INL/EXT-13-30442

Causal Analysis of the Inadvertent Contact with an Uncontrolled Electrical Hazardous Energy Source (120 Volts AC)

David E. James
Sean S. Cunningham

October 2013

The INL is a U.S. Department of Energy National Laboratory
operated by Battelle Energy Alliance

INL/EXT-13-30442

Causal Analysis of the Inadvertent Contact with an Uncontrolled Electrical Hazardous Energy Source (120 Volts AC)

Level 1 Cause Analysis
ORPS Number: NE-ID—BEA-HFEF-2013-0003
ICAMS Number: IO-029749
Event Occurred: September 25, 2013

David E. James
Sean S. Cunningham

October 2013

Idaho National Laboratory
Idaho Falls, Idaho 83415

http://www.inl.gov

Prepared for the
U.S. Department of Energy
Office of Nuclear Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

INTENTIONALLY BLANK

Causal Analysis of the Inadvertent Contact with an Uncontrolled Electrical Hazardous Energy Source (120 Volts AC)

Level 1 Cause Analysis

ORPS Number: NE-ID--BEA-HFEF-2013-0003

INL/EXT-13-30442
Revision 0

October 2013

David E. James — 11/5/13
Lead Cause Analyst — Date

Dennis E. Raunig — 11-6-2013
Cause Analyst in Training — Date

Sean S. Cunningham — 11/5/13
Post Irradiation Examination Nuclear Facility Manager — Date

for Lisbeth Mitchell per email — 11/6/13
Lisbeth A. Mitchell — Date
Peer Review

Jeremy T. Hartley — 11/5/13
MFC Facilities Operations Manager — Date

for Phil Breidenbach — 11/5/13
Philip J. Breidenbach — Date
MFC Mission Support Director

Approved by:

Riley R. Chase — 11/6/13
Riley R. Chase — Date
Deputy Laboratory Director,
Projects, Nuclear Support and Production

INTENTIONALLY BLANK

EXECUTIVE SUMMARY

The Hot Fuel Examination Facility (HFEF) is a Hazard Category 2 nuclear facility, located within the Materials and Fuels Complex (MFC) at the Idaho National Laboratory (INL), in which Post-Irradiation Examination (PIE) processes are conducted within a large, inert hot cell. One of the PIE processes involves using a pneumatic transfer system to transport radiological smears from the HFEF Decon Cell to *the Room 130 Glovebox* for evaluation. The *Room 130 Glovebox* is located within *Hood ID# 130 HP* in HFEF. This work is performed to determine contamination levels on equipment and general areas in the HFEF Hot Cell. This pneumatic transfer system was out of service for approximately five years and was returned to service in November 2012 following repairs to the system.

On September 25, 2013, a Health Physics Technician (HPT) was performing preparations to support a pneumatic transfer from the HFEF Decon Cell to the *Room 130 Glovebox* in HFEF, per HFEF-OI-3165 section 3.5, Field Preparations. This activity involves an HPT setting up and climbing a portable ladder to remove the 14-C meter probe from above ball valve HBV-7. The HPT source checks the meter and probe and then replaces the probe above HBV-7, which is located above *Hood ID# 130 HP*. At approximately 13:20, while reaching past the HBV-7 valve position indicator switches in an attempt to place the 14-C meter probe in the desired location, the HPT's left forearm came in contact with one of the three sets of exposed terminals on the valve position indication switches for HBV-7. This resulted in the HPT receiving an electrical shock from a 120 Volt AC source.

Upon moving the arm, following the electrical shock, the HPT noticed two exposed electrical connections on a switch. The HPT then notified the HFEF HPT Supervisor, who in turn notified the MFC Radiological Controls Manager and HFEF Operations Manager of the situation. Work was stopped in the area and the hazard was roped off and posted to prevent access to the hazard. The HPT was escorted by the HPT Supervisor to the MFC Dispensary and then preceded to CFA medical for further evaluation. The individual was evaluated and released without any medical restrictions.

Causal Factor (Root Cause)

A3B3C01/A5B2C08: *Knowledge based error/Attention was given to wrong issues*
Written Communication content LTA, Incomplete/situation not covered

The Causal Factor (root cause) was attention being given to the wrong issues during the creation, reviews, verifications, and actual performance of HFEF OI-3165, which covers the need to perform the weekly source check and ensure placement of the probe prior to performing a "rabbit" transfer. This resulted in the hazard not being identified and mitigated in the procedure. Work activities with in HFEF-OI-3165 placed the HPT in proximity of an unmitigated hazard directly resulting in this event.

Contributing Factor

A3B3C04/A4B5C04: *Knowledge Based Error, LTA Review Based on Assumption That Process Will Not Change*
Change Management LTA, Risks/consequences associated with change not adequately reviewed/assessed

Prior to the pneumatic system being out of service, the probe and meter were not being source checked together. The source check issue was identified and addressed during the period of time when the system was out of service. The corrective actions for this issue resulted in the requirement that a meter and probe be source checked together as it is intended to be used. This changed the activity and required an HPT to weekly, when in use, remove and install the probe from above HBV-7 to meet the requirement of LRD-15001 Part 5 Article 551.5. Risks and consequences associated with this change were not adequately reviewed or assessed. Failure to identify the hazard associated with this change directly contributed to this event.

INTENTIONALLY BLANK

CONTENTS

INTENTIONALLY BLANK

ACRONYMS

AC	Alternating Current
β/γ	Beta and Gamma
CFR	Code of Federal Regulations
gm	Geiger-Mueller
HFEF	Hot Fuels Examination Facility
HBV	Ball Valve
HPT	Health Physics Technician
ID#	Identification Number
INL	Idaho National Laboratory
ISMS	Integrated Safety Management
IWC	*(typographical error, should be 14-C)*
LRD	Laboratory Requirements Document
LTA	Less Than Adequate
MFC	Materials and Fuels Complex
NEC	National Electrical Code
NFPA	National Fire Protection Association
OI	Operations Instruction
ORPS	Occurrence Reporting and Processing System
PIE	Post-Irradiation Examination
RAM	Radiation Area Monitor
Rev	Revision
TPR	Technical Procedure (document type)

INTENTIONALLY BLANK

Causal Analysis of the Inadvertent Contact with an Uncontrolled Electrical Hazardous Energy Source (120 Volts AC)

1. BACKGROUND

The Hot Fuel Examination Facility (HFEF) is a Hazard Category 2 nuclear facility, located within the Materials and Fuels Complex (MFC) at the Idaho National Laboratory (INL), in which Post-Irradiation Examination (PIE) processes are conducted within a large, inert hot cell. One of the PIE processes involves using a pneumatic transfer system to transport radiological smears from the HFEF Decon Cell to the *Room 130 Glovebox* for evaluation. The *Room 130 Glovebox* is located within *Hood ID# 130 HP* in HFEF. This work is performed to determine contamination levels on equipment and general areas in the HFEF Hot Cell.

Figure 1. *Hood ID# 130 HP* containing the *Room 130 Glovebox*

1.1 Event

On September 25, 2013, a Health Physics Technician (HPT) was performing preparations for a pneumatic transfer from the HFEF Decon Cell to the *Room 130 Glovebox* in HFEF, per HFEF-OI-3165 section 3.5, Field Preparations.

3.5.2 Portable survey instrument source checks must be performed per the requirements of TPR-7325, "Portable Health Physics Instrumentation Functional and Performance Checks."

3.5.3 Ensure [14-C gamma] *probe is taped above ball valve HBV-7.*

This activity involves an HPT setting up and climbing a portable ladder to remove the 14-C meter probe from above ball valve HBV-7. The HPT source checks the meter and probe and then replaces the probe above HBV-7, which is located above *Hood ID# 130 HP* (see Figure 2 & 3).

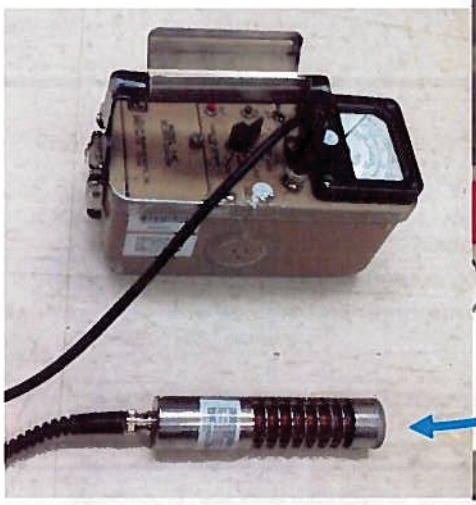


Figure 2. Type 14-C β/γ meter and probe

Figure 3. Side View, HBV-7 showing mounting clip for placement of probe

At approximately 13:20, while reaching past the HBV-7 valve position indicator switches in an attempt to place the 14-C meter probe in the desired location, the HPT's left forearm came in contact with one of the three sets of exposed terminals on the valve position indication switches for HBV-7. This resulted in the HPT receiving an electrical shock from a 120 Volt AC source.

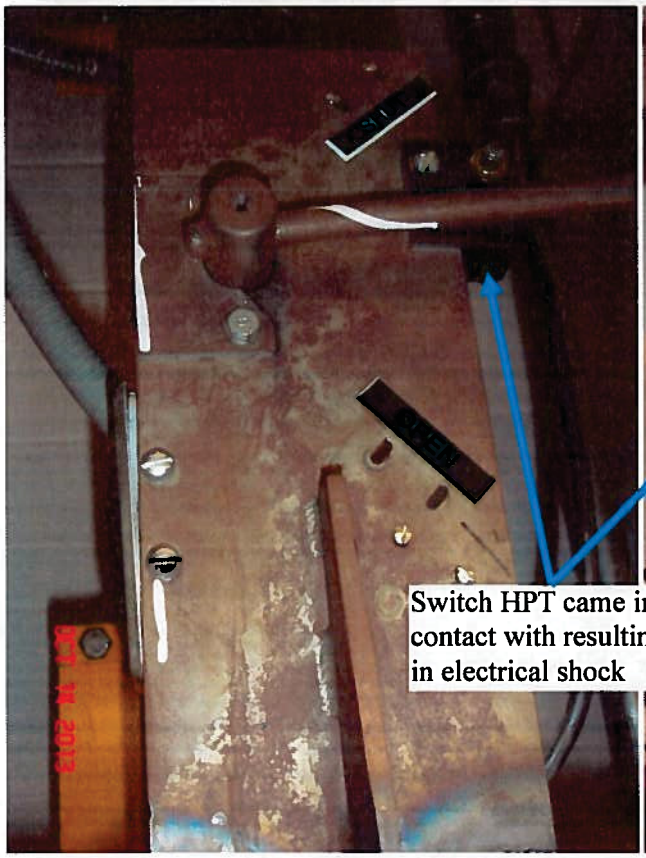


Figure 4. Front View, HBV-7 Valve Position Indicator Mounting Plate

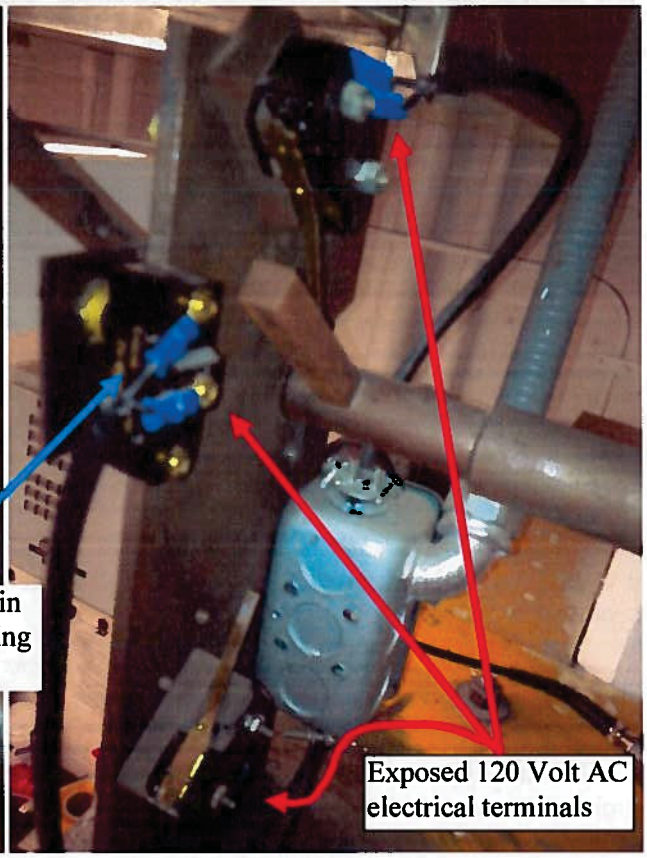


Figure 5. Back View, HBV-7 Valve Position Indicator Switches

Upon moving the arm following the shock the HPT noticed two exposed electrical connections on a switch (see Figure 5). The HPT then notified the HPT Supervisor, who in turn notified the MFC Radiological Controls Manager and HFEF Operations Manager of the situation. Work was stopped in the area and the hazard was roped off and posted to prevent access to the hazard.

The HPT was escorted by the HPT Supervisor to the MFC Dispensary and then preceded to CFA medical for evaluation. The individual was evaluated and released without any medical restrictions.

1.2 Post Event

An Instrumentation and Controls (I&C) Technician determined that the source of the electrical shock was exposed 120 Volt AC electrical terminal conductors on the valve position indication switches for HBV-7. Each of the three switches shown in Figure 5, have exposed electrical conductors. The System Engineer and facility operations personnel identified and opened the circuit breaker to de-energize this hazard and installed an administrative lock. The administrative lock is used to prevent unauthorized operation of equipment.

An Industrial Safety Engineer and I&C personnel walked the activity down after the event and stated that it was difficult to see the exposed electrical hazard even knowing where it was after the event. The exposed electrical hazard is difficult to see for the following reasons:

- The mounting plate obscures the view of the hazard (see Figure 4).
- The mounting plate is between the hazard and room lighting, at or above the lighting fixtures.
- The hazard is located above *Hood ID# 130 HP*.
- The hazard is at or above 8 feet.

Figure 6. Poor visibility in area of HBV-7, including signage that was posted after this event

Personnel interviewed believe that valve position indicators are from the original installation and that it has not been modified since it was placed in service sometime after facility commissioning in 1972. No other normally scheduled work occurs in this area.

1.3 NFPA 70 Requirements

The HBV-7 valve position indicators were installed with no engineered barrier or warning sign to guard personnel from accidental contact with exposed electrical conductors (live parts). The BEA NFPA 70 Authority Having Jurisdiction (AHJ) and BEA NFPA 70E AHJ stated that the installation choice not to guard with a physical barrier or warning sign was in compliance with the 1968 National Electrical Code requirements (applicable code during installation) and is currently in compliance with NFPA 70 2005, National Electrical Code, (current applicable code) because the hazard is located at or above eight feet.

The Instrumentation and Controls Foreman stated this type of exposed terminals was also previously used in another facility at MFC, EBRII for interlock switches.

Currently implemented NFPA 70E 2004, Standard for Electrical Safety in the Workplace, Article 110.8.B.3 and Article 130.2.D state that unqualified persons shall not be permitted to enter spaces that are

required under Article 400.16 to be accessible to qualified employees only, unless the electric conductors and equipment involved are in an electrically safe work condition.

NOTE: The code requirements in NFPA 70E 2004 Article 400.16 are the as NFPA 70 2005 Article 110.27.

NFPA 70E, 2004 Article 110.8 Working On or Near Electrical Conductors or Circuit Parts.
(B)(3) Unqualified Persons.
Unqualified persons shall not be permitted to enter spaces that are required under 400.16 to be accessible to qualified employees only, unless the electric conductors and equipment involved are in an electrically safe work condition.

NFPA 70E, 2004 Article 130.2(D) Approach by Unqualified Persons.
Unqualified persons shall not be permitted to enter spaces that are required under 400.16(A) to be accessible to qualified employees only, unless the electric conductors and equipment involved are in an electrically safe work condition.

NFPA 70 2005 Article 110.27 [also in NFPA 70E 2004 Article 400.16]
Except as elsewhere required or permitted by this standard, live parts of electrical equipment operating at 50 volts or more shall be guarded against accidental contact by approved enclosures or by any of the following means:

110.27 Guarding of Live Parts.

(A) Live Parts Guarded Against Accidental Contact. *Except as elsewhere required or permitted by this standard, live parts of electric equipment operating at 50 volts or more shall be guarded against accidental contact by approved enclosures or by any of the following means:*

(1) By location in a room, vault, or similar enclosure that is accessible only to qualified persons.

(2) By suitable permanent, substantial partitions or screens arranged so that only qualified persons have access to the space within reach of the live parts. Any openings in such partitions or screens shall be sized and located so that persons are not likely to come into accidental contact with the live parts or to bring conducting objects into contact with them.

(3) By location on a suitable balcony, gallery, or platform elevated and arranged so as to exclude unqualified persons.

(4) By elevation of 2.5 m (8 ft.) or more above the floor or other working surface.

(B) Prevention of Physical Damage. *In locations where electric equipment is likely to be exposed to physical damage, enclosures or guards shall be so arranged and of such strength as to prevent such damage.*

(C) Warning Signs. *Entrances to rooms and other guarded locations that contain exposed live parts operating at 50 volts shall be marked with conspicuous warning signs forbidding unqualified persons to enter.*

1.4 History

Personnel interviewed stated that the Decon Cell to Health Physics Lab pneumatic transfer system was placed out of service for needed repairs resulting from physical damage to the piping system. The repairs required personnel entry into the HFEF Decon Cell, which required a major repair outage for this part of the HFEF Hot Cell. This delayed the ability to access the area to repair this system for an extended period of time. The Decon Cell to Health Physics Lab pneumatic transfer system was out of service for approximately five years and returned to service in November 2012 following repairs.

While the system was out of service an issue was identified regarding the source checking practices of portable detection monitors. The probe and meter were not being source checked together. The past practice was to disconnect the cord of the permanently mounted probe above HBV-7 from the meter and

source check the meter with another probe. The corrective actions for this issue resulted in the requirement that the meter and probe be source checked together as they would be intended to be used. This requirement added a new activity which required an HPT to *weekly when in use* remove and install the probe from above HBV-7 to meet the requirement of LRD-15001-Part 5 Article 551.5.

***LRD-15001-Part 5 Article 551.5**, Weekly performance checks, using a known source will be conducted on in-use portable instruments*

This new activity routinely placed workers in close proximity to the unidentified exposed electrical hazard (see Figure 5). The electrical hazard was not identified during walk downs of this work prior to restarting this activity in November 2012 and was subsequently not eliminated or mitigated.

This pneumatic transfer activity is performed per the following procedures:

- HFEF-OI-3165, Health Physics Laboratory
- HFEF-OI-6401, Pneumatic Transfer System Decon Cell - Health Physics Lab

The activity of removing and installing the meter probe above HBV-7 has been performed seven times since the system has been placed back in service (determined from review of HPT log entries). Each time an HPT removed and reinstalled the probe above HBV-7, the technician was exposed to the unmitigated electrical hazard. This occurred two times for each source checking evolution, for a total of fourteen times. The last time the probe was reinstalled is when this event occurred.

Based on a review of prior events the BEA NFPA 70E AHJ determined that no other similar event had been previously identified at the INL

2. SCOPE OF THIS INVESTIGATION

This investigation was commissioned to perform a Level 1 Cause Analysis of the events that led to the Inadvertent Contact with an Uncontrolled Electrical Hazardous Energy Source (120 Volts AC) Event in HFEF that occurred on September 25, 2013. The scope of this investigation was to evaluate the overall operation, as depicted in the time line captured during the critique of the event, and discern the root causes of the exposure event. Corrective actions have been developed to address the causes of this event as well as other issues identified during the course of this investigation (see section 4.3). This issue and its corrective actions will be tracked in ICAMS issue number IO-029749 under source document SD-007390.

3. FACTS

3.1 Chronology of Activities

Date/Time	Action/Activity
Oct 2012	Pneumatic transfer system returned to service after being out of service for repairs for approximately 5 years • System used to transfer "rabbits" from HFEF Decon Cell to the *Room 130 Glovebox*
Nov 19, 2012	Set up area and performed weekly source check to support pneumatic transfer • First time since returning Pneumatic transfer system to service • This is in the prerequisite section of HFEF-OI-3165 to be performed prior to transferring pneumatics per HFEF-OI-6401 Note: *Weekly source check requires HPT to remove and replace a 14C meter head located next to HBV-7 above Hood ID# 130 HP in HFEF room 130.*
Feb 7, 2013	Set up area and perform weekly source check to support pneumatic transfer
Feb 14, 2013	Set up area and perform weekly source check to support pneumatic transfer
April 29, 2013	Set up area and perform weekly source check to support pneumatic transfer
May 20, 2013	Set up area and perform weekly source check to support pneumatic transfer
May - June	Bracket (see Figure 3) installed as in improvement so the probe would not need to be taped in place each time. This improvement occurred in the May to June time frame
June 17, 2013	Set up area and perform weekly source check to support pneumatic transfer
Sept 25, 2013 13:00	Commenced setting up area in preparation for pneumatic transfer per HFEF-OI-3165.
13:20	Following the weekly source check the Heath Physics Technician experienced a shock to left forearm while replacing the meter head above HBV-7. • Affected employee reported to medical • Stopped work in area • Guarded hazard by roping and posting off the area
13:51	• I&C Technician confirmed 120 Volts AC on 3 switches
15:40	• Employee returned to work from CFA medical with no restrictions
~16:00	• System Engineer and facility operations identified the circuit and opened the breaker and installed an administrative lock.

3.2 Analysis

3.2.1 ISMS Core Functions

The Why Tree, Barrier Table, and Behavior Analysis techniques were used in this investigation, and are attached as Appendix A, B, and C, respectively. The results of this analysis are summarized within the context of the ISMS guiding principles below. Reviews of records, procedures, interviews with participants, and reviews of similar events were used to complete this analysis.

Core Function 1 – Define the Scope of Work

Missions are translated into work, expectations are set, tasks are identified and prioritized, and resources are allocated.

This core function was fully met.

The work performed was within the scope of HFEF-OI-3165, and not causal to this event.

Core Function 2 – Analyze the Hazards

Hazards associated with the work are identified, analyzed, and categorized.

FAILED this core function.

The work activity of removing and replacing the probe while performing weekly source checks unknowingly placed the HPT in the proximity of exposed 120 Volts AC electrical conductors (live parts). The exposed electrical hazard was present on the three valve position indicator switches for HBV-7 located above room lighting, above *Hood ID# 130 HP*, and behind the mounting plate for the valve position indicators (see Figures 4, 5, & 6). The inability to identify this hazard directly resulted in the hazard not being analyzed or categorized.

The opportunity to identify this hazard was missed when this activity was first walked down after the system was originally installed, when the system was returned to service, and every time this activity was performed, reviewed, or observed. Failure to identify this hazard resulted in the hazard not being eliminated, mitigated, or included in the associated procedure, HFEF-OI-3165. ***(A3B3C01/A5B2C08)***

Prior to the pneumatic system being out of service, the probe and meter used to support this work were not being source checked together. This issue was identified and addressed during the period of time when the system was out of service. The corrective actions for this issue resulted in the requirement that a meter and probe be source checked together as it is intended to be used. This changed the work activity and required an HPT to weekly, when in use, remove and install the probe from above HBV-7 to meet the requirement of LRD-15001 Part 5 Article 551.5, but did not require a change to the procedure step in HFEF-OI-3165 and no new hazard was identified.

There was a less that adequate review of the hazards associated with the change in work activity based on the assumption that process did not change. The risks associated with the change of starting to routinely access the area above *Hood ID# 130 HP*, an area above eight feet in an industrial facility, were not adequately assessed. ***(A3B3C04/A4B5C04)***

Core Function 3 – Develop and Implement Hazard Controls

Applicable standards and requirements are identified and agreed upon, controls to prevent/mitigate hazards are identified, the safety envelope is established, and controls are implemented.

This core function was not met.

Hazard controls were not developed or implemented for the exposed electrical hazard due to the inability to identify this hazard, see Core Function 2.

Core Function 4 – Perform Work within Controls

Readiness is confirmed and work is performed safely.

This core function was not met.

Work was performed with in the established controls, but the controls were not adequate to perform the work safely due to failure to meet Core Function 2 and 3.

Core Function 5 – Provide Feedback and Continuous Improvement

Feedback information on the adequacy of controls is gathered, opportunities for improving the definition and planning of work are identified and implemented, line and independent oversight is conducted, and, if necessary, regulatory enforcement actions occur.

This core function is met.

This is the first event associated with this hazard for this equipment. The information gathered from this event is currently being used to perform an extent of conditions to identify if additional similar hazards exist elsewhere and to develop appropriate hazard mitigations to ensure this activity can be performed safely. There is no indication that feedback from this event will not be used to improve this activity and similar activities.

Corrective actions are in progress to address the issues identified with this event and are captured in Section 4.2.

4. CONCLUSIONS

The causes that contributed to this event are described as Causal Factors and Contributing Factors. Causal Factors are the root causes that if corrected would prevent this event from recurring. Contributing Factors identified are issues that contributed to the event but if corrected may not prevent this type of event from recurring. Both sections are in order based on the level of significance.

Cause codes listed are per the DOE Standard for Occurrence Reporting Causal Analysis, DOE-STD-1197-2011. Paired causal factors are required whenever a Human Error cause code is selected per DOE-STD-1197-2011.

4.1 Paired Causal Factor (Root Cause)

A3B3C01/A5B2C08:

Knowledge based error/Attention was given to wrong issues
Written Communication content LTA, Incomplete/situation not covered

Initial installation

The HBV-7 valve position indicator switches were installed with no engineered barrier or warning sign to guard against accidental contact with the exposed electrical hazard. According to the BEA NFPA 70E AHJ and BEA NFPA 70 AHJ, the installation met the 1968 NEC requirements and meets the currently implemented NFPA 70 and NFPA 70E electrical code requirements.

The decision not to install an engineered barrier or warning sign required that the personnel accessing the area either knew that a hazard existed and takes appropriate precautions or identifies the hazard prior to performing work. When the system was installed it was known that this hazard was present. This hazard was considered by code to be protected against accidental contact because it was at or above eight feet.

Attention was given to the wrong issue because relying on personnel to identify an unmitigated and unidentified hazard in a difficult to see location is an error likely situation. Written communication was less than adequate, situation not covered, because there was no warning sign to identify the hazard and the hazard was not included in the procedure.

The fact that no engineered or administrative barrier were present to identify or mitigate the hazard **directly resulted in this event**.

Post installation

Performing preparations for a pneumatic transfer from the HFEF Decon Cell to the *Room 130 Glovebox* in HFEF, per HFEF-OI-3165 section 3.5, Field Preparations, placed the HPT in the proximity of an electrical hazard.

3.5.2 Portable survey instrument source checks must be performed per the requirements of TPR-7325, "Portable Health Physics Instrumentation Functional and Performance Checks."

3.5.3 Ensure IWC gm probe is taped above ball valve HBV-7.

4.3 Corrective Actions

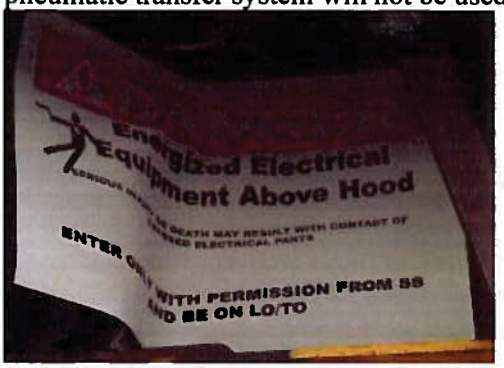
The following corrective actions have been developed to address the root causes (causal factors) that contributed to this event.

1. Perform medical evaluation of electrically shocked employee.

   Target Completion Date: COMPLETED 9/25
   Actions Assigned to: HPT Supervisor
   Objective Evidence: N/A, affected employee was evaluated at the MFC Dispensary and at CFA Medical. No injury detected and released to work with no restrictions.

2. Immediate action to mitigate and/or eliminate the electrical hazard (temporary fix). *(A3B3C01/A5B2C08)*

   Target Completion Date: COMPLETED 9/25
   Actions Assigned to: HFEF SS
   Objective Evidence: Opened power supply breaker to the HBV-7 valve position indicators and applied an administrative lock. The area was also posted with a DANGER posting, which identifies the electrical hazard, restricts access, and requires a lockout/tagout to enter the area. Additionally this pneumatic transfer system will not be used until new switches are installed.



3. Perform an extent of conditions to ensure that the exposed terminals do not exist in other similar valve position indication devices. *(A3B3C01/A5B2C08)*

   Target Completion Date: 12/12/2014
   Actions Assigned to: Sean Cunningham
   Objective Evidence: Provide documentation of completed extent of conditions review including any compensatory measures put in place to protect workers.

4. Evaluate appropriate actions to mitigate/eliminate the exposed electrical hazard for the HBV-7 valve position indication switches. *(A3B3C01/A5B2C08)*

   Target Completion Date: COMPLETED, Per EJ-1379, replacing the switches will eliminate the hazard.
   Actions Assigned to: Ron Johansen
   Objective Evidence: Copy of evaluation.

5. Per EJ-1379, replace HBV-7 valve position indicator switches. *(A3B3C01/A5B2C08)*

   Target Completion Date: COMPLETED
   Actions Assigned to: Ron Johansen
   Objective Evidence: Documentation that the switches have been replaced eliminating the hazard.

The exposed 120 Volt AC electrical hazard in the proximity of this activity was NOT IDENTIFIED, ANALYZED, or CATEGORIZED by qualified personnel and subject matter experts during the following;

- Activity walk downs,
- Each time this activity was performed,
- Each review and/or revision of the procedure covering this activity (HFEF-OI-3165),
- When the pneumatic transfer system was returned to service following being out of service for approximately five years,
- When there was a change to the way source checking was performed for this activity.

Qualified personnel and subject matter experts gave attention to the wrong issues during the tasks listed above by focusing on the radiological hazard and ladder safety, but did not identify the unmitigated and unidentified electrical hazard. HFEF-OI-3165 was less than adequately written because it did not communicate the electrical hazard.

Failure to identify the exposed electrical hazard **directly resulted in this event.**

4.2 Paired Contributing Factor

A3B3C04/A4B5C04:

Knowledge Based Error, LTA Review Based on Assumption That Process Will Not Change
Change Management LTA, Risks/consequences associated with change not adequately reviewed/assessed

Prior to the pneumatic system being out of service, the probe and meter were not being source checked together. The source check issue was identified and addressed during the period of time when the system was out of service. The corrective actions for this issue resulted in the requirement that a meter and probe be source checked together as it is intended to be used. This changed the activity and required an HPT to weekly, when in use, remove and install the probe from above HBV-7 to meet the requirement of LRD-15001 Part 5 Article 551.5.

Risks and consequences associated with this change were not adequately reviewed or assessed. Failure to identify the hazard associated with this change **directly contributed to this event.**

6. Perform a radiological controls engineering evaluation of the decontamination cell - health physics lab pneumatic transfer system requirements.

   Target Completion Date: 12/12/2013
   Actions Assigned to: Mike Morris
   Objective Evidence: Copy of evaluation including any additional recommendations and corrective actions.

7. Review and revise HFEF-OI-3165 and HFEF-OI-6401 to address observations 1, 2, and 3.

   Target Completion Date: 12/12/2013
   Actions Assigned to: Maxine Rubick
   Objective Evidence: Copy of the issued revised procedures.

8. Submit MFC lessons learned. *(A3B3C01/A5B2C08 and A3B3C04/A4B5C04)*

   Target Completion Date: 11/07/2013
   Actions Assigned to: Kelly Kynaston
   Objective Evidence: Copy of submitted MFC lessons learned.

9. Submit INL lessons learned. *(A3B3C01/A5B2C08 and A3B3C04/A4B5C04)*

   Target Completion Date: 11/07/2013
   Actions Assigned to: Kelly Kynaston
   Objective Evidence: Copy of submitted INL lessons learned.

4.4 Additional Issues/Observations

Issue 1 — Did not meet the NFPA 70E Article 110.8.B.3 or Article 130.2.D requirement for working on or near live parts, or approaching live parts by unqualified persons. ***(A3B3C01/A5B2C08)***

NFPA 70E 2004 Article 110.8.B.3 and Article 130.2.D state that unqualified persons shall not be permitted to enter spaces that are required under 400.16 (A) to be accessible to qualified employees only, unless the electric conductors and equipment involved are in an electrically safe work condition.

Observation 1 — HFEF-OI-3165 step 3.5.3, the placement of the probe above HBV-7 was improved to utilize a clip-on attachment for the probe placement instead of the tape called for in the type 2 procedure. This should be updated.

Observation 2 — HFEF-OI-3165 step calls out an "IWC gm probe" but the term IWC is not defined. The HPT's, HPT supervisor, and HPT engineer do not know what this is referencing.

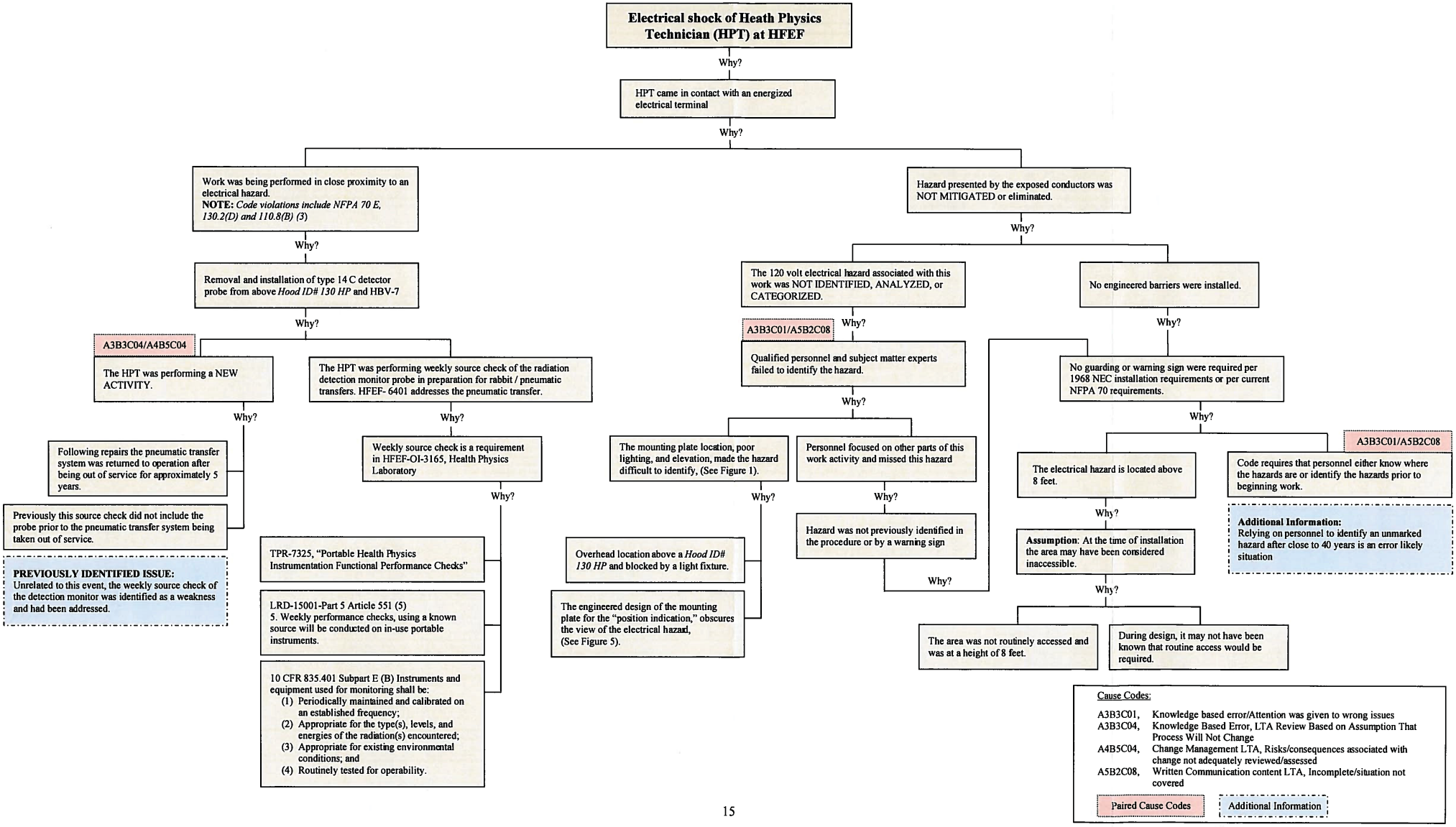
Observation 3 — HFEF-OI-6401 step 5.2.13, type 2 procedure calls out the use of the RAM, where a 14C meter is actually used

Observation 4 — There is no requirement look for unidentified hazards prior to performing work when accessing an area in an industrial facility at or above eight feet that is not routinely accessed. By code an unidentified and unguarded electrical hazard could exist.

Observation 5 — Current NFPA 70 code requirements would allow installation today of an electrical hazard that is at or above eight feet to be installed with no engineered barrier or warning sign.

INTENTIONALLY BLANK

Appendix A
Why Tree



INTENTIONALLY BLANK

Appendix B
Barrier Analysis

HAZARD: Three 120 Volts AC electrical connectors			TARGET: Health Physics Technician	
Barrier	**Type**	**How did barrier perform**	**Why did barrier fail**	**How did the barrier affect the event**
1. 1968 NEC	Administrative	Installed to meet code requirements	• Code requirement did not require installing an engineered barrier or a warning sign to guard against accidental contact because the electrical hazard was at or above 8 feet • Code relies on personnel to take appropriate precautions for known hazards (even unmarked). After close to 40 years since installation this hazard was no longer known. Code relies on personnel to identify hazards when working in areas where unguarded hazards may exist, in this case above 8 feet.	• Did not mitigate the hazard • Did not prevent this event.
2. NFPA 70/70E	Administrative	Failed	(A3B3C01/A5B2C08) • Met NFPA 70 Article 110.27 (A)(4), Live Parts Guarded Against Accidental Contact, because this hazard was at or above 8 ft., but this did not require identifying the hazard. • Qualified personnel and subject matter experts failed to recognize the change in condition when the area became routinely accessed to perform source checks. Did not meet NFPA 70E 110.8.B.3, Unqualified persons were permitted to enter spaces that are required under NFPA 70E 400.16 to be accessible to qualified employees only, unless the electric conductors and equipment involved are in an electrically safe work condition.	• Did not mitigate the hazard • Did not prevent this event.
3. HBV-7 position indication switches	Engineered	Barrier did not exist	• No engineered barrier installed to guard personnel from accidental contact with the hazard (see Figures 5) • The position indication switches are mounted on a plate which obscures the view of the hazard behind it (see Figure 4) NOTE: Industrial Safety Engineer and I&C personnel walked the activity down after the event and stated that it was difficult to see the exposed electrical hazard even knowing where it was after the event.	• Having an unguarded hazard directly resulted in this event • Difficult to see the hazard resulted in the inability to identify the hazard.
4. HFEF-IO-3165	Administrative	Failed	• Did not identify or mitigate this hazard	• Did not prevent this event (A3B3C01/A5B2C08) • Placed HPT in proximity of unmitigated hazard.
5. Procedure Reviews	Administrative	Failed	• Work activity walk downs failed to identify the exposed electrical hazard • Document reviews failed to identify the exposed electrical hazard, currently on Rev 6 (A3B3C04/A4B5C04) • Failed to identify additional hazards associated with the change in standard for source checking the meter and probe together.	(A3B3C01/A5B2C08) • Procedure does not identify or mitigate the hazard (A3B3C01/A5B2C08) • Placed HPT in proximity of unmitigated hazard.
6. Trained and qualified personnel	Person	Failed	(A3B3C04/A4B5C04) • Failed to identify an unmitigated hazard in a routinely accessed area at or above 8 feet following returning the system to operation • HPT's do not have the same level of awareness for this type of hazard as an electrically trained employee.	(A3B3C01/A5B2C08) • Failure to identify this hazard and working in the area resulted in contact with the hazard.

Cause Codes:

A3B3C01, Knowledge based error/Attention was given to wrong issues
A3B3C04, Knowledge Based Error, LTA Review Based on Assumption That Process Will Not Change
A4B5C04, Change Management LTA, Risks/consequences associated with change not adequately reviewed/assessed
A5B2C08, Written Communication content LTA, Incomplete/situation not covered.

INTENTIONALLY BLANK

Appendix C
Behavior Table

NOTE: LESS THAN ADEQUATE (LTA) BARRIERS ARE LISTED IN SEQUENCE FROM BARRIER ANALYSIS

LTA Barriers	Who Was Responsible	Expected Behavior	Actual Behavior	Why did the behavior make sense
1. 1968 NEC	• Electrical Engineering • Installing electrician	• Install per code requirements	• Did not identify the hazard with a warning sign	• Not required per 1968 NEC requirements NOTE: This installation also meets current NFPA 70 code requirements.
2. NFPA 70/70E	• Electrical Engineering • Electrically qualified personnel	• Review and ensure all applicable code requirements are met • Perform walk downs to ensure we meet code • Identify hazards during the performance of work.	• Hazard was not identified	• Hazard located in low visibility area • Area was previously not routinely accessed because the source check did not include the probe • Area not accessed by electricians or instrument and controls technicians.
3. HBV-7 position indication switches	• Engineering	• Design to meet all applicable code requirements	• Met code requirements at time of installation	• Hazard is at or above 8 feet • During design and installation it may not have been known that the area would be routinely accessed.
4. Procedure: HFEF-IO-3165	• Document owner • Performer	• Ensure that procedures have adequate hazard identification and mitigation • Ensure adequate review	*(A3B3C01/A5B2C08)* • LTA Hazard Identification and Mitigation for electrical hazard • Appropriate personnel reviewed the document.	*(A3B3C01/A5B2C08)* • Failed to identify the hazard when this process was first used after installation *(A3B3C04/A4B5C04)* • Failed to identify the hazard when the pneumatic transfer system was returned to service *(A3B3C04/A4B5C04)* • Failed to identify change to source

Appendix C
Behavior Table

NOTE: LESS THAN ADEQUATE (LTA) BARRIERS ARE LISTED IN SEQUENCE FROM BARRIER ANALYSIS

LTA Barriers	Who Was Responsible	Expected Behavior	Actual Behavior	Why did the behavior make sense
				checking which resulted in routinely accessing the area that contained an unmitigated hazard.
5. Trained personnel	• PIE Nuclear Facility Manager • HFEF Operations Manager • Qualified personnel	• Identify and mitigate and/or eliminate hazards associated with work activities	*(A3B3C01/A5B2C08)* • Failed to identify the exposed electrical hazard in the area during the review and performance of this work activity.	• Hazard located in low visibility area *(A3B3C04/A4B5C04)* • Area was previously not routinely accessed because the source check did not include the probe • Area not accessed by electrically trained personnel.

Cause Codes:

A3B3C01, Knowledge based error/Attention was given to wrong issues

A3B3C04, Knowledge Based Error, LTA Review Based on Assumption That Process Will Not Change

A4B5C04, Change Management LTA, Risks/consequences associated with change not adequately reviewed/assessed

A5B2C08, Written Communication content LTA, Incomplete/situation not covered.

Appendix D
Interviewee List

PIE Nuclear Facility Manager (NFM)
HFEF Operations Manager (OM)
HFEF Radiological Controls Supervisor
Health Physics Technicians (3)
Radiological Controls Engineer

MFC Maintenance General Foreman
MFC Instrumentation and Controls Foreman

Industrial Safety Engineer
MFC Registered Nurse

BEA NFPA 70 AJH, BEA Electrical Safety Committee member
BEA NPFA 70E AHJ, BEA Electrical Safety Committee member

INTENTIONALLY BLANK

Appendix E
Documents Reviewed

10 CFR 851.23		Safety and Health Standards
29 CFR 1910.333		Selection and Use of Work Practices
NFPA 70E	2004	Standard for Electrical Safety in the Workplace
NFPA 70	2005	National Electrical Code
LRD-14710		Worker Safety and Health: Electrical Safety
LRD-15001 Ch. 5 Section 5.5.1.4 & 5	Rev 3	Radiological Control Manual - Chapter 5 - Radiological Health Support Operations
MCP-139	Rev 16	Radiological Surveys
LI-15002	Rev 3	Health Physics Surveys, Source Checks, And Filter Change At MFC
HFEF-OI-3165	Rev 6	Health Physics Laboratory
HFEF-OI-6401	Rev 4	Pneumatic Transfer System Decon Cell - Health Physics Lab
10 CFR 835.401 Subpart B		Occupational Radiation Protection: General Requirements
ORPS Report		Number: NE-ID--BEA-HFEF-2013-0003
HPT Log Entries		218691, 218736, 218774, 223208, 223642, 228312, 228408, 229547, 231287, 231585, 237912