

PPPL QA Audit Report

To: Wayne Reiersen
From: Judy Malsbury
Subject: Audit #0406, NCSX Design Control
Date: November 17, 2004

This report documents audit number 0406, NCSX Design Control. For this audit there were four commendations, eight observations, six recommendations, and two findings. Corrective actions for the findings have already been specified and are contained on the findings forms.

Reference material pertaining to this audit is available in the audit file and may be obtained by contacting the Lead Auditor at x2415.

Responses to the audit will be followed up and corrective action status is reported on a regular basis.

Should you have any questions, please contact the Lead Auditor.

Signatures on copy in QA files.

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Accepted by:

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Audit File 0406

AUDIT REPORT

Audit Number: 0406
Audit Name: NCSX Design Control
Date(s) of Audit: August 16 – September 9, 2004
Place of Audit: PPPL
Auditors: Judy Malsbury (Lead Auditor),
Larry Dudek, Eng. Dept, F&OM
Charlie Gentile, Eng. Dept, Tritium Group
Organizations Audited: NCSX
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Al von Halle, Head, Electrical Engineering (Division
responsible for the Operations Center)
Exit Meeting: Friday, October 1, 2004, 1:30 PM, Eng. Conf. Rm
Wayne Reiersen, NCSX Project Engineer
Bob Simmons, NCSX Systems Eng Support Mgr
Tom Brown, NCSX Design Integration Mgr
Audit Team
References: See Appendix C

Executive Summary

NCSX is a significantly more complex machine than had previously been designed and built at PPPL. The designs are created using CAD drawings and models. As a result, an integrated system for the development and control of models and associated drawings has been established.

As a further complexity, it is being designed by a team of physicists and engineers at multiple sites, primarily from PPPL (in New Jersey) and Oak Ridge National Lab (in Tennessee). The capability to allow easy and accurate communication among all participants is important. In order to provide for this capability, the project has implemented a paper-less system, using the project web site as its operations center and NetMeeting as the tool to enable meetings with remote participants. These tools appear to have value, but, without adequate training, the full potential will not be achieved.

The NCSX has developed a comprehensive set of project plans and procedures to support the design control process. The audit team has identified problems with compliance to these plans and procedures. Such problems, we believe, partially result from the fact that adequate training on these new processes has not been given. In addition, the established plans and procedures are staff intensive; reviewing and streamlining the plans and procedures is recommended. The project should consider the appropriate graded approach for these processes based on the complexity and risks associated with each design and include this information in the plans and procedures.

The NCSX project has had formal reviews on the designs of the Vacuum Vessel Subassembly (VVSA) and the Modular Coil Winding Forms (MCWF) concluding that these designs “satisfy the technical requirements and needs of the project and are ready to proceed with procurement and fabrication.” [May 19-20, 2004 Final Design Review Report]

For the most part, the designs performed on behalf of NCSX have primarily focused on two areas, the VVSA and MCWF. This is reasonable, since these are the most complex and technically challenging designs for the project. However, it is important that the issues identified in this report be resolved in a timely fashion before the number of individuals involved in the design of NCSX increase.

I. Audit Overview

A. General

This was an audit of the processes used for the design of NCSX subsystems. It was performed by reviewing three specific subsystem designs – the Modular Coil Winding Form (MCWF), the Autoclave, and the C – D site Transmission Tower. Plans, procedures, drawings, and records were reviewed. Project and PPPL personnel were interviewed.

B. Objectives of the Audit

The performance objectives and criteria (POCs) for this audit (in normal font) along with the status as determined by the audit (*italicized*) are:

1. The requirements (technical, cost, schedule) for the design are clearly defined.

The requirements are identified in the General Requirements Document (GRD), which, in turn, flow down to the System Requirements Documents (SRD)s. Both the

- GRD and the Modular Coils and the Vacuum Vessel Subsystem SRDs remain in draft format even after designs for the Modular Coil Winding Form and Vacuum Vessel Segments have been generally completed and contracts for fabrication awarded. See finding #1.*
2. The design is appropriately documented in system descriptions, specifications, drawings, procurement documents, analysis and calculations, etc.
There are many documents associated with the design of the subsystems reviewed during this audit. As an example, for the MCWF, there exists a draft SRD, models and drawings, calculations, statement of work for the fabricator, and a product specification. Concerns were identified with the finalization of some of this documentation. See finding #1 for details.
 3. The design has been appropriately verified via peer and formal design reviews, independent reviews, checking of calculations, prototyping, comparisons to already working systems.
Many design reviews were held on the subsystems reviewed as part of this audit. Due to its complexity, the MCWF had frequent reviews including external experts, such as the FDR mentioned in the Executive Summary. Concerns were identified by the audit team with the resolution of design review chits and the verification of calculations. See finding #1.
 4. Design interfaces are identified and controlled.
It was not clear to the individuals interviewed or to the audit team what design interfaces needed to be formally documented and approved for the three subsystems that were reviewed. Few formal design interfaces were documented and approved. This is related to the training issue of finding #2
 5. Changes to designs are appropriately reviewed and processed.
The audit team is not aware of any problems that have occurred in this area. However, a future concern has been identified by project management. Actual drawing changes are authorized with the Engineering Change Notice (ECN) of ENG-010. Signatures for the ECN are the cognizant engineer and the Responsible Line Manager (RLM). Concerns were expressed that the RLM may not have adequate knowledge of the complex NCSX designs to perform an adequate review of field changes. See observation #8.
 6. NCSX staff members are knowledgeable about the PPPL and project specific requirements in this area.
Concerns regarding the lack of a comprehensive training plan for NCSX staff was identified in audit 0314, NCSX Management Systems. Since then, little has been accomplished. See finding #2 for details. The audit team believes that this finding is a contributory cause for finding #1.
 7. Environmental, Safety, and Health concerns are appropriately identified and processed during the design phase.

No problems were identified, during this audit. ES&H personnel are invited to all design reviews.

C. Commendations, Findings, Observations, and Recommendations

This audit resulted in two findings, four commendations, eight observations, and six recommendations. The findings are:

1. The NCSX systems for the control of designs are not consistently implemented.
2. Training on the NCSX systems for design control has not been defined or provided.

Details on the findings may be found on the findings forms contained in Appendix 1.

Commendations The commendations are:

1. The NCSX is the first project at PPPL to adopt an integrated tool for the development of models and drawings (ProEngineer and Intralink). This was adopted due to the complexity of the vacuum vessel and modular coils and further complicated by the fact that project participants are in multiple locations and need to be able to review and develop the models and drawings. NCSX continues to identify opportunities for improvement in this area. An example of this is the investigation currently underway of using FROtools, a software package that provides a browser interface to Intralink, allowing users to search for files by keywords and add selected files to an export list. The software can also create pdf files from 2D drawings.
2. The NCSX is also the first project at PPPL to move to a paperless, web based system for plans, procedures, and records. This was adopted because the project personnel are not all located at a single site. This provides convenient access to project files.
3. The NCSX project specifications include a section on quality conformance, identifying how each of the specified requirements will be verified.
4. Prototyping has been effectively used as a tool for clarifying and verifying the designs of the Modular Coil Winding Forms and the Vacuum Vessel Segments and obtaining more experience for the complex fabrication work that is just beginning. Trial implementations of proposed winding techniques are being tested using variously shaped winding forms.

Observations

1. The Users' Guide for the Intralink system is currently draft and defines NCSX project specific processes. Either these processes should be moved to

controlled procedures or the Users' Guide itself should become a controlled document.

2. While NCSX is not responsible for the design of the PPPL Work Planning form, it's design does impact them. The WP system was designed for work associated with project installations – first design, then build, then install. The second approval cycle for the form is approval to install, which is not really relevant to work activities such as procuring the Modular Coil Winding Forms. The form should be reviewed for changes that allow it to be used for work activities that are not the typical design, build, and install.
3. Few Interface Control Documents (ICDs) for NCSX systems under review have been published. The audit team was told that it was the cognizant engineer's and WBS manager's responsibility to identify what ICDs were necessary. However, the individuals interviewed as a result of this audit could not provide definitive answers about whether any ICDs were required. This is related to finding #2.
4. Information about all NCSX related NCRs are maintained on the project NCR web site (http://ncsx.pppl.gov/NCSX_Engineering/QualityAssurance/NCRs/index_NCRs.htm). However, the hyperlinked text on this web site brings up only copies of the initially issued NCRs, not the completed closed ones, even though the status indicated in the table is correct. The table does not contain all the information found on the closed NCRs including the final disposition. This latter is important information, especially if the NCR is dispositioned "use-as-is." QA transmitted copies of all closed NCRs to the NCSX Project Engineer for posting on this web site; the web copies should be updated.

The storage of NCRs is not consistent with the NCSX Data Management Plan, which states in ¶ 2.3.4 "Each NCR file will be assigned a unique number that relates it to the impacted project and component/drawing (and eventually the WBS) and will be stored in subfolder in the same folder as the impacted drawing or model." So far, the storage of NCRs in the subfolders has not occurred, even though relevant NCRs have been generated.

The NCSX NCRs generated so far have been for the prototype vacuum vessel segment and the Twisted Racetrack Coil, neither of which will become part of the actual experiment. The project is reminded that the NCSX Documents and Records Plan requires in ¶5.2.6.1.1, that if as-built drawings are not generated for a component having a PPPL generated NCR, then the drawing will be annotated to indicate the specific applicable NCR.

In addition to the QA NCRs discussed above, there are frequently supplier generated NCRs. QA-003, Procurement Quality Assurance, requires that the procurement technical representative deliver these NCRs to the Operations Center for filing once the procurement is completed. Prior audits indicated that this does not consistently happen. It is not clear that there is a process within NCSX for capturing these NCRs in the web based data system.

5. The audit team identified concerns with accessing files on the NCSX management web site from outside the PPPL firewall. The project is working on resolving these concerns.
6. The Burns drawings generated for the C-D Power Connection are located in the EMDRAC system and also located on the Intralink system. Having the same drawings in two locations is acceptable if there is no likelihood that they will be changed in the future and result in only one of the set of drawings being updated. The project should review the storage of such electronic supplier drawings.
7. The NCSX Data Management Plan, ¶1.1, states: “The purpose of this Data Management Plan (DMP) is to describe the process by which documents for the National Compact Stellarator (NCSX) Project will be stored and managed. The vast majority of project documents will be created, stored, and be accessible electronically. In instances where the electronic storage of project documents is not practicable (e.g., supplier submittals, Work Planning Forms, Job Hazard Analyses, etc.), hard copies will be provided to the PPPL Operations Center for storage. Where feasible, the cover page, first page, or other identifying sample of the hard copy will be scanned and stored, electronically with the appropriate annotation made in the electronic file as to the source repository. A specific NCSX Operations Center Web site has been developed to catalogue what is stored in the Operations Center and its location within the Operations Center.” As of this audit, there is no specific NCSX Operations Center Website where project records stored in the Operations Center are catalogued, though the Head of the Operations Center believes there are no project records stored there. However, the NCSX Project Engineer would consider NCSX NCRs, which, upon closure, are stored in the Operations Center to be project records. Two such NCRs have been transmitted to the Operations Center.
8. Actual drawing changes to reflect field changes are authorized with the Engineering Change Notice (ECN) of ENG-010. Signatures for the ECN are the cognizant engineer and the Responsible Line Manager (RLM). Usually the RLM is the PPPL manager responsible for the design and the work occurring in the field. However, for NCSX, the design engineer typically will not be the field engineer. It is important to get the design engineer involved in reviewing all field changes before implementation. This is complicated by the fact that the design engineer may be an ORNL staff member and physically not located at PPPL. In addition, ENG-010 allows field changes to be made with no further review if there is an open ECN for the associated drawing. Effective methods for assuring the proper and timely review of field changes by the design engineer prior to implementation needs to be developed. Such reviews should not unnecessarily delay the field work.

Recommendations

1. Information is stored on the NCSX engineering web site by record type, e.g., subsystem specifications, design review records, specifications/statements of work, analyses. During this audit, the team was most interested in reviewing records by subsystem; structuring the web site by WBS, where appropriate, would be more user friendly.
2. While drawings are available from Intralink, paper copies still have their advantage when the user needs to review a number of drawings or doesn't have ready access to a computer or printer capable of generating large prints. It is recommended that, for each approved drawing, a paper copy be made and stored in the Print Room for easy access. Some NCSX engineers are generating paper copies and storing them in the Print Room, but this is an individual decision, not a project requirement.
3. The NCSX web site is maintained manually, usually by the Project Engineer or the Systems Engineering Support Manager. While the team recognizes that resources for such work is limited, it would be cost effective, if possible, to develop a database of NCSX records from which such a web site could be automatically generated.
4. The NCSX Configuration Management Plan, NCSX-PLAN-CMP-01, states in paragraph 1.2 that "As-built drawings are encouraged, but not required due to potential adverse resource impacts." NCSX-PROC-002, Rev. 0, in the Introduction states that "The goal of the NCSX Configuration Management Program is to ensure that the configuration design evolution is controlled and the documentation of the configuration design shown in electronic drawings and models accurately reflect what is installed in the field *to the extent practicable.*" [emphasis added by writer] It is recommended that the project determine under what conditions as-built drawings are required.
5. NCSX documents are signed electronically. As electronic signatures are added, Adobe increases an internal document revision number by 1, the first signature is revision 1, the second revision 2, etc. These revisions may be viewed by reviewing the properties of a signature. When signatures are validated, signatures entered prior to the last one have an explanation mark (!) next to them indicating that changes were made to the document after this signature. The only changes appear to be additional signatures, but these error messages reduce the confidence that the reader has in the signature process. It is recommended that NCSX work with PPPL software engineers and Adobe to determine if there is a method of adding signatures that would not result in this error.
6. The specifications guidelines page, located at http://ncsx.pppl.gov/NCSX_Engineering/Requirements/index_SpecTypes.htm, does not use the "APEC", "BSPEC", etc. terminology that is used elsewhere within the NCSX plans, procedures, and naming conventions.

Since this terminology is used throughout NCSX, even in the file naming conventions, it should be added to the guidelines pages for clarification.

II. History

The only other audit performed upon NCSX was #0314, NCSX Management Systems. An observation concerning training was identified in this earlier audit and has been escalated to a finding in audit 0406.

Appendix A - Audit Finding Reports

Appendix B - Findings and Concerns from Earlier Audits and Appraisals

Appendix C – Documentation reviewed during this audit

Appendix A

Audit 0406 Findings Forms

AUDIT FINDING REPORT

AUDIT NO.: 0406 FINDING NO: 1

AUDIT NAME: NCSX Design Control

AUDITED ORGANIZATION: NCSX

DATE OF AUDIT: August 16 – September 9, 2004

REFERENCES:

DOE O 414.1A, Quality Assurance

PPPL Policy P-015, Records Management, Rev. 1

ENG-010, Rev. 2, Control of Drawings, Software, and Firmware

ENG-030, Rev. 1, PPPL Technical Procedures for Experimental Facilities

ENG-032, Rev. 3, Work Planning Procedure

ENG-033, Rev. 1, Design Verification

NCSX Project Execution Plan (PEP), Rev. 1, February 2004

NCSX Quality Assurance Plan, NCSX-PLAN-QAP, Rev. 0

NCSX Data Management Plan, NCSX-PLAN-DMP, Rev. 1, February 3, 2004

NCSX Systems Engineering Management Plan, NCSX-PLAN-SEMP-dI-RTS, Draft, dated December 17, 2003 (Note that normally draft documents are not used in an audit. However, the SEMP, which defines the proposed development process, is referenced by the NCSX Project Execution Plan which is approved.

NCSX Interface Control Management Plan, NCSX-PLAN-ICMP, Rev. 0, 2/20/03

NCSX General Requirements Document, Rev. 1, January 5, 2004

NCSX System Requirements Document for the Modular Coil System (WBS 14), Draft D, May 7, 2004

NCSX Structural Design Criteria, Draft E, dated 5/10/04

NCSX-PROC-004, Rev. 1, NCSX Work Planning Package Process, 8/4/04

Work Planning form #1096, Modular Coil Final Design and Analysis (FY2004)

PROGRAM REQUIREMENTS: The typical format for finding forms has program requirements listed separately from the actual finding items. It was not used here due to the complexity of this finding. For this finding, the requirements are listed prior to each issue supporting the main finding.

FINDING: THE NCSX SYSTEMS FOR THE CONTROL OF DESIGNS ARE NOT CONSISTENTLY IMPLEMENTED.

This finding is supported by the following:

1. THE SYSTEMS ENGINEERING MANAGEMENT PLAN HAS NOT BEEN FINALIZED.

Requirements: The NCSX PEP, section 1, under NCSX Project approved documents, lists the Systems Engineering Plan (SEMP) with the words “Describes systems engineering processes and management practices to be utilized by the NCSX Project.”

NCSX-PROC-004, NCSX Work Planning Package Process, references the NCSX Systems Engineering Management Plan (SEMP).

As found condition: The NCSX Systems Engineering Management Plan is draft and has not been approved. At least one of the features within the plan has not been implemented, the NCSX Work Planning Form. The project has dropped the concept of a project specific work planning form and decided instead to use the PPPL Work Planning Form.

2. SYSTEM REQUIREMENTS DOCUMENTS REMAIN IN DRAFT FORMAT EVEN AFTER DESIGNS HAVE BEEN GENERALLY COMPLETED.

Requirements: DOE O 414.1A, Attachment 1, Contractor Requirements Document, 2.b(2)(b) states that “Design work, including changes, must incorporate applicable requirements and design bases.”

The draft SEMP states in ¶ 3.2.1 Requirements Documentation Hierarchy: “Requirements for the NCSX Project are captured in a hierarchy of requirements documents, which begin with the system (top-level) engineering requirements in the General Requirements Document (GRD). The GRD represents a complete set of performance requirements and constraints at the system/project level and initial subsystem allocations. The top-level system requirements in the GRD flow down to a set of specific functional or “design to” requirements at the appropriate subsystem or major component/procurement level. These functional or “design to” requirements then flow down to specific fabrication requirements that get translated into products and services by the builders (“build to”).”

As found conditions The System Requirements Documents for both the Modular Coil System (NCSX-BSPEC-14-00) and the Vacuum Vessel System (NCSX-BSPEC-12-00) are in draft format, even though, during the audit, contracts were about to be awarded for the fabrication of key components of

these systems. Note that prior to the issuance of this report, these contracts were awarded.

3. NCSX DESIGN CRITERIA DOCUMENTS, REFERENCED AS PART OF THE REQUIREMENTS FOR THE MCWF, EITHER ARE DRAFT OR DO NOT EXIST.

Requirements: The NCSX General Requirements Document, NCSX-ASPEC-GRD-00, 5/5/03, references the NCSX Structural and Cryogenic Design Criteria Document as a “to be provided” document. It references this document in two places:

- a. ¶ 3.2.4.2.b “The facility shall be designed for the following maximum number of pulses when operated per the reference scenarios defined in Section 3.2.1.5.3.3.1 and based on factors for fatigue life specified in the NCSX Structural and Cryogenic Design Criteria Document.” and
- b. ¶ 3.3.1.3 “NCSX stellarator systems shall be designed in accordance with the NCSX Structural and Cryogenic Design Criteria.”

The System Requirements Document (SRD) for the Modular Coil System, still in draft, references in ¶ 2.1 the Structural and Cryogenic Design Criteria. Note that it also references a Seismic Design Criteria, which is not available, even in draft form on the NCSX web site. The SRD for the Vacuum Vessel also references the Seismic Design Criteria document.

As found condition: The NCSX Structural Design Criteria Document is draft even though structural designs have been completed. The Seismic Design Criteria document could not be located on the NCSX website.

4. NO SYSTEM HAS BEEN ESTABLISHED FOR THE CONFIGURATION CONTROL OF MODELS

Requirements DOE O 414.1A, Quality Assurance, Attachment 1, Contractor Requirements Document, specifies in 2.b(1)(b) that “Items must be identified and controlled to ensure their proper use.” It also states in 2.b (2)(b) that “Design work, including changes, must incorporate applicable requirements and design bases.”

As found condition While informal processes exist for the configuration control of 3D models, they have not been formalized. These models are being used for fabrication.

5. CONFIGURATION ITEMS HAVE NOT BEEN IDENTIFIED.

Requirement: NCSX-PROC-004 specifies in section A the procedure for configuration item identification. It includes steps for the WBS manager to define the configuration items (CIs) for the subsystem design, the Responsible Project Engineer to review and concur with the proposed CI identification, the

Engineering Manager to approve the proposed CI identification, the Systems Engineering Support Manager to update the spec tree to reflect the CIs and schedule of design reviews on the Engineering Web.

As found condition: The audit team asked for a list of configuration items for the three projects under review. No list was provided.

6. CONCERNS WERE IDENTIFIED WITH THE STORAGE OF NCSX RECORDS ASSOCIATED WITH WORK PLANNING FORMS.

Requirements:

ENG-032 defines the requirements for the maintenance of records (data files) associated with PPPL Work Planning forms. Under the Responsibilities section of ENG-032 is the following paragraph: “The Operations Center is responsible for maintaining the Work Planning data files. The Work Plan web site contains a current list of WPs. In the event that a project uses a project specific procedure encompassing work planning, the project shall *register* its project files as *satellite files* of the Ops Center as appropriate to maintain the linkage to central files. References to the Ops Center in this procedure shall be understood to include these types of satellite files.” [italics added by writer] The NCSX project specific work planning system is defined in NCSX-PROC-004, which adopts the PPPL WP system.

As found condition: The term “register” as contained in ENG-032 is unclear. Neither the Head of the Operations Center nor the next level manager knew what this meant or what was required to register project files. The term “Satellite files” is undefined. The closest term is “Satellite Areas,” defined in ENG-030, Rev. 1, as “Physics areas outside of the Operations Center which are authorized to issue run copies of approved procedures.” This definition is not consistent with the intent of the words in ENG-032.

7. CONCERNS HAVE BEEN IDENTIFIED WITH RECORDS ASSOCIATED WITH NCSX DESIGN REVIEWS

Requirements:

DOE O 414.1A, Quality Assurance, Attachment 1, Contractors Requirements Document, 2.b(2)(d) requires that “The adequacy of design products shall be verified and validated by individuals or groups other than those who performed the work.” 2.b(2)(e) requires that “Verification and validation work shall be completed before approval and implementation of the design.”

P-015, Rev. 1, is the PPPL policy on Records Management. It contains the following: “Typical quality documents and records include records documenting the design basis, review, and revision”

ENG-033, Rev. 3, establishes the PPPL process for verification and validation of designs.

ENG-033, Rev. 3, under Procedure, states: “In each case the above sections produce documentation that shall be forwarded to the Operations Center. In the event that a project creates and keeps its own centralized project files, the project shall register these project files with the Ops Center as satellite files. The project then has responsibility for maintaining these files until such time as the files are transferred to the Ops Center. Each reference to the Ops Center in A through E below shall be understood to include these registered satellite project central files also.”

ENG-033, Rev. 3, in section C, defines the PPPL process for design reviews. Defined in this section are the requirements for dispositioning the chits, closing them, and storing them in the Operations Center [or registered satellite project central files].

Note that the NCSX Documents and Records Plan, Revision 2, dated 5/27/04, has defined design review records as official project records.

As found condition

The use of the term “satellite files” is the same as described above with the same concerns. NCSX is not keeping copies of the original chits generated during the review. Instead a spreadsheet of the chits is generated, though the content of the spreadsheets vary from review to review. For some, the review board comments and recommendations, the project disposition, the cost and schedule impact, and the status are maintained on the NCSX web site. Others, such as the CDR chits for WBS 18, the cost and schedule impact is not on the spreadsheet. There are no places on the spreadsheets for the signature of the RLM indicating review and the Cog declaring close-out. There is the potential for transcription errors should the original chits be discarded. In addition, sometimes additional information is included on a chit that is not easily transcribed to an Excel spreadsheet; examples of this are hand-drawn sketches or emphases via special characters.

MCWF The purchase order for the MCWFs will be awarded shortly. The NCSX FDR conducted on May 19th and 20th of this year was considered to be the FDR for the Modular Coil Winding Forms (MCWF). The chits associated with the FDR are posted on the web as an Excel spreadsheet. There are no indications in this spreadsheet of the final resolution of the chits that would indicate that all the chits associated with the MCWFs have been resolved and closed. Examples of chits associated with the MCWF for which a final resolution is not evident are:

- (a) #23, Update the design criteria to reflect the appropriate maximum stress allowable for cast modified CF8M alloy. The response is “Zatz will work with Williamson on an update on the design criteria.” The design criteria, still in draft format, have not been updated since this FDR.
- (b) #20, Establish a set of hierarchical fiducials. The primary fiducials to set up the casting for machining should be located in regions where

they will not be machined away at a later time. Secondary fiducials should be inserted with each change of machining set up.” The response is “Agree. See ID#7 above. Williamson has provided a target number of fiducials for subcontractor planning purposes.

Heitzenroeder will add an item to spec saying that details of fiducials will be determined as part of the MIT finalization process.”

Revision 3 of the specification (NCSX-CSPEC-141-03-03) contains the following in ¶ 3.3.2.2: “The Supplier shall provide eighteen (18) or more permanent targets that are in known relationship to the CAD model of the winding form. Three (3) fiducials (spherical seats) shall be provided on each flange surface; four (4) targets shall be visible for each setup of machined fixtures, and four (4) targets shall be visible from any exterior view of the winding form.”

Note that the information associated with this FDR is located on the NCSX Management web site but not on the NCSX Engineering web site in the design reviews area.

D to C Site Transmission Line For the C to D-site Transmission line system PDR, the Excel spreadsheet for the chits does not contain the cost and schedule impact and current status of the chits (in progress, closed completed, etc.). There are no signatures, either on paper or electronic, for these spreadsheets. The cog considers words such as (from the FDR) “43 chits were generated during PDR. All chits have been addressed.” to document closure of the PDR chits. Note that the color code for this review at http://ncsx.pppl.gov/NCSX_Admin/Design_Reviews/index_DsgnRvws_WBS_4.htm indicates that the review was conducted but the chits not yet dispositioned. This is not consistent with the cog’s belief of the status.

For the FDR, the PDR chits and their status were updated and posted on the NCSX Web site, under the link “Chits and Disposition Plan” for the FDR. The audit team could not find the list of chits specifically generated at the FDR

Autoclave The chits for the autoclave from both the PDR and FDR are available in paper format with the cognizant engineer and have been formally closed. They are not available, however, on the NCSX web site as required by the NCSX Documents and Records Plan.

8. CONCERNS HAVE BEEN IDENTIFIED WITH NCSX CALCULATIONS AND ANALYSES.

Requirements:

DOE O 414.1A, Quality Assurance, 4.b(2)(b)4 requires that “The adequacy of design products shall be verified and validated by individuals or groups other than those who performed the work. Verification and validation work shall be completed before approval and implementation of the design.”

MCWF The associated work planning form (#1096) contains requirements for structural, eddy current, thermal, seismic, and FMEA analyses. The structural, eddy current, and thermal analyses are on the web in draft format. The FMEA is in draft format but still needs work as evidenced by answers to possible failures as “shutdown and repair, if accessible” with no probabilities or words on how to prevent or reduce the probability of failure. Seismic analysis has not been performed though the team did question the applicability of this analysis to this work element. Note that the May 2004 FDR did compliment the project on the excellent progress made on the analyses.

D to C Site Transmission Tower There are no calculation requirements on the WP form (#1118). PDR chits 2, 22, 28, 29 and 37 recommended calculations that, the audit team was told, were completed and checked by Burns and independently verified by a PPPL mechanical engineer. These calculations are not available on the NCSX website. It is not clear how the NCSX processes apply to facilities work performed on behalf of the project. However, NCSX has identified a WBS number for this work and has included some of the documentation associated with the WBS on its website.

Autoclave The team saw a calculation sheet documenting many calculations dated 5/5/03 and independently verified by a PPPL mechanical engineer. The calculations are not available on the NCSX website. The team was told that there is one calculation, the ability to pump down, that was done informally and is not part of the reviewed package.

ES&H Related Finding? Yes ___ No X

RECOMMENDED CORRECTIVE ACTION:

Note: Recommendations are suggestions only. Specific action taken to resolve the finding is at the discretion of the audited organization.

1. The specific problems with the three subsystems reviewed during this audit and as identified in this finding should be fixed. The status of other subsystems should be reviewed for similar problems and fixed.
2. The NCSX design control process is more complex than those used at PPPL in the past and not well understood by project members (see finding #2). In addition, it is not clear that there is adequate staff to support this program, including technical, administrative, and support staff. The NCSX Systems Engineering Support Manager has told project personnel that he will restructure information to project specified formats, if given the appropriate information. However, this approach may not be feasible as the design work load for the project expands. With this in mind, it is recommended that the project:
 - a. Review the current program to identify opportunities for streamlining the program while retaining consistency with other Laboratory policies and procedures. The Project Engineer has rightly expressed his concern that a

graded approach is necessary to complete the work with the available resources within the committed schedule. However, such a graded approach needs to be formally incorporated into the program.

- b. Cancel unnecessary plans and procedures and update others as needed to be consistent with the revised approach.
- c. Identify the method for verification and validation and configuration control of models. Update/develop project specific plans and procedures to reflect these methods. Work with Engineering to assure that Labwide procedures covering these topics (ENG-010, ENG-033) are appropriately updated, as necessary.
- d. After defining but prior to implementing the revised program, conduct a peer review to obtain input from the key players who have a stake in the program.
- e. Clarify the relationship between the NCSX filing system and the Operations Center.
- f. Assure that all players understand the system. See finding #2.
- g. Periodically monitor compliance to and effectiveness of the revised system.

CORRECTIVE ACTION (to be completed by audited organization):

Proposed by: Wayne Reiersen On date: 05 November 2004

1) CORRECTIVE ACTION TO RESOLVE THE FINDING:

- a. Documents that are ready for signature (e.g. the SEMP, VV SRD, TF SRD, MC SRD, Structural and Cryogenic Design Criteria, and Seismic Design Criteria) will be signed forthwith. (Reiersen, by 17 December 2004)
- b. The Configuration Management Plan and supporting guides and procedures will be reviewed and revised as necessary to ensure that the process for configuration control of 3D models is well defined and documented. (Simmons, 17 December 2004)
- c. The formal practice of configuration identification has never been done at PPPL and should not be required. Configuration item identification will be removed from NCSX-PROC-004. (Simmons, 17 December 2004)
- d. The project is using the PPPL Work Planning system directly. No work planning forms are stored outside of that system. (No action required.) (Note from the Lead Auditor: Potential concerns with records and the Work Planning system will be reviewed as part of audit #0501, currently scheduled for April, 2005.)
- e. The DMP will be revised to clarify the relationship between the Ops Center and the NCSX system for document storage and retrieval. (Simmons, 17 December 2004)
- f. The project views its *electronic* implementation of ENG-033 as a commendable practice and will continue to store records of design reviews electronically. The NCSX Project commits to the following:
 - The NCSX Engineering Administrator (Tyrrell) will formally obtain the concurrence from the cog engineer and RLM that ensure that the records are complete and that the chits have been properly dispositioned. (Ongoing practice, no special action required.)
 - Chits from peer reviews, CDRs, and PDRs will be checked for closeout at the next major design review. (Ongoing practice, no special action required.)

- The status of all chits from previous design the VVSA FDR and MCWF FDR will be reviewed in the near future. (Simmons, 17 December 2004)
 - All open chits will have milestones associated with them by which the chit should be closed. NCSX plans and procedures will be appropriately modified to reflect this practice. (Simmons, 17 December 2004)
 - The Engineering Administrator will contact cog engineers on a monthly basis to update the status of chit resolutions. (Ongoing practice, no special action required.)
 - The project will get the formal concurrence from the Engineering Department Head that the NCSX implementation of ENG-033 is acceptable. (Simmons, 17 December 2004)
 - Training in the NCSX implementation of ENG-033 will be provided to cog engineers and RLMs. (Simmons, 19 May 2005)
- g. The project will exercise due diligence to ensure that design basis calculations are checked and documented in accordance with NCSX and PPPL guidelines before approval and implementation of the design. Design basis calculations for the Modular Coil Winding Form FDR that were not formally documented and checked in analysis reports will be formally documented and checked by the Comprehensive Modular Coil FDR. (Reiersen, 03 March 2005)
- h. The Systems Engineering Support Manager (Simmons), Design Integration Manager (Brown), and Engineering Manager (Reiersen) will review the design and documentation of the project's plans and procedures for design control and incorporate improvements where needed (28 January 2005). They will then conduct a peer review (Simmons, 25 February 2005) of the project's plans and procedures for design control involving key project personnel (management, cog engineers, and RLMs) and lab personnel (Williams, Malsbury, Such, and Chrzanowski). The peer review will serve the dual purpose of [1] identifying deficiencies in our system for design control and [2] training key personnel. Following the peer review, the project's plans and procedures for design control will be revised in accordance with recommendations from the peer review (Simmons, 25

March 2005). The peer review material will be used as the basis for a training course in design controls (Simmons, 29 April 2005).

Completion date: _____ Assigned to: _____
(See above)

2. CORRECTIVE ACTION TO PREVENT A RECURRENCE OF THE FINDING:
- a. The project will practice due diligence in signing documents in a timely manner. (Ongoing practice, no special action required.)
 - b. Training will be provided to all project personnel involved in design control activities. (Simmons, 19 May 2005)
 - c. The Engineering Administrator will contact cog engineers on a monthly basis to update the status on action items resulting from design review chits and recommendations. (Ongoing practice, no special action required.)
 - d. The NCSX Training Plan will be developed and formally approved. The Training Plan will address training of new people as well as existing staff. (Simmons, 28 January 2005)

Completion date: _____ Assigned to: _____
See above.

AUDIT FINDING REPORT

AUDIT NO.: 0406 FINDING NO.: 2

AUDIT NAME: NCSX Design Control

AUDITED ORGANIZATION: NCSX

DATE OF AUDIT: August 16 – September 9, 2004

REFERENCES:

DOE O 414.1A, Quality Assurance

NCSX Quality Assurance Plan, NCSX-PLAN-QAP, Rev. 0, dated November 8, 2002

PROGRAM REQUIREMENTS:

DOE O 414.1A, Attachment 1, Contractor Requirements Document, ¶2.1(2)(a) states that “Personnel must be trained and qualified to ensure they are capable of performing their assigned work.”

The NCSX Quality Assurance Plan references the NCSX Training Matrix as the method for documenting the training requirements for design activities.

FINDING: TRAINING ON THE NCSX SYSTEMS FOR DESIGN CONTROL HAS NOT BEEN DEFINED OR PROVIDED.

As a result of an observation in QA Audit #0314, NCSX Management Systems, performed in June 2003, a training matrix was developed for the NCSX project. Note that this matrix is not available on the NCSX web site. The matrix primarily focuses on training such as General Employee Training (GET), Job Hazard Analysis, NEPA Review System, Electrical Utilization. With two exceptions applicable to only one subset of NCSX personnel, it does not address project specific training. The exceptions are applicable only to those personnel who, under the Laboratory matrix organization, report to the Head of the Fabrication, Operations, and Maintenance Division where the topics “Overview of Web-Based Project Engineering System for NCSX” and “NCSX Procedures” are listed; these NCSX specific topics, unique to the NCSX project and not part of the typical training given to especially the PPPL technical staff are extremely important but are not well defined.

Some training on the NCSX systems and procedures has been given. Informal overview sessions on Intralink, the system used for access to the Pro/Engineering drawings, and the structure of the NCSX website have been given. The primary mechanism used to explain the project specific processes to project personnel have been one-on-one sessions between the NCSX person involved in a task and either the

NCSX Project Engineer or the NCSX Systems Engineering Support Manager. However, many of the individuals interviewed as part of this audit did not understand the NCSX specific processes, indicating that this training is perhaps not effective. The audit team is also concerned that it may not be efficient, since it could require much of the limited time of the NCSX Project Engineer and the NCSX Systems Engineering Support Manager.

There is no document that identifies the topics required to be addressed by NCSX specific training or the approach to be taken. There is only a draft proposal that identifies the responsibilities of the various organizations involved in the PPPL matrixed organization structure including NCSX and the home organizations.

The audit team believes that this is a contributory cause to the issues identified in finding #1

ES&H Related Finding? Yes ___ No X

RECOMMENDED CORRECTIVE ACTION:

Note: Recommendations are suggestions only. Specific action taken to resolve the finding is at the discretion of the audited organization.

1. Because PPPL is a matrixed organization, the responsibilities of the home organizations and the project with respect to training should be clearly defined.
2. The specific topics requiring training for the NCSX project, how the topics will be covered, and who needs the training should be identified. This should be formally documented in an approved project specific training plan.
3. For each NCSX specific topic, course material should be established along with the method for presenting the course material – classroom, computer based training, read-only training, one-on-one training. Due to the newness to PPPL staff to some of the system concepts (e.g., B- vs. C-Specs, web based records systems), read-only training for processes and procedures is discouraged.
4. NCSX personnel should be trained. Processes should be established to assure that personnel newly assigned to the project receive the appropriate training.

CORRECTIVE ACTION (to be completed by audited organization):

Proposed by: Wayne Reiersen On date: 11/5/04

1) CORRECTIVE ACTION TO RESOLVE THE FINDING:

As outlined in the Corrective Action to Finding #1, training in NCSX plans and procedures for design control will be provided. In addition, the NCSX Training Plan will be developed and issued. It will define the responsibilities of home organizations and the project with respect to training. It will also identify the training modules that need to be developed for NCSX.

See finding #1

Completion date: _____ Assigned to: _____

2. CORRECTIVE ACTION TO PREVENT A RECURRENCE OF THE FINDING:

Implementation of the NCSX Training Plan should prevent recurrence of this finding.

See finding #1

Completion date: _____ Assigned to: _____

Audit History

The only previous audit for the NCSX project was number 0314, NCSX Management Systems. For this audit, there were no findings, twelve observations, and nine observations. The first three of the observations would have been findings had the NCSX Preliminary Design Review already occurred. The observations were tracked by the NCSX project. The status of these observations may be found at http://ncsx.pppl.gov/Management/Audit/Audit_0314_Recomm_Log_2_04.pdf.

Observations that are relevant to audit 0406, NCSX Design Control, and how they were resolved are listed below:

1. Observation #1: “The NCSX Training Matrix has not been developed nor has training on the project requirements and systems been given. Such training is required by DOE O 414.1A, Attachment 1, Contractor Requirement Document, Criterion 2 – Personnel Training and Qualification, which states:
 - (a) *Personnel must be trained and qualified to ensure they are capable of performing their assigned work.*
 - (b) *Personnel must be provided continuing training to ensure that job proficiency is maintained.*

The NCSX QA Plan, Rev. 0, approved 11/08/2002 states that this implementation for this requirement is specified in the NCSX Training Matrix.

The impact of this observation is that interviewed individuals were not aware of project requirements or systems. Some are counting on project management to help them, as needed, navigate the project requirements. However, while high level project management may have the necessary knowledge of project requirements, WBS managers are not adequately aware of these requirements. Training will be key to effective use of the plans and procedures being developed by NCSX, since they tend to be much more rigorous than those used in the past at PPPL and they introduce much new terminology, nomenclature, and acronyms which are not familiar to PPPL staff.

Prior to this planning, procedures should be developed to translate the requirements of the plans to the steps required by individuals – what they should do with their “hands and feet”.

Project Response / Plan / Status (12/2/03): “The project, with Human Resources (S. Murphy-LaMarche and R. Worthy), have developed a training matrix, which was issued as part of the project’s performance baseline documentation. The key NCSX personnel and applicable training courses have been identified. Subjects include both Laboratory and NCSX-specific procedures. A gap analysis is being conducted to determine training needs. To address the concern raised here, one of the training courses is “NCSX Web-Based Project Engineering System”. The first session was conducted by W. Reiersen in August, 2003. The project and Human Resources will work together to follow through on the training plan.”

2. Observation #3: “Many extremely complex calculations are being performed for WBS 1 using complex analysis codes. Others within the project will be using the results for their designs.

Typically the people performing these analyses are the most talented on the project within their specific areas. However, even extremely talented individuals may make mistakes that, if not detected in time, can have a significant impact on the project’s success. The audit team was not provided with satisfactory answers that a method has been identified for the effective review of these analyses.”

Project Response / Plan (12/2/03):” All design-basis engineering analyses will be independently checked and the checking results will be documented. This is an FDR requirement. Project Engineering has created the new position of Technical Assurance Manager, reporting to the Engineering Manager, to elevate the visibility and attention to calculation checking and other Technical Assurance functions. Art Brooks has been appointed.”

3. Observation #12: “Some of the NCSX geometry is too complex to be communicated to suppliers via paper drawings, thus models will be used. The project should assure that appropriate documented controls are established for these models.”

Project Response / Plan / Status (8/7/03): “A new procedure for control and release of electronic drawings for fabrication is being developed by the Laboratory Drawing Control committee as a follow-up to Audit #0308, Drawing Control.”

4. Recommendation #7: “Both the QA Order (DOE O 414.1A, Quality Assurance) and the ISM policy (DOE P 450.4, Safety Management System Policy) require continuous improvement. NCSX should develop a method for incorporating feedback from the staff to improve the systems and processes. Regular management assessments would provide an excellent means

for project participants to feed back on the positive and negative aspects of their work experience on the Project”

Project Response / Plan: “This audit and the follow-up have already provided a valuable mechanism for candid feedback to project management. The audit team and Human Resources have been very helpful in summarizing staff concerns that have been come up in their discussions and communicating them to NCSX management along with suggested solutions. One example is the need for training on NCSX web-based document management procedures, another is a set of concerns about drawing control. Positive feedback has also been received, reflecting a widely held enthusiasm for the project and its success. The NCSX Training course identified in Observation!1 will be used as a further opportunity for feedback, including the use of chits.

Status (2/5/04): The project has conducted training sessions in its web-based management systems. Engineering meetings have been used from time to time for sessions on project plans, such as how it plans to use design reviews, work planning forms (WPs), and WAFs. A lessons-learned report was written recently, concerning management of cost-reimbursement contracts, and follow-up measures from that study have been implemented. The project subscribes to the continuous improvement philosophy and has taken measures to make it part of the project culture.”

Relevant Documents

1. DOE O 414.1A, Quality Assurance
2. PPPL Policy P-015, Records Management, Rev. 1
3. ENG-010. Rev. 2, Control of Drawings, Software, and Firmware
4. ENG-030, Rev. 1, PPPL Technical Procedures for Experimental Facilities
5. ENG-032, Rev. 3, Work Planning Procedure
6. ENG-033, Rev. 1, Design Verification
7. NCSX Project Execution Plan (PEP), Rev. 1, February 2004
8. NCSX Quality Assurance Plan, NCSX-PLAN-QAP, Rev. 0
9. NCSX Data Management Plan, NCSX-PLAN-DMP, Rev. 1, February 3, 2004
10. NCSX Systems Engineering Management Plan, NCSX-PLAN-SEMP-dI-RTS, Draft, dated December 17, 2003 (Note that normally draft documents are not used in an audit. However, the SEMP, which defines the proposed development process, is referenced by the NCSX Project Execution Plan which is approved.
11. NCSX Interface Control Management Plan, NCSX-PLAN-ICMP, Rev. 0, 2/20/03
12. NCSX General Requirements Document, Rev. 1, January 5, 2004
13. NCSX System Requirements Document for the Modular Coil System (WBS 14), Draft D, May 7, 2004
14. NCSX Structural Design Criteria, Draft E, dated 5/10/04
15. NCSX-PROC-004, Rev. 1, NCSX Work Planning Package Process, 8/4/04 (also rev. 0)
16. Work Planning form #1096, Modular Coil Final Design and Analysis (FY2004)
17. NCSX Organization Chart
18. NCSX Documents and Records Plan
19. Pro/Intralink User Guide
20. Systems Requirements Document (SRD) for the Modular Coil System (WBS 14), NCSX-BSPEC-14-00, Draft D, May 07, 2004
21. NCSX-PROC-002, Rev. 0, NCSX Configuration Control, February 24, 2003
22. NCSX WP-WAF Map, dated 3/18/04
23. NCSX Guidelines for Analysis, dated 6/30/2004
24. NCSX Design Review Scheduled and status, dated 4/26/2004
25. ENG-029, Rev. 0, Technical Definitions and Acronyms, 10/1/99
26. Chits from May 19 – 20, 2004 NCSX FDR

27. NCSX Specification Guidelines
28. NCSX Configuration Management Plan, dated February 3, 2004
29. P-075, Configuration Management, Rev. 2, 10/22/99
30. NCSX Design Review Guide, 12/3/2003
31. ECN #4883, Modification to lead block and upper inboard vertical support for production mod coil winding form type-C
32. NCSX Product Specification Modular Coil Winding Forms, NCSX-CSPEC-141-03-03, August 6, 2004
33. NCSX Statement of Work Modular Coil Winding Forms, NCSX-SOW-141-02-00, June 30, 2004
34. Linear Analysis of the Modular Coil Structural Shell, NCSX-CALC-14-001-00, Draft A, August 02, 2004
35. Modular Coil Thermal Analysis, NCSX-CALC-14-002-00, Draft A, July 13, 2004
36. NCSX Failure Mode and Effect Analysis (FMEA), NCSX-FMEA-140-01, undated
37. WP #1118, NCSX DC Transmission Structure and Trays from D to D Site
38. Requisitions #401669 & 401453 for D to C Site DC Transmission Structure and Cable, 7/7/04 and associated purchase order
39. PPPL Statement of Work for the NCSX Power Systems – D to C Site DC Transmission Structure and Cable Trays
40. Information associated with FDR for D to C Site DC Transmission System held on 5/14/04
41. Information associated with PDR for D to C Site DC Transmission System held on Feb. 17, 2004
42. WP#1018, Modular Coil Winding Equipment and Tooling
43. Information associated with NCSX Autoclave FDR, held on 6/03/03
44. Specification for NCSX Modular Coil Autoclave Design, NCSX-BSPEC-142-01-00
45. Specification for NCSX Modular Coil autoclave Vessel Fabrication, NCSX-CSPEC-142-01-00
46. Specification for NCSX Modular Coil Autoclave Heating System Fabrication/Procurements, NCSX-CSPEC-142-02-00
47. NCSX-PROC-003, Rev. 0, NCSX Interface Control, No effective data specified
48. NCSX NCRs – information