NCSX

INTERFACE CONTROL MANAGEMENT PLAN

(NCSX-PLAN-ICMP_00)

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NCSX Interface Control Management Plan

1 Introduction

1.1 Purpose

An interface is a common boundary between the activities or WBS elements. Interface control is the process of developing a technical agreement between two or more activities or Work Breakdown Structure (WBS) elements that documents the functional, performance, and physical characteristics required to exist at this common boundary. Interface control defines the integration constraints to ensure that systems and subsystems mutually can be assembled and/or function together. As the design evolves, increasingly more detailed interfaces will also evolve and be documented. The process described in the Interface Control Management Plan (ICMP) describes the policies and procedures for generating and administering these technical agreements.

The process of defining and managing interfaces on NCSX is called Interface Control and Management (ICM). The ICM program outlined in this ICMP recognizes that the interface definition begins well before the start of conceptual design, but that the formal control and management process does not begin until the start of preliminary design. The ICM program ends with project decommissioning. Two key requirements of ICM are the:

- Technical efforts to arrive at mutually acceptable technical agreements and the preparation of supporting documentation of these agreements; and
- The administrative efforts to manage the generation of agreements and related documentation, including changes as the design evolves.

The ICM Program is closely linked to the Systems Engineering (SE) program and its detailed supporting programs such as Configuration Management and Data Management. A broader discussion of the relationship of the ICM Program to these is contained later in this plan.

1.2 Applicable Documents

This ICMP draws on the documents listed below. Documents referenced are the latest issues of the:

- Systems Engineering Management Plan (NCSX-PLAN-SEMP)
- Work Breakdown Structure (WBS) Dictionary (NCSX-WBS)
- Quality Assurance Plan (NCSX-PLAN-QAP)
- Data Management Plan (NCSX-PLAN-DMP)
- Documents and Records Plan (NCSX-PLAN-DOC)
- Configuration Management Plan (NCSX-PLAN-CMP)
- Pro/INTRALINK Users Guide
- NCSX Procedure, Glossary of Acronyms and Definitions (NCSX-PROC-001)
- NCSX Procedure, Interface Control (NCSX-PROC-003)
- PPPL Engineering Procedures and Standards, including, but not limited to the latest version of:
    - *ENG-006 "Review and Approval of Specifications and Statement of Work";*
    - *ENG-010 "Control of Drawings, Software, and Firmware";*
    - *ENG-019 "PPPL Engineering Standards"; and*
    - *ENG-029 "Technical Definitions and Acronyms";* and

1.3 Overview of the Interface Control and Management Program

1.3.1 Responsibility for the ICM Program

The Systems Engineering Support Manager is responsible to the NCSX Engineering Manager for administering the NCSX ICM Program. At a minimum, the following personnel will be involved in identifying, resolving interface problems, and documenting interface agreements:

- Systems Engineering Support Manager
- Cognizant Project Engineers impacted by the proposed interface
- Cognizant WBS Managers impacted by the proposed interface
- Other personnel deemed necessary to fully define and reach agreement on the interface

A major responsibility of the Systems Engineering Support Manager is to facilitate processing of and approval of the documentation that defines interfaces, resolving interface requirements definition and responsibility disputes (with the concurrence of the responsible Project Engineer and Engineering Manager), and resolution of interface incompatibilities and changes.

1.3.2 Interface Definition

1.3.2.1 Types of Interfaces

There are two types of interfaces; physical interfaces and functional interfaces. Physical interfaces define the physical envelopes and will eventually be reflected in an ICD. Functional interfaces define the performance requirements and will eventually be reflected in analyses and developmental or "design to" specifications. Supporting the development of these two types of interfaces will be design studies that assess and demonstrate the potential impact of either physical or functional interfaces.

Within these two types of interfaces are two classes of interfaces; primary interfaces and secondary interfaces.

1.3.2.2 Primary Interfaces

A primary interface exists between two separately deliverable items (referred to as Configuration Items/CIs in systems engineering terms) when the mutual boundary area is not controlled by a single developmental or "design to" specification, when the interface is with systems outside the project (external interfaces identified in the General Requirements Document/GRD), or when, at the discretion of the cognizant Project Engineer, the interface is determined to be critical to the performance of the NCSX program. Configuration Items (CIs) represent the lowest level of control under configuration management and may be a single physical or functional item and/or collection of items that will satisfy a final end product or deliverable. Primary interfaces will be defined, documented, and brought under configuration control by the time of the earliest Preliminary Design Review (PDR) for those CIs. The methods by which primary interfaces are identified, documented, and managed is controlled by the system described in this ICMP and other project plans and procedures.

Although the space envelopes are not directly interfaces, it is true that competing components may involve some competition for the same space. The Facility Model in ProE contains and controls space envelopes.

1.3.2.3 Secondary Interfaces

A secondary interface is an interface can be defined by a single developmental or "design to" specification. Secondary interfaces will remain under local control by the WBS Manager until such time that the design is completed and the CI ready for delivery or the CI interface is elevated to a primary interface status. The methods by which secondary interfaces are identified and managed are left to the discretion of the WBS Manager. Accordingly, the system described in this ICMP is not mandated for secondary interfaces.

1.3.3 Interface Documentation

Primary interfaces are defined by ICDs or developmental specifications. The need for new or updated ICDs/developmental specifications may be generated by the introduction of new components/software either by engineering changes to existing designs and/or design evolution. ICDs defining physical interfaces will always be in a book form (written) format, however, liberal reference to either existing or new drawings is encouraged. Functional interfaces are defined in updated or new developmental specifications. As a first step in generating ICDs and/or developmental specifications, scope sheets will be developed for each interface. Section 2 includes a broader discussion of the ICM process and its documentation. Approved ICDs and developmental specifications will be stored in the Engineering Web page.

1.3.4 Changes to Interfaces

Once an interface is defined, approved and posted as an ICD or in a developmental specification, the interface will come under configuration control. This will occur prior to the time of the PDR for the impacted CIs. Changes to interfaces will be processed in accordance with the via the Engineering Change Proposal (ECP) configuration control system outlined in the CMP.

2 The Interface Control And Management Process

2.1 Evolution of the ICM Process

During the establishment of the NCSX program in the pre-conceptual and conceptual design phases, a system-level interface analysis was conducted that resulted in the definition of the major functional interfaces for each concept being considered. These basic interfaces were reflected in the overall Pro/Engineer (Pro/E) models that were developed. At this stage, although no ICDs or developmental specifications below the General Requirements Document (GRD) level were generated, at the completion of Conceptual Design Review (CDR) the initial technical, cost, and schedule baselines are established. The technical documentation that provided the basis for the establishment of the technical baseline represented high-level interfaces between major components and WBS elements, but these interface agreements were not yet formalized. These baselines serve as the starting point for the preliminary design phase. It was also at this point in the Systems Engineering process outlined in the System Engineering Management Plan

(SEMP), that the majority of Configuration Items (CIs) that will form the configuration management bases were defined.

Once the conceptual design is established and preliminary design commences, the details and completeness of interfaces increase. Early in the preliminary design phase, scope sheets are prepared to initiate agreements that will eventually define the primary interfaces required between participants. These scope sheets are intended to act as planning documents that will facilitate definition and agreement as to the specific primary interfaces. As the Preliminary Design Review (PDR) approaches, ICDs and developmental specifications will be prepared that define and facilitate coordination between participants in support of the PDR. ICDs and developmental specifications shall be two of the items to be finalized by the completion of the PDR. These ICDs and developmental specifications then become part of the technical baseline documentation and are under the configuration control processes outlined in the Configuration Management Plan (CMP). These ICDs and developmental specifications represent key agreements that will enable each agreeing WBS Manager to proceed with his or her design secure in the knowledge that the interfacing WBS element will not alter the interface without going through the change control process. As indicated in the SEMP, not all subsystems and CIs undergo PDRs at the same time and so not all subsystems and CIs have their ICDs/developmental specifications developed on the same time scale. However, the ICD defining an interface will come under configuration control at the time the first CI in the interface undergoes a PDR. .

As the design progresses into final design and beyond, additional interfaces may be defined and documented on new scope sheets and ICDs and developmental specifications will be prepared and approved. Should modifications to existing ICDs or developmental specifications be identified as part of the design evolution process, these changes will be processed through the normal Engineering Change Proposal (ECP) processes described in the CMP. Completed and modified ICDs and developmental specifications will be controlled as part of the technical baseline and will be posted in pdf format on the Engineering Web page.

2.2 Scope Sheets Agreements and ICDs

2.2.1 Scope Sheet Agreements

Scope sheets are the first step in the process of generating ICDs representing primary interfaces. The scope sheet agreement is really only a planning document, usually in the form of e-mail agreements, that provides a formal acknowledgement between two parties (e-mail agreement satisfactory):

- That an interface exists between them;
- The general scope of the interface;
- Who is responsible for documenting the primary interface in the form of an ICD, developomental specification, or design study;
- The expected deliverable to be produced (e.g., ICD for a physical interface, developmental specifications defining the functional requirements, or a design memo that documents the basis for future interfaces;
- When the primary interface (ICD) will be needed; and

- The specific Work Authorization Form (WAF) task identification number to ensure that all interfaces are properly reflected in work plans with sufficient resources to accomplish those interfaces.

These will be generated early in the preliminary design phase and will eventually be replaced by formal ICDs prior to the CDR. The scope sheet agreement is a planning document that facilitates definition and recognition of the ownership of an interface and the ICD or developmental specification is a technical document that provides the technical definition agreement and documentation of the interface physical and functional characteristics. A single scope sheet agreement is prepared for primary interfaces between two WBS elements with a tabulation of each interface provided.

2.2.2 Interface Control Documents

2.2.2.1 Preparation of ICDs

ICDs will be prepared and identified in accordance with the instructions contained in procedure NCSX-PROC-003, NCSX Interface Control.

2.2.2.2 Kinds of Interface

The format and content of an ICD will vary depending upon the nature of the design requirements documented. For example, the interface between two electrical connectors may also include mechanical aspects (e.g., connector size, pin/socket configuration, etc.) of the interface. Thus, an ICD for this interface would necessarily include both electrical and mechanical information on that interface. Interface design requirements are typically grouped into the following categories:

- Mechanical, including envelopes
- Electrical
- Magnetic
- Fluid
- Environmental
- Sequencing/programming and Timing
- Computer Programming
- Man/Machine

2.2.2.3 Format of ICDs

All ICDs will be prepared in a book form (written format). If an interface can be completely described in a drawing or model, the book form ICD may only contain a single line reference to the applicable drawing or model on which the interface is shown or to a separate stand-alone Interface Description Drawing (IDD). These drawings and models will be numbered in accordance with the procedures outlined in the Data Management Plan (DMP) and the Pro/INTRALINK Users Guide. In many instances, functional design requirements (e.g., electrical, sequencing and timing, etc.) cannot be adequately described on drawings. When extensive written information or tabular data must be presented, the book form ICD will totally represent the interface. Book form ICDs may be multi-sheet, letter-size documents. They may also be used for mechanical/envelope interface requirements provided that the information can be adequately displayed on a standard letter-size page. Every book form ICD shall contain, as a minimum, a title page (including revision number), the unique ICD number, and a

description of the interface, and summary/tabular data that defines the interface. Annex II to this ICMP describes the book form ICD in greater detail.

2.2.2.4 Use of Drawing Notes to Describe Interfaces

The Pro/INTERLINK Users Guide provides a broader discussion of the preparation of CAD drawings and models using Pro/Engineer software. Interfaces that can be defined pictorially on a drawing will utilize this format as the preferred method of illustrating primary interfaces. When the ICD is prepared, the impacted drawing or model, or if needed a separate IDD, will be updated and promoted as appropriate. The drawing format ICD shall be prepared in sufficient detail to accurately reflect the interface and envelope. In addition, the overall drawing and model will be annotated to show the ICD number clearly on the drawing and drawing notes will be use used to qualify or amplify information on the interface.

For drawings and models developed in AutoCAD or other project-approved drawing software package, ICDs will also be clearly reflected on the drawing or model. If the ICD impacts component or subsystem envelopes, the ICD will also have to be reflected on the overall Pro/Engineering model to be used for space allocation and assembly.

Drawing notes will be utilized to amplify interface information. For mechanical and envelope interfaces, the callout will used to display critical dimensions and characteristics to assist the system designers in evaluating potential changes and to assist them in preventing changes that inadvertently alter an interface. Interface characteristics can be affected by a multitude of details in the design or modification to an electrical circuit, software, or timing or I/O sequencing documents. This sometimes makes it impractical for the callout to adequately describe the interface at the piece-part level. In this case, drawing notes will be placed on a higher level assembly drawing or software program component.

2.2.2.5 ICD Tracking and Implementation System

Each ICD will be tracked on an ICD tracking log that will be maintained on a sub-web the Engineering Web page that is dedicated to interfaces definition and control. This web page is envisioned to be a simple Excel spreadsheet format to facilitate various sorting options.

Once an ICD is approved and under configuration control, the implementation of the ICD into the impacted documentation shall be tracked as part of the ECP implementation tracking system outlined in the Configuration Management Plan (CMP). If an approved ICD is later modified as a result of a subsequent ECP, the ICD will be also listed as an impacted document and its implementation tracked.

2.2.3 Developmental ("Design To") Specifications

Developmental ("design to") specifications define the functional requirements of a system or interface. They are prepared in accordance with PPPL Engineering Procedure 006, (ENG-006), "Review and Approval of Specifications and Statement of Work."

2.3 Relationship to Data Management and the Configuration Management Programs

2.3.1 Data Management Program

An ICD whether in drawing or book form format is just another technical document that needs to be prepared, controlled, and managed. The Data Management Plan (DMP) provides a discussion of how these ICDs will be managed.

2.3.2 Configuration Management Program

The Configuration Management Plan (CMP) contains a broader discussion of the overall configuration control process. Once under configuration control, changes to ICDs and developmental specifications, like other technical documentation (e.g., drawings or models, or other specifications, etc.) are processed via the ECP and will be listed as an impacted document on the ECP. As indicated above, the implementation of modifications to ICDs and developmental specifications shall be tracked and discussed as part of the detailed ECP implementation status during the monthly status meetings with the WBS Managers.

The design process keeps the interface documentation current by continually addressing primary interfaces between WBS elements. ICDs and developmental specifications approved at the end of the PDR are used as the starting point for the design effort to proceed. As the design progresses, it may become necessary to modify the existing ICD or developmental specifications via an ECP or to impose an interface condition that did not previously exist.

Changes to drawings or models that reflect interfaces must be considered when processing ECPs. While the process of revising ICDs properly reflects updates to drawings or models, the opposite must also be considered – where changes to drawings or models may impact existing ICDs. As part of the impact statement on the ECP, the impact of the change to existing interfaces must be considered as part of the impact identification process.

2.4 Cancelled ICDs

In some rare instances, it may be appropriate to cancel an ICD since it no longer defines an existing interface or the interface requirements have changed so significantly due to design changes such that the ICD is no longer applicable. Requests to cancel an ICD will be processed via the ECP process. In cases where the interface requirements have changed so significantly, a new scope sheet and ICD will be developed and approved. The ECP will clearly identify the specific ICD being cancelled.

2.5 Interface Incompatibilities

Engineering errors, specification anomalies, manufacturing tolerance problems, etc., may result in interface incompatibilities that may not be discovered until after interface agreements are complete. Incompatibilities may be detected as the design matures, as prototypes are developed, during functional or verification fit checks, assembly and testing, etc. All incompatibilities must be identified to the impacted parties to the interface, the cognizant Project Engineer, and the Systems Engineering Support Manager as soon as they are discovered. The potential impact on other interfaces must also be assessed. A recovery plan will be developed by the two interface parties and may include

further analysis, hardware/software redesign, or interface revision to correctly define the actual interface. More than likely, an ECP will result from the resolution of interface incompatibilities.

2.6 Dispute Resolution

In cases where agreement cannot be reached between two parties, the Systems Engineering Support Manager will request the assistance of the cognizant Project Engineer to resolve the dispute. If the dispute cannot be resolved at that level, the Engineering Manager will be the deciding official.