

QUALITY ASSURANCE AUDIT REPORT

To: Hutch Neilson
From: Judy Malsbury
Subject: Audit #0609 – NCSX Modular Coil Fabrication
Date: October 31, 2006

This report documents audit number 0609, NCSX Modular Coil Fabrication. For this audit there were six observations, two recommendations, and three 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 monthly basis.

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

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QUALITY ASSURANCE AUDIT REPORT

Audit Number: 0609
Audit Name: Modular Coil Fabrication
Date(s) of Audit: August 15 – 22, 2006
Place of Audit: PPPL
Auditors: Judy Malsbury(Lead Auditor)
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Organizations Audited: NCSX
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Exit Meeting: Thursday, September 21, 2006, 9 AM, Eng Conf Rm
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Dudek, Geoff Gettelfinger, Judy Malsbury, Tom
Meighan, Hutch Neilson, Colin Phelps, Wayne
Reiersen, Bob Simmons, Mike Williams
References: See appendix B

Executive Summary

This is the most complicated fabrication effort that has ever been undertaken at PPPL. It has required new design tools, such as ProEngineer, a greater dependency upon state-of-the-art metrology, and more sophisticated tooling. It is a three dimensional design that is not easily converted to two dimensional drawings that can then be used for fabrication. The tolerances for the windings are tight; the analysis of any tolerance deviations sophisticated. The schedule is challenging and staffing limited. The project should be commended on the planning for the work performed so far and the quality of the completed work.

This audit identified issues that, in the opinion of the audit team, present significant risks. The most significant are presented in the three findings — change control for the fabrication of the modular coils, drawing control, and management of the metrology data and photographs.

Changes to the documents that contain the information necessary for the fabrication of the modular coils are not properly controlled. This concern has the potential for important changes being missed when a coil is fabricated. A side issue is that the actual configuration of a coil will not be completely documented should this information be needed in the future.

Drawings are either not available or not maintained current. Note that the audit team was told by the MC Fabrication Project Engineer that the number of drawings needed in the field is minimal. If so, perhaps a smaller number of required drawings could be identified and maintained.

Neither the NCSX Data Management Plan nor the NCSX Documents and Records Plan discuss records associated with metrology nor the photos taken during the fabrication process increasing the risk that such data would not be available when needed in the future.

Management Reaction

“The audit caused the project to critically evaluate our work practices which itself was beneficial. The audit committee did a commendable job delving into those work practices and identified several areas where improvements were needed. The project appreciated the committee’s focus on risk rather than compliance which greatly enhanced the usefulness of the audit. The project plans to request additional audits for field period assembly and final assembly efforts in the future.”

I. Audit Overview

A. General

This audit reviewed the fabrication of the NCSX Modular Coils, using primarily the C-1 coil as the baseline with the other partially completed coils as further input. It was performed by reviewing records, interviewing people, and observing work in progress.

B. Objectives of the Audit

The single performance objective is that the process for the fabrication of the Modular Coils meets the requirements of the quality assurance program as indicated in the PPPL, project, and modular coil-specific MIT/QA Plan. Of specific interest are appropriate planning, procurement, fabrication, record keeping, training, process assessment, and continuous improvement.

C. Commendations, Findings, Observations, and Recommendations

This audit has three findings, six observations, and two recommendations. The findings are summarized below with details in Appendix A.

Findings – There are three findings for this audit. A summary of each finding is given below with a few words on its impact.

1. Change control for the fabrication of the modular coils is less than adequate. This includes accurately recording how each coil was fabricated, assuring that all changes identified via ECNs are properly incorporated into each coil, and assuring that technical concerns impacting quality, such as permeability, are resolved while there is still time to correct these concerns on specific coils.

The risk associated with this finding is that the coils will not be fabricated the same way and that no adequate and complete record of the differences will exist should this information be needed in the future. Such information was extremely helpful for TFTR when trying to identify the cause of the TF coil leaks. Another aspect of this risk is that changes may not be properly communicated so that they can be implemented on all coils.

2. The Drawing Control program used by NCSX needs improvement. Besides differences in the use of the ECN form as documented on the finding form, ECN stamps are not placed on the drawings in a timely fashion, drawings with revisions referenced on the ECN form do not exist in Intralink, and current revisions of the drawings are not consistently available in the field.

The risk associated with this finding is that the personnel performing work in the field may not be working to the most current information and therefore may not implement the changes on all coils.

3. The Data Management and Documents and Records Plans do not include two important project records – metrology data and photos.

The risk is that the Project may not be able to easily find it be needed by the project should it be needed in the future.

Observations

1. Concerns were identified with communications, both among the various fabrication teams, and between design personnel and the field personnel. Examples are:

- a. In some cases, notes were added to the work procedures by the Lead Technician indicating things of which the teams should be aware. Examples are:

- On MCF-002-01 for C2, step 6/27/10 contained the note “Make sure that lacing is not trapped or crossed over side bar when installing smaller blocks.”

- On MCF-002-01 for C2, Step 6.33.3, there is a handwritten note “Make sure the chill plate fingers are tight against the chill tube before soldering. During soldering, turn unit to low setting. It’s a lot faster and there’s less carbon to clean.”

The individual should be commended on this, but it is not clear how these notes or caveats were shared with the other teams.

- b. A decision was made to modify A1 so that it could only be installed in one direction due to the lineup of porosity in the winding form. This decision was documented in an informal email; a more formal means of documentation would have been preferable. However, later, this decision was rescinded. The initial decision was communicated to the MC Fabrication Project Engineer but not the rescinding of this decision.
 - c. The MCF-004 run copy for C1 (rev. 0) contains the following in paragraph 6.7, Installation of cooling jumper around poloidal break marked "to be done at assembly for C-1". How has this step been identified in the work scope and associated schedule for assembly? Note that the installation step is still in rev. 1, indicating that possibly C1 may not be the only coil for which additional work is required to fix this before field period assembly.
 - d. The MC Fabrication Project Engineer is not always made aware of changes to drawings that are being used in the field for fabrication.
2. The copy of MCF-003 used in the field for the fabrication of C2 contained no approval signatures, i.e., the copy appeared to be a draft copy and was not issued as a run copy.
 3. While each of the MCF-xxx procedures requires post-job briefs, per the cover sheet, they are actually held at the discretion of the MC Fabrication Project Engineer. A notebook containing the notes of these post-job briefs is contained in his office.
 4. While it appears that individuals working on the modular coil fabrications have been appropriately trained, it can be difficult to find the supporting records. Examples of such difficulties are:
 - a. If the training is performed as part of a small group meeting, the record of training is maintained on paper only in a file. The information is not recorded in one of the training databases. If the training is performed as part of a pre-job brief, the training is recorded in one of the training databases, in addition to the paper being filed. It is unlikely that individuals completing a Record of Training form would be aware of the record storage implications of the check made to indicate the type of training. For the NCSX Modular Coil Fabrication program, training on the NCSX Facility Operations Plan was done via a "small group meeting", while training on the Emergency Response procedure was done via a "Pre-Job Brief.”

- b. The course title used for the training records is created using keywords of the title of the document. This is a subjective determination. Since most documents have a number and revision assigned to them, it is recommended that, for at least new training, the course identifier be created as a documentation number followed by an “R” followed by the revision number.
5. The NCSX Manufacturing Facility Operations Plan, NCSX-PLAN-MFOP-01, January 20, 2006, requires in paragraph 7.3.14 a Daily Summary Report. This is not being generated but none of the management personnel felt that it would add value. If so, the requirement should be removed.
6. The NCSX Modular Coil Manufacturing, Inspection, Test and Quality Assurance Plan, NCSX-PLAN-MIT/QA-142-00, Rev. 0, dated November 19, 2004, states in paragraph 2.4.2 that “A complete list of coil drawings for each coil type shall be added to the back section of this MIT Plan once they have been approved.” This has not been done, nor is it clear that this is worth the effort involved in maintaining the list.

Recommendations

1. Assembly of the machine assume that all the A coils are interchangeable and likewise for the B and C coils. However, this may not be a valid assumption, based on considerations such as permeability or as-built condition. The Project is currently identifying the assembly concerns and reviewing methods to reduce the associated risks and should include these considerations in this review.
2. The Project plans to make a copy of the fabrication notebooks for each completed coil prior to delivering the original notebook to the Operations Center. Prior to making the copy, the Project should perform a final review of the notebook to assure that the information is complete.

II. History

This was the first audit of the Modular Coil Fabrication process, though not the first audit of NCSX processes. No overlap between these NCSX audits was detected. Note, however, that a problem with assuring that ECN information was added to drawings in a timely manner was also identified in audit 0308, Drafting.

Appendix A - Audit Finding Reports

Appendix B - References

Audit 0609 – NCSX Modular Coil Fabrication

Finding Reports

AUDIT FINDING REPORT

AUDIT NO.: 0609 FINDING NO: 1

AUDIT NAME: NCSX Modular Coil Fabrication

AUDITED ORGANIZATION: NCSX

DATE OF AUDIT: August 15 – 22, 2006

REFERENCES:

NCSX Project Execution Plan, Rev. 3, June 2005

NCSX Configuration Management Plan, Rev. 3, May 2005

NCSX-PROC-002, REVISION 3, NCSX Configuration Control

NCSX-PROC-006, Rev. 4, Control of NCSX Supplier and In-house Fabrication Information

NCSX-PROC-007, Rev. 2, NCSX Electronic Model and Drawing/INTRALINK Processes

NCSX-PROC-009, Rev. 4, NCSX Request for Deviation Process

D-NCSX-MCF-001, Modular Coil Fabrication – Winding Form Preparation Activities

D-NCSX-MCF-002, Modular Coil Fabrication – Winding Station Activities

D-NCSX-MCF-003, Modular Coil Fabrication-VPI/Autoclave Activities

D-NCSX-MCF-004, Modular Coil Fabrication-Post VPI Activities

PROGRAM REQUIREMENTS:

To improve readability, details on program requirements are contained at the end of this finding. Where appropriate, summaries of requirements are provided in this section.

The **Project Execution Plan**, section 13, Data Management System, describes the basic requirements for control of drawings, documents, and data.

The **Configuration Management Plan**, in section 3.1.1, states that after a successful FDR, key fabrication documents will come under configuration control, which includes fabrication drawings. It also talks about the requirement for stamps indicating that one or more approved Request for Deviations, Nonconformance Reports, or Engineering Change Notices are pending to be incorporated into the drawing.

The **procedure for NCSX Configuration Control**, NCSX-PROC-002, Revision 3, describes the Engineering Change Proposal (ECP) process for changes to the configuration of the NCSX MIE project. Under the Introduction, the procedure states that the normal time frame between ECP approval and review of the impacted documents shall not exceed 30 days. The procedure goes on to state when an ECP, ECN, or RFD are needed. This information for ECNs is reproduced below:

Concerning ECNs: “Once a drawing is released for fabrication (Rev 0), an ECN is **ALWAYS** needed to authorize a change (i.e., revision) to that drawing. If a drawing is changed by an ECN, an ECP will be needed to revise the Specification at a convenient time. See ENG-010 and PROC-006 and PROC-007”.

The **procedure for Control of NCSX Supplier and In-house Fabrication Information**, NCSX-PROC-006, Rev. 4, requires that the NCSX cognizant engineer assure that the necessary technical (e.g., signed technical specifications and signed drawings) documentation is available for the NCSX personnel assigned the responsibility for in-house fabrication of a component.

The **procedure for NCSX Electronic Model and Drawing/INTRALINK Processes**, NCSX-PROC-007, Rev. 2, describes the process for adding RFD or NCR changes to signed “Released for Fab” pdf drawings.

The **work specific procedures, D-NCSX-MCF-*nnn***, all contain a requirement that deviations from the procedures can be made with the concurrence of the MC Field Supervisor as long as they do not affect the design of the coil. Such deviations shall be documented in the procedure and initialed by the MC Field Supervisor.

FINDING: CHANGE CONTROL FOR THE FABRICATION OF THE MODULAR COILS IS LESS THAN ADEQUATE.

Changes to the documents that contain the information necessary for the fabrication of the modular coils are not properly controlled. The risk associated with this finding is that the coils will not be fabricated the same way and that no adequate and complete record of the differences will exist should this information be needed in the future. Another aspect of this risk is that changes may not be properly communicated so that they can be implemented on all coils. This finding is supported by the following examples:

1. In a review of the books containing the actual run copies of the procedures used to fabricate C1 and C2, field changes were made without the initials of the Field Supervisor, as required by the MCF procedures. Examples are given below:
 - a. Revision 2 of D-NCSX-MCF-001 was used for casting preparation for C1 and C2. For C1, there is a handwritten note in the procedure to “add 2” Kapton tape – 2 mil overlapping edges.” This note was not initialed or dated. There was no similar note for C2, raising the question of what was done on C2.
 - b. A similar example for the same procedure is that for C1, a note was entered with Field Supervisor approval that “position blocks were not used

but two blocks were installed.” There was no similar note for C2, giving the impression that positioning blocks were used on C2.

- c. Revision 1 of D-NCSX-MCF-002 was used for winding station activities for both C1 and C2. Both run copies contained a handwritten note that the hydrostatic testing specified in the procedure was changed to pressure testing with helium, but the note was not initialed by the Field Supervisor.
Revision 2 of D-NCSX-MCF-002 was revised to specify pressure testing with helium with an initial pressure of 200 psi and the acceptance criteria of no detectable drop in pressure for at least ten minutes from the time the system was isolated.
 - d. Revision 1 of D-NCSX-MCF-003, Autoclave Activities, was used for C1, while revision 2 was used for C2. Both contain a step for the pump down to less than 1 Torr and leak check of the epoxy delivery system with the acceptance criteria pressure maintained for one hour with no greater than 15T rise. There was a comment in the run copy for C1 that the test was run for 4 minutes with approximately a 300T rise. There was no further information indicating if this represented an acceptable result even though it conflicted with the specified success criteria. A similar situation existed for C2 with a test run for 4 minutes with an approximate 242T rise and no additional comments. Note that revision 3 of this procedure contains the same acceptance criteria, giving the impression that the original criteria are still valid.
2. The audit team reviewed the book for C5 to determine if the issues identified above were recurring. While fewer problems were identified giving the impression that the procedures have been improved based on experience, the following issues were identified:
 - a. For MCF-001, Rev. 3, Casting Preparation, step 7.4, a different lift procedure was used than the one specified in the procedure without the Field Supervisors initials indicating approval (#996 used instead of #983).
 - b. Steps were done out of sequence without an approval indicated.
 - c. Step 7.12 Establish winding surface baseline values requires "A summary of all data shall be inserted into Section 9 of the Coil Field Package." The work was done and signed off on 6/12/06 but the summary was not there.
 - d. Figure 22, Install Terminal Lugs, had a note "Kapton sheet added" that was not initialed by the Field Supervisor.
 - e. Step 8.3 requires multiple signatures prior to releasing the coil to the next station. This was moved without all the required signatures.
 3. ECN 5140 R1 was approved on August 10, 2006 listing many changes to the modular coil lead area design. The ECN listed ten changes to be made, some for all coils. They are:

- On the top chill plate (the one with the long fingers that extend parallel to the coil) – cut off the fingers and eliminate the chill plate. *This change will be implemented for the C3 and follow-on coils.*
- Isolated copper cladding pieces (located on the base of the tee underneath the winding pack in the lead area, the vertical cladding pieces in the same area, and the cladding in the poloidal break area) – change the material to G-11cr. *This change will be implemented starting with the C5 and follow-on coils.* Note: The G-11 pieces should be made to look like the cladding (with slots) so that forming to the shape and wicking of epoxy will be that same as for other areas.
- For the power bus tie-in area, cap the attachment bolt with an epoxy seal to mitigate a potentially short tracking path. *This will be implemented on all coils.*
- Presently the four bolts that connect the power bus are floating which is an undesirable condition - connect them to one side by eliminating the insulating washers on the other side. *This will be implemented on all coils.*
- The bolts that attach the G-11 base plate underneath the jumper stack – put a cover (Kapton or thin G-11 sheet) to increase the tracking distance. *This will be implemented on all coils.*
- For the three studs that bolt the stack of jumper plates together that are isolated – electrically tie them to one of the jumpers. Also add an insulating “plug” at the base of the hole in the G-11 base plate to reduce the risk of the studs penetrating the G-11 backing sheet to the winding form. *This will be implemented on all coils.*
- Entire lead assembly – manufacture a cover/box over the entire lead assembly or spray the exposed surfaces with a cryogenically compatible electrical varnish (e.g., Glyptol if cryogenically compatible) in order to prevent shorting due to metal chips, bolts, washers, etc. from falling in these areas during operation. *This will be implemented on all coils.*
- (words appear to be missing) implemented on the C3 and follow-on coils. *This will be implemented on all coils.*
- Improve the insulation between the cladding and the tee, especially at the tip of the tee where there is a risk of penetrating the kapton during staking – additionally use a metal backing tool (e.g., a putty knife) between the copper and kapton during the staking operation. This will serve to spread the impact load and protect the kapton. *This will be implemented on all coils.*
- Tie the poloidal break shims and bolts electrically to the winding form. *This will be implemented on all coils.*

The audit team reviewed the field notebooks for selected coils to determine if the changes identified above were actually implemented and identified the following sample discrepancies:

- a. For C3, the run copy for MCF-001 documents, via a hand written note from the MC Field Supervisor, that the long copper fingers were removed

(first bullet of the ECN). There is no documentation of additional Kapton added to the external lead assembly area (third bullet).

- b. For C4, the run copy for MCF-001 does not document removing long copper fingers or adding additional Kapton to external lead area. However, a brief note of modifying the lead area copper chill plates was found in the station 4 log book (2nd shift 7/19/06 entry).
- c. The C5 book documents the additional Kapton in the external lead area but does not have a signature or date associated with the note. At the time of the audit, C5 had not reached the copper chill plate installation phase yet, so removal of copper fingers had not happened yet.
- d. The A1 book has no record of using G-11 cladding in place of copper cladding though the audit team was told that this was done (second bullet of ECN 5140). At the time of the audit, the A1 coil had not reached lead area assembly or copper chill plate installation yet.
- e. D-NCSX-RP-STEL-058 used for the C1 lead area repair does not mention adding additional Kapton to the external lead area or about adding insulating plugs at the bottom of the lead jumper screws (sixth bullet of ECN 5140). One of the Senior Lead Technicians recalls this being done to the C1 and C2 coils but had not, at least at the time of this audit interview, received any instruction to do this to the C3 and beyond coils.
- f. The ninth bullet of ECN 5140 R1 states improving the insulation between the cladding and the tee, ... Conversations with the Senior Lead Technician and two of the Lead Technicians who worked on the A1 coil did not reveal that any additional insulation between the copper cladding and winding form was installed nor were there notes indicating any changes in the run copy of the applicable procedures. They were confident that insulation in this area has not changed since the C1 coil and was installed the same way for all the coils to date.

In addition, a decision was informally made by the MC Fabrication Project Engineer to not incorporate all the changes identified by ECN 5140R1 into the coils. Since the ECN is approved by the NCSX Change Control Board, such decisions should also have been reviewed by the same board prior to implementation and formally documented.

- 4. Another source of changes to the actual configuration of modular coils are QC Nonconformance Reports (NCRs). Some of the Modular Coil NCRs concern permeability issues and require dispositioning. The disposition is being held up until material testing can be performed. Two of the NCRs, #3649 and 3659, are for items that have since been covered up and could not be replaced should permeability of these items not be acceptable. Other NCRs have a disposition of "Use-as-is", which requires additional field work that is not consistently incorporated into the field documentation.

5. In order to improve understandability of the work to be performed and due to the unavailability of drawings, cartoons of various aspects of the modular coil fabrication process were generated directly from the model and incorporated into the work procedures (MCF-xxx). These cartoons provide the primary information to the MC Fabrication Teams on how to do work and is a commendable practice. However, there is no change control mechanism for these cartoons.

RECOMMENDED CORRECTIVE ACTION:

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

1. During the audit, it was recommended to the project that a punch list of remaining/late-breaking items to be performed for each coil prior to field period assembly be maintained. The project is implementing this recommendation. This requires reviewing run copies of field procedures, NCRs, ECNs, and notes as well as using the recall of individuals involved in the fabrication or procurement work. It might be beneficial to get the work teams together to brainstorm any differences between the coils, which might, in turn, identify remaining work elements to be performed.
2. Consider, at the end of each shift, performing a quick review of proper completion of work procedures for the work performed during the shift. Assure that all changes have been entered and initialed by the MC Field Supervisor. Any open issues remaining from the shift's work should be clearly identified so that they are not forgotten.
3. Review the significance of steps being performed out-of-sequence. If appropriate to do, make certain that the MC Field Supervisor documents this decision and indicates approval to do this within the work procedures. Where appropriate, indicate in the work procedures themselves what steps can be performed in parallel or out of sequence.
4. Review the suggestions made by Lead Technicians within the work procedures to determine if they are appropriate to be shared with all those involved in the coil fabrication and to be included in revisions to the procedures. (observation 3)
5. Assure that ECNs are properly incorporated into all work procedures. Assure that the appropriate information is added to the work procedures, globally or for specific coils, to assure that the changes are implemented. If particular requirements of an ECN should not be incorporated based on the opinion of the MC fabrication team, assure that the dropping of these requirements is properly reviewed, documented, and the ECN revised. Note that the project has already done this for ECN 5140.
6. Assure that NCRs are dispositioned within ten working days as required by QA-005, even if the disposition documents that further analysis is required before a final disposition is determined and will be completed by a specified

date. Assure that NCRs have their final disposition in time to make any corrections on coils in fabrication.

7. Establish a configuration control mechanism for the use of cartoons in work procedures. Minimally, a date and time stamp of when the cartoon was generated might be acceptable.

NCSX Configuration Control Flow/Requirements

Project Execution Plan, Rev. 3, June 2005

13 DATA MANAGEMENT SYSTEM

A system for controlling documents and drawings, adapted from existing PPPL document and drawing control systems using hard copy and electronic media, will be developed to ensure the organized and consistent treatment and format of NCSX documents including procedures, plans, memos, drawings, calculations, requirement documents, design documents, and procurement documents. This system will utilize web-based file servers for rapid review, authorization, updating, and retrieval of documents and drawings. The majority of project documents (other than drawings) can presently be retrieved from the NCSX web page located at <http://www.ncsx.pppl.gov>. Drawings in electronic format can be accessed via the Pro/INTRALINK database. Legacy drawings only in hard copy can be obtained from the PPPL Drafting Center. The NCSX project has developed a separate Document and Records Plan (NCSX-PLAN-DOC) that identifies documents to be controlled on the project, including the document's purpose, approval level, format, naming convention, and records retention requirements. The Data Management Plan (NCSX-PLAN-DMP) describes the processes to be used for document and drawing control. Processes for effecting changes to controlled documents are described in the Configuration Management Plan (NCSX-PLAN-CMP). All participants are encouraged to use the project standards for documents of either the MAC or PC versions of Microsoft Word, Microsoft Excel, or Microsoft PowerPoint.

NCSX Configuration Management Plan, Rev. 3, May 2005

3.1.1 Placement of Documents Under Configuration Change Control

Final Design Reviews (FDRs) – At the completion of the final design process, specifications, interfaces, models/drawings, and supporting technical information will have matured to a level of detail sufficient to permit fabrication and assembly. A series of final design reviews or FDRs will be conducted to mark the transition point from design to fabrication. These key fabrication documents that will now come under configuration control include product specifications, fabrication drawings, and any other technical data that is needed to constrain the fabricator or assembler. Assembly procedures, testing procedures will also be developed, but will come under revision control vs. configuration control.

3.3.1.3.1 Drawings and Models

During the MIE Project, changes to drawings released for fabrication will also require that an Engineering Change Notice (ECN) be prepared as an attachment to the ECP. The ECP/ECN connection will be revisited when operations commence. The ECN will be processed in accordance with the latest revision to PPPL Engineering Procedure ENG-010, "Control of Drawings, Software, and Firmware" with one alteration. When an ECN

is pending on a particular drawing the Drafting Supervisor will extract the affected drawing from the NCSX Pro/INTRALINK drawing released folder and add an Acrobat stamp records the ECN number and any summary description added to the drop-down note. Once the Acrobat stamp is added, the Drafting supervisor will place the drawing back into the released drawing folder. This process allows all viewers of drawings in the Released Drawing folder to be made aware that an ECN is pending on a particular drawing. After the ECN changes have been completed a PDF file will be made of the revised drawing and placed in the Release Drawing folder and the drawing with the ECN Acrobat stamp removed.

As part of the PPPL Work Planning Process, a decision will be made up front as to whether or not as-built drawings will be required and the PPPL Work Planning (WP) will be annotated accordingly and approved by the RLM. If the decision is made that as-built drawings are not required, the RLM will direct that notations (including red-lining) will be made on physical drawings. If there are approved Requests for Deviation (RFD) and/or NCR and ECNs impacting that respective model and drawing that have not been reflected on those models or drawings, a notation will be made on the pdf version of the drawing to indicate that there are approved RFDs/NCRs/ECNs not incorporated into the electronic models and drawings. Storage of all release points of the design process will allow models to be checked to assure compliance to earlier space allocations.

NCSX-PROC-002, REVISION 3, NCSX Configuration Control

From Introduction: “Once under configuration control, the “configuration” of the NCSX MIE Project may only be changed via the Engineering Change Proposal (ECP) process described in this procedure.”

Also from Introduction: **“Once an ECP is approved, the normal time frame between ECP approval and revision of the impacted documentation shall not exceed 30 days. However, this does not relieve the Project from proper notification of impacted WBS elements and impacted Suppliers – contract amendments/addenda shall be issued in a timely manner with an indication on when the impacted documentation will be updated.”** (emphasis in procedure)

Note that there is no ECP for the changes documented in ECN #5140R1.

This procedure described two different ECPs – a “standard” ECP that requires a full review and approval cycle via the NCSX Change Control Board (CCB) and an “expedited” ECB with an abbreviated review. One of the criteria for the use of expedited ECBs includes “If field activities may be delayed by the normal ECP process involving full reviews and the CCB”

The procedure goes on to provide addition information on when ECPs, ECNs, RFDs, and NCRs are needed.

Type of Document	When Needed	When NOT Needed
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Type of Document	When Needed	When NOT Needed
ECP	When there is a design change that impacts a Specification (Technical Baseline Requirements) or the Cost or Schedule baselines. Drawing changes (technical baseline) will also impact a Specification since the Specification also contains a table that lists the latest drawing revisions.	Minor editorial changes will not normally require the processing of an ECP. The Systems Engineering Manager will determine whether an ECP is required on a case-by-case basis.
ECN	Once a drawing is released for fabrication (Rev 0), an ECN is ALWAYS needed to authorize a change (i.e., revision) to that drawing. If a drawing is changed by an ECN, an ECP will be needed to revise the Specification at a convenient time. See ENG-010 and PROC-006 and PROC-007.	An ECN is NOT needed to utilize the “stamp” process outlined in PROC-007 in which an implementing RFD or NCR is determined by the RLM to be relatively minor or that the necessary resources and funding is not available; in this instance, a “stamp” will be added to the existing drawing and the drawing revision will only be advanced by adding a letter (e.g., a, b, etc.) to the existing revision. However when the released for fabrication drawing is next formally revised (e.g., number revision), an ECN will ALWAYS be required.
RFD	When either the supplier or PPPL identify a deviation from the established design before the component is fabricated (as indicated in either a Specification or Drawing), a RFD may be submitted to request a deviation either only for this specific component or for all remaining components. In dispositioning a RFD, the determination needs to be made as to whether or not the impacted drawing(s) or Specification need to be revised; if they do, then an ECN and ECP will be required. If the determination is made to not revise either the drawing or Specification, the Systems Engineering Manager will determine if a “stamp” can be placed on the impacted drawing and a note added to the Specification. (See PROC-009)	A RFD should NEVER be used to document an after the fact deviation from the requirements – the NCR will be the vehicle to document the change.

Type of Document	When Needed	When NOT Needed
NCR	NCRs are used to identify items, services, or activities that fail to conform to specified requirements. The purpose of the NCR is provide a controlled method to prevent the inadvertent installation or continued use of the non-conforming items, services, or activities. As part of the NCR process outline in QA-005, the Project must identify, evaluate, and disposition the specific non-conformance(s), including if deemed necessary, provisions to segregate the item or to stop the specific nonconforming activity or condition causing the nonconformance.	A NCR should NEVER be used to document a deviation BEFORE it occurs – a RFD shall be used in that case. However, a NCR for a specific issue or nonconformance can lead to a follow-on RFD if it is decided that the specific non-conformance will be accepted for follow on components.

NCSX-PROC-006, Rev. 4, Control of NCSX Supplier and In-house Fabrication Information

II. In-House Fabrications

“For those components assigned for in-house fabrication, it is equally essential that the technical information provided to PPPL fabricators is up-to-date and accurate. The NCSX cognizant engineer is responsible for assuring that the necessary technical (e.g., signed technical specifications and signed drawings) documentation is available for the NCSX personnel assigned the responsibility for in-house fabrication of a component. In addition, the NCSX Project utilizes a utility called *FroTools* to permit access to the NCSX model and drawing files via a INTRALINK users account. The cognizant engineer will normally utilize this method to view the latest electronic models and drawings and Part C of this procedure outlines the process. As an alternative, a special “In-House Fabrication” folder has been added to the Supplier FTP site in lieu of *FroTools*.”

NCSX-PROC-007, Rev. 2, NCSX Electronic Model and Drawing/INTRALINK Processes

“It has been noted, especially for the MCWF and VVSA procurements, that we are processing and approving RFDs and NCRs that have an impact on existing revisions to the drawings, but are relatively minor in nature. Formally revising a drawing each time (via ECN to incorporate the RFD or NCR) is both time consuming and has created a real budget issue. Accordingly, it has been decided to permit an interim change to the drawing using the “Stamp Tool” in Adobe Acrobat to enable either the Design Integration Manager or the Systems Engineering Support Manager – **these are the only two** -- to make a change to the PDF drawing using the “Stamp Tool” without changing the full revision of the drawing or requiring a full review and approval cycle within INTRALINK to change the ProE models and drawings – this proposed change will **ONLY** impact the

signed “Released for Fab” pdf drawings. *NOTE: the “Stamp” will only reference the RFD or NCR. However, in keeping with the philosophy of PPPL ENG-010, once three “stamps” are accumulated against a drawing, the next “stamp” will require a formal ECN and drawing revision in a timely manner.*”

NCSX-PROC-009, Rev. 4, NCSX Request for Deviation Process

Introduction

“Prior to performing a specified step in a manufacturing or fabrication process, either the Project or a supplier may identify an alternative design/method/material to the requirements or a process change that could result in cost, or schedule savings. The documentation to formally define this proposed departure from the established performance, design requirements, or processing plan is called a Request for Deviation (RFD). The RFD is a specific written request to depart from a particular requirement(s) of the item’s current approved documentation (including vendor MIT/QA Plan). RFDs shall be processed and adjudicated under the Engineering Change Process (ECP) process defined in the NCSX Configuration Management Plan (NCSX-PLAN-CMP) and the accompanying NCSX Configuration Control Procedure (NCSX-PROC-002) unless a determination is made by the NCSX Engineering Manager that an ECP is not required (generally for editorial-type RFDs or process RFDs). Until the ECP associated with the RFD is approved or approval by the NCSX Engineering Manager is received to process without an ECP, the item or process may not deviate from the technical requirements. The RFD may be either a letter or tabular format and shall contain the specific required information as defined in this procedure.”



This procedure also contains the requirement to update the drawing once 3 RFDs are generated against it.

Note that this procedure talks about changes to the requirements or process change that could result in cost or schedule savings. What if a change is made to one coil only to expedite its fabrication that will not be done to other coils. Assuming this decision is made prior to performing the applicable work step, then an RFD must be generated to document the decision. A stamp is put on the drawing indicating that this RFD exists. At some point, the drawing is updated to include this RFD. This reflects Brad’s concern that design drawings shouldn’t be updated to reflect these types of changes. Instead the design drawing plus the list of RFDs (and ECNs in some cases?) would be adequate to describe how something was actually built.

CORRECTIVE ACTION (to be completed by audited organization):

Proposed by: Wayne Reiersen

On date: October 20, 2006

1. The project will develop punchlists clearly indicating what work remains to finish each coil. These punchlists will be affixed to the coils. Punchlists will be applied to all existing coils that have completed post-VPI operations. Punchlists will also be applied to coils as a final step in the post-VPI procedure. The post-VPI procedure (D-NCSX-MCF-004) was updated on October 13th and is now posted. The VPI procedure (D-NCSX-MCF-003) will be updated to reflect revised leak check requirements [changing the acceptance criteria from 15 to 50 Torr pressure drop in 1 hour. If that level is exceeded, the VPI director shall make the decision whether to proceed or to make additional corrections and retest.] **(ACTION: J. Chrzanowski to update the VPI procedure (MCF-003) by December 22, 2006) Status from QA 10/31/06: D-NCSX-MCF-004-02 completed and posted on the web.** 
2. The lead technician is responsible for assuring that the work procedures are properly signed off for the work completed on that shift. Any changes shall be entered and initialed by the field supervisor. At the start of a shift, the lead technician will review the signoffs in the procedure and question any signoffs that are not complete. **(ACTION: J. Chrzanowski will review these responsibilities with lead technicians by November 30, 2006).**
3. The lead technician has the authority to perform steps in the procedure out of sequence. If the lead technician has any question about performing steps out of sequence, he should consult the field supervisor. **(ACTION: J. Chrzanowski will review these responsibilities with lead technicians and field supervisors by November 30, 2006)**
4. Suggestions made by the lead technicians are reviewed for relevance. Procedure changes are processed where appropriate at the discretion of the field supervisor. Technicians are also encouraged to submit cost saving suggestions which are recorded and tracked. (No further action required.)
5. The Modular Coil Facility Manager is responsible for ensuring that work procedures that are impacted by approved ECNs are updated appropriately. A section will be added to the updated procedures noting which ECNs have been incorporated in the procedure revision. NCSX-PROC-007-03 is being updated to clarify that the Systems Engineering Support Manager notifies the Design Integration Manager and the ATI that the ECN has been approved and includes a copy of the ECN with the e-mail notification. **(ACTION: R. Simmons update and post Rev 3 by November 30, 2006.)** 
6. NCRs will be dispositioned within 10 days per QA-005.

Proposed by: Judy Malsbury

On date: October 24, 2006

7. The Audit Team will review the effectiveness of the changes made as a result of findings 1 and 2 prior to closure of the report. **(ACTION: J. Malsbury by April 30, 2007)**

AUDIT FINDING REPORT

AUDIT NO.: 0609 FINDING NO 2

AUDIT NAME: NCSX Modular Coil Fabrication

AUDITED ORGANIZATION: NCSX

DATE OF AUDIT: August 15 – 22, 2006

REFERENCES:

ENG-010, Rev. 3, Control of Drawings, Software, and Firmware

NCSX-PROC-007 Revision 2, NCSX Electronic Model and Drawing/INTRALINK Processes

PROGRAM REQUIREMENTS:

ENG-010 describes the process for changing already existing drawings including the use of the Engineering Change Notice (ECN) form and the indication of pending ECNs for drawing, either via placing a paper ECN Sticker on the drawing or using the Adobe Acrobat Stamp tool. The procedure also states that only drawings stamped “Approved for fabrication” can be used for installation or fabrication, whether at PPPL or a supplier’s facility.

NCSX-PROC-007 defines the project specified processes for the control of drawings, including the use of ECNs.

FINDING: **THE DRAWING CONTROL PROGRAM USED BY NCSX NEEDS IMPROVEMENT.**

This finding is supported by the following:

1. The ECN form contains the following minimal information in Attachment 1, page 1, of ENG-010: the drawings affected, the current revision, and the title. Note that ENG-010 Attachment 1, page 2, is inconsistent and lists drawings affected, the new revision, and the title, but the intent of the procedure is to list the revision level of the drawings that the cognizant individual wants to revise

For at least some of the NCSX ECNs, the revision field is used to specify the new revision for the drawing. Therefore, some of the ECNs contain drawings that are listed as revision 0, which, according to the design engineer, means that the drawings are new. This change in meaning in the revision number presents some concerns, as follows:

- a. The different uses of the revision number field could be confusing to PPPL personnel who work on multiple projects.

- b. With the rule that up to three ECNs may be pending before a drawing is actually changed, there does not exist a one-to-one correspondence between ECNs and new drawing revision levels.
2. Prior to actual updating a drawing, an ECN note (stamp) is supposed to be added to each drawing indicating that an ECN is pending for the drawing. This provides a visual note to the reader of the drawing that a copy of the ECN must be obtained and reviewed prior to using the drawing. All of the drawings associated with ECNs 5130 (5 of 5 drawings) and a sample of the drawings associated with ECN 5140R1 (8 of 76 drawing/sheet combinations) were reviewed to assure that they contained the required ECN stamp. Of these 13 drawings, the following 9 drawings did not contain the required ECN stamp:

ECN Number	Drawing ID	New Revision	Current Rev. in Intralink
5130	SE123-049	1	0
5140R1	SE141-101	4	3
5140R1	SE142A-242	1	0
5140R1	SE142B-252	2	1
5140R1	SE142C-047	1	0
5140R1	SE142C-386	1	0
5140R1	SE142C-482	1	0
5140R1	SE142C-484	1	0
5140R1	SE142C-486	1	0

3. Some of the drawings referenced on ECN forms and not indicated as revision 0 (i.e., new) do not exist in Intralink. From the samples used in item #2 above, the following drawings could not be found for ECN #5140R1: SE142C-051, new revision 1, and SE142C-054, new revision 1.
4. The new drawings referenced on ECN #5140R1, specifically SE140-101, SE140-102, and SE140-103 do not yet exist. The intent of the Lab-wide ECN program is to control changes to existing approved drawings, not to identify drawings that are new. ECNs are then to document the changes in the drawing with the intent that once the ECN is approved, the drawings can be finalized, i.e., all the information required for the drawings is available.
5. The MC Fabrication Project Engineer stated that only a few of the drawings are relevant to the onsite fabrication process. One of these drawings is SE141-123, Type C Winding Form and Stud Weld. The current version of this drawing, Revision 1, is not available in the field. It is not clear that the MC Fabrication Project Engineer was aware of the new revision.

RECOMMENDED CORRECTIVE ACTION:



1. The audit team was told by the MC Fabrication Project Engineer that the number of drawings that are needed in the field are minimal. If so, this smaller set of drawings should be identified and formally maintained with a higher priority, helping to assure that the current versions are always available in the field.
2. This project is the first one at PPPL to be heavily involved with CAD models. With the exception of procurements and field work, it is not clear that the large number of drawings maintained is value added. The information is available within ProEngineer. If a drawing is not needed by someone else in the fabrication line, then why take the time to generate it?
3. The issue with indicating ECNs on approved drawings occurred in an earlier audit of the PPPL Drawing Control program (audit #0308, August 2003). The project should review why this problem recurred and what can be done to prevent it from recurring.
4. The Project should determine the cause for the time delay between the approval of the ECN and the updating of the drawings in the field.


CORRECTIVE ACTION (to be completed by audited organization):


Proposed by: Wayne Reiersen

On date: October 20, 2005

PROJECT RESPONSE

1. Drawings not yet released for fabrication will be identified as “NEW” per TCR-004 to Rev 3 of ENG-010. The Project will follow the convention in ENG-010 of making reference to the current drawing revision. The NCSX ECN form is consistent this practice, but adds in a space for RLM comments to state whether or not an immediate update (vs. an ECN stamp) is needed. **(COMPLETED.)** 
2. The Head of Design Integration (Tom Brown) is responsible for posting all drawing updates in PDF form within Intralink. When a drawing is updated that relates to modular coil fabrication, the Head of Design Integration is responsible for notifying the ATI for the modular coils (Jim Chrzanowski), the ATI for Field Period Assembly (Mike Viola), or the ATI for Machine Assembly (Erik Perry) that the drawing(s) has been updated. The respective ATI is responsible for maintaining a current file in the field of all and only those drawings required for modular coil fabrication or field period assembly. The ATI will update the drawing file in the field when notified of a drawing change and the manufacturing procedures when appropriate. The project will be diligent in exercising these responsibilities. **(ACTION: Tom Brown to implement this process effective immediately.)**
3. The Systems Engineering Support Manager (Bob Simmons) is responsible for notifying the responsible ATI when an ECN is processed that relates to modular coil fabrication. The ATI is responsible for ensuring that the field personnel are properly notified and that appropriate changes are made to the manufacturing procedures and drawing file in the field (note on paper copies that ECN has been issued if appropriate). The Systems Engineering Manager is involved in every ECN (he or the Design Integration Manager are the only ones authorized to obtain an ECN number from the Design Supervisor. PROC-007 is being updated to reflect this and the requirement to notify the both the Design Integration Manager and the responsible ATI that an ECN has been approved. **(ACTION: Bob Simmons to immediately implement this process and update NCSX-PROC-007-03 by November 30, 2006)** 
4. When an ECN or RFD is approved, a stamp is placed on the drawing indicating that there is an outstanding ECN or RFD against that drawing. (Note that an ECN stamp may not be applied if the Systems Engineering Support Manager determines that a drawing update is imminent.) Each time a stamp is applied, either an ECN stamp or a RFD stamp, the revision level of the drawing will be denoted differently in order to uniquely identify the drawing. An “a” will be applied to the revision level for the first stamp, a “b” for the second stamp, and so on. A revision 2 drawing with two stamps on it would appear as Rev. 2-b. Drawings will be updated when there are three

stamps requiring drawing changes. Not all RFDs require drawing changes. There are instances when a supplier requests permission to build a part differently than the drawing and the project approves the deviation without any intent of changing the design or generating an as-built drawing of the part. In those cases, the stamps for the RFDs will not be removed from one drawing revision to the next. **(ACTION: Bob Simmons to update NCSX-PROC-007-03 by November 30, 2006.)** 

5. The project will continue to update drawings based on its assessment of priorities. We are working under tight resource constraints and updating drawings sometimes takes much longer than desired. The responsible design and manufacturing engineers determine if there is an immediate need to update the drawing(s) or whether the ECN stamp or RFD stamp will suffice and the NCSX ECN form shown in Rev 3 to PROC-007 reflects this. Nonetheless, the responsible ATI is notified when either an ECN or RFD is approved. **(ACTION: Bob Simmons to update NCSX-PROC-007-03 by November 30, 2006.)** 

Proposed by: Judy Malsbury

On October 24, 2006

6. The Audit Team will review the effectiveness of the changes made as a result of findings 1 and 2 prior to closure of the report. **(ACTION: J. Malsbury by April 30, 2007)**

AUDIT FINDING REPORT

AUDIT NO.: 0609 FINDING NO 3

AUDIT NAME: NCSX Modular Coil Fabrication

AUDITED ORGANIZATION: NCSX

DATE OF AUDIT: August 15 – 22, 2006

REFERENCES:

NCSX Data Management Plan, NCSX-PLAN-DMP-02, April 21, 2005

NCSX Documents and Records Plan, NCSX-PLAN-DOC-03, December 13, 2005

PROGRAM REQUIREMENTS:

The NCSX Data Management Plan describes the processes by which documents for the NCSX project will be stored and managed.

The NCSX Document and Records Plan defines the official documents and records for the design, fabrication, and construction stages of the NCSX project. It defines the purpose, content, format, approval level, records retention requirements, and file/document naming convention for each document and record.

FINDING: **THE DATA MANAGEMENT AND DOCUMENTS AND RECORDS PLANS DO NOT INCLUDE TWO IMPORTANT PROJECT RECORDS – METROLOGY DATA AND PHOTOS.**

The metrology data is taken at various times throughout the fabrication of the coils and determines the actual physical configuration of the coils. This information is important to calculate the current center of each coil and should be formally protected. It is currently planned to be stored on CDs in the notebook for each coil containing all the data associated with the fabrication.

The photos are a more informal system for documenting aspects of the fabrication of the modular coils. These are currently stored on the computer of the MC Fabrication Project Engineer in a structured format within folders and in the Photo Drop area in an unstructured format.





Loss of either data could have a significant impact for the project. While the project has established informal methods to save and protect this data, a systemic approach should be created so that the methods are consistently used and documented.

RECOMMENDED CORRECTIVE ACTION:

1. The project should consider a backed-up server for this data. In addition, a file structure and file naming convention should be established to assure that the data can be found when needed.

CORRECTIVE ACTION (to be completed by audited organization):

Proposed by: Wayne Reiersen On date: October 24, 2006

1. The Systems Engineering Support Manager has been charged with developing a plan for properly archiving construction data. NCSX-PROC-012 has been developed and is in the review cycle. In addition, Project Personnel were briefed at the NCSX Monday morning teleconference on October 16th and are currently putting construction information (see VVSA Contract) on this site. (ACTION: **Bob Simmons to issue PROC-012 by November 15, 2006**) 
2. The DMP and DOC will be revised to reflect this plan. In addition, a new procedure will be developed to detail the process. Updates to both have been issued for review. (ACTION: **Bob Simmons issue updates to both the DMP and DOC by November 15, 2006**). **Note from QA on 10/31/06: Both the DMP and the DOC have been updated – DMP dated October 25, 2006 and DOC dated October 26, 2006, and posted on the NCSX website.**  
3. Project personnel to be informed about these additions. (ACTION: **Bob Simmons by November 17, 2006**) Email sent 12/1/06 

Reference Documents for this Audit

1. NCSX Project Execution Plan, NCSX-PLAN-PEP-03
2. NCSX Quality Assurance Plan, NCSX-PLAN-QAP-01
3. NCSX Modular Coil Manufacturing, Inspection, Test and Quality Assurance Plan, NCSX-PLAN-MIT/Q-142-00
4. NCSX Manufacturing Facility Operations Plan, NCSX-PLAN-MFOP-01
5. NCSX Coil Manufacturing Facility Operations Plan, NCSX-PLAN-CMFOP-01
6. NCSX Modular Coil Winding Dimensional Control Plan, NCSX-PLAN-MCWDC-00 (as used for each coil)
7. Modular Coil Fabrication – Winding Form Preparation Activities, D-NCSX-MCF-001 (as used for each coil)
8. Modular Coil Fabrication – Winding Station Activities, D-NCSX-MCF-002 (as used for each coil)
9. Modular Coil Fabrication-VPI/Autoclave Activities, D-NCSX-MCF-003 (as used for each coil)
10. Modular Coil Fabrication-Post VPI Activities, D-NCSX-MCF-004 (as used for each coil)
11. Dimensional Control and Metrology for NCSX Modular Coils, D-NCSX-MCF-005
12. Modular Coil Autoclave Operating Procedure, D-NCSX-OP-G-162 (as used for each coil)
13. Modular Coil Mfg. Facility – Emergency Response procedure, D-NCSX-OP-EO-41
14. Modular Coil Lead Repair – Part 1 Exploration, D-NCSX-RP-STEL-057
15. Modular Coil Lead Repair – Part 2 Repair, D-NCSX-RP-STEL-058
16. Modular Coil Winding Form Lift Procedure, D-L-NCSX-983-00
17. Modular Coil Lift Procedure, D-L-NCSX-984-00
18. Finished Modular Coil Winding Form Lift Procedure, D-L-NCSX-996
19. QA-005, Rev. 2, Control of Nonconformances