The as-built flight articles HW/SW have been built to the applicable plans, processes, specifications and drawings. Any waivers, deviations or changes from the design requirements have been approved.	i.1 NASA Insight indicates that changes to the tooling and equipment used in the manufacture of flight hardware are verified to meet all production requirements and tolerances.	MM&I	N/A	N/A	N/A	X	X	N/A	N/A

Endorsement Statements	Sub-Endorsement Statement	Final Sign off	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
	i.2 NASA Insight indicates that the Commercial Provider's production and assembly personnel maintain certification of critical skills.	MM&I	N/A	N/A	N/A	X	X	N/A	N/A
	i.3 NASA Insight indicates that changes to the manufacturing, fabrication, storage, and transportation processes comply with the CTS design.	MM&I	N/A	N/A	N/A	X	X	N/A	N/A
	i.4 NASA Insight indicates that changes to the Commercial Provider's manufacturing is in compliance with the production, assembly/ refurbishment, and product acceptance plans and processes.	MM&I	N/A	N/A	N/A	X	X	N/A	X
	i.5 NASA has reviewed and accepted the results of tests, analyses, and evaluations of the As-Built CTS.	MM&I	N/A	N/A	N/A	X	X	N/A	X
	i.6 NASA Insight indicates changes to non-conformance identification, tracking, and corrective action processes are documented and implemented, and that issues are returned to print or accepted as a design change as appropriate.	MM&I	N/A	N/A	N/A	X	X	N/A	X

Endorsement Statements	Sub-Endorsement Statement	Final Sign off	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
	i.7 Any As-Built open items are tracked as standard open work or have ECDs to support launch.	MM&I	N/A	N/A	N/A	X	X	N/A	X
	i.8 The facilities, systems, and processes to support production and assembly of the integrated space vehicle have been verified to meet the applicable specifications and drawings. Any waivers, deviations or changes from the design requirements have been approved.* *Sub-endorsement applicable only to Space-X missions	MM&I	X	N/A	N/A	N/A	N/A	N/A	N/A
Operations									
j. The facilities and systems to support flight articles integration, ground processing, launch, flight, and recovery of the NASA crew and/or vehicle have been verified to function within the operational controls, limitations and constraints. Any waivers, deviations or changes from the design requirements have been approved.	j.1 NASA Insight indicates the Commercial Provider's operational supporting and enabling capabilities (e.g., final assembly, integration, and testing facilities, planning, training and mission execution facilities, equipment, documents, updated databases) necessary for nominal and contingency operations have been tested and delivered/installed at the site(s).	MM&I	N/A	N/A	N/A	N/A	N/A	X	N/A

Endorsement Statements	Sub-Endorsement Statement	Final Sign off	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
k. The Operational plans, products, training, and mission execution processes have been verified to meet the operational requirements. Operational controls, limitations, and constraints of integrated vehicle have been incorporated.	k.1 NASA Insight indicates that new/modified Commercial Provider operational plans, processes, and procedures are consistent with the design of the flight elements and incorporate operational controls, limitations, and constraints of the integrated vehicle (e.g. Launch Commit Criteria, Flight Rules, operationally managed Hazard Controls, etc.). Any open items are tracked as open work with ECDs to support flight.	MM&I	N/A	X	N/A	X	X	X	X
	k.2 NASA Insight indicates that a process for changes to the Commercial Provider's Ground Crew and NASA Crew nominal and contingency procedures are to be validated and reviewed for completeness and meets operational standards.	MM&I	N/A	N/A	N/A	N/A	N/A	X	N/A
	k.3 NASA Insight indicates that Operations Management plans, real-time analysis capability, and contingency action plans have been validated for real-time mission operations.	MM&I	N/A	N/A	N/A	N/A	N/A	X	N/A

Endorsement Statements	Sub-Endorsement Statement	Final Sign off	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
	k.4 NASA Insight indicates that NASA Crew and operations personnel post-flight debriefings are planned to be exercised per the Commercial Provider's documented processes.	MM&I	N/A	N/A	N/A	N/A	N/A	X	N/A
	k.5 NASA Insight indicates that the Commercial Provider has a process to validate and maintain operational tools consistent with operational standards. NASA confirms operational tools are validated and maintained according to the process and used consistent with process and flight hardware/software.	MM&I	N/A	N/A	N/A	N/A	N/A	X	N/A
	k.6 All waivers, deviations, or exceptions from the operational requirements have been dispositioned and any open items are tracked as open work with ECDs to support flight.	MM&I	N/A	N/A	N/A	N/A	N/A	X	N/A
l. CTS Test, checkout, servicing, and ground processing have been completed or is standard open work.	l.1 NASA Insight indicates that CTS test, checkout, servicing, and processing are complete. Any open items are tracked as open work with ECDs to support flight.	MM&I	N/A	N/A	N/A	X	X	X	X

Endorsement Statements	Sub-Endorsement Statement	Final Sign off	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
m. Mission Specific Operations personnel training requirements necessary for successful mission (launch thru recovery) have been defined, and the planning for implementation has been accomplished or it is standard open work.	m.1 NASA Insight indicates that a training process for the Commercial Provider's personnel to be trained, certified, and ready to support the launch, mission control, and recovery operations (CTS nominal and contingency) has been reviewed and meets operational standards.	MM&I	N/A	N/A	N/A	N/A	N/A	X	N/A
	m.2 NASA Crew have been trained on the CTS operations by the Commercial Provider and are prepared to support the mission.	MM&I	N/A	N/A	N/A	N/A	N/A	X	N/A
	m.3 NASA real-time support personnel have been trained and prepared to support the launch, mission control (including console training and Joint Mission Simulations), recovery, rescue, and CMMT operations (CTS nominal and contingency).	MM&I	N/A	X	N/A	N/A	N/A	X	N/A
n. Sites, facilities, personnel, and procedures are ready to support launch, flight, on-orbit, landing, and recovery operations or are standard open work.	n.1 NASA Insight indicates that CTS sites, facilities, personnel, and procedures to support launch, flight, on-orbit, landing, and recovery operations are ready to support. Any open items are	MM&I	N/A	X	N/A	N/A	N/A	X	N/A

Endorsement Statements	Sub-Endorsement Statement	Final Sign off	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
	tracked as open work with ECDs to support.								
	n.2 NASA Insight indicates that Launch Site, Range, Landing Site, and recovery Support Organizations have committed to launch and landing.	MM&I	N/A	N/A	N/A	N/A	N/A	X	N/A
o. Final ground and flight software loads have been verified and are acceptable or it is standard open work.	o.1 NASA Insight indicates that Commercial Provider software changes have been incorporated into the final software loads. All issues are dispositioned and complete. Any open items are tracked as open work with ECDs to support flight.	MM&I	N/A	N/A	N/A	X	X	X	X
p. Reported ground and flight HW/SW anomalies (including problems and non-conformances) have been dispositioned and do not pose a constraint to flight or to on-orbit operations.	p.1 NASA Insight indicates that Commercial Provider applicable ground and flight HW/SW anomalies (including problems and non-conformances) have been closed or dispositioned and do not pose a constraint to flight or on-orbit operations. Any open items are tracked as open work with ECDs to support flight.	MM&I	X	N/A	N/A	X	X	X	X