

## Space Flight Operations Contract

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# Product Development Plan for Combined Element Integration PDP MS4-001

January 11, 1999  
Revision C

DRD-1.1.1.1-f

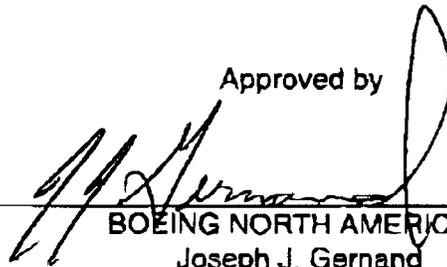
Contract NAS9-20000



**Product Development Plan  
for  
Combined Element Integration  
PDP MS4-001**

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Approved by



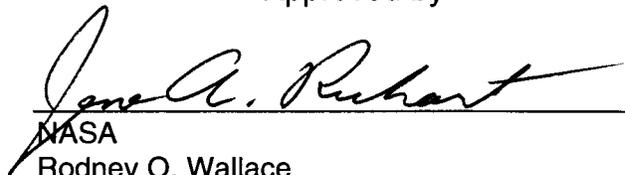
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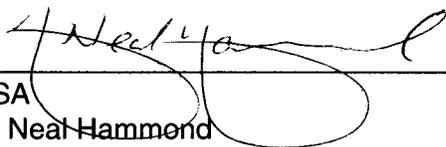


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### REVISION LOG

REV LTR	CHANGE NO	DESCRIPTION	DATE
	Baseline		01/07/97
	Errata	Republished to correct publication errors.	03/06/97
A		Revised to reflect transition to USA.	05/20/97
B		Revised to reflect current requirements.	04/17/98
C		Revised to reflect audit findings and observations.	01/11/99

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for  
Combined Element Integration  
PDP MS4-001**

LIST OF EFFECTIVE PAGES

January 11, 1999

The current status of all pages in this document is as shown below:

<u>Page No.</u>	<u>Change No.</u>	<u>Date</u>
i - iii	Rev. C	January 11, 1999
1 - 38	Rev. C	January 11, 1999

## **PREFACE**

This Product Development Plan for Combined Element Integration PDP MS4-001 was prepared by the United Space Alliance (USA) and USA prime subcontractor, Boeing North American (BNA), Reusable Space Systems (RSS), Downey, California.

The primary responsibility is with USA's Systems Integration, a department of Program Integration.

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## **1.0 OVERVIEW**

This Product Development Plan (PDP) is revised from the FY96 baseline document to incorporate the changes as defined in the PDP Transition Plan (both documents dated January 7, 1997), for the transition of process ownership to the United Space Alliance (USA).

The specific activities (see table in Paragraph 1.0) covered by this PDP involve Projects Integration and Combined Element verification. Projects Integration provides for the identification and coordination of Space Shuttle Program (SSP) engineering issues among the Flight Elements - Orbiter, Space Shuttle Main Engine (SSME), External Tank (ET), Reusable Solid Rocket Motor (RSRM), and Solid Rocket Booster (SRB). Combined Element verification is the process of verifying system level requirements derived from NSTS 07700, Volume X, Flight and Ground System Specification. When two or more elements are involved in verifying a requirement, and the combined effect cannot be the responsibility of one, the overall verification of the requirement is performed by Combined Element. Combined Element is responsible for verification of the integrated requirement and excludes the performance of individual element hardware. Combined Element verification is stated in terms of integrated vehicle system capability or performance. The Combined Element verification activity as specified in this PDP is compliant with the SSP verification approach as outlined in NSTS 07700-10-MVP-01, Shuttle Master Verification Plan, General Approach and Guidelines and NSTS 07700-10-MVP-02, Shuttle Master Verification Plan, Combined Element Verification Plan.

This PDP captures these activities as part of the transition of process ownership to USA. This PDP also captures and defines the roles and responsibilities of USA and the National Aeronautics and Space Administration (NASA) management for in-family and out-of-family conditions. See definitions in Paragraph 1.1. The processes covered by this PDP may support the work described in Section 1.7 of the Space Flight Operations Contract (SFOC) Statement of Work (SOW), NASA Managed Activities, but are not directly applicable.

### **1.1 SCOPE**

This PDP has been prepared pursuant to Data Requirements Description (DRD) 1.1.1.1-f, Space Flight Operations Product Development Plans. This PDP characterizes the work efforts required to deliver products to satisfy Program Integration requirements. Descriptions of the processes followed, products delivered, acceptance criteria utilized, organizational responsibilities, as well as the conditions which are in or out-of-family are contained in this PDP.

The specific tasks covered by this PDP are shown in the following table.

<b>PDP Section</b>	<b>Sub-Contract No. 1970483303 WBS</b>	<b>SFOC SOW NAS-9-20000</b>	<b>Task Title</b>
3.1	1.2.2.1	1.2.3	Project Integration Liaison
3.2	1.2.2.1	1.1.5.2	Verification Management

The products associated with this PDP are shown below:

<b>PDP Section</b>	<b>Product</b>
3.1	Projects Integration Weekly Status and Summary Reports (prepared by BNA) for Orbiter, SSME ET, RSRM/SRB and L&L
3.1	Change Requests, Waivers, Evaluations and Briefing Charts for ICB and/or PRCB
3.1	System Integration Plans (SIPs)
3.1	RCN/LCN/IRN Waivers/Exceptions Evaluations
3.1	Projects Integration Pre-FRR Charts
3.1.1	RID and Action Closures
3.1.1	IFA Closeout Rationale
3.2.1.1	Verification Information System (VIS) CRs
3.2.1.1	Requirements Verification Review Sheets (RVRs)
3.2.1.1	Space Shuttle Program Change Requests (CRs)
3.2.1.1	Verification Completion Notices (VCNs)
3.2.1.3	Combined Element Verification Pre-FRR Charts
3.2.1.4	Space Shuttle Program Verification Status Report
3.2.1.5	Combined Element Master Verification Plan (MVP) Revision/Update Report

## 1.2 DEFINITIONS

For the purpose of this PDP the following definitions apply:

- a. Insight: Observation and assessments of the required work being done.
- b. Oversight: Supervision or direction of work. It constitutes technical management, in-depth knowledge, authority, and responsibility of required work to be done.
- c. In-family: Any condition, anomaly or failure within established operational limitation or experience.

- d. Out-of-family: Any condition, anomaly or failure which is outside established operational limitations or experience. This determination is made by the SFOC with NASA approval.
- e. Development Activity: The undertaking to bring online any new hardware/software capabilities and/or enhancements/upgrades.
- f. Surveillance: Continual monitoring and verification of the status of work performed to ensure that requirements are being fulfilled. Items to be monitored and verified are selected; this is not an all inclusive activity.

### **1.3 ROLES AND RESPONSIBILITIES**

The following defines the general roles and responsibilities of USA and NASA to be performed as part of the SFOC transition of ownership to USA.

#### **1.3.1 USA Roles and Responsibilities**

The role of USA is to control and perform all tasks and functions required to maintain operability of the Space Shuttle. USA personnel are required to take on all responsibilities for oversight of all in-family conditions and insight of all out-of-family conditions and development activities. USA readiness to perform this role has been demonstrated at the PDP Transition Readiness Review, approved by the NASA Safety, Reliability and Quality Assurance (SR&QA), and by an SFOC letter for readiness of responsibilities, approved by the NASA Technical Management Representative (TMR). The specific USA responsibilities for oversight and insight of Combined Element integration activities are given in Sections 3.1.4 and 3.2.4.

#### **1.3.2 NASA Roles and Responsibilities**

The role of NASA is to maintain technical insight and surveillance of the USA's effort in maintaining Shuttle safety and operability. NASA oversight support is at the discretion of the NASA TMR or by special exceptions for all out-of-family conditions and development activities. The specific NASA responsibilities for oversight and insight of Combined Element integration activities are defined in Sections 3.1.4 and 3.2.4. The scope of NASA surveillance activities are defined in Program Integration Surveillance Plan for the SFOC, NASA document.

## 2.0 DOCUMENTATION

### 2.1 APPLICABLE DOCUMENTS

Program documentation defining the procedures, methodologies, and processes to be used in the development of the products covered by this PDP are shown below. The current versions of the following documents are applicable to this PDP and shall be used as described in the specific process descriptions.

<b>Document Number</b>	<b>Document Title</b>
BNA-RSS Department 279 Group 500 Document	Desk Instructions for Combined Element Verification
BNA-RSS Document Engineering Operations Manual (EOM) Publication 543-Z-70	Article: 1-5.1.11, Verification Completion Notice (VCN), Preparation and Control
BNA-RSS System Integration Document SSD95D0205A	Program Integration Flight Preparation Process Definition Document
BNA-SSD-96D0061	Projects Integration Operations Plan
NSTS 07700, Volume X	Flight and Ground System Specification
NSTS 07700-10-MVP-01	Shuttle Master Verification Plan, Volume I - General Approach and Guidelines
NSTS 07700-10-MVP-02	Shuttle Master Verification Plan, Volume II - Combined Element Verification Plan
NSTS 08117	Requirements and Procedures for Certification of Flight Readiness
NSTS 08126	Problem Reporting and Corrective Action (PRACA) System Requirements
PDP MS8-002	KSC Program Boards (Revision A)
PDP MS8-004	Engineering Information Management Maintenance
PDP MS8-005	United Space Alliance Program Integration Certificate of Flight Readiness Process
SFOC-PG9605	Configuration Management Plan

### **3.0 TASKS**

Combined Elements integration tasks consist of Project Integration and Shuttle Program verification tasks. These tasks are performed by a team of USA personnel from the Systems Integration Office (Houston) and NASA personnel from the Johnson Space Center (JSC) Flight Systems Analysis Office. Additional support is provided by USA subcontractor Boeing North American (BNA) personnel located at Kennedy Space Center, Florida; Downey, California; and Huntsville, Alabama.

#### **3.1 PROJECTS INTEGRATION**

Projects Integration is the process of identifying and coordinating SSP engineering and programmatic issues among the Flight Elements - Orbiter, SSME, ET, RSRM, and SRB. Although not directly responsible, Projects Integration personnel maintains cognizance of Launch and Landing (L&L) element issues. The primary functions performed to accomplish this are:

- a. Element Project Review Support - Participate in specific element project activities, such as acceptance reviews, control boards, element Flight Readiness Reviews (FRRs), Certificate of Flight Readiness (CoFR) reviews in order to provide required program representation and/or coordination.
- b. Element Integration and Liaisons - Obtain knowledge of current and/or potential Space Shuttle integration issues and provide the required coordination with the appropriate technical panel, functional discipline, and element project-level subsystem manager to establish or communicate program level management positions on Projects Integration issues. This effort includes monitoring program schedules for element technical support milestones and issues.
- c. Element Impact Identification/Coordination - Provide the necessary coordination of program-level (e.g., existing requirements, waivers, or design) changes in accordance with established Office of Primary Responsibility (OPR) obligations. This includes the coordination and program approval for In-flight Anomaly (IFA) reporting to the NASA Program Requirements Control Board (PRCB) for each flight.
- d. Program Change Implementation Planning - Manage, develop, and maintain System Integration Plans (SIPs) that represent the program management planning required to integrate changes into the SSP and provide the basis for resource commitments for budgetary planning. Included are all efforts necessary to obtain project commitments on needed activities and products, to maintain the status of SIP compliance and responsibilities, and to resolve issues between responsible parties.
- e. Daily PRCB Support - Although not directly responsible, Projects Integration personnel maintains cognizance of the Daily PRCB activity and provide support as required. Primary support to the Daily PRCB is defined in PDP MS8-002, KSC Program Boards (Revision A).

- f. Integration Control Board (ICB)/PRCB Support - Prepare and coordinate changes and presentations to the ICB and regular PRCB. Be a voting member of the PRCB and develop a coordinated response/recommendation for PRCB items.
- g. Shuttle Upgrades Development/Planning - Support any Shuttle upgrades development activity.

### **3.1.1 Process**

Projects Integration functions are accomplished utilizing process and requirements as defined in the reference documents and/or flow diagrams.

- a. Element Project Review Support - USA's Systems Integration Project Integration Manager's (PIM's) participation in the Element Acceptance Reviews, Element FRR, Preliminary Design Review/Critical Design Review and Design Certification Review (DCR) is in accordance with NSTS 08117, Requirements and Procedures for Certification of Flight Readiness.
- b. Element Integration and Liaison - Overall leadership (oversight) for this function is provided by USA, Systems Integration and monitored by NASA, Figure 3-2 shows the interfaces between USA, NASA and BNA for in-family conditions. Figure 3-4 presents the NASA/USA process flow. All NASA/USA effort is accomplished at JSC.
- c. Element Impact Identification/Coordination - USA Systems Integration, PIM are responsible for coordinating IFA presentation to the NASA PRCB for each flight and this is in accordance with NSTS 08126, Problem Reporting and Corrective Action (PRACA) System Requirements.
- d. Program Change Implementation Planning; Shuttle Upgrades Development/ Planning - Overall leadership (oversight) for this function is provided by NASA JSC Flight Systems Analysis Office. This activity is supported by USA PIM and subcontractor personnel, as appropriate. Figure 3-1 shows the interfaces between NASA, USA, and BNA for out-of-family conditions.
- e. ICB/PRCB Support - USA PIM OPR responsibility for USA Program Review Board, NASA ICB and PRCB change flow evaluation is in accordance with SFOC-PG9605, Configuration Management Plan.
- f. BNA Projects Integration Task - BNA's Projects Integration task in support of USA are shown in Figure 3-3. BNA accomplishes its Projects Integration task in accordance with BNA-SSD-96D0061, Projects Integration Operations Plan.

### **3.1.2 Products**

The USA products for Projects Integration includes.

- a. Projects Integration Weekly Status Reports prepared by BNA: A series of weekly reports, one each for Orbiter, SSME, ET, RSRM/SRB, and L&L. Issued every working Thursday.
- b. NASA formal products include the SIPs. USA and NASA formal products include Change Requests (CRs) and waivers, and the briefing charts for the ICB and PRCB.
- c. RCN/LCN/IRN Waivers/Exceptions Evaluations
- d. Projects Integration Pre-FRR Charts
- e. RID and Action Closures
- f. IFA Closeout Evaluations
- g. Many informal products associated with managing, coordinating, and providing technical visibility and status to management.

### **3.1.3 Product Acceptance Criteria**

The products submitted by USA to NASA for Projects Integration must be factual, accurate, and timely. The NASA may at any time question the data and request that additional details or new data be provided. BNA-SSD-96D0061 contains both USA and NASA-generated information and is done on a team basis so that by the time of submittal it incorporates all NASA comments and has defacto NASA approval. The Weekly Status and Summary Reports are information items and are not revised. Any updated or missing data in these reports is provided in the next week's submittal. These reports are part of the data base drawn upon in the management decision making process and therefor all inputs must be error free. All other product submittals are on an "as required" basis with no set format or content.

As noted in Section 1.0, there are no SFOC DRDs for Projects Integration and, as a result, no applicable Standards or maximum error rates.

### **3.1.4 Oversight and Insight Responsibilities for Projects Integration**

The oversight and insight roles and responsibilities (see definitions, Sections 1.1 and 1.2), for Projects Integration for USA and NASA are provided in the following sections.

#### **3.1.4.1 USA Oversight/NASA Insight**

- a. Element Projects Review Support
- b. Element Integration and Liaisons

- c. Element Impact Identification/Coordination
- d. ICB/PRCB Support

#### **3.1.4.2 NASA Oversight/USA Insight**

- a. Program Change Implementation Planning
- b. Daily PRCB Support
- c. Shuttle Upgrades Development/Planning

#### **3.1.5 In/Out-of-Family Conditions for Projects Integration**

In-family conditions for Projects Integration refer to any element or integration activity associated with an issue within established operational limitation or experience. Recurrence control for this condition is in place.

Out-of-family conditions for Projects Integration refer to any element or integration activity associated with an anomaly outside established operational limitations or experience. Recurrence control for this condition does not exist.

### **3.2 COMBINED ELEMENT AND SHUTTLE PROGRAM VERIFICATION**

Combined Element verification is the process of verifying system-level requirements derived from NSTS 07700, Volume X. When two or more elements are involved in verifying a requirement, and the combined effect cannot be the responsibility of one, the overall verification of the requirement is performed by Combined Element. Combined Element is responsible for verification of the integrated requirement and excludes the performance of individual element hardware. Combined Element verification is stated in terms of integrated vehicle system capability or performance.

#### **3.2.1 Process**

Combined Element and Shuttle Program verification consist of six separate processes:

1. Combined Element verification of major NSTS 07700, Volume X requirements changes which culminate in a DCR or other major program milestone.
2. Combined Element verification of routine or minor NSTS 07700, Volume X requirements changes.
3. Combined Element verification support of the FRR process.
4. Preparation and submittal of the Space Shuttle Program Verification Status Report.

5. Preparation, submittal, and follow-up of the Combined Element Master Verification Plan (MVP) Revision/Update Report.
6. Identification of updates to the Verification Information System (VIS) software required to reflect applicable changes in SSP documentation referenced in Section 2.1.

Other Combined Element and Shuttle Program verification process information used in support of this PDP can be found in the BNA-RSS Engineering Operations Manual (EOM) Publication 543-Z-70, Article: 1-5.1.11, Verification Completion Notice (VCN), Preparation and Control, and BNA-RSS Department 279 Group 500 Document, Desk Instructions for Combined Element Verification.

### **3.2.1.1 Combined Element Verification of Major NSTS 07700, Volume X Requirements Changes Process**

The Combined Element verification process of major NSTS 07700, Volume X requirements changes is shown in Figure 3-5.

Major NSTS 07700, Volume X requirements changes are those which culminate in a DCR or other major program milestone. The Combined Element verification of the changes normally entails the preparation and approval by the NASA of a Requirements Verification Review Sheet (RVRS).

#### **3.2.1.1.1 USA/BNA Process**

The USA/BNA process is:

- a. Program Requirements Change Board Directives (PRCBDs) are reviewed for NSTS 07700, Volume X requirements changes which will culminate in a major program milestone.
- b. NSTS 07700-10-MVP-02 requirements verification planning is reviewed to determine Combined Element verification impact.
- c. Combined Element verification impacts and required verification products are identified.
- d. Verification products to be entered into the Artemis (engineering master schedule) to maintain tracking and visibility through the Artemis milestone review process are identified. (See NSTS 07700-10-MVP-02, Section 3.2.)
- e. Verification product information is entered into the VIS data base.
- f. Integration requirements verification plans are developed by generating RVRSs to assure that a complete and systematic review will identify new tasks which encompass the current verification baselines and identify appropriate updates based on work already accomplished and accepted by the program.
- g. BNA provides concurrence signature on RVRSs.

- h. BNA forwards the RVRs to the USA Combined Element verification lead for delivery to the NASA Integration Verification Manager.
- i. NASA approval of RVRs is obtained. (See Paragraph 3.2.1.1.2.)
- j. VIS CRs are generated for all verification product additions, deletions, changes, and closures, per program review.
- k. BNA concurrence of VIS CRs is obtained.
- l. BNA forwards the VIS CR to the USA Combined Element verification lead for delivery to the NASA Integration Verification Manager.
- m. NASA approval of VIS CR is obtained. (See Paragraph 3.2.1.1.2.)
- n. Space Shuttle CRs are generated to add verification products to NSTS 07700-10-MVP-02. (See Paragraph 3.2.1.1.3.)
- o. Verification Completion Notices (VCNs) are generated for closure of integrated verification logic networks at major program milestones.
- p. BNA approval of VCNs is obtained.
- q. BNA forwards the VCNs to the USA Combined Element verification lead for delivery to the NASA Integration Verification Manager.
- r. NASA approval of the VCNs is obtained. (See Paragraph 3.2.1.1.2.)

#### **3.2.1.1.2 NASA Process for RVRs, VIS CRs and/or VCNs**

The NASA process for RVRs, VIS CRs and/or VCNs are defined as follows:

- a. RVRs, VIS CRs and/or VCNs are received from BNA via USA for NASA review and signature.
- b. The RVRs, VIS CRs and/or VCNs are delivered by NASA Integration Verification Manager to the appropriate NASA technical managers for review and approval.
- c. The RVRs, VIS CRs and/or VCNs are reviewed and approved by the Flight Systems Analysis Office.
- d. The RVRs, VIS CRs and/or VCNs are returned to BNA via the USA Combined Element verification lead for documentation update as well as entered into the NASA data archives.

### **3.2.1.1.3 NASA Process for NSTS 07700-10-MVP-02 Updates**

The NASA process for the resulting NSTS 07700-10-MVP-02 update CRs are defined as follows:

- a. The NSTS 07700-10-MVP-02 update CR is received electronically by the NASA Integration Verification Manager from BNA via USA Combined Element verification lead. A hardcopy is subsequently provided to the same offices.
- b. The CR is reviewed by the Flight Systems Analysis Office.
- c. Under the sponsorship of the Systems Integration Office, the CR is submitted to the Configuration Management Office (CMO).
- d. A PRCBD is prepared following approval of the CR by the PRCB.
- e. NSTS 07700-10-MVP-02 is updated as directed by the PRCBD.

### **3.2.1.2 Combined Element Verification of Routine NSTS 07700, Volume X Requirements Changes Process**

The Combined Element verification process of routine NSTS 07700, Volume X requirements changes is shown in Figure 3-6.

Routine NSTS 07700, Volume X requirements changes are those which do not culminate in a DCR or other major program milestone. The Combined Element verification of the changes normally entails the preparation and approval by the NASA of a VIS CR.

#### **3.2.1.2.1 USA/BNA Process**

The USA/BNA process are defined as follows:

- a. PRCBDs are reviewed for NSTS 07700, Volume X requirements changes which will not culminate in a major program milestone.
- b. NSTS 07700-10-MVP-02 requirements verification planning is reviewed to determine Combined Element verification impact.
- c. Combined Element verification impacts and required verification products are identified.
- d. Verification products to be entered into the Artemis (engineering master schedule) to maintain tracking and visibility through the Artemis milestone review process are identified. (See NSTS 07700-10-MVP-02, Section 3.2.)
- e. Verification product information is entered into the VIS data base.
- f. VIS CRs are generated to add or delete verification products and technical area plan in NSTS 07700-10-MVP-02.

- g. BNA concurrence of the VIS CR is obtained.
- h. The VIS CR is provided to the USA Combined Element verification lead for delivery to the NASA Integration Verification Manager.
- i. NASA approval of VIS CRs is obtained. (See Paragraph 3.2.1.2.2.)
- j. A VIS CR is generated for all verification product additions, deletions, changes, and closures, per program review.
- k. BNA concurrence of the VIS CR is obtained.
- l. The VIS CR is provided to the USA Combined Element verification lead for delivery to the NASA Integration Verification Manager.
- m. NASA approval of the VIS CR is obtained. (See Paragraph 3.2.1.2.2.)
- n. A Space Shuttle CR is generated to add verification product to NSTS 07700-10-MVP-02. (See Paragraph 3.2.1.2.3.)

#### **3.2.1.2.2 NASA Process for VIS CR**

The NASA process for VIS CR are defined as follows:

- a. The VIS CR is received from BNA via USA for NASA review and signature.
- b. The VIS CR is delivered by the NASA Integration Verification Manager to the appropriate NASA technical managers for review and approval.
- c. The VIS CR is reviewed and approved by the Flight Systems Analysis Office.
- d. The VIS CR is returned to BNA via USA for documentation update, as well as entered into the NASA data archives.

#### **3.2.1.2.3 NASA Process for NSTS 07700-10-MVP-02 Updates**

The NASA process for the resulting NSTS 07700-10-MVP-02 update CRs are defined as follows:

- a. NSTS 07700-10-MVP-02 update CR is received electronically by the NASA Integration Verification Manager from BNA via the USA Combined Element verification lead. A hardcopy is subsequently provided to the same offices.
- b. The CR is reviewed by the Flight Systems Analysis Office.
- c. Under the sponsorship of the Systems Integration Office, the CR is submitted to the CMO.
- d. A PRCBD is prepared following approval of the CR by the PRCB.
- e. NSTS 07700-10-MVP-02 is updated as directed by the PRCBD.

### **3.2.1.3 Combined Element Verification Support of the FRR Process**

The Combined Element verification process flow for the support of the FRR process is shown in Figure 3-7. Support of the FRR process is conducted in compliance with NSTS 08117 and SSD95D0205A, Program Integration Flight Preparation Process Definition Document. The contents and format of the FRR briefing charts are specified in SSD95D0205A.

USA and BNA supports the FRR with a Combined Element Verification Summary for Generic Verification activity. The number of open generic NSTS 07700, Volume X verification requirements is reported from the SSP Verification Status Counts. Verification activity since the previous flight is reported.

Open generic verification is presented at the FRR to identify design requirements that have been partially verified. Generic verification refers to the incremental process of confirming full compliance with requirements. While this process is in work, design areas produce flight-by-flight analyses which establish the capability of the system to perform a specific mission which does not require the full capability envelope. Typically, post-flight analyses are performed to compare predicted performance versus actual flight data. For example, after sufficient flight data has confirmed system capabilities, the requirement is approved as generically verified. Open generic verification is not then a constraint to flight unless there is no interim supporting flight-by-flight rationale. The FRR process identifies interim constraint rationale. Re-verification may become necessary if the flight data or other evidence indicates that previous verification may require an update.

Verification constraints are established for the first flight of significant design, hardware, or software changes. Preflight tests, analyses, and simulations are performed and documented by the requirements described in NSTS 07700-10-MVP-01 and NSTS 07700-10-MVP-02. The FRR presentation summarizes the verification activities and the impacted requirements. After the first flight, the verification activity normally reverts to the generic activity described above. However, if the data used for verification shows significant deviation from the predictions, the flight-specific verification may need extra iterations which would also be documented as a flight-specific constraint.

#### **3.2.1.3.1 USA/BNA Process for FRR Support**

The USA/BNA process are defined as follows:

- a. About six weeks before the flight, the BNA pre-FRR charts are coordinated internally with project and functional management.
- b. The BNA draft pre-FRR charts are coordinated with the USA Combined Element verification lead counterpart.
- c. The draft pre-FRR briefing charts are electronically forwarded to the NASA Integration Verification Manager counterpart by BNA via the USA Combined Element verification lead.

- d. The charts are presented at an internal BNA dry run for FRR management review.
- e. If needed to accommodate any first dry run redlines or interim updates of incomplete work, the cycle for a delta dry run is repeated.
- f. BNA distributes the pre-FRR data package to USA and NASA as described in PDP MS8-005, Certification of Flight Readiness Review (CoFR).

#### **3.2.1.3.2 NASA Process**

The NASA process are defined as follows:

- a. The draft pre-FRR charts are received electronically from BNA via the USA Combined Element verification lead.
- b. The charts are reviewed, questions resolved, and redlines/comments provided to BNA via USA.

#### **3.2.1.4 Preparation and Submittal of the Space Shuttle Program Verification Status Report Process**

The Combined Element verification process for the preparation and submittal of the Space Shuttle Program Verification Status Report is shown in Figures 3-8 and 3-9.

Figure 3-8 shows the USA/BNA process flow. The Space Shuttle Program Verification Status Report provides visibility of Space Shuttle Vehicle (SSV) generic verification status and provides a quantitative historical reference of requirements and verification completion.

Two semi-annual status reports which incorporate all NSTS 07700, Volume X PRCBDs since the last report and the verification status for each element for all SSV NSTS 07700, Volume X requirements are published. The reports are submitted the third Friday of February and August. If unscheduled reports are requested by NASA, the reports are submitted 15 working days following the NASA task manager's request, utilizing current Combined Element verification status and last received Element Verification Status Reports, as reflected in the VIS data base.

The reports contain:

- a. A brief summary of verification status activities since the last report.
- b. Current verification status counts for the program and each element.
- c. Historical verification status counts for each element and the program.
- d. Open NSTS 07700, Volume X requirement verification list for Combined Element contractor.
- e. Open NSTS 07700, Volume X requirement verification lists for each element.

#### **3.2.1.4.1 USA/BNA SSP Verification Status Report Process**

The SSP Verification Status Report process are defined as follows (reference Figure 3-8):

- a. Commencing 35 working days prior to the report due date, BNA begins a good faith effort to obtain updates to the element's verification status reports directly from the element project offices or element contractor program offices, as appropriate.
- b. These efforts to obtain verification report updates are continued until the last update is obtained by BNA or until 10 working days prior to the SSP Verification Status Report submittal due date, whichever comes first. (If one or more element's verification status report update is not obtained within the 35 working day time period, the SSP Verification Status Report is submitted using the last submitted update for the delinquent element.)
- c. The report is compiled by BNA in the prescribed format.
- d. BNA coordinates the report with the USA Combined Element verification lead counterpart.
- e. BNA project management approval is obtained.
- f. The report is delivered electronically to the USA Combined Element verification lead and the NASA Integration Verification Manager. A hardcopy is subsequently provided to the same offices.

#### **3.2.1.4.2 NASA Process**

The NASA process are defined as follows (reference Figure 3-9):

- a. The SSP Verification Status Report is received from BNA in both electronic and hardcopy format.
- b. The status report is reviewed and the hardcopy is stored in the NASA data archive.

#### **3.2.1.5 Preparation, Submittal, and Follow-up of the Combined Element MVP Revision/Update Report Process**

The Combined Element verification process for the preparation, submittal, and follow-up of the Combined Element MVP Revision/Update Report is shown in Figures 3-10 and 3-11.

Figure 3-10 shows the USA/BNA process flow. This report documents recommended and required revisions or updates to NSTS 07700-10-MVP-02. Government-furnished data consists of the NASA technical area counterpart coordination signature on VIS CRs, RVRS, and VCNs which have been delivered by BNA via USA to document concurrence for verification planning and completed tasks.

The report identifies all updates to NSTS 07700-10-MVP-02 necessitated by NSTS 07700, Volume X PRCBDs and reported SSP element or element contractor generic verification activity since the last semi-annual SSP Verification Status Report. The Combined Element MVP Revision/Update Report content consists of:

- a. NSTS 07700-10-MVP-02 updates which reflect PRCBD changes to NSTS 07700, Volume X requirements verification applicable to Combined Element, as specified in Table 4.1.
- b. Updates to NSTS 07700-10-MVP-02 Verification Summary and Process Requirements, Table 2.2.
- c. Updates to Verification Traceability Tables (3.X) with verification products for the affected Combined Element Technical Areas.
- d. Updates to applicable text which are needed to maintain the plan to current program configuration.

The report is submitted 20 working days following the submittal of the semi-annual SSP Verification Status Report.

#### **3.2.1.5.1 USA/BNA Process for MVP Revision/Update Report**

The USA/BNA process for MVP Revision/Update Report are defined as follows (reference Figure 3-10):

- a. Applicable data is extracted from the VIS data base.
- b. The report is compiled by BNA, and a draft Space Shuttle CR to request update of NSTS 07700-10-MVP-02 is prepared.
- c. BNA coordinates the report and the draft Space Shuttle CR with the USA Combined Element verification lead counterpart.
- d. BNA project management concurrence is obtained.
- e. The report and draft CR are delivered electronically to the USA Combined Element verification lead and NASA Integration Verification Manager. A hardcopy is subsequently provided to the same offices.

#### **3.2.1.5.2 NASA Process**

The NASA process are defined as follows (reference Figure 3-11):

- a. The Combined Element MVP Revision/Update Report is received from BNA and reviewed by the Flight Systems Analysis Office.

- b. Under the sponsorship of the Systems Integration Office, the CR accompanying the report is submitted to the CMO.
- c. Following approval by the PRCB, NSTS 07700-10-MVP-02 is updated in accordance with the PRCBD.

### **3.2.1.6 VIS Data Base Software Maintenance Identification Process**

The VIS software is updated to reflect current SSP documentation relevant to verification status fields such as the element contractor identification and responsibilities (NSTS 07700, Volume X, Table 4.1). The VIS is a computerized data system that defines further the information documented in this verification plan. To maintain the capability of the VIS to track current program configurations, changes to the VIS software and/or VIS data fields may be required. In such cases, change control sheets for the data base maintenance entities are generated to cause the development and implementation of reflective changes to the VIS software and/or data fields. The software maintenance process and procedures are specified in PDP MS8-004, Engineering Information Management Maintenance.

### **3.2.2 Products**

The products of this process are:

- a. VIS CRs
- b. RVRs
- c. Space Shuttle Program CRs
- d. VCNs
- e. Combined Element Verification Pre-FRR charts
- f. Space Shuttle Program Verification Status Report
- g. Combined Element MVP Revision/Update Report

### **3.2.3 Product Acceptance Criteria**

The products developed by USA and BNA and submitted to NASA under Combined Element and Shuttle Program verification are developed in close coordination with the NASA Combined Element verification counterparts. All products delivered are to be accurate, timely, and factual.

In addition, the following metrics have been developed to provide NASA additional insight into the USA and BNA Combined Element verification process.

- a. Electronic submittal of the Space Shuttle Program Verification Status Report on or before the due date specified in Paragraph 3.2.1.4 and as reflected in the Artemis schedule.

- b. Electronic submittal of the Combined Element MVP Revision/Update Report on or before the due date specified in Paragraph 3.2.1.5 and as reflected in the Artemis schedules.
- c. Submittal of the Combined Element MVP Revision/Update Report with technical content as outlined in Paragraph 3.2.1.5 and with acceptable technical quality so as not to require a redelivery.

As noted in Section 1.0, there are no SFOC DRDs for Combined Element and Shuttle Program verification Integration.

### **3.2.4 Oversight and Insight Responsibilities for CE Verification**

The oversight and insight roles and responsibilities (see definition, Sections 1.1 and 1.2) for Combined Element verification for USA and NASA are provided in the following sections.

#### **3.2.4.1 USA Oversight with NASA Insight**

- a. Preparation, submittal, and review of Space Shuttle Verification Status Report
- b. Preparation and submittal of Combined Element MVP Revision/Update Report
- c. Support of the CoFR process

#### **3.2.4.2 NASA Oversight with USA Insight**

- a. Combined Element verification of NSTS 07700, Volume X requirements changes, to include RVRs, Space Shuttle CRs, and VIS CRs.
- b. CRs to update NSTS 07700-10-MVP-02.
- c. Provide funding and authorization for VIS software updates.

### **3.2.5 In/Out-of-Family Conditions for CE Verification**

The in/out-of-family roles and responsibilities (see definition, Sections 1.1 and 1.2) for Combined Element verification for USA and NASA are provided in the following sections. It should be noted that the Combined Element verification tasks that relate to requirements management, such as Combined Element verification of major NSTS 07700, Volume X requirements changes and submittal of Space Shuttle CRs to update NSTS 07700-10-MVP-02 are not out-of-family conditions.

#### **3.2.5.1 In-Family Conditions**

- a. Combined Element verification of routine NSTS 07700, Volume X requirements changes.

- b. Combined Element verification support of the FRR.
- c. Preparation and submittal of the Space Shuttle Verification Status Report.
- d. Preparation and submittal of the Combined Element Master Verification Plan Revision/Update Report.

#### **3.2.5.2 Out-of-Family Conditions**

- a. Identification of constraints to flight resulting from open verification.
- b. Changes in generic verification plans which impact planned implementation.
- c. Non-response by non-SFOC SSP elements to BNA-RSS request for verification status.

#### **4.0 CoFR ACCOUNTABILITY**

#### **4.1 PROJECTS INTEGRATION**

##### **4.1.1 USA Accountability**

USA is in the leadership role for in-family conditions which involves Projects Integration. The Projects Integration activities related to in-family conditions are in support of the overall flight preparation process, but do not include any product which in itself is a constraint to flight. The effort performed by Projects Integration relative to repetitive flight operations in-family IFAs and other integration issue resolution are supportive of CoFR activities. However, the USA PIM does not sign a CoFR endorsement for Projects Integration.

##### **4.1.2 NASA Accountability**

NASA is in the leadership role for development and out-of-family conditions which involve Projects Integration. The Projects Integration activities related to development and out-of-family conditions are in support of overall flight preparation process, but do not include any product which in itself is a constraint to flight. The effort performed by Projects Integration relative to an out-of-family integration IFAs and other integration issues resolution or a first flight development item are supportive of CoFR activities. However, the NASA Integration Verification Manager does not sign a CoFR endorsement for Projects Integration.

#### **4.2 COMBINED ELEMENT AND SHUTTLE PROGRAM VERIFICATION**

##### **4.2.1 USA Accountability**

Historically, BNA has reported on the Combined Element verification status, generic system verification constraints to flight, and the open system integration verification products. This reporting requirements, for NSTS 07700, Volume X requirements associated with flight operations items, will continue to be performed by BNA in accordance with SSD95D0205A, Program Integration Flight Preparation Process Definition Document.

##### **4.2.2 NASA Accountability**

There is no CoFR accountability for Combined Element and Shuttle Program verification defined in NSTS 08117. Historically, BNA has reported on the combined element verification status, generic systems verification constraints to flight, and open system integration verification products. These reporting requirements for NSTS 07700, Volume X requirements associated with development items, will continue to be performed by BNA and will be a NASA management responsibility.

## **5.0 CONTINUOUS IMPROVEMENT (CI)**

### **5.1 PROJECTS INTEGRATION CI METRIC APPROACH**

All areas of Projects Integration where changes in the requirements or process improvements might be applicable will be identified to determine the effectiveness of, or need for, CI implementation.

### **5.2 COMBINED ELEMENT AND SHUTTLE PROGRAM VERIFICATION**

This task has been streamlined in prior fiscal years and reduced to a minimal manpower level. However, all areas where requirements changes or process improvements might be applicable will be identified to determine the effectiveness of, or need for, CI implementation.

## **6.0 CRITERIA FOR INITIATING NASA AUDITS**

NASA may at their discretion perform an audit of any (or all) of the Combined Elements Integration tasks. This may be done at any time and may be accomplished for both NASA oversight and insight tasks.

The actual audit procedure will be defined by NASA and may range from a submittal of data to be reviewed to a face-to-face interchange. NASA will provide a written request for any audit which will define the required data, audit procedure, and the audit schedule. For NASA oversight tasks, the request will be directed to BNA with a coordination copy to USA. For NASA insight task, the request will be directed to USA.

NASA can request any data generated in support of these tasks including any technical data such as briefings and memoranda.

All data maintained for information are generally available and will be provided as requested (if available) whenever NASA conducts an audit of the tasks covered by this PDP.

**APPENDIX A**  
**ACRONYMS AND ABBREVIATIONS**

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The following acronyms and abbreviations appear in this PDP.

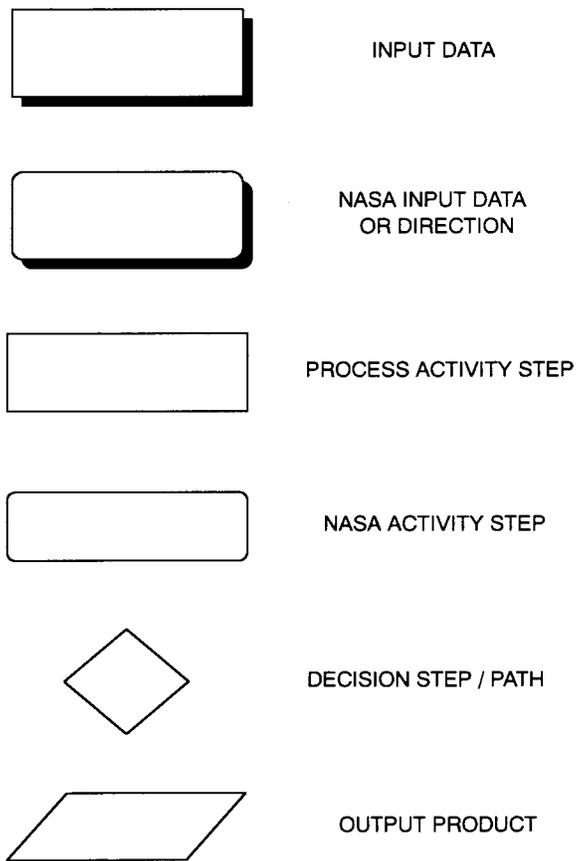
BNA	Boeing North American
CI	Continuous Improvement
CMO	Configuration Management Office
CoFR	Certificate of Flight Readiness Certification of Flight Readiness
CR	Change Request
DCR	Design Certification Review
DRD	Data Requirements Description
ET	External Tank
FRR	Flight Readiness Review
ICB	Integration Control Board
IFA	In-flight Anomaly
JSC	Johnson Space Center
L&L	Launch and Landing
MVP	Master Verification Plan
NASA	National Aeronautics and Space Administration
OPR	Office of Primary Responsibility

PDP	Product Development Plan
PIM	Project Integration Manager
PRCB	Program Requirements Change Board
PRCBD	Program Requirements Change Board Directive
RSRM	Reusable Solid Rocket Motor
RSS	Reusable Space Systems
RVRS	Requirements Verification Review Sheet
SFOC	Space Flight Operations Contract
SIP	System Integration Plan
SOW	Statement of Work
SR&QA	Safety, Reliability and Quality Assurance
SRB	Solid Rocket Booster
SSD	Space Systems Division
SSME	Space Shuttle Main Engine
SSP	Space Shuttle Program
SSV	Space Shuttle Vehicle
TMR	Technical Management Representative
USA	United Space Alliance
VCN	Verification Completion Notice
VIS	Verification Information System

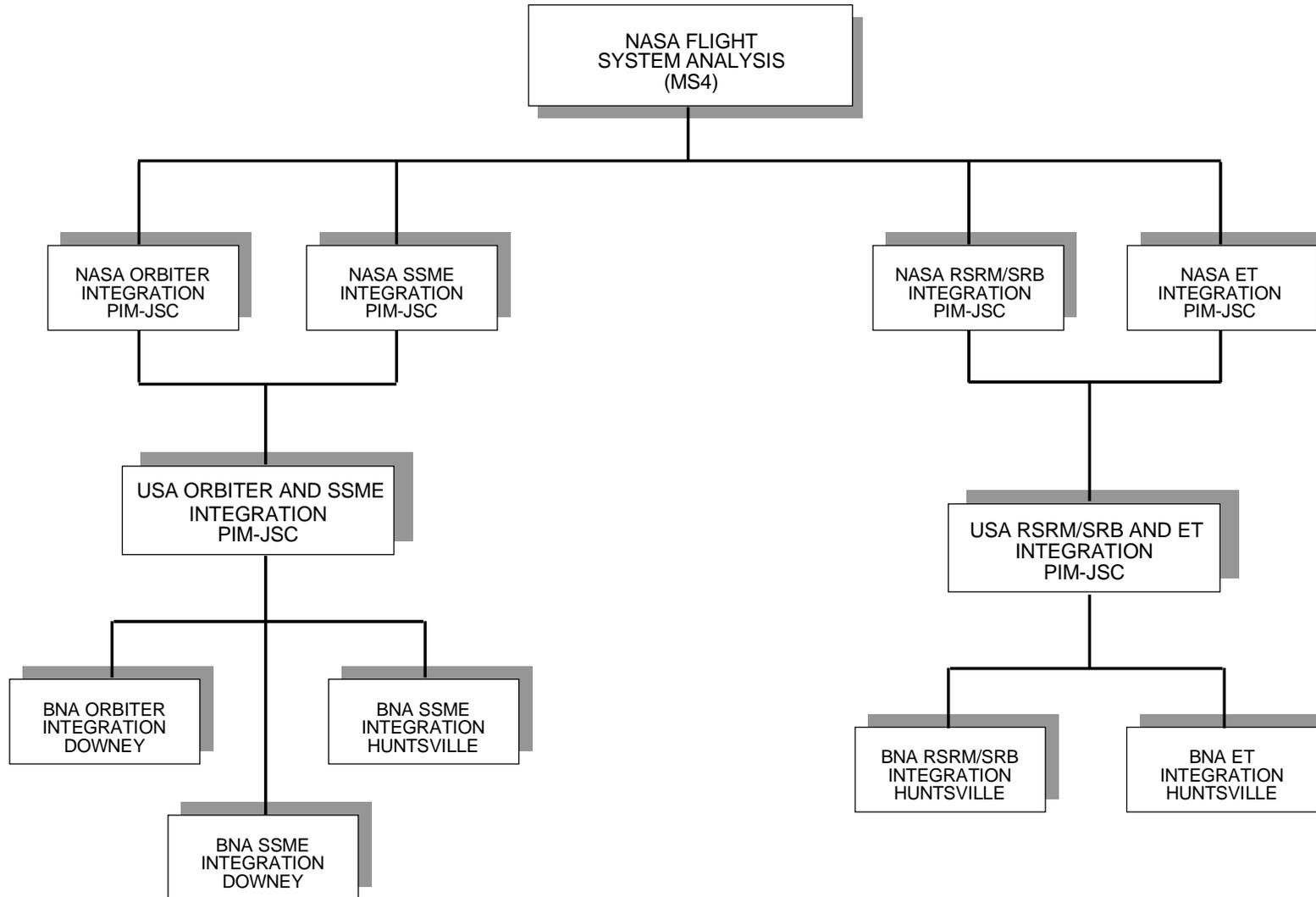
**APPENDIX B**  
**TASK PROCESS FLOWS**

**APPENDIX B**  
**TASK PROCESS FLOWS**

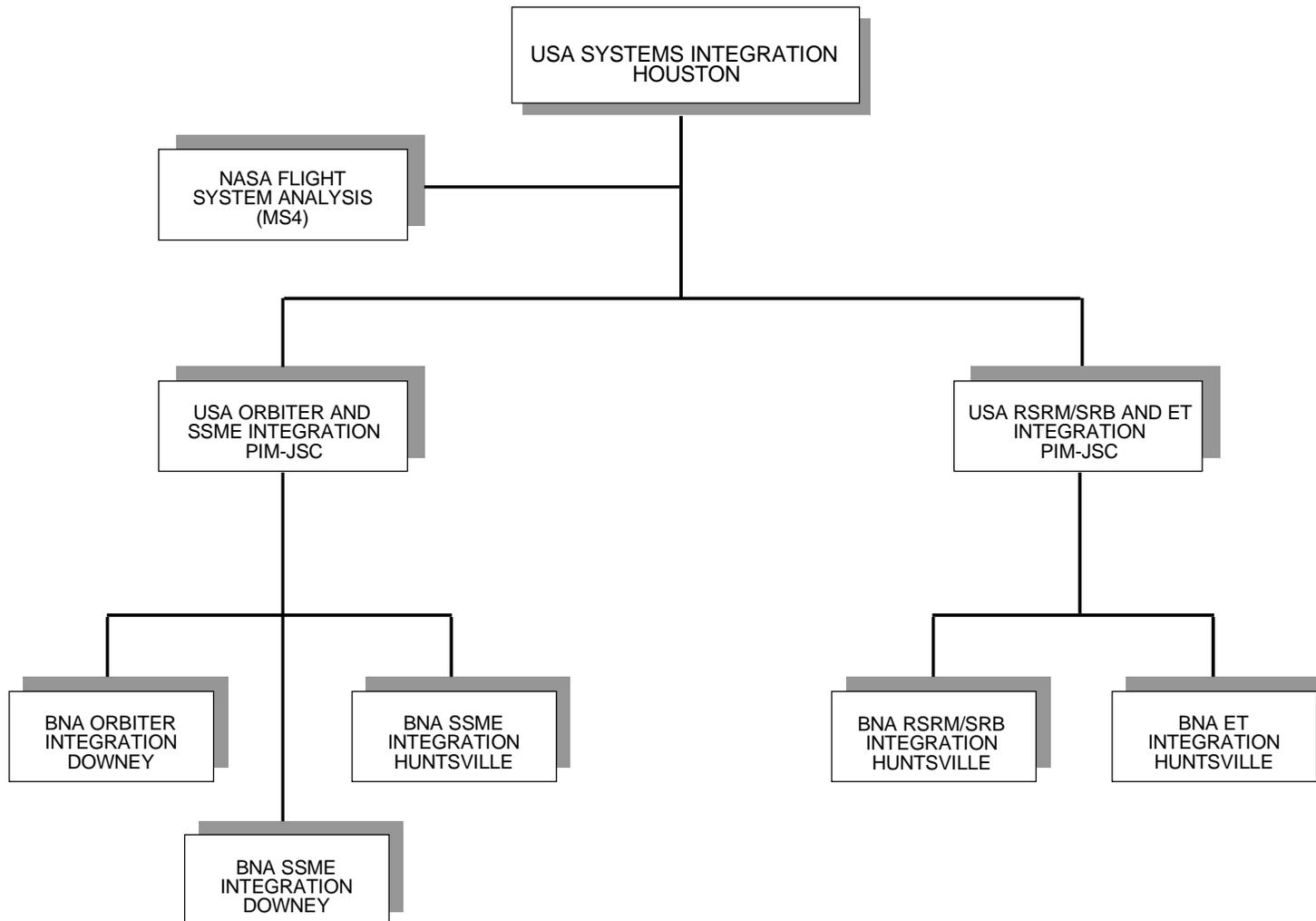
This appendix contains all of the task process flow diagrams discussed in the PDP document. The following legend is used to indicate input data, process activity steps, and output products:



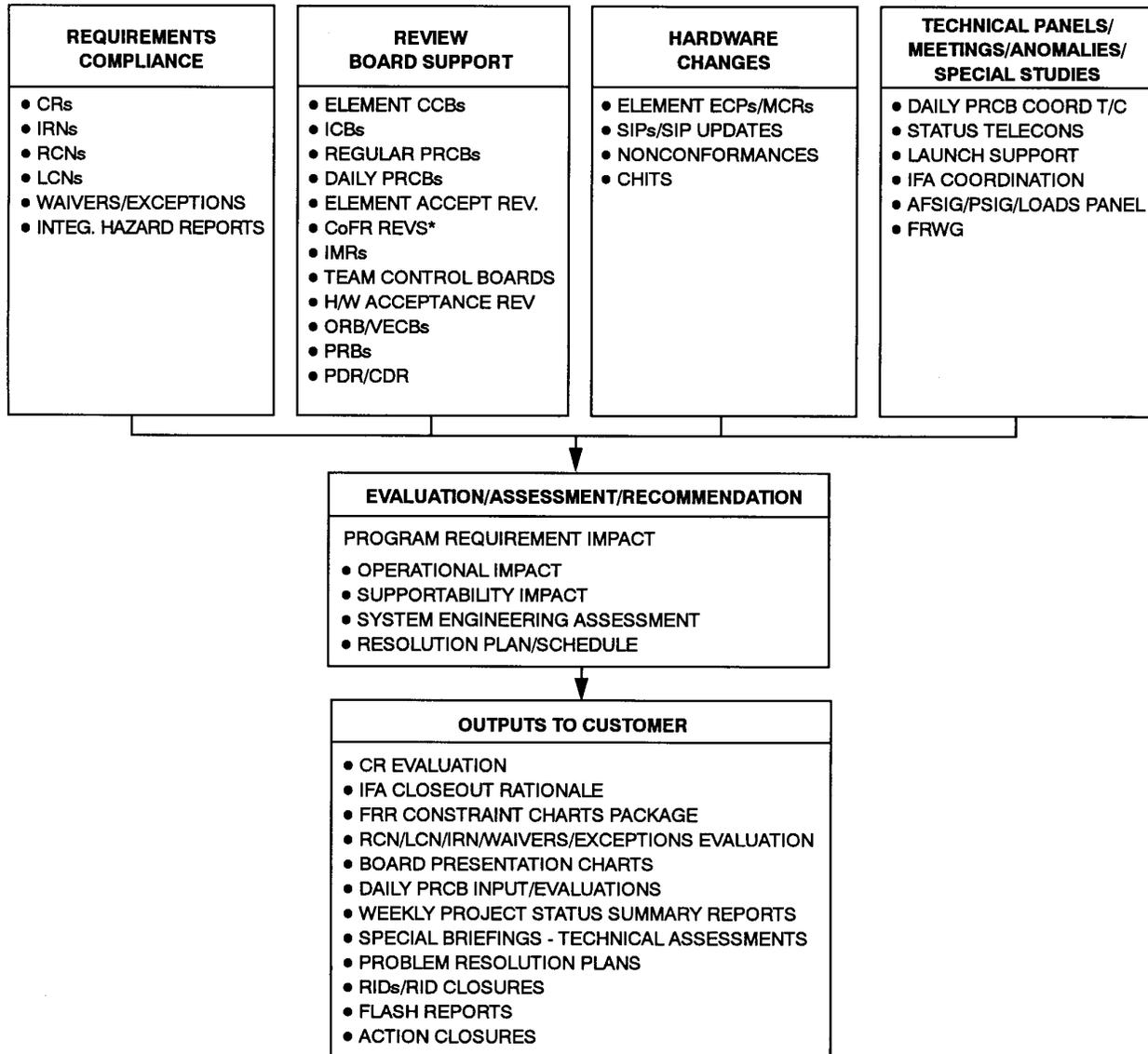
**FIGURE 3-1  
PROJECT INTEGRATION TEAM INTERFACES (NASA OVERSIGHT, USA INSIGHT)**



**FIGURE 3-2  
PROJECT INTEGRATION TEAM INTERFACES (USA OVERSIGHT, NASA INSIGHT)**

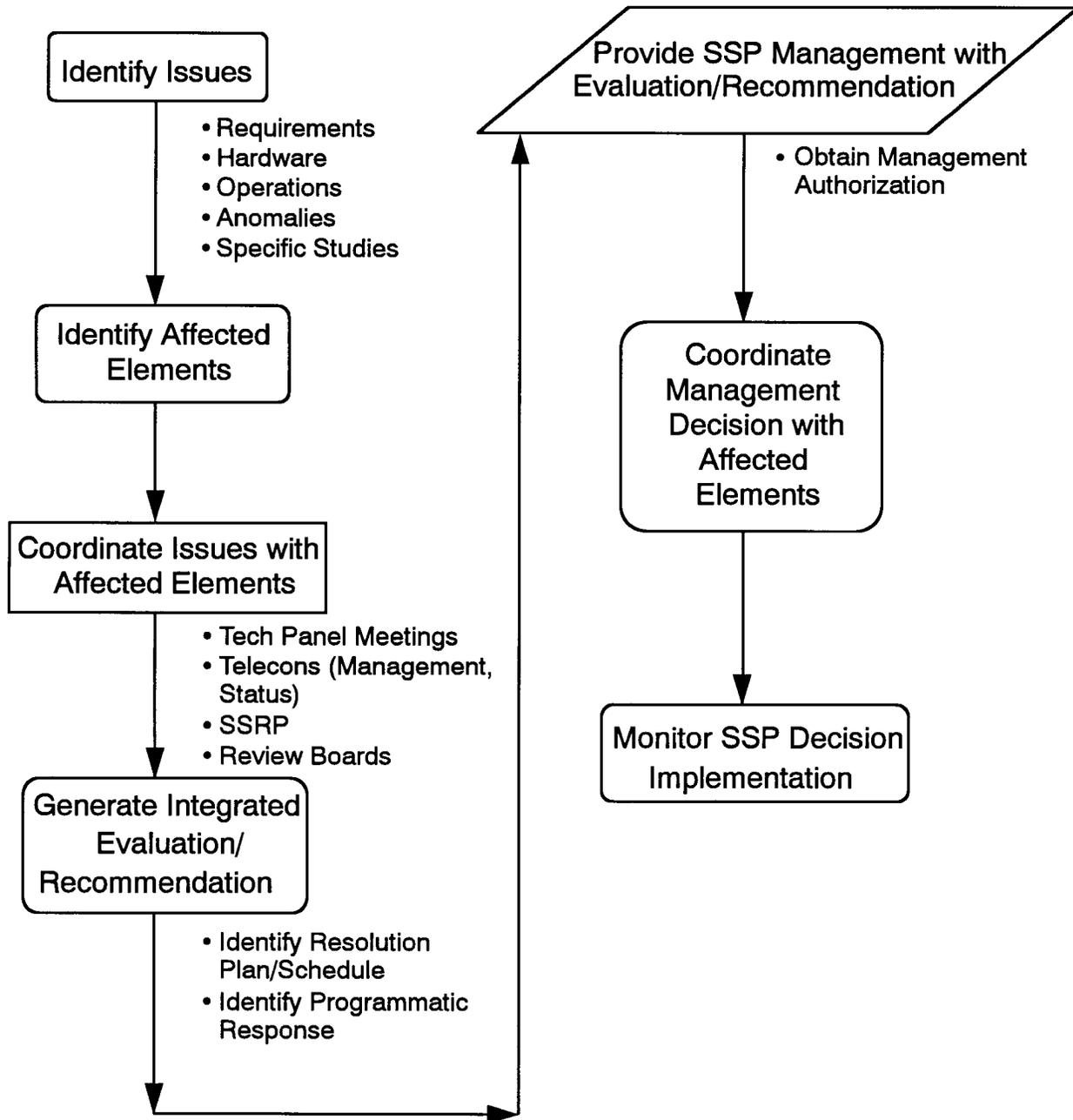


**FIGURE 3-3  
BNA PROJECT INTEGRATION TASK**

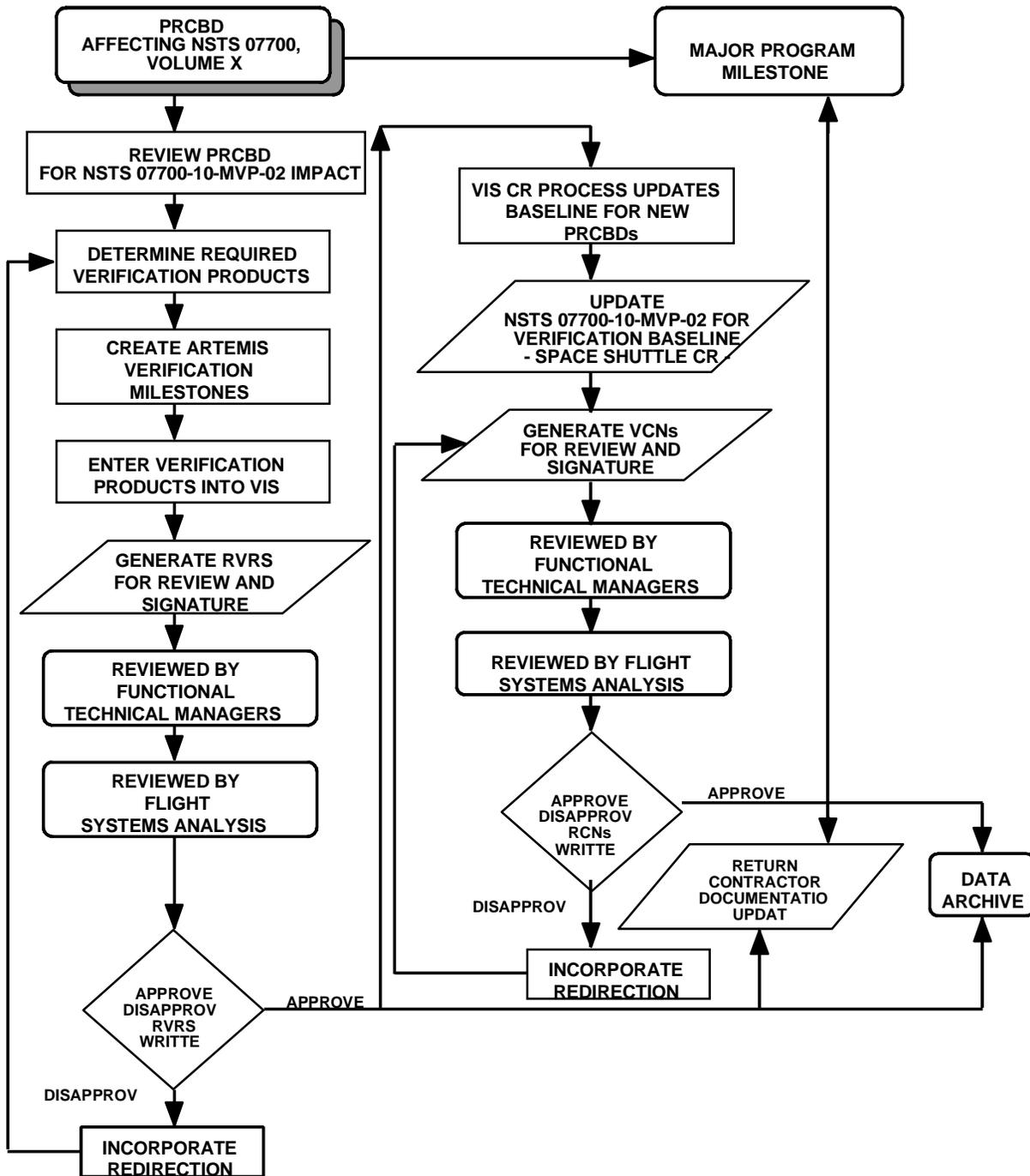


\*CoFR reviews covers mate/rollout, elements, pre Level II FRRs

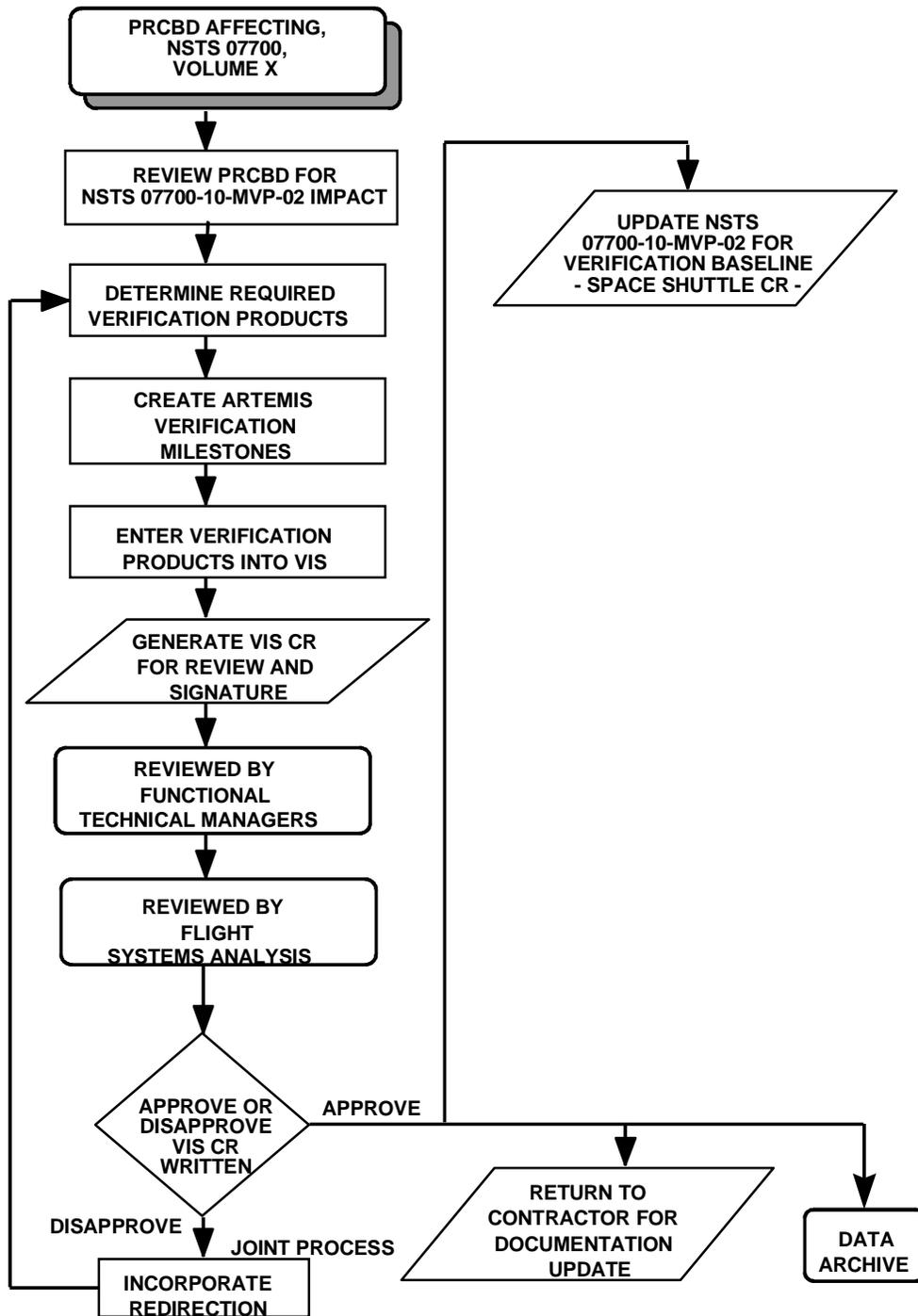
**FIGURE 3-4  
USA/NASA PROJECTS INTEGRATION PROCESS FLOW**



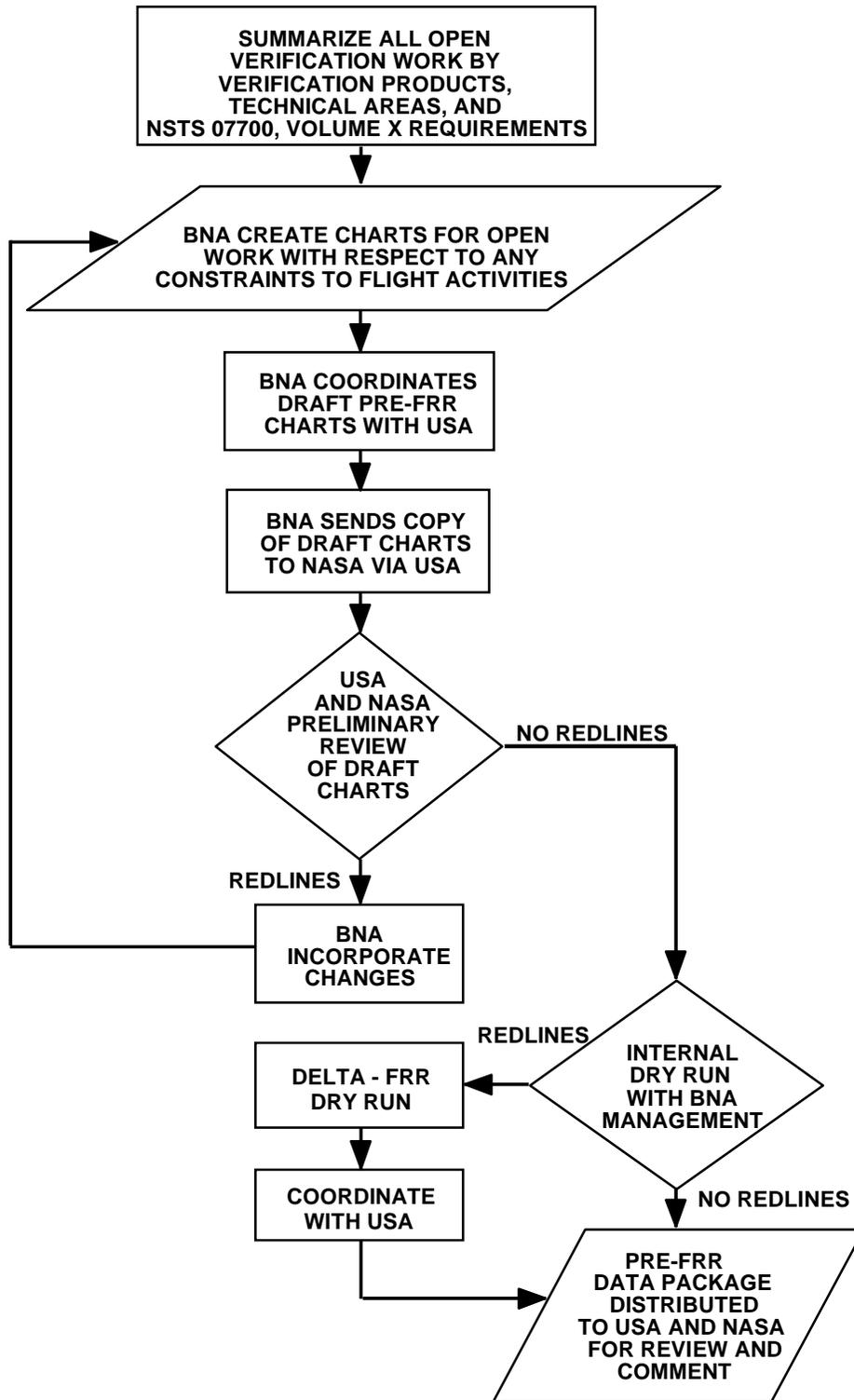
**FIGURE 3-5  
NASA/USA/BNA COMBINED ELEMENT VERIFICATION  
OF MAJOR NSTS 07700, VOLUME X REQUIREMENTS CHANGES  
PROCESS FLOW**



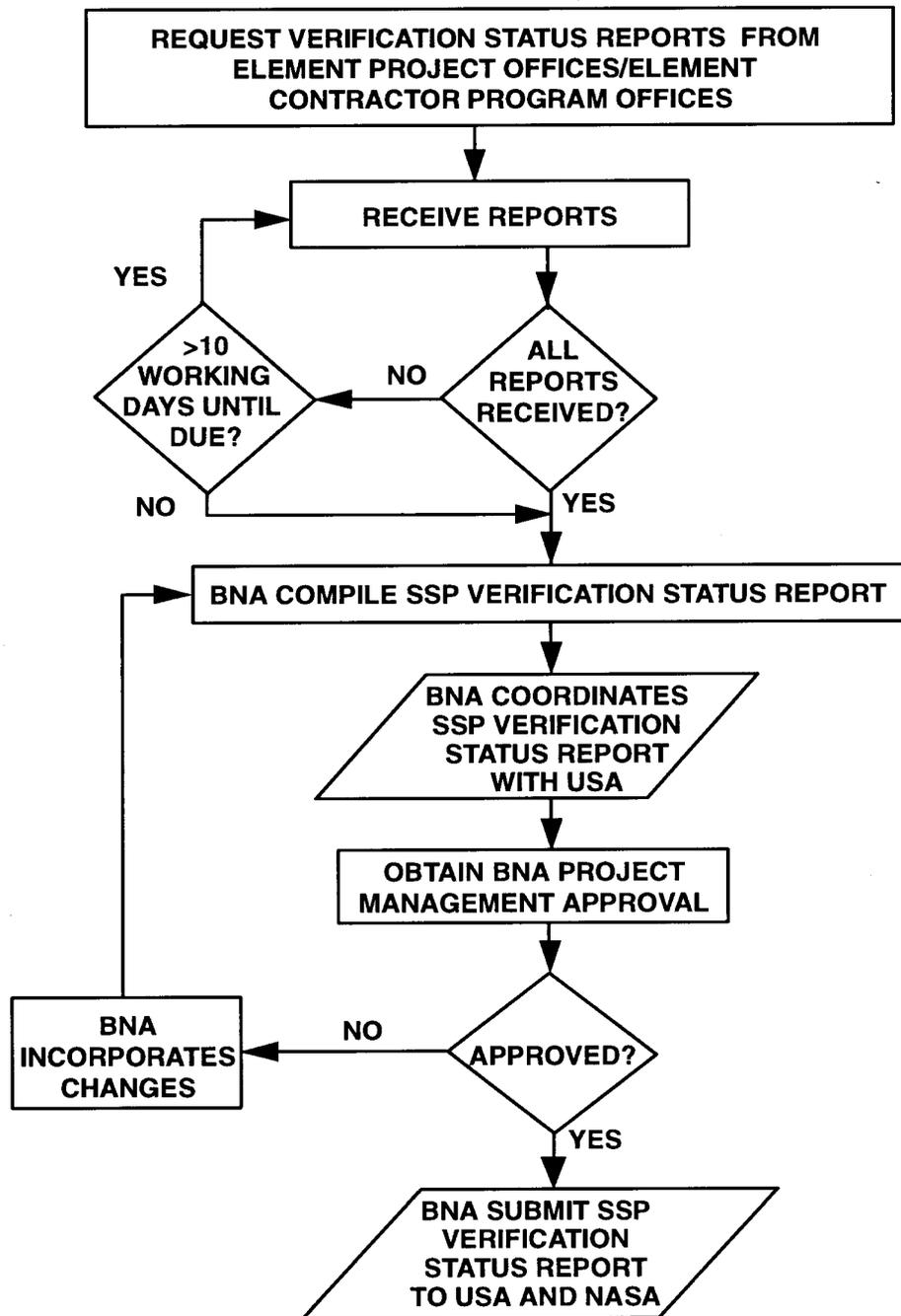
**FIGURE 3-6  
NASA/USA/BNA COMBINED ELEMENT VERIFICATION  
OF ROUTINE NSTS 07700, VOLUME X REQUIREMENTS CHANGES  
PROCESS FLOW**



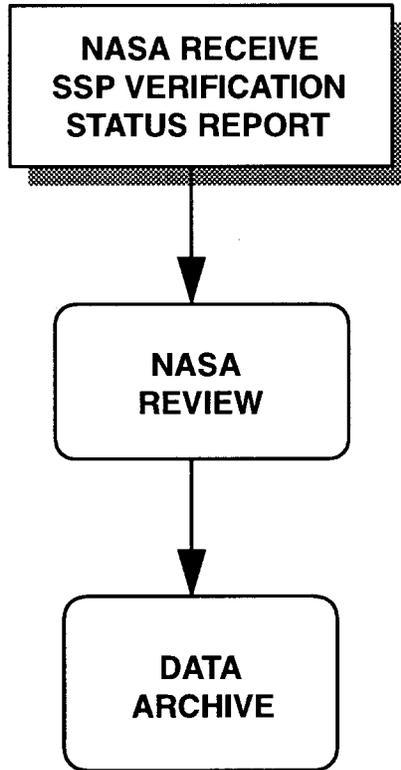
**FIGURE 3-7  
NASA/USA/BNA COMBINED ELEMENT FRR SUPPORT PROCESS FLOW**



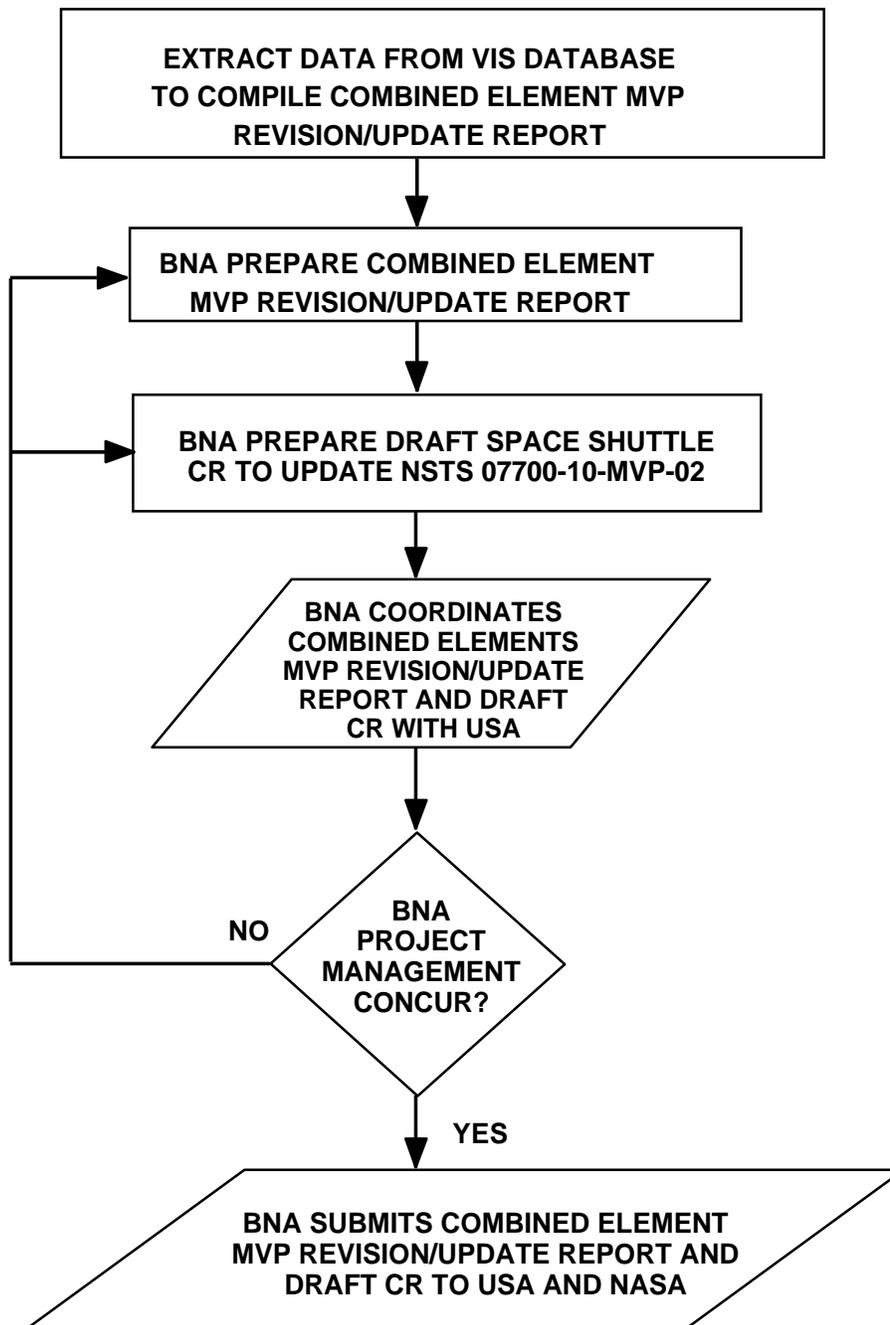
**FIGURE 3-8  
USA/BNA SSP VERIFICATION STATUS REPORT PROCESS FLOW**



**FIGURE 3-9  
NASA SSP VERIFICATION STATUS REPORT PROCESS FLOW**



**FIGURE 3-10  
USA/BNA COMBINED ELEMENT MVP REVISION/UPDATE REPORT PROCESS  
FLOW**



**FIGURE 3-11  
NASA COMBINED ELEMENT MVP REVISION/UPDATE REPORT PROCESS FLOW**

