

Occurrence Report After 2003 Redesign

Chestnut Ridge

(Name of Facility)

Accelerators

(Facility Function)

Oak Ridge National Laboratory

Oak Ridge National Laboratory

(Site)

(Contractor)

Name: Kevin W. Jones

Title: Research Accelerator Division Director

Telephone No.: (865) 241-6794

(Facility Manager/Designee)

Name: PEHRSON, PAUL B.

Title: OCCURRENCE REPORTING MANAGER

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(Originator/Transmitter)

Name:

Date:

(Authorized Classifier (AC))

1. Occurrence Report Number: SC-ORO--ORNL-X10CHRIDGE-2013-0005

Discovery of Non-Operable Safety System during Testing

2. Report Type and Date: FINAL

	Date	Time
Notification:	08/02/2013	17:11 (ETZ)
Initial Update:	09/16/2013	20:40 (ETZ)
Latest Update:	09/16/2013	20:40 (ETZ)
Final:	09/16/2013	20:40 (ETZ)
Revision 1:	09/17/2013	07:47 (ETZ)

3. Significance Category: 3

4. Division or Project: Research Accelerator Division

5. Secretarial Office: SC - Science

6. System, Bldg., or Equipment: Building 8600

7. UCNI?: No

8. Plant Area: Building 8600

9. Date and Time Discovered: 07/31/2013 09:17 (ETZ)

10. Date and Time Categorized: 07/31/2013 12:15 (ETZ)

11. DOE HQ OC Notification:

Date	Time	Person Notified	Organization
NA	NA	NA	NA

12. Other Notifications:

Date	Time	Person Notified	Organization
07/31/2013	12:15 (ETZ)	Lab Shift Superintendent	ORNL LSS
07/31/2013	13:12 (ETZ)	Johnny Moore	DOE ORNL
07/31/2013	11:40 (ETZ)	Douglas Paul	DOE ORNL
07/31/2013	13:12 (ETZ)	Martha Kass	DOE ORNL

13. Subject or Title of Occurrence:

Discovery of Non-Operable Safety System during Testing

14. Reporting Criteria:

4A(1) - Performance degradation of any Safety Class (SC) or Safety Significant (SS) Structure, System, or Component (SSC), or any support system that is required for safety operation of the SC or SS SSCs, which prevents satisfactory performance of its design function when it is required to be operable.

15. Description of Occurrence:

On Wednesday, July 31, 2013, while performing an end-to-end test of the Instrument Personnel Protection System (IPPS), per approved procedure, technicians initiated a trip condition from an instrument enclosure to disable the beam injector at the Front End of the Spallation Neutron Source (SNS) accelerator through the Personnel Protection System (PPS). The beam injector was not disabled as expected demonstrating that the PPS was not operable as required.

The PPS/IPPS systems are Credited Engineered Controls (CEC) that prevent entry into areas with significant radiation hazard, trip the accelerator beam off when specific radiation levels are detected in areas that may be occupied, and prohibit beam to the target. The approved Accelerator Safety Envelope (ASE) specifies that the PPS shall be operable to support the applicable operational configuration during operations with beam. Prior to starting the IPPS certification, limited beam operation had been initiated to support the transition from maintenance to beam operations.

At the time of the event, standard administrative access controls were in place, including locked doors and physical barriers for personnel protection. Compensatory actions specified in the ASE were promptly implemented to place the facility in a safe configuration.

The event was categorized as Group 4 - Facility Status, Subgroup A(1), Significance Category 3, - Performance degradation of any Safety Class or Safety Significant (SS) Structure, System, or Component (SSC), or any support system that is required for safety operation of the SC or SS SSCs, which prevents satisfactory performance of its design function when it is required to be operable. In this case, the non-nuclear facility SSC (PPS) has a mitigative function that is a major contributor to worker safety.

There were no injuries or other environmental, health or safety impacts associated with this event.

16. Is Subcontractor Involved? No

17. Operating Conditions of Facility at Time of Occurrence:

Shut Down for Maintenance; Initial Equipment Start-up for Transition to Operation

18. Activity Category:

03 - Normal Operations (other than Activities specifically listed in this Category)

19. Immediate Actions Taken and Results:

- The IPPS certification procedure was immediately suspended.
 - Line and operations management were immediately notified.
 - Operations management immediately implemented compensatory measures to prevent beam operation.
 - Operations management directed an investigation to determine the cause of the failure.
 - Operations categorized the event, notified the DOE Facility Representative and the Laboratory Shift Superintendent.
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20. ISM:

- 1) Define the Scope of Work
- 2) Analyze the Hazards
- 3) Develop and Implement Hazard Controls
- 4) Perform Work Within Controls

21. Cause Code(s):

A3B1C01 - Human Performance Less Than Adequate (LTA); Skill Based Errors; Check of work was LTA

-->couplet - NA

A1B4C02 - Design/Engineering Problem; Design Verification / Installation Verification LTA; Testing of design/installation LTA

A2B3C03 - Equipment/ material problem; Inspection/ testing LTA; Post-maintenance/Post-modification testing LTA

A1B2C03 - Design/Engineering Problem; Design output LTA; Design output not correct

A4B5C04 - Management Problem; Change Management LTA; Risks / consequences associated with change not adequately reviewed / assessed

A5B2C08 - Communications Less Than Adequate (LTA); Written Communication Content LTA; Incomplete / situation not covered

22. Description of Cause:

The DOE Causal Analysis Tree was used to determine the causes for this event. An apparent cause analysis was completed and the identified causes were translated into the related DOE cause code identified in DOE-STD-1197-2011, "Occurrence Reporting and Causal Analysis."

An independent controls system engineer was assigned to examine the system and document the as-found condition. Post-event evaluation revealed that the High Energy Beam Tunnel (HEBT) segment of the PPS was not providing appropriate signal inputs to the Linear Accelerator (Linac) segment of the PPS. The inter-segment communications were located in the PPS racks in the SNS Central Control Room (CCR). Physical examination and measurement revealed that the terminal block segments for the common terminals and ground terminals of the Programmable Logic Controllers' (PLCs') power supply redundancy modules were not electrically connected as expected. The direct cause was improper installation on April 2, 2013, of a terminal block jumper during installation of an approved system modification. This allowed system voltages to float, resulting in fixed logic signals from both "A" and "B" PLCs for the HEBT segment. This caused a PPS system inability to respond to external state changes.

Direct causes include human errors:

- An error was made in installing the jumpers.
- The scope of the PMT was not properly defined.
- An error was made in performance of the PMT.

DOE Cause Code: A3B1C01 - Skill based error, check of work was less than adequate.

DOE Cause Code: A1B4C02 - Design/Installation Verification less than adequate (LTA), testing of design/installation LTA.

Corrective Actions 3 and 4 address these causes.

The improperly installed jumper caused a very small gap between the common and ground terminals that was difficult to detect visually. Also, the installation with the defect was mounted on a rail approximately one and one-half feet from the floor, well below eye level. This location made it highly unlikely that the defect would be easily noticed unless it was expected and was being actively checked for. Circuit continuity was checked using a multi-meter set to measure resistance assisted by an audible indication. The readout on the meter was not viewed. With 16V floating on the system, the resistance measurement will engage the audible "buzz" on the meter, leading to the false conclusion that the grounding is correct. A voltage check should have been accomplished in addition to the continuity check. Following these installation checks, a functional system test should have been performed to verify the operability of the changed configuration before returning the system to service.

DOE Cause Code: A2B3C03 - Post-modification testing LTA.

Corrective Actions 3, 4, 7, and 10 addresses this cause.

On November 21, 2011, a SNS Protection Systems Engineer initiated a Permanent Change Request (PCR) for the SNS PPS, PCR-109090101-CM-0022. The change request was to add power supply redundancy modules to PPS racks in the Ring, RTBT, Target, and CCR. Installation of the power supply redundancy modules to the CCR different PPS segments was accomplished on scheduled maintenance days. The installation of the power supply redundancy modules for the HEBT segment PLCs occurred on April 2, 2013. Although redundancy was designed into the system, the wiring distribution for the PLC-A and PLC-B power supply redundancy modules for the PPS was mounted on a common rail bus and shared a common ground (except for the Klystron gallery). This arrangement introduced the possibility of a common mode failure. This mounting and grounding configuration is not in accordance with the safety documentation's description of the PPS system architecture, which requires that "Each redundant PLC in a one-out of-two configuration is maintained as a separate system to minimize common mode failures."

DOE Cause Code: A1B2C03 - Design output not correct.

Corrective Actions 3, 4, 7, 8, 9, and 10 address this cause.

The design change to add redundant power supplies was inadequately assessed and the USI process was not adequately applied. The configuration management procedure for certain credited controls allowed grading of changes and this change was inappropriately graded as a level 1C. Therefore, the design was not adequately assessed to ensure system design criteria defined in the facility safety documents were maintained.

DOE Cause Code: A4B5C04 - Risks/Consequences associated with change not adequately reviewed/assessed.

Corrective Actions 3, 4, 9, and 10 address this cause.

The Post Maintenance Test (PMT) instructions lacked the detail to ensure that this potential error was detected. The PMT instructions stated, "Verify that all 24 VDC returns are tied to building ground" without specifying method of performing the check. Because the terminal blocks were not grounded properly, the simple check of continuity was not adequate to detect the error. An additional check of voltage should have been performed.

DOE Cause Code: A5B2C08 - Written communication content LTA, Incomplete/situation not covered.

Corrective Actions 3, 4, 7, 9, and 10 address this cause.

23. Evaluation (by Facility Manager/Designee):

ORNL management is evaluating the circumstances around the event will implement actions as appropriate, and share any resulting lessons learned.

UPDATE:

August 5, 2013

The revisions made to Section 19 "Immediate Actions Taken" did not save on Friday August 2, 2013. This revision/update was made to put the correct information into Section 19.

FINAL:

September 16, 2013

The SNS PPS system has been thoroughly tested, the extent of condition identified, and the system has been repaired and re-certified. A backwards-looking USID has been conducted and issued. Interim actions for operability are in place. An additional independent evaluation of the SNS PPS system and processes is planned to identify potential improvements.

24. Is Further Evaluation Required?: No

25. Corrective Actions

(* = Date added/revised since final report was approved.)

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|---|--|---|------------------------------------|
| 1. | Repair the identified defect and fully recertify the entire SNS PPS system. (ACTS No. 0.28733.2) | | |
| | <table border="1"><tr><td>Target Completion Date: 08/06/2013</td><td>Completion Date: 08/06/2013</td></tr></table> | Target Completion Date: 08/06/2013 | Completion Date: 08/06/2013 |
| Target Completion Date: 08/06/2013 | Completion Date: 08/06/2013 | | |
| 2. | Perform and issue a "backward looking" Unreviewed Safety Issue Determination (USID) for the event. (ACTS No. 0.28733.3) | | |
| | <table border="1"><tr><td>Target Completion Date: 08/09/2013</td><td>Completion Date: 08/09/2013</td></tr></table> | Target Completion Date: 08/09/2013 | Completion Date: 08/09/2013 |
| Target Completion Date: 08/09/2013 | Completion Date: 08/09/2013 | | |

3. Revise SNS-OPM 3.A-8.1 Configuration Management Procedure for the Following Certified Credited Engineering Controls: Personnel Protection System (PPS), Oxygen Deficiency Hazard (ODH) System, Transfer Bay Access Control (TBAC), Service Bay Differential Pressure Monitoring System (SBDPMS) and Target Protection System (TPS) to:
- a. Eliminate the graded approach to Level 1 work, require a mandatory USID, require the SNS Accelerator Configuration Control Committee review to include the Accelerator Operations Manager and Mechanical Systems and Operations Group Leader, and final review and approval by the SNS Operations Manager
 - b. Include requirements to ensure adequacy of post-maintenance tests.

(ACTS No. 0.28733.4)

Target Completion Date: 08/09/2013	Completion Date: 08/09/2013
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4. Conduct refresher training for PPS-certified maintenance workers to ensure full understanding of configuration control requirements, post maintenance testing requirements and proper use of approved, calibrated test equipment. (ACTS No. 0.28733.5)

Target Completion Date: 08/09/2013	Completion Date: 08/09/2013
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5. Develop and implement an interim procedure to test the inter-segment PLC communication inputs/outputs. (ACTS No. 0.28733.6)

Target Completion Date: 08/09/2013	Completion Date: 08/09/2013
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6. Develop, review, approve and implement a design change package to eliminate the identified PPS common mode failure. The design package will be provided to the Oak Ridge National Laboratory Site Office prior to start of implementation. (ACTS No. 0.28733.7)

Target Completion Date: 02/15/2014	Completion Date:
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7. Conduct an internal review of PPS system architecture and an associated Failure Modes and Effects Analysis (FMEA) to determine if other unanalyzed failure modes are possible. (ACTS No. 0.28733.8)

Target Completion Date: 12/31/2013	Completion Date:
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8. Conduct external reviews of FMEA and system architecture analysis results. (ACTS No. 0.28733.9)

Target Completion Date: 03/31/2014	Completion Date:
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9. Perform an in-depth review of adequacy of PPS procedures for configuration control, change requests, and testing/certification. (ACTS No. 0.28733.10)

Target Completion Date: 12/31/2013	Completion Date:
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10. Implement any necessary changes to PPS systems and procedures that result from Corrective Actions 7-9. (ACTS No. 0.28733.11)

Target Completion Date: 07/15/2014	Completion Date:
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11. Remove compensatory measures after successful completion of all preceding action items. (ACTS No. 0.28733.12)

Target Completion Date: 07/31/2014

Completion Date:

26. Lessons Learned:

Any design change to a critical system should be critically analyzed for potential unintended consequences, including potential human errors during installation. Then the post maintenance testing should be specified with enough details to catch any error.

27. Similar Occurrence Report Numbers:

[SC--BHSO-BNL-AGS-2006-0001](#)

[SC--SSO-SU-SLAC-2013-0010](#)

28. User-defined Field #1:

ACTS No. 0.28733

29. User-defined Field #2:

30. HQ Keyword(s):

04A--Instrumentation and Controls - I & C Equipment

12E--EH Categories - Equipment Degradation/Failure

14L--Quality Assurance - No QA Deficiency

31. HQ Summary:

On July 31, 2013 while performing an end-to-end test of the Instrument Personnel Protection System (IPPS) per certification procedures, technicians initiated a trip condition from an instrument enclosure to disable the beam injector at the front end of the spallation neutron source accelerator through the Personnel Protection System (PPS). The beam injector was not disabled as expected, demonstrating that the PPS was not operable as required. The approved Accelerator Safety Envelope specifies that the PPS shall be operable to support the applicable operational configuration during operations with beam. The IPPS certification procedure was suspended and appropriate notifications were made.

32. DOE Facility Representative Input:

33. DOE Program Manager Input:

34. Approvals:

Approved by: Kevin W. Jones, Facility Manager/Designee

Date: 09/16/2013

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