**Entergy Nuclear Operations**
**Palisades Plant**

# Root Cause Evaluation Report

## Plant Trip During Panel ED-11-2 Maintenance

## CR-PLP-2011-4822: 09-25-11

## REPORT DATE: 10-17-11

## Rev 2. 12-27-11

| POSITION | NAME/DEPT. | DATE |
|---|---|---|
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| **Revision** | **Changes** | Evaluator |
|---|---|---|
| 0 | Initial version approved by PLP CARB | A. Baerren |
| 1 | 1. Incorporation of Fleet Comments<br>2. Incorporation of IPEC O&P review<br>3. Update to RC1<br>4. Change RC2 to a contributing Cause<br>5. Update Corrective Action Plan<br>6. Replace Attachment 1 timeline with timeline developed under PSA Engineering Analysis EA-PSA-SDP-D11-2-11-07 Rev 0, Attachment 1<br>7. Added Why Staircase in Attachment 9. | P. Deniston<br>J. Kuemin |
| 2 | Incorporation of 12/27/2011 CARB Comments | P. Deniston<br>J. Kuemin |

# Problem Statement

On September 25, 2011, at 1506, while performing maintenance activities on DC electric distribution panel D-11-2, a short circuit condition occurred resulting in reactor trip.

# Event Narrative

The following narrative describes the sequence of events leading up to the short circuit and the subsequent reactor trip on Sunday 09/25/11. This information is based on available documentation from the event, interviews with plant personnel involved in the event and statements made during the Level 1 Human Performance Error Review (HPER) conducted following the event. Specific details are included in Attachment 1 - Event Time Line.

### PREVIOUS MAINTENANCE ON PANEL ED-11-2

Prior to the 2010 refueling outage 1R21, routine preventive maintenance performed per work order WO52025543-01 identified that the green status indication lights for the containment escape air lock MZ-50 were not working. Although CR-PLP-2010-3580 and work request WR210717 were issued at the time, this condition was not addressed until the troubleshooting activities scheduled for Thursday 09/22/11 under WO248834-01. This was because the repair of the lights was prioritized for completion during the next system window per EN-WM-100, “Work Management System”.

During refueling outage 1R21, ten of the eighteen breakers were replaced with new breakers and the remaining eight breakers were removed for periodic testing. The removal and installation of the DC breakers was completed per WO212303, “Breaker Testing for ED-11-2 which included work instructions and attachments from Maintenance Procedure EPS-E-10, “DC Breaker Inspection and Testing”. The setting sheet for breaker 52-123, which later failed, was completed and included in the work order package. Upon the completion of D-11-2 breaker replacement the panel was returned to service per WO212303-04, step 5.1, by verifying that all loads of ED-11-2 have been restored.

Discovery of cross-threaded bus connectors and a bus connector air gap during troubleshooting under WO291194 on 09/25/11 suggested that the breaker replacement workmanship during 1R21 could have been substandard. An examination of the two removed connectors that was done for this root cause evaluation found that the threads had been partially stripped, either by repeated use or by over-torquing the bolts in the relatively softer metal of the connectors. There was no evidence of damage on the tops of the connectors, such as scoring or gouging, to show that workers had found difficulty replacing the bus connector bolts which should have caused them to stop work and ask for help.

The bolts used to attach each breaker to its bus connectors are stainless steel and less than one inch long.

Electricians present during the examination that was done for this evaluation, who were not involved in the work on the panel or with the current event situation, stated that the thread damage could have occurred during 1R21 or possibly earlier and that it would not have been recognized unless the threads had stripped free because the bolts need to positioned through a two inch deep recess. The bolts are normally taped to a long screwdriver to feed each through to its location.

As completed during 1R21, WO212303, and EPS-E-10, which was included with it, included no instructions other than steps to remove and then restore each breaker along with a caution to control breaker bolt nuts. Work order instructions did not specify a bus connector bolt torque value similar to Maintenance Procedure EPS-E-12, "DC Breaker Replacement" (12 inch-pounds). In addition, the instructions did not include detailed directions for breaker removal or for the method and sequence of reassembly. Although the procedure included a step for Maintenance management approval for work on energized circuits, this step was not completed because, as verified in eSOMS and work order records, the panel was tagged out with incoming fuses removed.

Based on this information, the cross-threading occurred during 1R21 and workers at that time failed to recognize the damage because of the lack of visibility and the lack of detailed instructions for breaker removal and installation in EPS-E-10.

**INITIAL TROUBLESHOOTING AND REPAIR**

Following completion of forced outage associated with primary coolant system leaks, power ascension was in progress and work week managers were coordinating efforts to determine what work could be performed for the remainder of the week. During this coordination meeting it was determined that mechanical work associated with Containment Escape Hatch MZ-50 would be scheduled for early Monday 09/26/11. In support of the scheduled work, electrical maintenance needed to troubleshoot the green indicating lights for the Containment Escape Hatch door that were reported as inoperative.

WO248834 was issued to troubleshoot the indicating lights for MZ-50 and workers were briefed and sent to the field where they found that local interlock circuitry, indicating light bulbs, and limit switches were all functioning properly. Troubleshooting on 09/22/11 determined there was no load side voltage on breaker 72-123 indicating the need for replacement.

WO291123 was generated to replace breaker 72-123 with additional work order tasks generated to test and install a replacement and the Right Train was

declared the protected train. The new work order plan was clear that breaker replacement involved work on the energized ED-11-2 bus. The Plant impact statement, approved on 09/22/11 by an on-duty SRO, recognized a potential risk in the loss of ED-11-2 and recommended a contingency review of ONP 2.3, "Loss of DC Power" which provides instructions for operators in the event of loss of DC power. Though the SRO recognized a potential risk, the EOOS risk assessment model was not run for the loss of the ED 11-2 bus. (EOOS shows loss or removal from service of ED-11-2 results in an Orange (High) nuclear safety risk factor of 5.8 requiring GMPO approval for entry.)

Testing was completed near the end of day shift on 09/23/11. The new breaker 72-123 was then replaced under the same work order beginning at approximately 1500 on 09/23/11. It was recognized that replacement of the breaker would allow completion of scheduled preventive maintenance on MZ-50. Although EOOS showed that removal of this breaker (risk factor 1.03) had no significant impact on nuclear safety, no evidence was found that the qualitative risk assessment also called for in EN-WM-104, "On-Line Risk Assessment" had been performed and documented. This assessment should have considered a broader range of affects including work on an alternate Friday when craft and management oversight resources were limited, the potential for loss of ED-11-2 noted above and the personnel safety issues involved with working on an energized bus. (EOOS shows loss or removal from service of ED-11-2 results in an Orange (High) nuclear safety risk factor of 5.8 requiring GMPO approval for entry.)

During restoration following completion of WO291123, at approximately 1635, Operations reported losing instrument air indication, a generator over-excitation alarm with the generator stable and a flickering voltage regulator auto-adjustor indicator. These conditions were documented under CR-PLP-2011-4801. Operations entered Off Normal Procedure 7.1, "Loss of Instrument Air" and Electrical Maintenance resources were aligned through dayshift on Saturday and an initial EN-MA-125, "Maintenance Troubleshooting", troubleshooting plan was drafted, assigned Risk Level 2 and approved by EFIN, electrical maintenance and the shift manager. Risk Level 2 was justified based on procedure guidance - the breakers being checked remained in service but troubleshooting involved only voltage checks, connection tightening and breaker operating. However, with the causes unknown, this additional troubleshooting was performed under WO291123 beginning on the night shift of 09/23/11.

Troubleshooting revealed no voltage on load side of 72-119 (Main Control Room Panel EC-13). In addition, a slight misalignment in the mounting of breakers 72-119, 72-121 (Excitation Control Panel E01), and 72-123 (Emergency Air Lock MZ-50) was identified. Efforts also identified a small air gap between the positive bus connector and its line side positive connection on breaker 72-119 which had resulted in minor arcing and a slightly elevated temperature (~2 degrees F) as determined by thermography of the panel with all breakers installed.

Troubleshooting was complete by the end of the night shift on the morning of 09/24/11.

Based on the troubleshooting results, an OCC alignment meeting was held at 0800 on 09/24/11 with the system engineering manager, the operations shift manager, the maintenance manager, the assistant operations manager, the outage manager, the training manager, the engineering programs manager and the MP&C manager. Following a discussion of Plant status and recognition of the equipment out of service, there was a discussion about potential Plant risk including loss of ED-11-2, entry into an 8 hour LCO and the potential for tripping the Plant.

In addition, it was recognized that a temporary modification would be required to power the generator voltage regulator to allow removal of suspect DC breakers in ED-11-2 for examination to ensure that bus connections were properly aligned, flush mounted, and making secure electrical contact. This would include the three suspect breakers as well as breaker 72-120 to ensure access to the breaker bus connector bolts. The temporary modification would power breaker 72-121 loads from an alternate source fed from the same bus through breaker 72-127. Although the full scope of planned work was discussed, as well as the potential risk Plant risk, no qualitative risk assessment was documented.

By the end of day shift on 09/24/11, replacement breakers were procured and tested for 72-119 and 72-121 in the event they were found defective. An EOOS risk assessment was performed by Operations considering the breakers to be removed. It did not include a review of the potential loss of ED-11-2 and no qualitative risk assessment review was documented which included the breakers, the temporary modification and the panel along with the industrial safety and resource factors involved with working during an off-Friday weekend. (A post-event EOOS evaluation shows loss or removal from service of ED-11-2 itself results in an Orange nuclear safety risk factor of 5.8 requiring GMPO approval to go forward.)

## TEMPORARY MODIFICATION

The temporary modification was approved for installation at 0345 on 09/25/11 as EC31973 and translated into work instructions which were included in WO291209. It was identified that work hour rules would require the Electrical supervisor to leave at 0600 on the morning of 09/25/11 with no suitable replacement eligible to report until 0800. Because of the scope of work, it was not considered feasible to cover that gap with inexperienced or cross discipline supervision. However, after further discussion, it was determined that the brief would proceed to capture any learning to prepare the next shift.

The temporary modification brief was started beginning at 0515 on 09/25/11 with duty station manager, electrical superintendent, NRC resident, engineering and work crew present. During the brief the electrical superintendent noted that workers appeared tired and recognized that no supervisor would be present between 0600 and 0800. Based on this information and complexity and risk associated with the task, the electrical superintendent decided to delay the work until the 09/25/11 day shift with the superintendent providing face-to-face turnovers with the day shift Maintenance Superintendent and the Electrical Supervisor.

For development of the breaker removal and inspection work order task instructions, the electrical superintendent and the responsible engineer reviewed with the electrical planner the scope of repair work after the temporary modification was installed. Input included engineering ideas for inspection of the breakers and panel as well as details on work sequencing and warnings.

A prejob brief was conducted with the day shift Electrical maintenance work crew upon arrival of the dayshift supervisor at 0800. Discussion included the critical steps identified for installing the temporary modification as well as additional details on the sequence of work in panel ED-11-2. Two critical steps were clearly outlined in the work order task instructions, both related to the industrial safety aspects of work on 125 VDC during installation of the temporary power. The Plant impact statement identified the potential for the loss of the turbine. During the HPER, crew members indicated that discussions also included avoiding worst case possible events by insulating the bus connectors and sequencing the breaker removal per the instructions in the temporary modification. These details had been discussed during the brief conducted on the previous shift.

The brief used the EN-HU-102, “Human Performance Tools” medium risk prejob brief checklist that had been prepared for that work by the previous Electrical maintenance crew. However, based on the Prejob Brief Decision Flowchart (EN-HU-102, Attachment 9.1), a Detailed Checklist would have been appropriate because the potential turbine impact and work on energized equipment. Although both checklists include the same areas, the detailed checklist provides more detailed coverage of roles and responsibilities, human performance tools and potential risk that would have been appropriate for the planned work.

The temporary modification was successfully installed under WO291209 and EC31973. This activity was completed at approximately 1100 on 09/25/11.

## BREAKER REMOVAL AND REPLACEMENT

Following the installation of EC31973, preparations began for the removal, inspection and restoration of panel ED-11-2 breakers 72-119, 72-120, 72-121, and 72-123. This work was performed under WO291123 for 72-123, WO291194 for 72-119 and 72-120 and WO291210 for 72-121. These work orders indicated

they were based on Maintenance Procedure EPS-E-10, “DC Breaker Removal and Inspection”. This procedure, which had not been revised since 2007, included outdated Nuclear Management Corporation and Plant procedure references. In addition, no critical steps were identified even though the procedure stated there was potential for worker injury and specifically, that shorting ED-11-2 bus bars could result in Plant trip. Also, instructions to insulate energized bus bars and to control breaker bolt nuts were contained in procedure “Notes,” and not in procedure steps. Finally, instructions for restoration of removed breakers were limited to “reinstall breakers in proper position”. At the HPER, crew members stated that they had attempted to obtain detailed panel drawings and had not been able to locate them. The need for this information was supported by the later discovery of cross-threaded bus connector bolts which indicated that the method and sequence of reassembly required more detailed instructions or drawings.

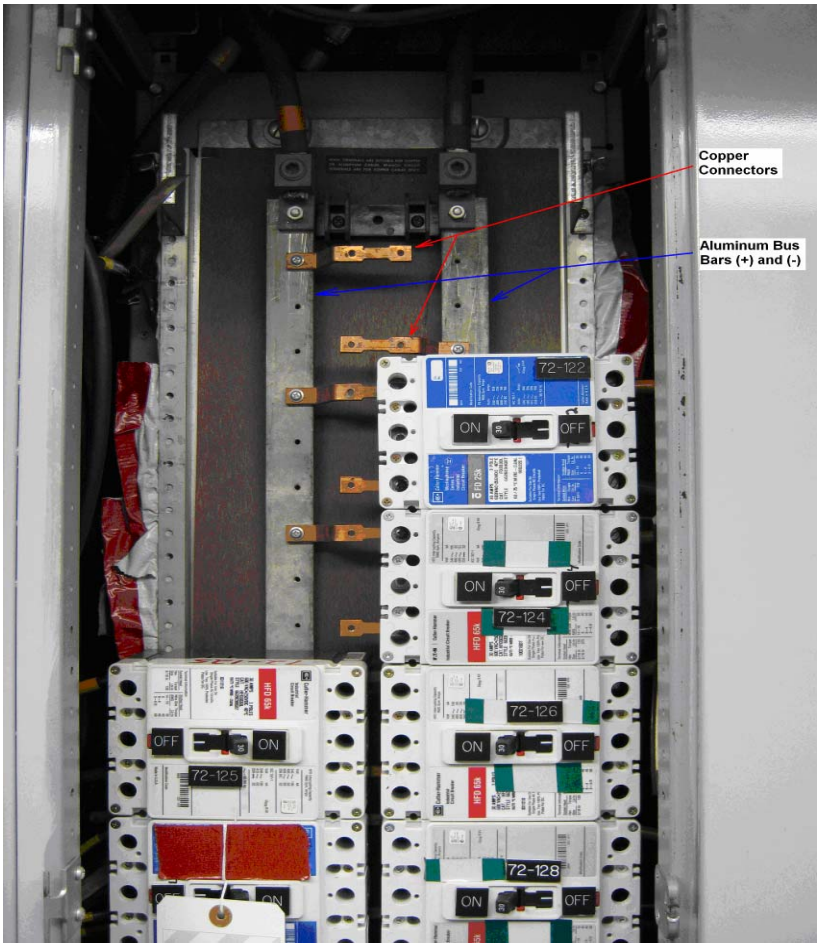
Based on the scope of work to be performed, the EN-HU-102 Prejob Brief Decision Flowchart again indicated a Detailed Brief, at a minimum, should have been performed and documented. However, no qualitative risk assessment had been performed earlier or after the 0800 OCC meeting the previous day. The electrical maintenance crew conducted a prejob brief, although, in this case, no prejob brief checklist was used and the guidance provided by EN-MA-101, “Conduct of Maintenance” and EN-HU-102 was not consulted. CR-PLP-2011-4981 was issued to document this condition.

This prejob brief, which was conducted at 1300 on 09/25/11, was attended by the duty station manager and the shift manager, as well as the NRC resident. Because this work would be performed with panel ED-11-2 still energized, the crew discussed the need for care in the use of Personal Protective Equipment and electrical insulation to prevent personal injury and to make sure the non-captive breaker attachment nuts were positively controlled. No critical steps were assigned. It was determined that insulating plastic sheets would be used to cover the energized bus and connectors. The acting Maintenance Manager, who attended the brief and who was made aware after the fact by the supervisor that no formal prejob brief checklist had been used, gained assurance from the supervisor that necessary points had been covered.

Following the prejob brief, work began on removal of breaker 72-120 under WO291194. As it was removed, a small air gap was noted between the positive bus connector and the line side positive connection on breaker 72-119. An initial attempt was made to tighten this connection and close the air gap. However, the termination screw was found to be cross-threaded which prevented it from being tightened further. All breakers were then removed under their respective work orders.

**BUS CONNECTOR REPAIRS**

Following the removal of all four breakers, evidence of cross-threading damage was also found on the bus connector for 72-120. With concurrence from engineering, maintenance management and electrical maintenance supervision, the crew reached a decision to remove the bus connectors for both breakers 72-119 and 72-120 from the energized bus and to return them to the maintenance shop where the damaged threads could be repaired by retapping. The work could then be performed away from the energized bus and free from the risk of small metal particles falling into the bus or into other breakers. The following picture shows the two bus connectors that were to be removed:

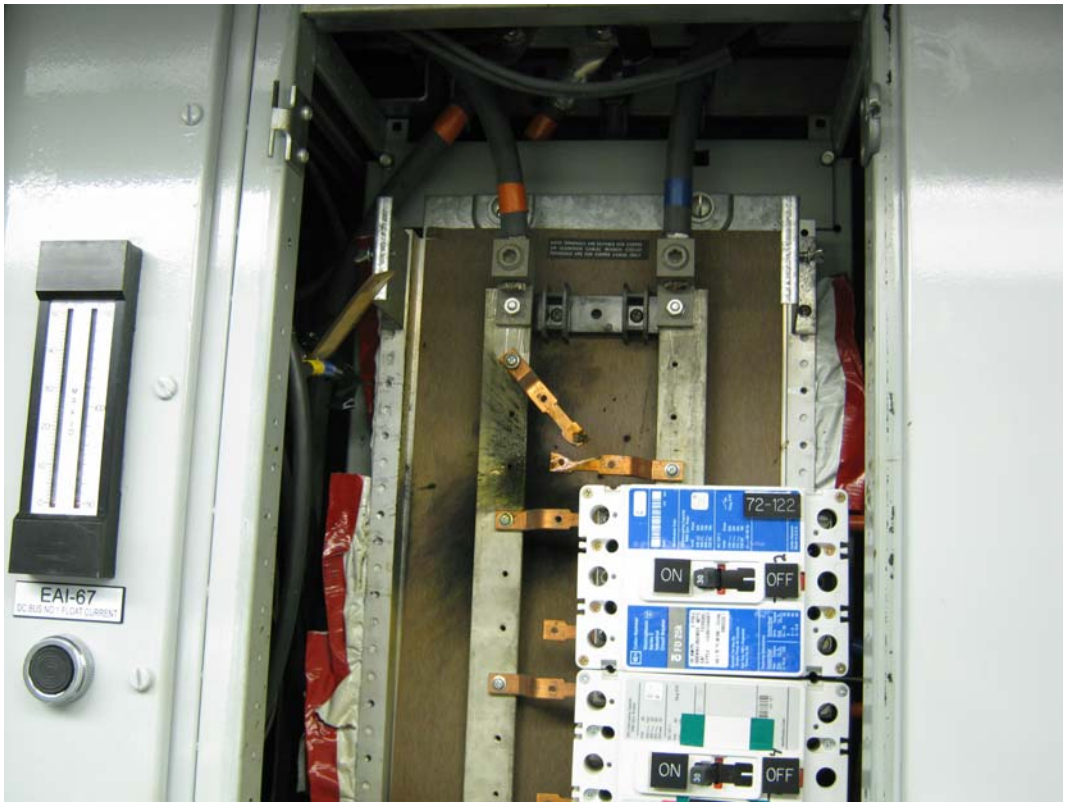



During the HPER, crew members stated this did not constitute an increase in work order scope or a change in its intent because of the general words about "chasing threads and replacing fasteners". Removal of the connectors from the energized bus was considered both within the skills of experienced workers and prudent because it eliminated the potential for loose foreign material from tapping the threads in place. However, those work order instructions emphasized CLEAN and TIGHTEN and did not specifically include the term REMOVE.

The bus connectors were removed starting from the 72-119 connectors at the top. One worker would hold a flashlight while another, using an insulating glove

in one hand to control the position of the connector and to provide insulation, loosened the screw that held it to the bus with the other hand. Although use of insulating material placed over the connectors had been discussed at the prejob brief, crew members decided on their own that insulating gloves would provide better control. The electrical maintenance supervisor, who was not consulted, was close enough to be in a position to observe and question the approach that was taken.

As the connectors were being removed, the worker holding the connector was startled, by an apparent flash or spark, into an involuntary motion that caused him to release the connector. Fortunately, the involuntary motion was such that no electrical shock occurred. The end of the connector, which had by now been loosened at its bus end, was able to swing down and contact the bus connector below it resulting in a short circuit between the positive and negative bus sections. The following picture was taken shortly after the short circuit occurred:

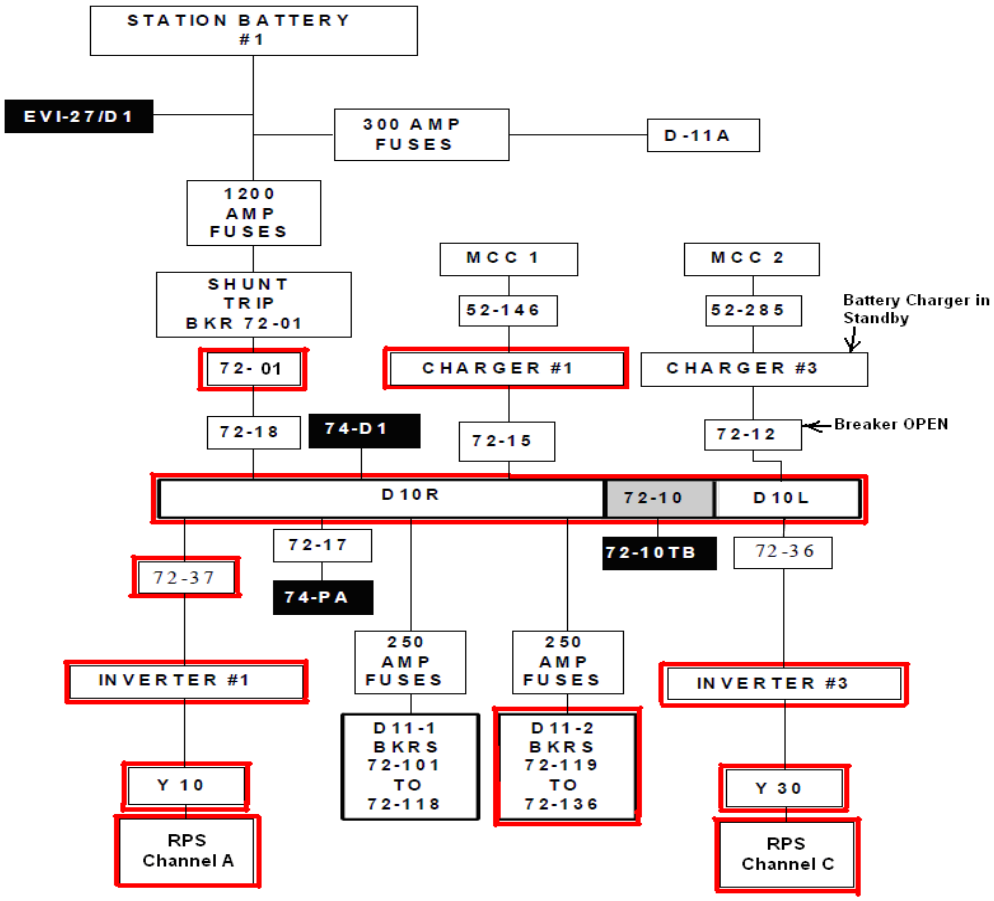



In this situation, both the decision to remove damaged bus connectors from the panel and the decision to use insulating gloves rather than insulating material between the connectors were changes in work scope that should have resulted in a work stop to re-brief.

**PLANT EQUIPMENT RESPONSE**

As a result of this occurrence, the reactor tripped following a loss of power to ED-11-2. The 125 VDC diagram below can be used to visualize the sequence of equipment events leading up to the Plant trip. Items boxed in red factored into the trip.

**125 VDC System Left Train**




Upon completing the short circuit, three events occurred in a short time frame (the actual sequence cannot be determined).

- Breaker 72-37 (Inverter No.1 ED-06 Power Supply Breaker) opened. This was due to internal capacitors on the line side of ED-06 (Inverter No. 1). These capacitors discharged, feeding the fault in ED-11-2 (125 VDC Panel). The discharge resulted in an outrush of current that caused breaker 72-37 to trip open.

- ED-15 (Battery Charger No. 1) supplied fault current and tripped its output breaker 72-15.

- Breaker 72-01 (Isolation Breaker To DC Battery No. 1 ED-1) opened due to internal protective features.

Due to the above protective functions, the connected busses, ED-10R (125 VDC Bus) and ED-10L (125 VDC Bus) were isolated and dead at zero volts DC.

With ED-10R (125 VDC Bus) at zero volts DC, there is no power input to ED-06 (Inverter No. 1) and therefore no 120 VAC output from ED-06. As ED-10L (125 VDC Bus) is at zero volts DC, there is no power input to ED-08 (Inverter No. 3) and therefore no 120 VAC output from ED-08.

Y-10 (Preferred AC Bus EY-10 No. 1 Inverter) receives power from Inverter #1 (Inverter No. 1 ED-06 ) and given no output from Inverter #1, the Y-10 bus drops to zero VAC. Y-30 (Preferred AC EY-30 Bus No. 3 Inverter) receives power from Inverter #3 (Inverter No. 1 ED-08) and given no output from Inverter #3, Y-30 bus drops to zero VAC.

In the cases of the Y-10 and Y-30 busses, output from the Inverters did not automatically transfer to the alternate source due to the design of the system. On all four Station Inverters ED-06, ED-07, ED-08 and ED-09; the alternate source is not normally powered due to system configuration. Power to the alternate source of a Station Inverter comes from Instrument AC at the Y-01 panel and connection to a particular Inverter is controlled via a Kirk Key interlock. Thus, it is not possible to power more than one inverter at a time from the Instrument AC bus.

RPS Channel A (RPS Channel A RPS-AW8 Power Assembly) is a drawer which contains ±15 Vdc power supplies, one for each RPS Trip Unit as well as the 28 Vdc Matrix power supplies. RPS Channel A receives power from Y-10 (Preferred AC Bus EY-10 No. 1 Inverter). As Y-10 output is at zero VACS, there is no input power to the RPS power supplies in RPS Channel A.

RPS Channel C (RPS Channel C RPS-CW8 Power Assembly) is a drawer which contains ±15 Vdc power supplies, one for each RPS Trip Unit as well as the 28 Vdc Matrix power supplies. RPS Channel C receives power from Y-30 (Preferred AC Bus EY-30 No. 3 Inverter). As Y-30 output is at zero VACS, there is no input power to the RPS power supplies in RPS Channel C.

Given the loss of power to two of the four RPS Logic Channels (Channel A and Channel C), a Reactor Trip signal occurred, all four RPS Clutch Power Supplies deenergized, and control rods dropped into the core. Plant systems functioned to shut down the reactor safely and the Right Train of the 125 VDC system

remained operable. A similar Plant response would have occurred if breaker 72-02 had tripped causing a loss of power to RPS Logic Channels B and D.

Revision 1 of the Operability Evaluation for CR-PLP-2011-4835 and CR-PLP-2011-4965 showed that, based on as found testing, the instantaneous trip setting for breaker 72-01 was 3400A against an expected instantaneous trip of FUZ/ D11-2 of 8000A. Its setting was at its minimum value. This provided an explanation for the failure of FUZ/ D11-2 to actuate prior to breaker 72-01 trip. As found testing of breaker 72-02 found it at its maximum setting of 5600A. Based on discussions with system engineering, if breaker 72-01 had stayed closed, FUZ/D-11-2 would have been expected to isolate the fault. CR-PLP-2011-4835 CA-07 has been assigned to analyze the adequacy of breaker 72-01/ panel fuse coordination.

## CORPORATE EVENT RESPONSE TEAM (CERT)

Following the reactor trip, a corporate event response team (CERT) was dispatched to Palisades to independently review the causes and contributors to the event with a special focus on the organizational and programmatic aspects. A CERT report summarized the team's findings.

Portions of the CERT report executive summary that answer why the processes were not followed are provided below. Supporting details as well as other event related conclusions are included CERT report.

Overall, the CERT found that senior leaders have not been sufficiently engaged and intrusive to identify and correct significant behavior and performance gaps at all levels of the organization. Even on those occasions when issues are identified, leaders have not exhibited a bias for action to close those gaps. As a result, plant personnel have a culture of informality that pervades many aspects of the site's performance, including risk assessment, work control, and procedure adherence. This informality was demonstrated in several processes over the course of the events that led up to, and after, the reactor trip. Examples include failure to document a pre-job brief (pre-trip) and the Shift Manager acting outside of their assigned role (post-trip). Managers and supervisors do not have a clear picture of excellence with regard to their roles and responsibilities, and have not been consistently challenged to strictly adhere to fleet or station processes and procedures.

The following findings are considered to be the most significant:

Intrusiveness and Engagement – Senior leaders were not sufficiently intrusive into plant activities, did not understand the work scope and potential plant impact, and, therefore, did not ensure an appropriate organizational response. For example, following the initial transient on the D-11-2 bus resulting in loss of instrument air compressors, leaders did not assemble appropriate managers to

review the scope and risk of the planned activities, challenge the proposed course of action, and arrange adequate oversight for the work activities.

Risk Recognition and Management – Senior leaders have not established a culture in which station personnel are sufficiently sensitive to risk recognition and management. Both individual and organizational behaviors exhibited during the events leading to the reactor trip underscore this insensitivity. Managers, supervisors, and workers consistently indicated that work on energized DC circuits was “not a big deal” and stated that such work is performed frequently. Personnel involved in development of the plan to address the issues in D-11-2 made the decision to perform the work on a live bus and were comfortable relying on fuses to protect against cascading faults. Additionally, workers made a decision that it was not necessary to insulate the live bus bar extensions because it was “only” 125 VDC and because, if anything happened, the fuse would blow. Engineers and operators agreed to temporarily power the generator automatic voltage regulator from the same panel that contained the fault they were trying to correct even though they were not sure of the nature or extent of the fault.

Commitment to Process Implementation – Senior leaders have not adequately reinforced a commitment to implementation of fleet and station processes and procedures, and are not effectively leveraging those tools to establish the framework required to ensure safe and reliable plant operations. The team identified several fleet and station processes that have not been properly implemented at Palisades. These include:

- Leadership and Alignment (L&A) Meetings
- Leadership Effectiveness Logbook
- MELT identification
- Critical evolution process (EN-FAP-WM-102)
- Focused crew assessment
- Online Risk Assessment (EN-WM-104)

Weaknesses in the implementation of these, and other, processes contributed to the event and leave the station vulnerable to future events and\or plant transients.

**Nuclear Safety Culture Monitoring Panel**

Subsequent to the Reactor Trip on 9/25/11, The Nuclear Safety Culture Monitoring Panel convened on 11/3/11. As a result of the discussion surrounding the 9/25/11 Reactor Trip and the subsequent analysis conducted by the RCE team, the NSCMP members unanimously recommended that a 3rd party Nuclear Safety Culture Assessment take place at Palisades. The independent evaluation was determined to be necessary based on feedback from previous assessments indicating employee perceptions that no action would be taken based on self-assessment and that fleet procedures and policies are part of the problem.

# Root Cause Analysis

## METHODOLOGY

Following the initial interviews of workers involved during the Human Performance Error Review process and a review of relevant procedures, an Event Timeline (Attachment 1) was developed. Attachment 1 was based on the timeline provided to the Corporate Event Response Team during the week following the event. The evaluation team employed a Failure Mode Analysis (Attachment 2) to identify significant factors that lead to the trip which is also shown graphically in Attachment 3 – Failure Mode Chart. A Barrier Analysis (Attachment 4) and a Change Analysis (Attachment 5) were used to identify and classify the actual causes. A "Why Staircase" was developed for Revision 1 of this report in order to help clarify the decision sequence leading up to the Reactor Trip. The "Why Staircase" is presented in Attachment 9. The analysis process identified the following causes:

### Root Cause 1

Senior leaders have not established a sufficiently sensitive culture of risk recognition and management, which resulted in the plant's managers, supervisors and workers not recognizing, accounting for, or preparing for the industrial safety risk and plant operational nuclear risk, involved with the panel ED-11-2 breaker inspection and replacement maintenance.

*Supporting Information:*

During the evaluation and during HPER1 interviews conducted immediately following the event, numerous examples demonstrated that managers, supervisors and workers do not adhere to risk control processes. Interviews and review by the CERT following the event brought evidence of senior leadership involvement in the root cause. The site culture has been acceptance of behaviors that resulted in failure to take any of the steps which could have prevented the event during the 09/25/11 breaker removal and inspection work on panel ED-11-2:

- Senior leaders have not been sufficiently engaged and intrusive to identify and correct significant behavior and performance gaps at all levels of the organization. As a result, plant personnel have a culture of informality that pervades many aspects of the site's performance, including risk assessment, work control, and procedure adherence. This informality was demonstrated in several processes over the course of the events that led up to, and that followed, the reactor trip. Managers and supervisors do not have a clear picture of excellence with regard to their roles and

responsibilities, and have not been consistently challenged to strictly adhere to fleet or station processes and procedures.

- The Maintenance crew accepted their work order plan even though they had raised questions about the availability of panel drawings which could not be found and although the Operations plant impact review indicated there was a risk for Plant trip.

- Breaker replacement work orders were not flagged as compliance work orders although Attachment 9.5 to EN-WM-105, “Planning” includes risk of transient and reliance on skill of the craft as compliance work order criteria.

- The Maintenance crew assigned no critical steps although work involved maintenance on high critical equipment for which spurious control room signals had been received. This was regardless of the fact that a temporary modification was installed to provide that power from breaker 72-127 in panel ED-11-2.

- The EOOS risk assessments that was performed by plant Operations staff, was based on breaker removal, did not include loss of ED-11-2, and no qualitative assessments were documented to capture the more subjective concerns of weekend work or work on energized equipment. Although there were clear notations that breaker removal could affect ED-11-2, this work was not identified as a high risk activity requiring GMPO approval as described by EN-WM-104. Opportunities for this to happen occurred when breaker 72-123 was replaced Friday night, during the 0800 OCC meeting on Saturday morning, prior to temporary modification Sunday morning and before breaker replacement on Sunday morning.

- So that a planned surveillance on the containment escape hatch could be completed the following week, the original breaker replacement work was performed on an alternate Friday off with fewer resources on site. When difficulties were encountered, additional work was required over the weekend when resources were limited.

- No formal documented prejob brief was performed for the breaker replacement work using the checklists identified by EN-HU-102 even though the work involved safety related equipment that required troubleshooting and work would be performed on energized equipment. Although EN-IS-123 was consulted to identify PPE requirements, neither EN-MA-101 nor EN-HU-102 was consulted for prejob brief guidance.

- After cross-threaded breaker connectors were discovered, the decision to remove them from the panel was made by the crew although the work order plan did not include the term REMOVE. The Lead Electrician

confirmed that no additional OE had been considered with respect to the bus stab removal. OE had been covered at the morning brief, but did not include OE relevant to the disassembly of portions of the bus.

- Workers were initially briefed on a plan to use insulating plastic sheets to prevent injury and short circuits. The plan was changed to the use of insulating gloves without stopping to rebrief.

- Regardless of supervisor and manager training based on SOER 10-2, none of those present at the prejob brief, including the Duty Station Manager and the Shift Manager, or at the work site, identified or corrected lapses in the conduct of the prejob brief, the lack of critical steps or the failure to stop and rebrief when the job plan changed.

- Management personnel, including the Electrical Superintendent and the Duty Station Manager, exceeded established work hours potentially reducing their effectiveness for oversight and direction. (CR-PLP-2011-5095)

- Beginning with the initial plans to replace breaker 72-123 on an off Friday, senior site leadership were not sufficiently intrusive into work on panel ED-11-2, did not sufficiently challenge planned courses of action and did not provide adequate oversight.

- There were indications that the acting senior leadership team was reluctant to take decisive, timely action to address problems.

- May 2011 mid-cycle assessment identified, in AFI OR.2-1, that weakness in alignment of the management team by senior leaders has resulted in failure to sustain a culture of continuous improvement.

**Contributing Cause 1**

Breaker and fuse coordination for the 125 VDC system left train was insufficient to prevent a reactor trip under the short circuit conditions experienced during ED-11-2 maintenance on 09/25/11.

*Supporting Information:*

Breaker 72-01, “Isolation Breaker To DC Battery ED-1”, is a shunt breaker that is used in conjunction with a trip switch to isolate the balance of the left channel DC circuit from panel ED-11A for a fire in the cable spreading room. The shunt breaker will actuate if it sees a fault current. It will also operate if it receives a remote signal to operate. Plant documentation has recognized that the breaker operates from a remote signal. This remote signal comes from the trip switch.

Plant documentation has not recognized that, because of its configuration, breaker 72-01 will also actuate magnetically.

Breaker 72-01, and its right train counterpart 72-02, Isolation breaker to DC Battery ED-2", were installed in 1981 under FC-407-14C. The design specification included with the modification called for breakers equipped with a shunt trip and auxiliary switch to prevent battery drain from ground faults in the DC system due to fires in the cable spreading room. The design specification did not call for a breaker with magnetic trip or auto-trip feature. While this was in agreement with FSAR 8.3.5.2 which describes the two breakers as non-automatic and not intended to interrupt fault currents, it did not specifically state that the auto trip feature should not be provided which would have been more correct and which would have prevented the mistake in ordering the breakers.

The modification package also included procurement and receipt inspection documents. When breakers 72-01 and 72-02 were ordered from the supplier, Gould-ITE under PO 5248 (dated 12-28-79), the items specified were Class 1E/ Seismic Class 1 circuit breakers similar to Gould-ITE Catalog KM3B-800 which were to be shipped with KM2RD shunt trips and KM0LO auxiliary switches. It was not recognized at the time that the breakers ordered this way included the auto-trip feature.

Because no bill of lading or certificates of compliance were received when the two shunt trip breakers arrived, receipt inspectors performed a detailed physical inspection on 10/21/80. Disassembly of one breaker determined that, based on the supplier catalog, the KM3T800 trip assembly and the KM3F800 frame were, as ordered, a type KM3B800 breaker. Current Maintenance personnel explained that although workers experienced with circuit breakers would have recognized by the adjustable settings that the breakers received included an automatic trip feature, the receipt inspectors would not have realized that unneeded features had been provided.

Given the loss of power to two of the four RPS Logic Channels (Channel A and Channel C), a Reactor Trip signal occurred, all four RPS Clutch Power Supplies deenergized, and control rods dropped into the core. Plant systems functioned to shut down the reactor safely and the Right Train of the 125 VDC system remained operable.

This condition was resolved temporarily after the event by changing the magnetic trip setting of breaker 72-01 (and breaker 72-02) to its maximum value – approximately 5600 amperes. This was accomplished via a temporary modification under EC32028 which will remain in force until a permanent method of resolving the design discrepancy is implemented.

**Contributing Cause 2**

Work orders used for removal and inspection of breakers 72-119, 72-120, 72-121 and 72-123 did not include details appropriate for maintenance on energized, high critical electrical equipment with the Plant on line.

*Supporting Information:*

The work order plans used in this case were based on Maintenance Procedure EPS-E-10 which was identified as having the weaknesses listed below. Work on this equipment during 1R21 was performed using this procedure directly which the evidence suggests were the cause of the deficiencies being repaired:

- No critical steps were identified even though the procedure stated there was potential for worker injury and Plant trip

- Instructions to insulate energized bus bars and to control breaker mounting bolt nuts were contained in Notes.

- The discovery of cross-threaded bus connectors indicates the method and sequence of reassembly require more detailed instructions and/ or drawings to prevent damage in the future (refer to pgs 2 & 3 above)

- An examination of the two removed connectors found that the threads had been partially stripped by over-torquing the bolts in the relatively softer metal of the connectors.

- The method for insulating and removing damaged bus connectors for repair was left up to the discretion of the work crew.

- The conditions surrounding work in these panels, such as the close proximity of the opposite phase bus connectors and the non-captive breaker bolt nuts, coupled with the fact that the work in the panels is not performed regularly, increased the chance of error and prompted an unsuccessful attempt by the crew to find detailed drawings.

- Work order plans were based on EPS-E-10 which had not been revised since 2007. This document contained outdated references to NMC and Plant documents and, as a model for work being performed, included no critical steps.

- Although it had been in use since 2007, the outdated status of EPS-E-10 had not been recognized by workers and identified for update. No DRNs were found to be active.

In this situation, the quality of the work instructions was affected by the use of an outdated procedure for emergent work. For the future, this should be corrected by the use of approved procedures for all work on these busses. Corrective action is assigned to update EPS-E-10.

**Contributing Cause 3**

Oversight by managers and supervisors did not result in identification and correction of the human performance errors and weaknesses in the work involving the inspection and replacement of breakers in the ED-11-2 panel.

*Supporting Information:*

Although management observers and maintenance supervisors were present at both the breaker replacement prejob brief and during the work itself, the following conditions, which existed or took place, could have been identified but were not corrected:

- No critical steps were identified during planning and the prejob brief even though there were Plant operational and industrial safety considerations
- The prejob brief was not conducted as a high risk or IPTE brief per EN-HU-102 (Human Performance tools) and the procedure was not used as a reference.
- The prejob brief was not documented on any of the checklists provided in EN-HU-102. Following the brief, the decision not to use the checklist was made known to and discussed with the acting Maintenance manager who was present for the brief.
- The supervisor did not challenge the decision to change the insulation method to be used during breaker removal.
- Managers and supervisors present did not challenge the decision to remove bus connectors from the panel for repair without re-brief or work plan revision

**Contributing Cause 4**

Managers, supervisors and workers did not consistently follow approved procedures for job preparation, job execution and risk management.

*Supporting Information:*

- The Maintenance crew accepted their work order plan even though they had raised questions about the availability of panel drawings which could not be found and although the Operations plant impact review conflicted with work plan precautions which indicated there was a risk for plant trip. Workers continued in the face of uncertainty contra to EN-MA-101.

- No critical steps were identified during planning and the prejob brief even though there were plant operational and industrial safety considerations per EN-HU-105.

- The prejob brief was not documented on any of the checklists provided in EN-HU-102 and was not conducted as a high risk or IPTE brief per EN-HU-102 (Human Performance tools). The procedure was not used as a reference.

- Work order plans to repair breaker bus connectors on the bus were changed and briefed plans to use insulating plastic sheets were changed to use insulating gloves. These changes were made without proper controls per EN-MA-101.

- Assessments of plant risk were limited to EOOS calculations of nuclear safety risk for removal of breakers. No qualitative assessments of risk as described in EN-WM-104 were performed to consider the more subjective aspects of schedule, personnel safety or the effects on other equipment.

- Management personnel, including the Electrical Superintendent and the Duty Station Manager, exceeded EN-OM-123 established work hours potentially reducing their effectiveness for oversight and direction.

## Organizational and Programmatic Weakness Evaluation

An evaluation for organizational and programmatic weaknesses was performed to understand the relationship between the identified causes and to identify any Latent Organization Weaknesses (LOW) that influenced this condition. The root and contributing causes were screened against the five categories of O&P issues defined in EN-LI-118, “Root Cause Evaluation Process”, Attachment 9.5.

### ORGANIZATION TO ORGANIZATION INTERFACE WEAKNESSES

No weaknesses identified

## ORGANIZATION TO PROGRAM INTERFACE WEAKNESSES

**OP2A - Lack of Commitment to Program Implementation:** Examples of procedure noncompliance involved managers, supervisors and workers and included changes to established work plans.
(Supports Root Cause 1/ Contributing Cause 4; CA27)

**OP2B - Inadequate Program Monitoring or Management Skills:** Based on overall results of the evaluation including internal plant operating experience. This condition, which is described in the Safety Culture Evaluation (decision-making work control, and work practices), involves leadership performance and organizational effectiveness, and is considered to be a Latent Organizational Weakness. (Root Cause 1; CA49, 50, & 51)

**OP2D - Lack of Program Implementing Authority :** Managers, supervisors and workers in all parts of the plant organization did not employ established risk management processes or prepare for the industrial safety and plant operational risk involved with the panel ED-11-2 breaker maintenance. (Root Cause 1; CA28, 30, & 32)

## PROGRAM TO PROGRAM INTERFACE WEAKNESSES

No weaknesses identified

## PROGRAMMATIC DEFICIENCIES

**OP4A - Insufficient Procedure Details:** Work orders used for removal and inspection of breakers 72-119, 72-120, 72-121 and 72-123 did not include details appropriate for maintenance on energized, high critical electrical equipment with the plant on line and they were based on a procedure that was out of date. (Contributing Cause 2; CA33, 34, 35)

**OP4M - Inadequate Design Change Documentation:** Breaker and fuse coordination for the left train 125 VDC system did not prevent the 09/25/11 reactor trip (Contributing Cause 1; CR-PLP-2011-4835, CA07)

## ORGANIZATIONAL DEFICIENCIES

**OP5A - Inadequate Function or Structure:** The Maintenance crew accepted their work order plan even though they had raised questions about the availability of panel drawings which could not be found. There were no changes to the plan because of this and no critical steps were assigned. (Supports Root Cause 1; CA30, 31, 33, & 34)

**OP5AD- Inadequate Evaluation of Risk and Consequences:** At four different points, opportunities to perform qualitative risk assessments were not performed (Supports Root Cause 1; CA30)

**OP5AD- Inadequate Evaluation of Risk and Consequences:** Workers initial plans to repair bus connectors on the bus and to use insulating plastic sheets were revised without rebrief (Supports Root Cause 1; CA-27)

**OP5AE- Insufficient Awareness of Impact on Safety and Reliability:** Regardless of supervisor and manager training based on SOER 10-2, none of those present at the prejob brief or at the work site, identified or corrected lapses in the conduct of the prejob brief, the lack of critical steps or the failure to stop and reconsider when the job plan changed. (Root Cause 1; CA27, 30, 31, & 32)

**OP5C - Inadequate Work Prioritization Process:** No formal documented prejob brief was performed for the breaker replacement work using the checklists identified by EN-HU-102 even though the work involved safety related equipment that required troubleshooting and work on energized equipment. Although EN-IS-123 was consulted to identify PPE requirements, neither EN-MA-101 nor EN-HU-102 was used by the crew. (Root Cause 1 and Contributing Cause 4; CA-25)

**OP5C - Inadequate Work Prioritization Process:** Management personnel, including the Electrical Superintendent and the Duty Station Manager, exceeded established work hours potentially reducing their effectiveness for oversight and direction. (Root Cause 1; CA26)

**OP5D - Inadequate Communication within the Organization:** Although it had been used more than once, including 1R21, workers had not questioned the 2007 revision status of Maintenance Procedure EPS-E-10 and no outstanding DRNs were found. (Contributing Cause 2; CA33, 34, 35, 36, & 37)

**OP5Q - Lack of Supervisory Monitoring:** Oversight by managers and supervisors did not result in identification and correction of the errors and weakness that lead to this event. (Contributing Cause 3; CA49, & 50 )

**OP5T - Inappropriate Schedule Emphasis:** The original breaker replacement work was performed over a weekend, when limited resources were available, so that a scheduled surveillance on the containment escape hatch could be completed as scheduled the following week. (Root Cause 1; CA28, & 30)

Summary

A collective review of the Organizational and Programmatic Weaknesses did not identify any additional gaps that need to be evaluated under this root cause evaluation. Organizational Deficiencies were the primary drivers identified during this review and substantiate the root cause as determined in this evaluation.

## Safety Culture Evaluation

The Safety Culture Evaluation reviewed the Root and Contributing Causes against the thirteen Safety Culture impact areas described in EN-LI-118 Attachment 9.6. The purpose of this review was determine whether the identified causes reflected in a negative way on the sensitivity and priority of plant personnel with respect to nuclear safety. After reviewing each cause statement against the descriptive information in Tables 1 and 2 of EN-LI-118 Attachment 9.6, there was evidence of gaps in the fleet expected nuclear safety culture as follows:

Decision-Making:

1. Following the departure of the last site vice president in November 2010, the GMPO was elevated to the position of acting site vice president. The NSA director was made the acting GMPO, and the licensing manager was made the acting NSA director. There are indications that this team was reluctant to take decisive, timely action to address problems. The May 2011 mid-cycle assessment identified, in AFI OR.2-1, that weakness in alignment of the management team by senior leaders has resulted in failure to sustain a culture of continuous improvement.

2. Senior leaders do not consistently exhibit a bias for action when addressing organizational issues. For example, senior leaders had seen indications of weakness in managers' support of the duty team during the forced outage earlier in the month, but they did not take action to ensure that the necessary levels of support were provided over the weekend of the event. Entergy does not have a formalized process for duty team activation, therefore activation is not rigorous and was not effectively implemented. During interviews, it was determined that the site duty manager remained on site for more than 24 hours before being relieved.

3. The site vice president and directors did not understand the scope and risk of the maintenance activities that were being conducted on the D-11-2 bus. When questioned, both the site vice president and the GMPO stated that they did not believe that it was necessary for them to be made aware when planned work was occurring in an energized DC bus. The site vice president did, however, state that he should be informed of any unplanned work in energized DC buses and that the GMPO should be aware of both planned and unplanned work in DC buses.

4. Personnel involved in the decision to perform the work believed that the worst consequence of a problem during the job was a loss of the D-11-2 bus and exhibited relative ease accepting the potential for the extensive consequences of

such an event. Additionally, the individuals involved were comfortable relying on a fuse to prevent cascading of a fault.

5. Decision-making reflects a lack of understanding of proper risk assessment and management. For example, the decision to remove the bus bar extensions (the activity that caused the trip) was made in the field by the work crew and the site duty manager without written direction and without the knowledge of operations personnel. Also, the decision not to insulate the bus bar extensions was made by the electricians without consultation with others even though during their prejob discussion of the work they had informally talked about installing the insulation. Both the shift manager and the electrical supervisor assumed that the insulation would be used, but because of the informality of the discussion and the vagueness of the work order guidance (installation of insulation was in a note rather than as a step), the crew felt that they did not need to insulate.

Resources:

1. Work was suspended on the "Alpha" shift on 9/24/11 due to worker fatigue. There was a two hour overlap between the "Alpha" shift Electrical Supervisor leaving the site and the "Bravo" shift Electrical Supervisor coming on shift. This necessitated a face-to-face turn over with the Electrical Superintendent who was himself in violation of fatigue rule standards.

Work Control:

1. The plant impact statements for the work orders used over the weekend stated that the work carried low risk. This was not challenged by operations personnel. The EOOS risk process was not used consistently to evaluate the impact of work. For example, EOOS risk profile was evaluated for troubleshooting of the D-11-2, but not for later work involving removal of several breakers. An EOOS risk profile was not obtained for loss of this panel. As such, the potential risk of this activity was never fully assessed.

2. The electrical supervisor allowed work to proceed with a work order that did not meet fleet standards.

Work Practices:

1. The supervisor and crew rationalized that a “thorough discussion” was an acceptable substitute for a formal prejob briefing. The station duty manager and the shift manager participated in the discussion but did not recognize or correct this gap.

2. Several members of the management team stated that the work on the bus was being performed by “master electricians” who should not need a lot of oversight.

3. In several cases, personnel proceeded in the face of uncertainty rather than stop and obtain definitive resolution. For example, no prints documenting the layout of the bus work behind the breakers were available and the electricians

who were performing the work were not familiar with the panel design and layout; however, no requirements to stop and re-evaluate after the first breaker was removed were included in the work order nor were other electricians who had experience in the bus consulted.

The station has failed to make substantive improvements in plant operation in response to SOER 10-2. In this situation, weaknesses in supervisor oversight and risk recognition were significant factors. None of those present at the prejob brief or at the work site identified or corrected lapses in the conduct of the prejob brief, the lack of critical steps or the failure to stop and reconsider when the job plan changed. In addition, as noted by the Extent of Cause examples, plant personnel have continued to allow long-standing performance and organizational problems to exist.

As discussed in the Organization and Programmatic Weakness Evaluation section of this report, long-standing performance and organizational problems are considered to be a Latent Organization Weakness which is the Extent of Cause for Root Cause 1. Corrective actions have been assigned to address this condition. Safety Culture Evaluation Tables 1 and 2 are Attachment 6 to this evaluation report.

## Generic Implications - Extent of Condition/Extent of Cause

### EXTENT OF CONDITION

*Root Cause 1*

The information obtained during the evaluation and the examples used to support this cause found that all organizations involved did not follow risk management processes. Site leadership at all levels was not sufficiently intrusive into work on panel ED-11-2, did not sufficiently challenge planned courses of action and did not provide adequate oversight.

The use of the qualitative risk assessments as described in EN-WM-104 would have provided more accurate insights into the plant risks of the work being performed. Based on discussion with Maintenance and PS&O personnel, the use of this approach was rolled out in August 2011 with limited attempts to coordinate the change or make sure there was an understanding of how to use it.

Choices made for prejob brief level reflected a Maintenance knowledge gap in the use of the Prejob Brief Decision Flowchart, EN-HU-102 Attachment 9.1.

Although supervisors and above have been part of continuing training in SOER 10-2, “Thinking and Engaged Workforce”, these efforts have not resulted in close attention to the details of the work being performed and the conditions surrounding it.

This incident identified weaknesses in human performance management defenses such as critical steps and the use of quality prejob briefs identified in EN-HU-105. Work being performed in the ED-11-2 panel met virtually all of the guidelines for an IPTE brief as described in EN-OP-116 Attachment 9.2 including work not covered by existing procedures, infrequently performed work and work on critical DC power equipment.

*Contributing Cause 1*

The conditions identified for breaker 72-01, which include a deviation from its FSAR description, also apply to breaker 72-02. These conditions are addressed through breaker modification and PM corrective actions related to Contributing Cause 1.

CR-PLP-2011-4958 documented a "failure to close reliably" condition for breaker 72-02. This condition should also be suspected to affect breaker 72-01 because although the trip function of these two breakers is tested periodically, the cause of the failures to close is unknown. The CR-PLP-2011-4958 operability review states that "the breaker would trip free when trying to close the breaker. Several attempts were required to close the breaker, however the breaker was successfully closed and remains closed. This satisfies the purpose of the breaker. Station battery ED-01 remains operable and right train DC power distribution subsystems remain operable. Therefore, no Degraded or Non-conforming condition exists per EN-OP-104, Revision 5, Attachment 1, Table 9.1." These conditions will also be addressed through corrective actions related to Contributing Cause 1.

In addition, the Inverter 1 and Charger 1 breaker trips could suggest that there is need for revised breaker or fuse coordination effort. Although the Operability Determination for CR-PLP-2011-4835 indicated that loss of one DC train was acceptable from a plant shutdown and nuclear safety standpoint, in this case, the loss of one train resulted in a reactor trip. Corrective actions to address Contributing Cause 1 may affect and need to address coordination issues involving other components for both breakers 72-01 and 72-02. Actions are assigned under CR-PLP-2011-4835.

*Contributing Cause 2*

Because the work order plans used for the breaker removal and inspection were based on Maintenance Procedure EPS-E-10, the weaknesses identified for the work plans should also be corrected in the procedure. Corrective actions are assigned to revise that procedure for all DC panel work.

A review of Maintenance Emergency Power System procedures found that, even though these procedures have been in use, six of the twelve current procedures

have not been revised since 2007 when the plant was part of NMC. With respect to this situation, the more current DC breaker procedure EPS-E-12 includes requirements for breaker bolt torquing and the use the EN-IS-125 electrical safety checklist. Corrective actions have been assigned to review and revise these procedures.

Currently, more than 400 change requests exist for the Permanent Maintenance procedures. Based on the number of severely outdated EPS system procedures, the status of Maintenance procedures for other systems could also be at risk. This has been affected by the willingness of Maintenance workers, as in this case, to continue to use inadequate work instructions. Corrective actions are assigned to identify and correct these procedures and to establish a method for regular update review.

With respect to the quality of plant procedures in general, corrective actions from the root cause evaluation of CR-PLP-2011-1522 will address the extent of procedure quality and change backlog issues.

*Contributing Cause 3*

EN-HU-102 contains thirty pages of manager and supervisor human performance tools that, if properly applied, could possible have prevented this incident. However, the likelihood of successfully deploying thirty pages of checklist items for a prejob brief or work observation would be limited unless some form of advance planning to decide which elements were applicable.

The root cause evaluation of CR-PLP-2011-4522, “Cross-Cutting Issue in Management Oversight” has been completed to address the history of plant weakness, as seen by the NRC, in this area. The corrective action plan includes three actions which include reinforcement of expectations and performance-based training designed to prevent recurrence. These actions address the concerns identified by this evaluation. No additional actions are recommended.

*Contributing Cause 4*

Most recently, the plant assigned CR-PLP-2011-2397 to evaluate a potential emerging trend in NRC violations with a cross cutting aspect in procedure compliance (H4b). Corrective actions from the evaluation focused heavily on placekeeping. Because of the current event, action is assigned to reevaluate this decision.

**EXTENT OF CAUSE**

*Root Cause 1*

Conditions identified during the evaluation of this event indicated that managers, supervisors and workers had not embraced established methods for risk identification and management. Beyond this concern, recent plant operating experience shows a pattern which suggests that senior management has not established a culture sensitive to risk recognition and management and has not concentrated their attention on ensuring that standards and procedures are being followed in all aspects of plant operation:

- A review of the plant Licensing "Cross-Cutting Issues Analysis and Trending" summary for the current quarter found eight condition reports listed in the Management Oversight (H4C) category since the beginning of 2011. This issue is currently the subject of root cause evaluation under CR-PLP-2011-4522 which determined that supervisors and managers were too closely focused on work practice rather than oversight. This category was identified through the Safety Culture Evaluation for this report.

- The Licensing summary also lists six recent condition reports in the Procedural Compliance (H4B) category. The HT apparent cause evaluation of CR-PLP-2011-2397 determined that the failure to use and adhere to procedures is caused by failure to adequately utilize Human Performance Tools of EN-HU-102 - Human Performance Tools. This category was also identified through the Safety Culture Evaluation and supports contributing Cause 4.

- The root cause evaluation of CR-PLP-2011-0903 determined that inadequate oversight which was a contributing cause of weaknesses and delays in the execution of the Maintenance Initial Training Program.

- The root cause evaluation of CR-PLP-2011-2443 resulted because of long-standing failures on the part of Maintenance and Engineering personnel to ensure workers were meeting procedure requirements for control of nonconforming parts per EN-LI-102.

- The HT apparent cause evaluation of CR-PLP-2011-1108 found that plant personnel at all levels did not work together to plan and carry out an efficient diesel generator outage and that this was made worse by weak Maintenance oversight and poor decision making on the part of responsible managers.

- The plant INPO Mid-cycle assessment found that the site leadership team and other managers were not providing the necessary leadership to sustain continuous improvement. The HT apparent cause evaluation of CR-PLP-2011-2831 found a focus on department rather than station goals resulting in, among other things, a lack of progress in resolving issues identified during the 2010 WANO assessment.

### CONDITION REPORTS CLOSED TO THIS EVALUATION

The following condition reports were closed to this evaluation. Where noted below, corrective actions have been identified under CR-PLP-2011-4822 to address the conditions identified by them:

*CR-PLP-2011-4779 (09/22/11)*

Documented defective breaker 72-123 during 09/22/11 troubleshooting under WO248834. This breaker was replaced under WO291123 prior to the discovery of breaker connection problems in 125 VDC panel ED-11-2. It was later replaced under WO291123 following the reactor trip on 09/25/11. No additional actions are required.

*CR-PLP-2011-4801 (09/23/11)*

Documented control room alarms and loss of Instrument Air following the initial replacement of breaker 72-123. The 09/25/11 reactor trip occurred during repairs to correct these problems which were finally resolved following the reactor trip under WO291123 and others.

When this condition report was closed to CR-PLP-2011-4822, corrective actions for a Maintenance Rule evaluation and an Equipment Failure Evaluation were transferred. These are included in the corrective action plan for CR-PLP-2011-4822 as CA-04 and CA-03, respectively.

*CR-PLP-2011-4981 (09/30/11)*

Documents the failure to use a prejob brief form per EN-HU-102 and EN-MA-101 prior to the start of breaker replacement work on 09/25/11. This issue supports Root Cause 1 and Contributing Causes 3 and 4 of this evaluation and is discussed in the Narrative. Corrective actions will be assigned from this evaluation.

## Previous Occurrence Evaluation

### INTERNAL OPERATING EXPERIENCE

#### Plant Condition Reports

Using a 15-year PCRS search for DC system breaker and fuse issues, the following condition reports were considered relevant to this evaluation. Additional more recent searches for “INPO”, “AFI” and “Risk” identified additional

examples which supported the issues identified by root cause 1 and the latent Organizational Weakness:

*CPAL-97-1493 (10/17/97)*

Panel EC-15 deenergized during maintenance on CRDM-38 contactors resulting in loss of manual control for all control rods. Root cause evaluation corrective actions included increasing administrative controls over emergent work, establishing and reinforcing fundamental standards for procedure use and adherence, prejob preparation and briefs, control of work scope, and incident response.

*CR-PLP-2006-5388 (11/13/06)*

Negative trend in actual risk profile higher than predicted. Common cause evaluation found no trend.

*CR-PLP-2008-2890 (02/24/08)*

Common cause evaluation identified trend in maintenance work continued with active safety risk precursors was due to newness and quantity of Entergy safety procedures. Actions were taken to improve procedure visibility during transition period.

*CR-PLP-2009-0917 (03/04/09)*

NRC cross-cutting issue in human performance - design, procedures and labeling . Root cause evaluation lead to development of a procedures improvement team and changes in handling of DRNs.

*CR-PLP-2009-3730 (07/29/09)*

NRC cross-cutting trend in Work Planning (H3a). Apparent cause evaluation identified and assigned actions to improve familiarity with change management processes.

*CR-PLP-2010-3434 (08/16/10)*

Non-cited violation for failure to assess and manage risk in maintenance activities. Apparent cause evaluation found and assigned action to correct weaknesses in administrative procedures for operations risk assessment.

*CR-PLP-2010-6035 (11/09/10)*

NRC green finding in Human Performance - Resources due to examples of procedure compliance involving procedure use and adherence. Common cause

analysis found reasons were that procedure users, writers and reviewers were not recognizing and correcting procedure problems. Actions focused on training of procedure writers and reviewers.

*CR-PLP-2011-0903 (02/24/11)*

Its root cause evaluation determined that inadequate oversight which was a contributing cause of significant and continuing problems with the Maintenance Initial Training Program.

*CR-PLP-2011-1108 (03/07/11)*

Weak Maintenance oversight, poor decision making on the part of responsible managers and the failure of plant personnel at all levels to work together resulted in an inefficient diesel generator outage.

*CR-PLP-2011-2443 (05/12/11)*

QA identified condition. Evaluation identified failures on the part of Maintenance and Engineering personnel to ensure workers were meeting procedure requirements for control of nonconforming parts per EN-LI-102.

*CR-PLP-2011-2397(05/12/11)*

The evaluation determined that the failure to use and adhere to procedures is caused by failure to adequately utilize Human Performance Tools of EN-HU-102 - Human Performance Tools.

*CR-PLP-2011-2831(06/08/11)*

The HT apparent cause evaluation of CR-PLP-2011-2831 found a focus on department rather than station goals resulting in, among other things, a lack of progress in resolving issues identified during the 2010 WANO assessment.

*CR-PLP-2011-4522 (09/12/11)*

Plant trend issue in NRC cross-cutting issues in management Oversight category H4C. Significance A.

*Summary*

The most relevant information was found in the recent plant condition reports related to the INPO AFIs and the 2011 root cause evaluations. These provided the basis for extent of cause relative to root cause 1 and the details used in the event narrative. Condition reports relative to plant operation actions and

equipment failures following the trip were considered beyond the scope of this evaluation.

**Entergy Fleet Condition Reports**

Using a 5-year PCRS search, as well as references in condition reports identified by that search, the following Entergy Fleet condition reports were considered relevant to this evaluation.

*CR-ANO-1-2010-01830 (4/16/2010)*

While performing EFIC Channel "A" monthly test under WO-52039429, meter lead slipped and made contact with one of the 120 vac input terminals. This caused EFIC channel "A" to trip

*CR-ANO-C-2008-01053 (05/04/2008)*

ANO experienced a loss of 500 KV Pleasant Hill line as a result of maintenance on Ring Bus breaker B5148 which caused as short to current transformers feeding protection circuitry and tripped B5122 on timed overcurrent.

*CR-CNS-2008-05397 (07/11/2008)*

The electrician re-terming the two leads which both needed cut back and stripped due to water damage assumed that the leads were de-energized due to the live-dead-live check that was performed the prior morning. The electrician grabbed both leads completing the circuit and received the shock.

*CR-GGN-2010-01404 (03/03/2010)*

Loss of 480 VAC power due to inadvertent phase to ground short. Feeder breaker 52-14106 tripped which deenergized MCC 14B12.

*CR-PNP-2011-2475 (05/10/11)*

Reactor SCRAM on HI-HI-Flux resulted from lack of strict enforcement of procedure use and adherence for reactivity management. Root cause actions included development of a management oversight qualification program.

*Summary*

Recent Fleet examples show that inadvertent short circuits can result in industrial safety threats as well as losses of major equipment in a variety of systems. Although not directly referenced, the need for improvements in oversight quality were reflected in actions assigned from the recent CR-PLP-2011-4522 root cause evaluation. These include actions to improve supervisor observation

training and to increase the level of oversight of supervisor observations during on-line and outage periods.

## EXTERNAL OPERATING EXPERIENCE

As a part of the evaluation, searches of the INPO website and the Entergy Operating Experience Database were performed for applicable events. No time limit was used for these searches which used the keywords “Risk Assessment”. Of the examples resulting from the search the following were found to be applicable for this evaluation:

*SOER 81-15 (10/06/81)*

Millstone operator error causing loss of one DC bus resulted in a reactor trip which was not followed by a turbine trip. There were significant operator challenges resulting from the turbine trip delay, a loss of control room annunciators and a partial loss of medium voltage busses.

*SOER 91-1 (06/20/92)*

Discussion of three 1990s Operations related activities resulting in reactor safety challenges. Within Entergy, EN-OP-116 implements measures to recognize and plan for infrequent activities or activities that, due to their subjects, are not controlled by approved procedures. Training information dating from March 2010 shows SOER 91-1 has been seen as primarily a concern for Operations although I&C Maintenance has received a one hour Fleet training class. The enhanced review and management visibility provided by EN-OP-116 could have been effective in preventing this incident. (Reference Contributing Cause 2)

*SOER 10-2 (09/07/10)*

Entitled “Engaged Thinking Organizations”, this document outlined significant operating events at eleven domestic and foreign sites. Common causes included tolerances of long-standing problems, failures to understand risk, weaknesses in supervisor oversight - all of which were significant in this event. Leadership for the response to this document is at the Fleet level with corrective actions controlled via CR-HQN-2010-0974.

*OE 33804 - Lack of Rigor in the Evaluation of Risk in Decision-Making During Refuel Outage (Waterford 3, 05/16/2011)*

During Refuel 17 (RF-17), the Operations Department exhibited multiple examples of a lack of rigor in the evaluation of risk in decision-making. The lack of rigor resulted in actions not being taken for an emergency feedwater (EFW) pump AB temperature logged as out of specifications, a portion of the station air and condensate make-up headers in containment were contaminated, and

transfer of reactor coolant system (RCS) inventory. The primary common cause was determined to be that some operations supervisors were allowing overconfidence as well as time pressure to impact the level of rigor applied to their decision making process. This resulted in a breakdown in normal reviews and communications standards during high work load outage conditions.

*OE 34376 - Failure to Follow Requirements of the Operability Determination Process Procedure Resulted in Delayed Resolution of Operability Concern. (Waterford 3, 08/17/2011)*

Operations personnel found a function in the control circuit for the safety related essential chillers which appeared to prevent the restart of the chillers if a loss of offsite power (LOOP) event or safety injection actuation signal (SIAS) occurred within 20 minutes of the last start of a chiller. This concern was promptly entered into the site corrective action program. Procedure inadequacies and improper use of procedures delayed the final operability review until twenty-two days after the identification of the condition. This OE relates to the event in that Operations did not perform a risk assessment as required by procedure. Operations accepted engineering input stating that there was a missed surveillance, Technical Specification (TS) Surveillance Requirement (SR) 4.0.3 was not invoked at this time. Operations personnel perceived the risk as low.

*OE 33613 - Loss Of Shutdown Cooling Due To Maintenance Activity Loss of Shutdown Cooling. (Browns Ferry Unit 3, 5/12/2011)*

During the recent Unit 3 forced outage, a maintenance activity that had been planned for a refueling outage was scoped into the forced outage in order to resolve a degraded non-conforming item. As the result of lifting a wire on a relay during performance of this activity, an unplanned Primary Containment Isolation Signal (PCIS) Group 2 isolation occurred which resulted in the closure of the applicable isolation valves, a trip of the in- service Residual Heat Removal Pump, and a loss of shutdown cooling. Poor decision making and lack of risk recognition allowed the work scope to continue during plant conditions that included an elevated risk state.

*OE 33864 & LER 298-110004 - Technical Specification Prohibited Condition for Non-Compliance with LCO 3.0.4 (Cooper, 06/13/2011)*

On June 13, 2011, while reviewing a post Refueling Outage 26 (RE26) report, it was discovered that Technical Specification {TS} Limiting Condition for Operation (LCO) 3.0.4.b was not complied with during startup from RE26. TS LCO 3.0.4.b requires, in part, "When an LCO is not met, entry into a MODE or other specified condition in the Applicability shall only be made: b. After performance of a risk assessment addressing inoperable systems and components, consideration of the results, determination of the acceptability of entering the MODE or other specified condition in the Applicability, and establishment of risk management

actions ... " Cooper Nuclear Station changed from Mode 2 to Mode 1 while in an LCO for the Low Pressure Coolant Isolation (LPCI} subsystem "B" being inoperable without performing a risk assessment prior to changing modes.

*OE 33681 - Nuclear Regulatory Commission Notice Of Violation For Risk Not Properly Assessed And Managed For Work In The Switchyards/Transformer Yards. (Cooper, 05/03/2011)*

On May 3, 2011, the Nuclear Regulatory Commission (NRC) issued a green-cited violation, NOV 2011-02-02, of 10 CFR 50.65(a)(4), "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," to Cooper Nuclear Station (CNS) for failure to adequately assess and manage the increase in risk associated with maintenance activities.

There was lack of staff understanding of what is required for a quality risk assessment. This fundamental shortcoming resulted in inadequate program design and implementation with respect to applicable CNS procedures, and inadequate training for personnel responsible for implementing those procedures. Administrative Procedures for managing risk and controlling access to the plant switchyard were not user-friendly for the performance and documentation of qualitative and blended risk assessments

Develop and provide training to Senior Reactor Operators, Shift Technical Engineers, Work Week Directors, the Switchyard System Engineer and his backup, the direct supervisor of the Switchyard System Engineer, the Corporate Switchyard System Engineer and his backup, and the Risk Management Engineers on performing Risk Management Assessments.

Develop and implement a Qualification for performance of Risk Management Assessments that support work order approval and schedule approval.

*OE 33654 - Loss of 230kV Startup Power Due to Panel Modification. (Diablo Canyon, 05/17/2011)*

During a Unit 2 shut down for refueling, modification to a shared Unit 1 / 2 relay panel inadvertently actuated an adjacent relay resulting in the loss of Unit 1 12kV startup power. The primary cause of the Unit 1 relay actuation was the risk assessments performed during the planning phase of the Unit 2 work did not adequately address the risks to the adjacent equipment of the on-line unit.

*OE 33451 - Plant Risk Improperly Modeled for Several Hours. (Susquehanna, 01/26/2011)*

A risk calculation was performed for online maintenance work on a motor generator (MG) set and, based on the known breaker blocking at the time of the calculation, it was determined that EOOS (Equipment Out Of Service) risk

assessment would remain Green during the work window. The root cause of the event was determined to be that the station's risk program ownership was not *commensurate with the significance of performing accurate risk assessments.*

*OE 31058 - Adverse Trend in the Performance of Risk Assessments. (Palo Verde, 03/19/2010)*

While in Modes 1 and 2, Operations has performed inadequate or untimely risk assessments, for work performed outside of its scheduled timeframe and emergent work activities. A method for identifying and managing risk impacting emergent and scheduled work outside of its scheduled timeframe during the execution week is not formally defined in the current work management process.

*Summary*

For these examples, review of SOER 91-1 provided insights into the use of EN-OP-116 and its potential for preventing future similar events. In addition, this incident provided evidence of the need for actions taken in response to SOER 10-2 have not been effective. Plant OE examples provided specific ideas for corrective actions.

# Safety Significance Evaluation

## INDUSTRIAL SAFETY

The initiating event of a short circuit in ED-11-2; 125 VDC PANEL posed a risk to Industrial Safety. During the maintenance the panel doors were open and an electrical maintenance repairman was removing a copper bus bar connection from the breaker 72-123; EMERGENCY AIRLOCK ED-123 location. With one hand supporting the copper bus bar and the other loosening the connection to the positive bus bar, the electrician observed an apparent flash of light which startled him. The copper bus bar slipped and made contact with the negative bus causing the short circuit and an arc flash..

The arc flash was very brief and there were no personnel injuries. The electrician was wearing standard PPE along with electrical safety gloves rated at 1000 volts. He was handling live 125 V DC equipment during the maintenance activity and the appropriate flash boundary had been established.

Performing work on energized equipment, although discouraged is allowed by EN-OP-102; PROTECTIVE and CAUTION TAGGING and EN-IS-123; ELECTRICAL SAFETY. The required face to face discussion with the Shift Manager in EN-OP-102 was met during a pre job discussion with the Shift Manager, although EN-OP-102 was never referred to. The required discussion is not listed in EN-IS-123. Although the three electricians involved with the work were briefed and fully aware of the hazards, an enhancement action is assigned to request clarification of EN-IS-123 (CA 40).

The actions taken in response to the event involved clearing the fault from ED-11-2 by electrical maintenance, several breaker operations and many equipment manipulations by the Operations Department. All of the activities were performed with no Industrial Safety incidents.

## ENVIRONMENTAL SAFETY

This event posed no risk to Environmental Safety. A thorough search of Condition Reports and Narrative Logs surrounding the event was performed. There were no releases to affect ground water or to the atmosphere from the primary system to the environment.

During a reactor trip, there is risk that low levels of tritium could be released to the environment as secondary steam is released through the steam dump valves or code safety valves. The concentrations of this isotope are normally below regulatory levels and it dissipates into the atmosphere before it becomes an environmental safety concern. Monitoring per Plant Procedures CH 6.10, “Radiological Environmental Monitoring Program” and CH 6.20, “Radioactive

Effluent Operating Procedure" identified that the levels in secondary chemistry were low and that, as a result, any releases to the environment were negligible.

## RADIOLOGICAL SAFETY

This event itself posed no risk to radiological safety. A thorough search of Condition Reports and Narrative Logs surrounding the event was performed. Although a CONTAINMENT HIGH RADIATION (CHR) ALARM was generated, this proved to be a result of de-energizing 2 out of 4 CHR monitors, which fail to the tripped condition. However, workers sustained unnecessary dose because of the normal evolutions involved with restoring the Plant which would not have been received if the reactor had not been inadvertently tripped.

## NUCLEAR SAFETY

The inadvertent short circuit caused by the copper bus bar connection directly and indirectly resulted in de-energizing of the following electrical buses:

- ED-10R; 125 VDC BUS NO. 1- RIGHT
- ED-10L; 125 VDC BUS NO. 2-LEFT
- ED-11-2; 125 VDC PANEL
- ED-11-1; 125 VDC PANEL
- EY-10; PREFERRED AC BUS NO. 1
- EY-30; PREFERRED AC BUS NO. 3

Note that the loss of ED-10R and ED-10L was the result of other protective features which operated unexpectedly. Specifically, ED-17; BATTERY CHARGER NO. 3 output fuses opened and breaker 72-01; ISOLATION BREAKER TO DC BATTERY NO. 1 ED-1 tripped on over current. ED-10R supplies power to ED-11-1 and ED-11-2 busses.

The fault from ED-11-2 propagated upstream, resulting in a loss of left train DC power to two-of-four inverters and subsequent loss of alternating current (AC) power from the inverters to two-of-four preferred busses. The loss of power initiated a reactor trip via the automatic actuation of the reactor protection system (RPS). Additional automatic actuations include the closure of the main steam isolation valves (MSIVs), actuation of the safety injection system (SIS), actuation of the containment isolation system (CIS), and actuation of the auxiliary feedwater system (AFS). The MSIVs, RPS, SIS, CIS and AFS performed as designed for the loss of power condition.

The operating crew entered EOP-1; STANDARD POST-TRIP ACTIONS upon the reactor trip and subsequently entered EOP-9; FUNCTIONAL RECOVERY PROCEDURE as directed by EOP-1 due to the loss of the electrical buses.

The basis for entering EOP-9 is that no other Optimal EOP Safety Function Status Checks would pass acceptance criteria due solely to the loss of EY-10 and EY-30. At no time did the plant experience any loss of a Safety Function because the full right train of safety related equipment, including the right channel of DC power, remained available and fully functional throughout. However, the loss of 125 VDV redundancy created challenges for the operators and Plant personnel as noted in the Post-Event Review and the Operations Log in eSOMS.

- Inoperable atmospheric steam dump valves
- Loss of letdown
- Main Generator output breakers did not trip
- Loss of 2400 VAC bus 1E
- Increase in unidentified PCS leakage
- Failure of Charger 1
- Loss of preferred AC busses EY-10 and EY-30
- Loss of some control room annunciators
- High steam generator level
- High pressurizer level

This list is not all inclusive. Resolution of degraded and nonconforming conditions was documented in the attachments to the Offsite Safety Review Committee meeting minutes of 09/29/11.

## Corrective Action Plan

| Identified Cause | Corrective Actions | Resp. Dept. | Due Date |
|---|---|---|---|
| **Immediate Actions (COMPLETED)** | | | |
| CC1 | To reduce the risk of recurrence, EC32028 was approved and installed 09/26/11 to increase magnetic trip settings of breakers 72-01 and 72-02 to their highest level. | | |
| CC1 | Plant trip conditions affecting left train 125 VDC breakers were resolved and approved via Startup On-Site Safety Review Committee | | |
| RC1 | A Level 1 Human Performance Error Review was conducted with the Maintenance crew that had been assigned to remove and inspect breakers in the ED-11-2 panel. (CA-06) | | |
| RC1 | A Red Memo was issued by the Human Performance staff on 09/26/11 and stand downs were conducted at the Plant and Fleet levels. | | |
| RC1/CC4 | This incident was treated as an avoidable human error under the MARC process for the Maintenance work crew | | |
| Other | Damaged bus connectors and suspect breakers in Panel ED-11-2 were replaced by 09/27/11 under WO291123, WO291124 and WO291210. | | |
| Other | Maintenance Rule evaluation was completed per CR-PLP-2011-4822 CA-03 | | |
| Other | Equipment Failure Evaluation was completed per CR-PLP-2011-4822 CA-04 | | |

| Interim Actions (COMPLETED) | | | |
|---|---|---|---|
| CC1 | Operators received information sharing 09/26/11 on the new settings and the function of breakers 72-01 and 72-02. This information, which will remain in effect until coordination issues have been resolved via the engineering change process, was obtained from Engineering Change EC32038. | | |
| RC1 | Guidance was issued to Maintenance supervisors for use of EN-IS-123 to assist them with identifying situations that could result in Plant shutdown and industrial safety risk when working on energized circuits. This now includes electrical superintendent approval when working on any exposed energized equipment (live conductive parts) at 50 volts and higher and completion of attachment 9.5 Electrical Safety Checklist. This requirement will remain in effect until EN-IS-123 has been revised to incorporate these changes. | | |
| RC1 | Compensatory measures were implemented that administratively prevent work from being performed on the affected DC electrical distribution panels, and cables within the cable spreading room connected to the affected DC electrical distribution panels, when the associated DC bus is required to be operable. | | |
| RC1 | Compensatory measures were implemented that allow only one battery charger to be connected an operable DC bus and the opening of breakers in the affected DC electrical distribution panels that supply power to non-safety related loads. | | |
| **Short and Long Term Actions** | | | |
| CAPR1 RC1, CC3, CC4 | Reinforce and institutionalize Entergy Standards for Procedure Compliance, Accountability, and Unacceptable Behaviors via face to face communications from the COO through Individual Contributor Levels. | SVP | Complete |
| CAPR2 RC1, CC3, CC4 | Implement, and ensure compliance with, Entergy Risk Management procedures EN-WM-104 and EN-FAP-WM-002. (CA 63) | GMPO | 1/26/12 |
| CC1/ CR-PLP-2011-4958 | Complete installation of an Engineering Change to correct coordination issues with breakers 72-01 and 72-02. Closure requires Engineering Change installation and closeout. (CA-22 LTCA) | Design | 06/15/12 |

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|---|---|---|---|
| CC1 | Notify Operations that interim settings for breakers 72-01 and 72-02 have been revised via the engineering change process and that EC32038 has been removed. (CA-23 LTCA) | Design | 06/29/12 |
| CC1 | Identify other modification FC-407-14C procurements which could be subject to error and initiate condition reports for further evaluation. (CA-24) | Design | 12/01/11 |
| CC1 | Analyze the coordination between the shunt breaker 72-01 (72-02) and D11-1 and D11-2 (D21-1 and D21-2) panel fuses and propose a resolution to obtain better coordination. The panel fuses are FUZ/D11-1, FUZ/D11-2, FUZ/D21-1, and FUZ/D21-2. (CR-PLP-2011-4835 CA-07) This action is tied to the root cause evaluation of CR-PLP-2011-4822 . CARB chair extension approval is required. | Design | 03/22/12 |
| RC1/ CC4/ CR-PLP-2011-4981 / OP5C | Provide complete information sharing for all Maintenance workers on the use of the three standard prejob brief checklists included in EN-HU-102 including the use of the Prejob Brief Decision Flowchart, EN-HU-102 Attachment 9.1 (CA-25) | Maint | 11/17/11 |
| RC1/ CC4/ Extent / OP5C | Confirm that corrective actions assigned from the evaluation of CR-PLP-2011-5116 will adequately address the Fatigue Rule violation concerns identified by this evaluation. Develop follow up corrective actions and return to CARB for approval if CR-PLP-2011-5116 results are not satisfactory. (CA-26) | Maint | 12/15/11 |
| RC1/ CC4 / OP2A / OP5AD /OP5AE | Provide information sharing to Maintenance personnel on the use of EN-HU-105 including use of prejob briefs, critical steps LEL and IPTE. (CA-27) | Maint | 11/17/11 |
| RC1 / OP2D / OP5T | Perform a Focused Area Self Assessment of station risk assessment practices and behaviors. (CA-28 Site Recovery Plan Activity) | PS&O | 01/20/12 |

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|---|---|---|---|
| RC1 | Revise EN-IS-123 to reduce the limit for electrical superintendent approval for work on energized equipment from 240 volts to 50 volts. (CA-29) | Maint | 04/28/12 |
| CC4/ Extent /OP2B / OP5AD / OP5AE / OP5T | Using the SAT process, initiate a TEAR and perform a needs analysis on the need for initial and continuing training in the use of EN-WM-104 for qualitative and quantitative risk assessment and their relationship to the work planning process described by EN-WM-104 and the use of prejob briefs described in EN-HU-102 and EN-HU-105. Identify the correct population and establish schedule for training. If training is not recommended, develop a schedule of recommended actions and return to CARB for approval. (CA-30) | Training | 01/26/12 |
| CC4/ Extent / OP5A / OP5AE | Based on results of Training needs analysis for EN-WM-104 training, determine scope and schedule for effectiveness review. (CA-31) | Maint | 02/15/12 |
| CC2/CC4/ Extent / OP2B /OP5AE | Provide information sharing to Maintenance supervisors and superintendents on the use of use of EN-WM-104 for qualitative and quantitative risk assessment and its relationship to EN-WM-105. (CA-32) | Maint | 11/17/11 |
| CC1/ CC2/ CC4 /OP4A / OP5A / OP5D | Revise EPS-E-10 to include all outage and on-line maintenance on these 125 volt DC panels and breakers. Include critical steps and consideration of IPTE. Clarify Plant impact to make clear the potential for train failure and Plant trip and remove Notes which provide instructions in lieu of actual procedure steps. Instructions should account for the fact that the physical layout and construction of the increases the chance of error during maintenance. (CA-33) | Maint | 02/28/12 |
| CC2/ Extent/ OP4A /OP5A / OP5D | Revise or cancel other Maintenance EPS (Emergency Power System) procedures that have not been revised since the 2007 Entergy transition, which now contain outdated references and which do not conform to Entergy standards of completeness. (CA-34) | Maint | 03/31/12 |

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|---|---|---|---|
| CC2/ Extent/ OP4A / OP5D | Quarantine any Maintenance EPS procedures that have not been revised recently and are considered out of date. (CA-35) | Maint | 11/17/11 |
| CC2/ CC4/ Extent / OP5D | Develop a plan to prioritize and eliminate outdated references, workarounds, tribal knowledge and human performance traps in all Maintenance procedures and which includes plans to improve Maintenance worker ownership of procedure quality.(CA-36) | Maint | 11/28/11 |
| CC2/ CC4/ Extent / OP5D | Complete the plan to eliminate outdated references, workarounds, tribal knowledge and human performance traps in all Maintenance procedures and which includes plans to improve Maintenance worker ownership of procedure quality. (CA-37) | Maint | 12/31/12 |
| CC4/ Extent | Reconsider the existence of an emerging trend in NRC violations with a cross cutting aspect in procedure compliance (H4b) based on situations that have been identified since the evaluation of CR-PLP-2011-2397. Issue a follow up condition report if required to evaluate a new recognized trend. (CA-38) | Licensing | 01/31/12 |
| RC1/CC3/ LOW | Verify that completed actions to address weaknesses in management oversight of work activities assigned from the evaluation of CR-PLP-2011-4522 (CA-11 through CA-13) that include the development, instruction and use of WILL sheets and the review for formal training, have addressed concerns identified for this evaluation. Develop follow up corrective actions and return to CARB for approval if CR-PLP-2011-4522 results are not satisfactory. (CA-39) | Maint | 02/28/12 |

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|---|---|---|---|
| RC1 / OP2B | Submit a training evaluation action request (TEAR) to improve PLP staff knowledge of the meaning of a Condition Adverse to Quality (CAQ). Specifically, provide direction to PLP staff on the definitions of "Nuclear Safety", "Industrial Safety", "Equipment Reliability" and "Procedure Adherence". If the training needs analysis results in a finding of no training is necessary, then arrange to have this accepted or overridden by the corrective action review board (CARB). This corrective action is to remain open until the completion of the training needs analysis.<br>(Refer to Recovery Plan WT-PLP-2011-366 CA199, and CA238) (CA 65) | CA&A | 12/29/11 |
| RC1 / OP2B | Develop and implement WILL sheets on the 8 attributes of a strong safety culture. (Close Recovery Plan WT-PLP-2011-366 CA401) (CA-50) | ISHP | 12/18/11 |
| RC1 | Coordinate a third party safety culture assessment, (Close Recovery Plan WT-PLP-2011-366 CA397) (CA-51) | NSA | 2/28/12 |
| RC1 | Create and implement a WILL sheet specific to observing trip risk activities (Close Recovery Plan WT-PLP-2011-366 CA75) (CA-52) | Maint | 12/8/11 |
| RC1 | Revise on-line scope add form to include statement that appropriate risk and risk mitigators have been added to appropriate schedule. (Close Recovery Plan WT-PLP-2011-366 CA408) (CA-53) | PS&O | 12/23/11 |
| RC1 | Perform a causal analysis, which should include a review of previous 12 months RCEs, significant ACEs, NRC findings, Cross-cut issues, AFIs, etc. Apply special focus on O&Ps. Use of 95-001/002/003 inspection manuals (Close Recovery Plan WT-PLP-2011-366 CA90) (CA-54) | CA&A | 12/23/11 |
| RC1 | CRG and DPICS to ensure that the keyword "Stop When Unsure" is applied all CR's written regarding failure to complete a task based the work being stopped because either: a. the workers are unsure, b. the task is not correct as written, c. the task cannot be completed as written, d. the replacement components are different, d. the scope of the work changes, e. the workers are directed to stop by Supervision/Management/Engineering. CRG and DPICS to ensure appropriate follow-up actions are assigned. (CA-55) | GMPO | 1/8/2012 |

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|---|---|---|---|
| RC1 | At the T-5 Critical Evolutions Meeting (CEM) and the T-2 meeting, Members validate the rigor and correctness of the Risk Analysis associated with evolutions identified by EN-FAP-WM-002. For work packages that do not have adequate Risk Analysis as determined by the members, a CR will be generated with the keyword "Risk Management" applied and appropriate actions created. (CA-56) | GMPO | 1/8/2012 |
| RC1, CC3, CC4 | Create an annual CBT to re-affirm employee understanding of and commitment to Entergy Accountability, Behavioral and Procedure Use standards. Create an accompanying Job Familiarization Guide for use with new employees. Ensure created materials reference this CR and require CARB approval for removal from site curriculum. (CA-57) | Training | 3/9/12 |
| Extent | Submit the LER for the identified conditions within the 60-day time period. (CA-02) | Licensing | 11/22/11 |
| Enhance ment | Request EN-IS-123 clarification of the EN-OP-102 requirement for a Shift manager face-to-face meeting with workers when work on energized equipment without tagging is involved. (CA-40) | Maint | 11/30/11 |
| Enhance ment | Request EN-WM-104 clarification for disposition of completed risk assessments as records or incorporation into work order packages. (CA-41) | Maint | 11/30/11 |
| Other | Perform Learning Opportunity Review per EN-QV-112, “Learning Opportunity Review Process” (CA-42) | QA | 12/15/11 |
| Other | Locate the actual root cause evaluation record for CPAL-97-1493 and initiate additional corrective actions to address issues not addressed by this corrective action plan. (CA-43) | Maint | 11/30/11 |
| Other | Arrange with CA&A to have referenced actions from CR-PLP-2011-4835 and CR-PLP-2011-4522 appropriately linked in PCRS to this corrective action plan. (CA-44) | Maint | 11/30/11 |

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|---|---|---|---|
| CC2/ CC3/ CC4/ LOW | Verify completion of CERT Team Report 18 recommended actions as identified in LO-WTPLP-2011-0366 which address procedure use, procedure quality and management oversight (CA-45) | NSA | 03/15/12 |
| EFR | Obtain an LO document number and assign effectiveness review actions to verify that actions to preclude recurrence have been successful (CA-46) | Maint | 11/30/11 |
| OE | Prepare and issue internal Entergy fleet OE summary (CA-13) | OE | 10/26/11 |
| OE | Prepare and issue external OE summary (CA-16) | Maint | 10/26/11 |

# Effectiveness Review Plan

**LO-PLPLO-2011-00061**

**CAPR1/ RC1** Reinforce and institutionalize Entergy Standards for Procedure Compliance, Accountability, and Unacceptable Behaviors via face to face communications from the COO through Individual Contributor Levels.

**CAPR2/RC1** Implement, and ensure compliance with, Entergy Risk Management procedures EN-WM-104 and EN-FAP-WM-002.

| | Action | Resp. Dept | Due Date |
|---|---|---|---|
| **Method:** | Focused self assessment by non-Palisades (PLP) personnel of Palisades procedure adherence with respect to promoting a sensitive risk culture | **GMPO** | 6/20/2012 for first assessment |
| **Attributes:** | Risk Management<br>Work Practices<br>Management Oversight<br>Management Intrusiveness | | |
| **Success:** | Non PLP personnel self assessment confirms that Palisades has properly institutionalized the applicable work oversight and methodology combined with institutionalized knowledge of work practice expectations | | |
| **Timeliness:** | Approximately every 6 months for 2 years. | | |

# References

### Documents reviewed

Documents used in this evaluation which are not identified directly in the body of the report as they are used are identified as footnotes at the end of each report section.

### Team Members

Chuck Sherman - Sponsor/ RP
Brad O'Donnell - Electrical Maintenance
Mark Floyd - Training
Brian Meredith - System Engineering
Maggie Koyo - System Engineering
Ted Berry - Training
Paul Johnson - HU/ IS
George Stieber - Operations
Richard Swanson - Contractor
Al Baerren - Maintenance

### Attachments

Attachment 1 - Event Time Line from **EA-PSA-SDP-D11-2-11-07**

Attachment 2 - Failure Modes Analysis

Attachment 3 - Failure Modes Chart

Attachment 4 - Barrier Analysis

Attachment 5 - Change Analysis

Attachment 6 - Safety Culture Evaluation

Attachment 7 - O&P Evaluation Checklist

Attachment 8 - Maintenance Crew Statements

Attachment 9 - Why Staircase

## Attachment 1: Event Timeline Chart and Narrative

This attachment contains the following:

- Event timeline in chart format (Table A01-1)
- Event timeline in narrative format

**Table A01-1: Event Timeline Chart**

| Friday 9/23 1607 | Saturday 9/24 2218 | Sunday 9/25 1109 | Sunday 9/25 1500 | Sunday 9/25 1506 | Sunday 9/25 1506 | Sunday 9/25 1506 | Sunday 9/25 1506 | Sunday 9/25 1506 |
|---|---|---|---|---|---|---|---|---|
| Electrical maintenance restoring breaker 72-123 (Emergency Airlock ED-123) | Battery chargers #1 ED-15 and #2 ED-16 initially in-service | Temp mod 31973 Installed. (Temp power for breaker 72-121 (generator exciter field breaker control) from 72-127 (test cabinets)) | Electrical maintenance removed 4 dc panel ED-11-2 breakers (72-119,72-120,72-121,72-123) | While removing bus bar, short occurred in dc panel ED-11-2 | MSIS (2/4 logic low SG pressure) due to loss of preferred ac buses EY-10 and EY-30 | Right channel SIAS (2/4 logic low PZR pressure) due to loss of preferred ac buses EY-10 and EY-30 | AFAS (2/4 logic low S/G level) due to loss of preferred ac buses EY-10 and EY-30 | Right channel CIS/CHR (2/4 logic, RIAX-1805/RIAX-1807) due to loss of preferred ac buses EY-10 and EY-30. Left channel containment isolation valves closed due to loss of power |
| Control room alarm: EK-0316 GEN FIELD FORCING/OVER EXCITATION cycling on/off | | FWP air compressor C-903B cross-tied supplying plant air system | | Shunt trip breaker 72-01 opened de-energizing dc buses ED-10R and ED-10L | MSIVs CV-0510 and CV-0501 and E-50B MFRV CV-0703 closed on MSIS, and E-50A MFRV CV-0701 closed due to loss of power to EY-10 and EY-30 | IE bus EA-13 de-energized, no power to C-903B FWP air compressor (was cross-tied supplying plant air). Closed MV-CA320 to isolate FWP from instrument air. C-2A instrument air compressor was in "sleep" mode and started | Turbine driven AFW pump P-8B starts (CV-0522B failed open due to loss of ED-11-1). AFW flow control valves CV-0727 and CV-0749 fail full-open. Flow imbalance develops between SGs due to differential in dome pressures (no flow indication available) | PCP controlled bleedoff valves CV-2083 and CV-2099 close due to CHR/loss of power, directing flow to primary system drain tank T-74 in containment (5 gpm) |
| Multiple containment isolation valves position indication lost | | | | Dc panels ED-11-1 and ED-11-2, and preferred ac buses EY-10 and EY-30 de-energized | All ADVs CV-0779, CV-0780, CV-0781, and CV-0782 fail closed/inoperable (quick open and normal operation) due to loss of preferred ac panel EY-10 (LCO 3.7.4) | In service PZR level control channel A fails, charging pumps P-55A and P-55B in service (93 gpm), and letdown orifices CV-2003, CV-2004,CV- 2005 close (0 letdown),PZR heaters de-energize | AFW pump P-8C starts (AFAS) supplying 165 gpm to each SG.<br>Loss of EY-10 causes low suction pressure trip signal which prevents P-8A operation.) | PCS unidentified leakage > 1 gpm for PCP controlled bleedoff isolation (LCO 3.4.13.A.1, B.1, B.2) |
| Entered ONP-7.1 (72-119 failure caused loss of service air and CV-1221 FWP building cross-tie to fail open) | | | | Preferred ac panel EY-10 inoperable LCO 3.8.9.B (LCO 3.0.3)<br>Preferred ac panel EY-30 inoperable LCO 3.8.9.B (LCO 3.0.3) | MSSVs lift on both SGs | In service PZR pressure control channel A fails, spray valves CV-1057 and CV-1059 fail closed, no spray available | Inverter #1 ED-06 input breaker to EY-10, 72-37 tripped (LCO 3.8.7.A) | Right channel CHP alarm (2/4 logic,PSX-1801/PSX-1803) due to loss of EY-10 and EY-30 panels, no actuation (actuation logic requirements not met) |
| | | | | Reactor trip (2/4 logic RPS) due to loss of preferred ac buses EY-10 and EY-30 | Turbine trip (from reactor trip), generator breakers do not open due to loss of dc panel D-11-1 | Operators enter EOP-1.0 Standard Post-Trip Actions | Battery charger #1 ED-15, output breaker closed but charger not operating | Dc bus ED-10R inoperable (LCO 3.8.9.6)<br>Dc bus ED-10L inoperable (LCO 3.8.9.6) |

**Table A01-1: Event Timeline Chart**

| Sunday 9/25 1515 | Sunday 9/25 1517 | Sunday 9/25 1527 | Sunday 9/25 1531 | Sunday 9/25 1537 | Sunday 9/25 1542 | Sunday 9/25 1544 | Sunday 9/25 1549 | Sunday 9/25 1555 |
|---|---|---|---|---|---|---|---|---|
| MSSVs open and then operate (throttle/close/open) to maintain SG pressure PCS Tave 544˚F | Operator jumpered relay 487u (Y-phase) to open generator output breakers 25F7 and 25H9 | Enter EOP-9.0 Functional Recovery Procedure (due to <3 out of 4 preferred ac buses available) | Operator observed high E-50A level (90%). Order given to isolate CV-0522B (steam to AFW pump P-8B) per EOP Supplement 19 (LCO 3.7.5) | Per EOP-9.0, enter ONP-24.1 and ONP-24.3 due to loss of preferred ac buses EY-10 and EY-30 | Isolated RV-2006 letdown relief by placing letdown orifice stop valves CV-2003, CV-2004, and CV-2005 to close | NCO closed P-8C AFW flow control valve CV-0737A to isolate flow to E-50A, continue supplying 165 gpm to E-50B via CV-0736A | Restored 1E bus EA-13 (lost on SIAS at 1506) and reenergized associated PZR heaters | Observed PZR level >62.8% (LCO 3.4.9.A). Actual PZR level 78% |
| | 1A bus EA-21 de-energized. Primary coolant pumps P-50A and P-50C stop, P-50B and P-50D remain in service | PZR level 62% | ~1530 Entered ONP-2.3 Loss of DC Power (time not verified) | PZR pressure peaks high 2200 psig. PZR level 71% | Charging 73 gpm, 0 gpm letdown, 5 gpm PCP controlled bleedoff to primary system drain tank T-74 | | | |
| | | | | Realigned PZR pressure control to B channel to enable spray, pressure begins lowering | | | | |
| | | | | Realigned PZR level control and heater control select switch to B channel. Letdown orifices open and RV-2006 (letdown heat exchanger inlet safety relief) lifts due to CV-2009 (letdown containment isolation) being closed on CHR/loss of power. 1D bus EA-12 PZR backup heaters reenergize | | | | |
| | | | | Charging pumps P-55A and P-55B in service (73 gpm charging,108 gpm letdown relieving to quench tank) 5 gpm PCP controlled bleedoff to PSDT | | | | |

**Table A01-1: Event Timeline Chart**

| Sunday 9/25 1557 | Sunday 9/25 1602 | Sunday 9/25 1603 | Sunday 9/25 1609 | Sunday 9/25 1615 | Sunday 9/25 1621 | Sunday 9/25 1630 | Sunday 9/25 1639 | Sunday 9/25 1646 |
|---|---|---|---|---|---|---|---|---|
| Electricians report no faults on dc buses ED-10L and ED-10R. Reenergized ED-10L and ED-10R by closing breaker 72-01 (ED-10L and ED-10R now operable) | Charging pump P-55B suction relief RV-2096 lifting to the equipment drain tank T-80. The tank overfilled causing floor drains to backup on the 590' Auxiliary Bldg (order sent to isolate P-55B) | Steam to P-8B turbine isolated by closing CV-0522B. 0 AFW flow to E-50A. Still supplying 165 gpm to E-50B via P-8C and flow control valve CV-0736A | CV-0736A closed to isolate flow from AFW pump P-8C to E-50B, no AFW flow to either SG at this time | SG E-50A MSSVs lift, E-50B MSSVs throttle open. MSSVs then operate (throttle/close/open) to maintain SG pressure Tave 544˚F | Entered ONP-7.1 "Loss of Instrument Air (due to loss of all instrument air compressors at 1557) | Charging pump P-55B suction and discharge valves closed to isolate suction relief RV-2096 leak | Restored AFW to E-50B from P-8C 150 gpm | Preferred ac bus EY-30 realigned from bypass regulator to #3 inverter ED-08 supply |
| Generator field breaker 341 opened when ED-11-2 reenergized | Restored power to 1E bus EA-13 and reenergized associated pressurizer heaters | PCS Tave 529˚F. PZR level 85% | | PZR level peaks high 101.5% | | | | Preferred ac bus EY-10 placed on bypass regulator. EY-10 operable |
| Preferred ac bus EY-30 powered via bypass regulator (EY-30 now operable) | | | | | | | | ADVs CV-0779, CV-0780, CV-0781, and CV-0782 operable due to EY-10 restored (HIC-0780A now powered), started controlling heat removal using ADVs. MSSVs close Tave 540˚F |
| Left channel safety injection actuated when EY-30 reenergized, resulting in loss of 1E bus EA-13 | | | | | | | | |
| Throttled safety injection. Stopped charging pumps P-55A and P-55B. Charging flow 0, letdown flow 0, 5 gpm PCP controlled bleedoff to PSDT. PZR level 80% | | | | | | | | |
| When dc restored, instrument air compressor C-2A tripped (reason unknown) | | | | | | | | |
| Control room manually started instrument air compressors C-2B and C-2C | | | | | | | | |

| Table A01-1: Event Timeline Chart | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sunday 9/25 1720** | **Sunday 9/25 1746** | **Sunday 9/25 1818** | **Sunday 9/25 1852** | **Sunday 9/25 1909** | **Sunday 9/25 1911** | **Sunday 9/25 1923** | **Sunday 9/25 1933** | **Sunday 9/25 2100** |
| Entered ONP-4.1, Containment Spurious Isolation, reset CHR | Exited EOP-9 and entered GOP-8, Power Reduction and Plant Shutdown to Mode 2 or Mode 3 $\geq$ 525°F(All 4 preferred ac buses in service) | Reset SIAS | Restored P-8B steam supply CV-0522B to AUTO (LCO 3.7.5) | Exited ONP-24.1, Loss of Y-10 | Exited ONP-24.3, Loss of Y-30 | ED-01, main station battery left channel, inoperable per 3.8.4.B (no connected battery charger and surveillance requirement 3.8.4.1 not met) | #3 battery charger ED-17 in service supplying ED-01 (battery chargers #2 and #3 now in service) | P-910 (main condenser vacuum pump) in-service |
| | | | | | | #1 battery charger ED-15 inoperable per LCO 3.8.4.A.2 | | |

| Table A01-1: Event Timeline Chart | | | | | |
|---|---|---|---|---|---|
| **Sunday 9/25 2330** | **Sunday 9/25 2348** | **Monday 9/26 0156** | **Monday 9/26 0311** | **Monday 9/26 0441** | **Tuesday 9/27 1733** |
| Test started instrument air compressor C-2A satisfactorily, and then placed in AUTO (C-2B still in-service, C-2C in SLEEP mode) | PZR level <62.8% (LCO 3.4.9) | Restored P-55B charging pump to service (available) | Placed #4 battery charger ED-18 in-service and removed #2 battery charger ED-16 from service, #3 battery charger ED-17 and #4 battery charger ED-18 now in service | Main station battery ED-01 left channel operable | #1 inverter ED-06 operable, supplying preferred ac bus EY-10 (LCO 3.8.7) |

## Event Timeline Narrative

I. Initial Conditions (prior to event)

- 100% reactor power
- normal single charging and letdown lineup
  - Charging pump P-55A in service
  - Letdown orifice stop valve CV-2003 open
  - Primary coolant pump CBO returning to volume control tank T-54
- pressurizer T-72 pressure and level control channel A in service
- auxiliary feedwater system in normal standby lineup
- #1 battery charger ED-15 and #2 battery charger ED-16 in service
- feedwater purity air system cross-tied with and supplying the plant compressed air system

II. Electrical Equipment Conditions Concurrent with the Reactor Trip at 1506

- dc buses ED-10L and ED-10R de-energized
  - shunt trip breaker 72-01 opened
  - #1 battery charger de-energized
- dc distribution panels ED-11-1 and ED-11-2 de-energized
- #1 battery charger ED-15 failed, not supplying associated buses ED-10L and ED-10R
- #1 inverter ED-06 and #3 inverter ED-08 de-energized (ED-06 internal breaker also tripped)
- preferred ac buses EY-10 and EY-30 de-energized
- 2400v 1E bus EA-13 de-energized

III. Conditions Resulting from Loss of Power to Preferred AC Buses EY-10 and EY-30

Reactor Trip / Turbine Trip: main generator breakers 25F7 and 25H9 did not open due to loss of ED-11-2.

Main Steam Isolation Signal: both main steam isolation valves CV-0501 and CV-0510 closed and both main feedwater regulating valves CV-0701 and CV-0703 closed. CV-0701 closed as result

of loss of EY-10 and EY-30; CV-0703 closed due to MSIS.

Auxiliary Feedwater Actuation Signal: P-8A did not receive a start signal due to loss of D-11-1, but also did not run due to low suction pressure trip logic actuation on loss of EY-10. P-8C started and supplied 165 gpm to each steam generator (E-50A and E-50B). Steam driven AFW pump P-8B started due to loss of panel ED-11-2 and AFW flow control valves CV-0749 (E-50A) and CV-0727 (E-50B) failed full open. P-8B flow indication was not available. Flow distribution was dependent on SG pressures. E-50A is the steam source for P-8B, resulting in initially lower pressure, while E-50B had no steam removal path other than MSSVs.

Safety Injection Actuation Signal: Right channel SIAS only - resulted in de-energizing (load shedding) 2400V 1E bus EA-13, isolating non-critical service water header isolation valve CV-1359 and starting associated equipment including charging pump P-55B.

Containment High Radiation: Right channel CHR only – resulted in containment isolation valves closing, including letdown isolation valve CV-2009 and PCP controlled bleedoff valve C-2099. Left channel containment isolation valves also closed due to the loss of dc to their control circuits.

Containment High Pressure: Logic inputs were not sufficient for system actuation, i.e. no initiation signal was generated, alarm only.

Pressurizer Pressure Control: In service pressurizer pressure controller PIC-0101(channel A) de-energized – resulted in pressurizer spray valves CV-1057 and CV-1059 failing closed, and all available heaters energizing.

Pressurizer Level Control: In service pressurizer level controller LIC-0101(channel A) de-energized – resulted in letdown orifices closing, charging pump P-55A running at maximum speed (53 gpm) and all pressurizer heaters de-energizing. P-55C did not start due to loss of breaker control power (ED-11-1).

2400V 1E Bus EA-13: de-energized – resulted in unavailability of associated PZR heaters and FWP air compressors. Plant air compressor C-2A automatically started to restore pressure.

Atmospheric Steam Dump Valves: all ASDVs CV-0779, CV-0780, CV-0781 and CV-0782 failed closed (both normal and ‘quick open’) due to loss of power to controller HIC-0780A (EY-10).

Generator Output Breakers: breakers 25F7 and 25H9 failed closed and all switchyard breaker indication lost due to loss of ED-11-1. 1A bus EA-21 and 1F bus EA-23 did not transfer to startup power on turbine trip due to loss of ED-11-2. 1A bus EA-21 remained powered from #1-1 station power transformer EX-01 until operators opened the generator breakers using a jumper on relay 487u (Y phase) in control room panel EC-04. 1F bus EA-23 remained powered from #1-3 station power transformer until the generator breakers opened.

IV. Plant / Equipment Conditions and Operator Actions Following Event Initiation

Notes:

- Due to the high activity level and unavailability of some plant computer data during this event, times recorded in the Operator Log are generally correct, but may not exactly match information from other sources.
- Effects of conditions/actions described below are depicted in Appendix 1 – PCS and SG Post-Trip Behavior.

1506: Conditions noted in III above.

Main steam safety valves (MSSVs) on both steam generator headers opened and operated (throttled/closed/opened) to maintain SG pressures and lower PCS temperature and pressure. (MSSVs opened due to ASDVs failing closed and MSIVs closing on MSIS.)

Operators entered EOP-1.0 Standard Post-Trip Actions.

1515: Due to there being no steaming path available, PCS temperature rose to 544°F resulting in MSSVs opening further and PCS temperature, pressure and level lowering. PCS temperature continued lowering primarily due to relatively cold (87°F) AFW being supplied to the steam generators (690 gpm total).

AFW pump P-8B flow control valves CV-0727 and CV-0749 failed full open. The flow delivered to each SG was dependent on piping losses and SG pressure differences. SG pressures were initially both ~930 psig. However, E-50A's pressure lowered more than E-50B's (possibly due to varying MSSV characteristics), resulting in significantly more cool AFW flow to E-50A, which further lowered its pressure. By 1530 total AFW flows (P-8B +P-8C) to the SGs were 502 gpm to E-50A and 195 gpm to E-50B. This flow imbalance contributed to over-filling E-50A.

1517: Power Control verified main generator breakers 25F7 and 25H9 were closed (failed to open on turbine trip). Operators installed a jumper on relay 487u (Y phase) in control room panel EC-04 to open the breakers per EOP-1.0. Opening the generator breakers de-energized 4160v 1A bus EA-21, stopping primary coolant pumps P-50A and P-50C. PCPs P-50B and P-50D remained in service, maintaining forced circulation with one operating pump in each PCS/SG loop.

1527: Operators entered EOP-9.0 Functional Recovery Procedure due to less than 3 preferred AC buses being available. (Pressurizer level 62%)

1531: Operator observed high SG E-50A water level (90%) and an NPO was directed to isolate steam to P-8B per EOP Supplement 19 Alternate Auxiliary Feedwater Methods, i.e. manually closing steam supply valve CV-0522B. Both SG levels had been observed approximately equal (35% – 40%) during EOP-1.0 verbal verifications (1515). Operators entered ONP-2.3 Loss of DC Power.

1537: Operators first addressed safety function MVAE-DC-1 due to it being jeopardized (acceptance criteria not being met). Per MVAE-DC-1 operators entered ONP 24.1 Loss of Preferred AC Bus Y-10 and ONP-24.3 Loss of Preferred AC Bus Y-30 to recover the buses.

Operator observed high PCS pressure (2200 psia) due to loss of power to pressurizer pressure controller channel A which failed spray valves CV-1057 and CV-1059 closed. Operator placed pressurizer pressure control channel B in service, lowered pressure in manual mode and then placed the controller in auto mode. PZR spray valves then remained available for pressure control.

Operator also noted loss of power to pressurizer level controller channel A and placed channel B and pressurizer heater select channel B in service. This resulted in letdown orifice stop valves CV-2003, CV-2004 and CV-2005 opening and charging pump P-55A speed lowering from 53 gpm to 33 gpm, and restored bus 1D pressurizer heater availability. Opening the letdown orifice valves resulted in letdown relief valve RV-2006 opening, due to CV-2009 having closed on CHR. RV-2006 directed letdown flow (108 gpm, 560 gal total) to quench tank T-73 in containment, and resulted in relief valve 2006 discharge high temperature annunciator EK-0702 alarming. (Pressurizer level 71%)

1542: Operator closed letdown orifice stop valves CV-2003, CV-2004 and CV-2005 to isolate letdown flow per ARP-4 Annunciator Response Procedure Primary System Volume Level Pressure Scheme EK-07 (C-12).

At this time charging flow was 73 gpm with 0 letdown and 5 gpm PCP bleedoff flow, resulting in 68 gpm PCS net inventory addition. When the density change from charging temperature to PCS temperature is considered this gives a 90 gpm effective charging rate or 1.36%/minute pressurizer level rise rate (90 gpm / 66.16 g/% = 1.36%/m). (Pressurizer volume gal / % indicated level = 66.16 g/% per surveillance procedure DWO-1 Operator's Daily/Weekly Items Modes 1, 2, 3, and 4 Rev 80.)

1544: Operator closed CV-0737A, isolating P-8C AFW flow to steam generator E-50A. P-8C flow to E-50B continued at 165 gpm, and P-8B flow continued at 380 gpm to E-50A and 0 gpm to E-50B.

1549: Operators restored power to 2400v 1E bus EA-13 per SOP-30 Station Power and reenergized associated pressurizer heaters.

1555: Operator logged pressurizer level high (>62.8%) (actual level 78%). Due to PCS temperature continuing to lower, the observed level rate of rise was less than would be observed if temperature was stable. Changing PCS temperature one degree has the effect of changing PCS water volume 74.43 gallons (per DWO-1). (Note: Per PZR pressure/level recorder LPIR-0101B, pressurizer level exceeded 62.8% at 1528.)

1557: Operator aligned preferred ac bus EY-30 to be supplied from instrument ac bus EY-01 via the bypass regulator. Energizing EY-30 resulted in Left channel safety injection actuation which de-energized (load shed) 2400V 1E bus EA-13 and started associated equipment. P-55C did not start due to panel ED-11-1 being de-energized.

Operators verified SI throttling criteria met and stopped both operating charging pumps P-55A and P-55B to stop PCS inventory addition. Charging and letdown flows = 0, 5 gpm PCP bleedoff to primary system drain tank T-74 continues. (Pressurizer level 80%)

Electricians reported buses ED-10L and ED-10R fault free. Operator closed shunt trip breaker 72-01 reenergizing Left channel dc buses ED-10L, ED-10R, ED-11-1, ED-11-2 from battery ED-01. Generator field breaker 341 automatically opened when ED-11-2 was reenergized. Instrument air compressor C-2A tripped for an unknown reason when dc power was restored. Operator manually started compressors C-2B and C-2B. The brief loss of air compressor had no noticeable effect.

1602: NPO reported charging pump P-55B suction relief valve RV-2096 lifting and not reseating, equipment drain tank T-80 full and floor drains backing up on the auxiliary building 590 elevation. Control room directed closing pump suction and discharge valves to isolate P-55B and its suction relief. Water discharged from the relief was from concentrated boric acid tanks T-53A and T-53B.

Operators restored power to 1E bus EA-13 and reenergized associated pressurizer heaters.

1603: Auxiliary operator reported steam supply valve to P-8B turbine CV-0522B manually closed per EOP Supplement 19. AFW flow to and steam flow from E-50A = 0. AFW flow to E-50B continued at 165 gpm and steam flow from E-50B was controlled by associated MSSVs. PCS heat removal rate was reduced and PCS temperature stopped lowering and started rising. The

PCS heatup rate was 1°F/m, resulting in PZR level rising 1.125%/m. (Tave 529°F, PZR level 85%)

1609: Operator closed CV-0736A, isolating AFW flow to E-50B, slightly raising the PCS heatup rate. There was no AFW to either SG at this time and steam was only being removed from E-50B via MSSVs throttling.

1615: MSSVs on both steam generator headers opened due to PCS temperature rising to 544°F. PZR level peaked at 101.5% and then lowered as PCS temperature lowered. (Note: There was no PCS inventory addition since 1557. The PZR level rise was entirely due to PCS heatup from 529°F to 544°F.) After opening, the MSSVs remained partially open, effectively controlling PCS Tave 540°F until the ASDVs were placed in service.

1621: Operators entered ONP-7.1 Loss of Instrument Air and placed C-2B and C-2C in service. Compressor C-2A tripped during electrical bus restoration as previously noted.

1630: Charging pump P-55B suction and discharge valves reported closed, isolating suction relief valve leakage.

1639: Operator restored 150 gpm AFW flow to E-50B using P-8C.

1646: After confirming no faults on preferred ac bus EY-10, #3 inverter ED-08 was aligned to supply EY-30 and EY-10 was powered from instrument ac bus EY-01 via the bypass regulator. All preferred ac buses were now available.

All 4 ADVs were available when EY-10 was restored, and operators began using them for PCS temperature control. MSSVs fully closed. (Tave 539°F)

1720: Operators entered ONP-4.1 Containment Spurious Isolation and operator reset CHR.

1746: Operators exited EOP-9.0 and entered GOP-8 Power Reduction and Plant Shutdown to Mode 2 or Mode 3 $\geq$ 525°F.

1818: Operators reset SIAS and restored non-critical service water per SOP-15 Service Water System.

1852: Operators restored AFW pump P-8B steam supply CV-0522B to AUTO per EOP Supplement 19.

1933: Placed #3 battery charger ED-17 in service supplying station battery ED-01. #2 and #3 battery chargers ED-16 and ED-17 in service.

2348: Pressurizer level lowered to 62% and continued lowering due to PCP bleedoff.

09/26/11, 0311: Placed #4 battery charger ED-18 in service supplying station battery ED-02. Battery chargers #3 ED-17 and #4 ED-18 in service.

09/27/11, 1733: Placed #1 inverter ED-06 in service supplying #1 preferred ac bus EY-10.

Acronyms

| | |
|---|---|
| AFAS | Auxiliary Feedwater Actuation Signal |
| AFW | Auxiliary Feedwater |
| ASDV | Atmospheric Steam Dump Valve |
| CAS | Compressed Air System |
| CBO | Controlled Bleedoff |
| CHP | Containment High Pressure |
| CHR | Containment High Radiation |
| CIS | Containment Isolation Signal |
| CVCS | Chemical and Volume Control System |
| FWP | Feedwater Purity |
| MFRV | Main Feedwater Regulating Valve |
| MSIS | Main Steam Isolation Signal |
| MSIV | Main Steam Isolation Valve |
| MSSV | Main Steam Safety Valve |
| NCO | Nuclear Control Operator |
| NPO | Nuclear Plant Operator |
| PCP | Primary Coolant Pump |
| PCS | Primary Coolant System |
| PSDT | Primary System Drain Tank |
| PZR | Pressurizer |
| RPS | Reactor Protective System |
| SG | Steam Generator |
| SI | Safety Injection |
| SIS | Safety Injection Actuation Signal |
| VCT | Volume Control Tan |

# Attachment 2 - Failure Modes Analysis

**Problem Statement:** Electrical Power was lost to DC Bus ED-10L and ED-10R

| Failure Modes | Supporting Evidence | Refuting Evidence | Assumptions | Additional Information | Conclusion |
|---|---|---|---|---|---|
| Simultaneous manual opening of: [Bkr 72-18 (Battery No. 1 ED-1) or 72-01 (Isolation Breaker To DC Battery No. 1 ED-1)] **AND** Bkr 72-11 (Charger No. 3 ED-17) **AND** Bkr 72-15 (Charger No. 1 ED-15) | Power to 125 VDC Bus ED10-L & R was lost. | There was no reported observation of individuals opening these breakers. The breakers would have to have been opened simultaneous with the shorting event observed during the ED-11-2 work. | None | None | It is extremely unlikely these events could be coordinated to occur at the same time. Therefore this Failure Mode is not considered to be credible. |
| A (+) to (-) short occurred in ED-08 (Inverter No. 3) or in its connected power feed cabling. | Power to 125 VDC Bus ED10-L & R was lost. | Multiple individuals observing the Electrical Maintenance work being performed in DC Distribution Panel ED-11-2 observed an electrical arc when a piece of copper bar attached to the aluminum bus bar swung and made contact with the opposite polarity bus. There is also photographic evidence of the results of an electrical arc. | The short caused Bkr 72-18 (Battery No. 1 ED-1) to open and the short caused Battery Chargers ED-15 and ED-17 to cease output operation. | Upon restoration, ED-08 (Inverter No. 3) was reported to be operating normally. | It is extremely unlikely that a short would spontaneously occur in ED-08 (Inverter No. 3) or it's connected power feed cable simultaneously with the electrical arc caused by the loss of physical control of the copper bar being worked in DC Distribution Panel ED-11-2. Therefore this Failure Mode is not considered to be credible. |
| A (+) to (-) short occurred internally | Power to 125 VDC Bus ED10-L & R was lost. | Multiple individuals observing the Electrical Maintenance | The short caused Bkr 72-18 (Battery No. 1 ED-1) | None | It is extremely unlikely that a short would spontaneously occur in spare |

| | | | | | |
|---|---|---|---|---|---|
| to spare breaker 72-11 (no connected load or cabling) | | work being performed in DC Distribution Panel ED-11-2 observed an electrical arc when a piece of copper bar attached to the aluminum bus bar swung and made contact with the opposite polarity bus. There is also photographic evidence of the results of an electrical arc. | to open and the short caused Battery Chargers ED-15 and ED-17 to cease output operation. | | breaker 72-11 simultaneously with the electrical arc caused by the loss of physical control of the copper bar being worked in DC Distribution Panel ED-11-2. Therefore this Failure Mode is not considered to be credible. |
| A (+) to (-) short occurred in ED-17 (Battery Charger No. 3) or in its connected power feed cabling. | Power to 125 VDC Bus ED10-L & R was lost. | At the time of the event, ED-17 (Battery Charger No. 3) was in standby with it's breaker 72-12 (Charger NO. 3 ED-17) OPEN. Therefore, a short in ED-17 could not have affected 125 VDC Bus ED10-L & R as it was not electrically connected. | The short caused Bkr 72-18 (Battery No. 1 ED-1) to open and the short caused Battery Chargers ED-15 and ED-17 to cease output operation. | Upon restoration, ED-17 (Battery Charger No. 3) was reported to be operating normally. | It is extremely unlikely that a short would spontaneously occur in ED-17 (Battery Charger No. 3) or it's connected power feed cable simultaneously with the electrical arc caused by the loss of physical control of the copper bar being worked in DC Distribution Panel ED-11-2. Therefore this Failure Mode is not considered to be credible. |
| A (+) to (-) short occurred in P-81A (DC Primary Coolant Pump Oil Lift Pump) or in its connected power feed cabling. | Power to 125 VDC Bus ED10-L & R was lost. | Multiple individuals observing the Electrical Maintenance work being performed in DC Distribution Panel ED-11-2 observed an electrical arc when a piece of copper bar attached to the aluminum bus bar swung and made contact with the opposite polarity bus. There is also photographic evidence of the results of an electrical arc. | The short caused Bkr 72-18 (Battery No. 1 ED-1) to open and the short caused Battery Chargers ED-15 and ED-17 to cease output operation. | None | It is extremely unlikely that a short would spontaneously occur in P-81A (DC Primary Coolant Pump Oil Lift Pump) or it's connected power feed cable simultaneously with the electrical arc caused by the loss of physical control of the copper bar being worked in DC Distribution Panel ED-11-2. Therefore this Failure Mode is not considered to be credible. |
| A (+) to (-) short occurred in P-81C (DC Primary Coolant Pump Oil Lift Pump) or in its connected power | Power to 125 VDC Bus ED10-L & R was lost. | Multiple individuals observing the Electrical Maintenance work being performed in DC Distribution Panel ED-11-2 observed an electrical arc when a piece of copper bar attached | The short caused Bkr 72-18 (Battery No. 1 ED-1) to open and the short caused Battery Chargers ED-15 and ED-17 to cease output operation. | None | It is extremely unlikely that a short would spontaneously occur in P-81C (DC Primary Coolant Pump Oil Lift Pump) or in its connected power feed cable simultaneously with the electrical arc caused by the |

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| feed cable. | | to the aluminum bus bar swung and made contact with the opposite polarity bus. There is also photographic evidence of the results of an electrical arc. | | | loss of physical control of the copper bar being worked in DC Distribution Panel ED-11-2. Therefore this Failure Mode is not considered to be credible. |
| A (+) to (-) short occurred in ED-11-1 (125 VDC Panel) or any of the loads connected to this panel. | Power to 125 VDC Bus ED10-L & R was lost. | Multiple individuals observing the Electrical Maintenance work being performed in DC Distribution Panel ED-11-2 observed an electrical arc when a piece of copper bar attached to the aluminum bus bar swung and made contact with the opposite polarity bus. There is also photographic evidence of the results of an electrical arc. | The short caused Bkr 72-18 (Battery No. 1 ED-1) to open and the short caused Battery Chargers ED-15 and ED-17 to cease output operation. | None | It is extremely unlikely that a short would spontaneously occur in ED-11-1 (125 VDC Panel) or any of the loads connected to this panel simultaneously with the electrical arc caused by the loss of physical control of the copper bar being worked in DC Distribution Panel ED-11-2. Therefore this Failure Mode is not considered to be credible. |
| A (+) to (-) short occurred in ED-11-2 (125 VDC Panel) or any of the loads connected to this panel. | Power to 125 VDC Bus ED10-L & R was lost.<br><br>Multiple individuals observing the Electrical Maintenance work being performed in DC Distribution Panel ED-11-2 observed an electrical arc when a piece of copper bar attached to the aluminum bus bar swung and made contact with the opposite polarity bus. There is also photographic evidence of the results of an electrical arc. | None | The short caused Bkr 72-18 (Battery No. 1 ED-1) to open and the short caused Battery Chargers ED-15 and ED-17 to cease output operation.<br><br>After the event, Bkr 72-37 (Inverter No.1 ED-06 Power Supply Breaker) was found tripped. Per the Inverter vendor, capacitors on the feed side of the Inverter would have fed a connected fault. The vendor concurred that it was reasonable to conclude that Bkr 72-37 could have tripped from the current produced by | Based on inspection post event, Bkr 72-18 (Battery No. 1 ED-1) was found CLOSED, but breaker 72-01 (Isolation Breaker To Dc Battery No. 1 ED-1) was discovered TRIPPED.<br><br>Per Dwg. E-8 Sh. 1, Breaker 72-01 (Isolation Breaker To Dc Battery No. 1 ED-1) is | This Failure Mode has a high probability as being the cause of the loss of electrical Power to DC Bus ED-10L and ED-10R. |

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| | | | the Inverter capacitors. Located between ED-10R (125 VDC Bus) and ED-11-2 (125 VDC Panel) is fuse FUZ/D11-2 (Feeder Fuse To Relay In Panel ED-11A). This fuse was found intact. The assumption is that it is reasonable to expect that the fault current contributed by ED-06 (Inverter No. 1) would trip Bkr 72-37 and not fuse FUZ/D11-2. Note that for the stated failure mode, all of the fault current would have passed through fuse FUZ/D11-2, and this fuse was found intact. | identified as a Non-Automatic shunt trip breaker, that is this breaker would not incorporate a magnetic or thermal automatic trip feature. As has been discovered, this breaker does in fact contain a magnetic automatic trip feature. | |
| A (+) to (-) short occurred in ED-15 (Battery Charger No. 1) or in its connected power feed cabling. | Power to 125 VDC Buss ED10-L & R was lost. | Multiple individuals observing the Electrical Maintenance work being performed in DC Distribution Panel ED-11-2 observed an electrical arc when a piece of copper bar attached to the aluminum bus bar swung and made contact with the opposite polarity bus. There is also photographic evidence of the results of an electrical arc. | The short caused Bkr 72-18 (Battery No. 1 ED-1) to open and the short caused Battery Chargers ED-15 and ED-17 to cease output operation. | Upon restoration, ED-15 (Battery Charger No. 1) was reported to be operating normally. | It is extremely unlikely that a short would spontaneously occur in ED-15 (Battery Charger No. 1) or it's connected power feed cable simultaneously with the electrical arc caused by the loss of physical control of the copper bar being worked in DC Distribution Panel ED-11-2. Therefore this Failure Mode is not considered to be credible. |
| A (+) to (-) short occurred internally to spare breaker 72-16 (no connected load or cabling) | Power to 125 VDC Buss ED10-L & R was lost. | Multiple individuals observing the Electrical Maintenance work being performed in DC Distribution Panel ED-11-2 observed an electrical arc when | The short caused Bkr 72-18 (Battery No. 1 ED-1) to open and the short caused Battery Chargers ED-15 and ED-17 to | None | It is extremely unlikely that a short would spontaneously occur in spare breaker 72-16 simultaneously with the electrical arc caused by the loss of physical control of the copper bar |

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| | | a piece of copper bar attached to the aluminum bus bar swung and made contact with the opposite polarity bus. There is also photographic evidence of the results of an electrical arc. | cease output operation. | | being worked in DC Distribution Panel ED-11-2. Therefore this Failure Mode is not considered to be credible. |
| A (+) to (-) short occurred in ED-06 (Inverter No. 1) or in its connected power feed cabling. | Power to 125 VDC Buss ED10-L & R was lost. | Multiple individuals observing the Electrical Maintenance work being performed in DC Distribution Panel ED-11-2 observed an electrical arc when a piece of copper bar attached to the aluminum bus bar swung and made contact with the opposite polarity bus. There is also photographic evidence of the results of an electrical arc. | The short caused Bkr 72-18 (Battery No. 1 ED-1) to open and the short caused Battery Chargers ED-15 and ED-17 to cease output operation. | Upon restoration, ED-06 (Inverter No. 1) was reported to be operating normally. | It is extremely unlikely that a short would spontaneously occur in ED-06 (Inverter No. 1) or it's connected power feed cable simultaneously with the electrical arc caused by the loss of physical control of the copper bar being worked in DC Distribution Panel ED-11-2. Therefore this Failure Mode is not considered to be credible. |
| A (+) to (-) short occurred in EU-72 (Public Address System Inverter) or connected cabling. | Power to 125 VDC Buss ED10-L & R was lost. | Multiple individuals observing the Electrical Maintenance work being performed in DC Distribution Panel ED-11-2 observed an electrical arc when a piece of copper bar attached to the aluminum bus bar swung and made contact with the opposite polarity bus. There is also photographic evidence of the results of an electrical arc. | The short caused Bkr 72-18 (Battery No. 1 ED-1) to open and the short caused Battery Chargers ED-15 and ED-17 to cease output operation. | None | It is extremely unlikely that a short would spontaneously occur in ED-06 (Inverter No. 1) or it's connected power feed cable simultaneously with the electrical arc caused by the loss of physical control of the copper bar being worked in DC Distribution Panel ED-11-2. Therefore this Failure Mode is not considered to be credible. |
| A (+) to (-) short occurred in the ED-10L (125 VDC Bus) bus work. | Power to 125 VDC Buss ED10-L & R was lost. | Multiple individuals observing the Electrical Maintenance work being performed in DC Distribution Panel ED-11-2 observed an electrical arc when a piece of copper bar attached to the aluminum bus bar swung and made contact with the opposite polarity bus. There is | The short caused Bkr 72-18 (Battery No. 1 ED-1) to open and the short caused Battery Chargers ED-15 and ED-17 to cease output operation. | Upon restoration, the ED-10L (125 VDC Bus) bus provided power to it's connected load without incident. | It is extremely unlikely that a short would spontaneously occur in the ED-10L (125 VDC Bus) bus work simultaneously with the electrical arc caused by the loss of physical control of the copper bar being worked in DC Distribution Panel ED-11-2. Therefore this Failure Mode is not considered to be |

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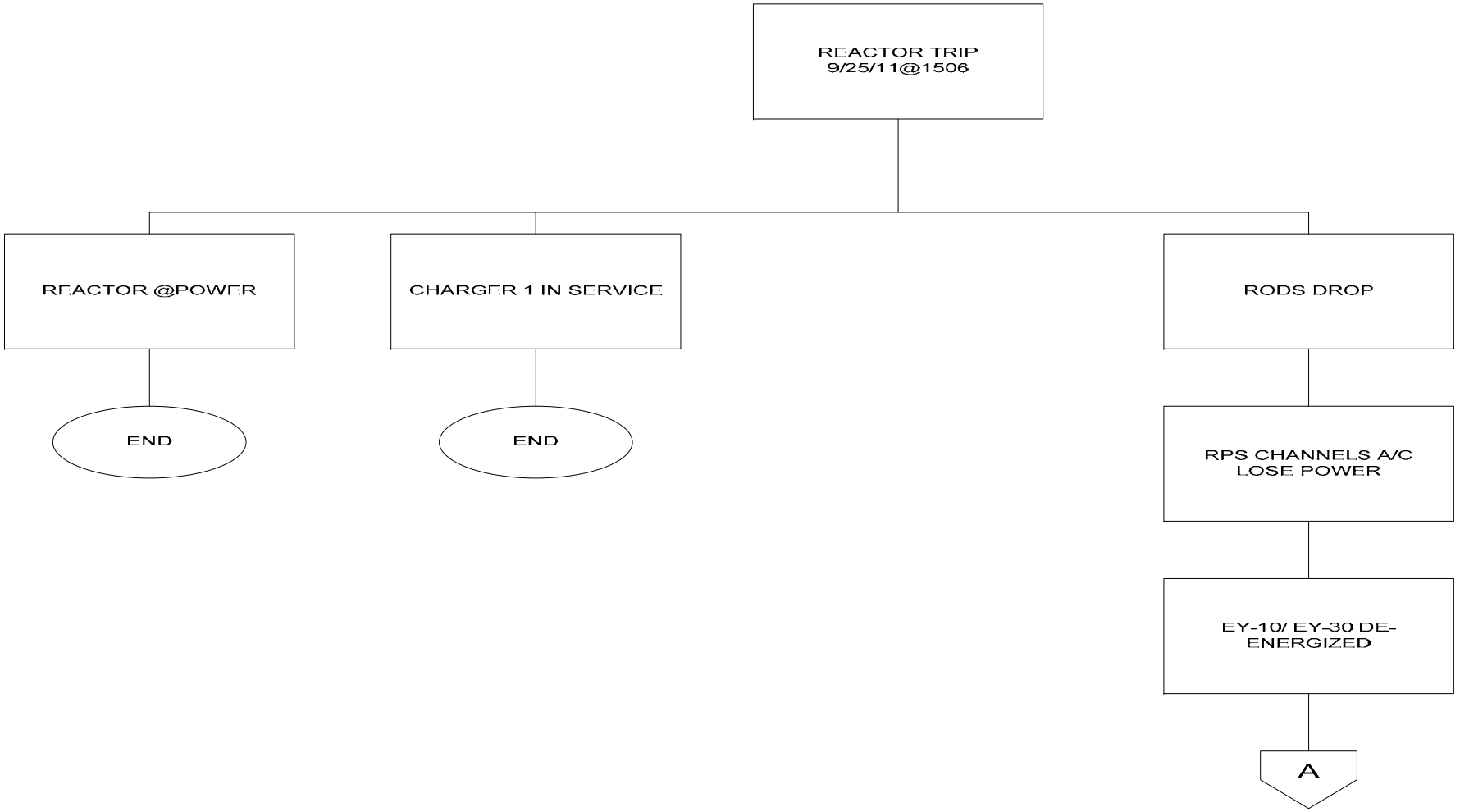
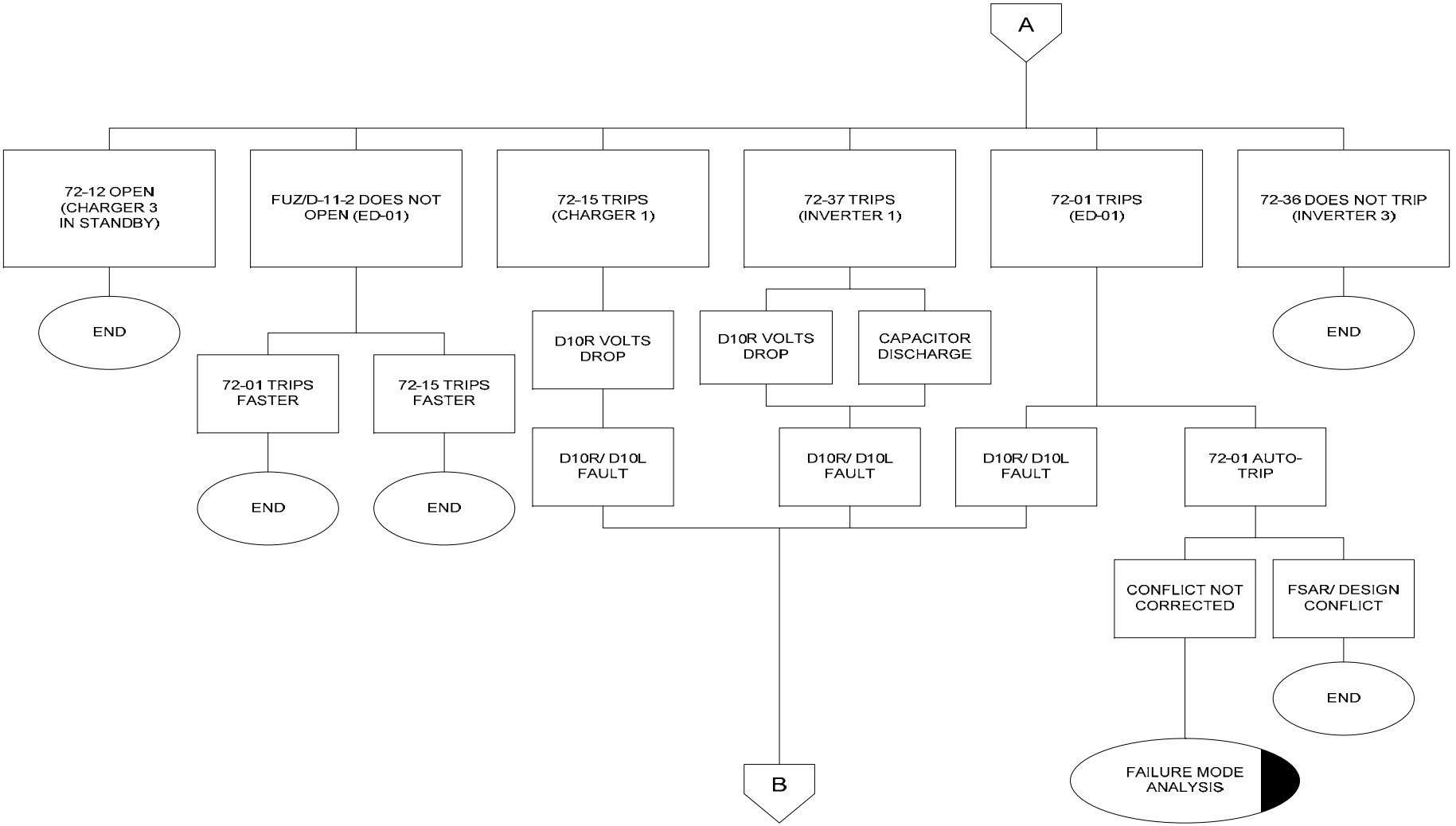
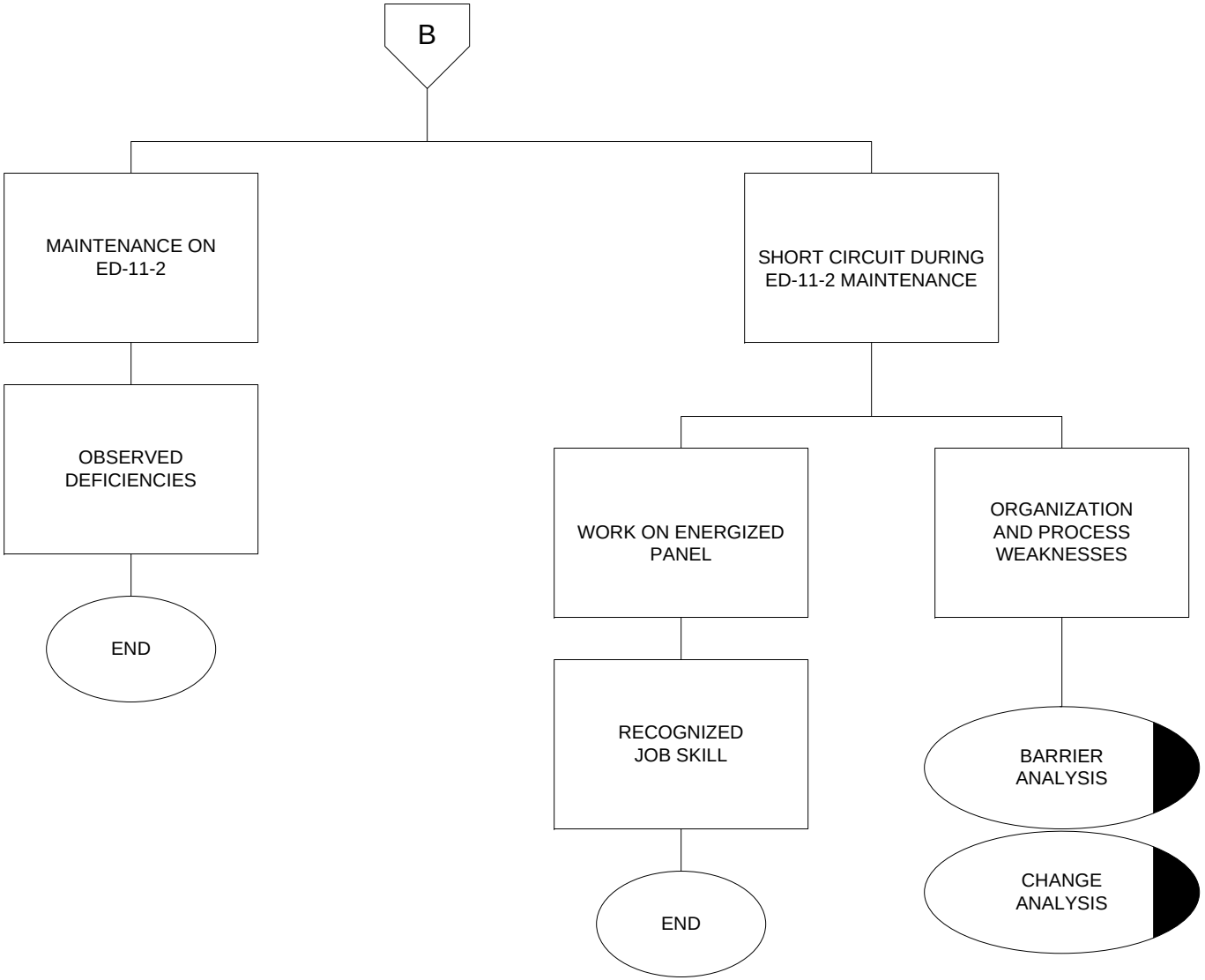
| | | also photographic evidence of the results of an electrical arc. | | | credible. |
| A (+) to (-) short occurred in the ED-10R (125 VDC Bus) bus work. | Power to 125 VDC Buss ED10-L & R was lost. | Multiple individuals observing the Electrical Maintenance work being performed in DC Distribution Panel ED-11-2 observed an electrical arc when a piece of copper bar attached to the aluminum bus bar swung and made contact with the opposite polarity bus. There is also photographic evidence of the results of an electrical arc. | The short caused Bkr 72-18 (Battery No. 1 ED-1) to open and the short caused Battery Chargers ED-15 and ED-17 to cease output operation. | Upon restoration, the ED-10R (125 VDC Bus) bus provided power to it's connected load without incident. | It is extremely unlikely that a short would spontaneously occur in the ED-10R (125 VDC Bus) bus work simultaneously with the electrical arc caused by the loss of physical control of the copper bar being worked in DC Distribution Panel ED-11-2. Therefore this Failure Mode is not considered to be credible. |
| A (+) to (-) short occurred in the ED-13 (Metering Section W/IN MN DC Dist Bus #1) ground detection circuitry. | Power to 125 VDC Buss ED10-L & R was lost. | Multiple individuals observing the Electrical Maintenance work being performed in DC Distribution Panel ED-11-2 observed an electrical arc when a piece of copper bar attached to the aluminum bus bar swung and made contact with the opposite polarity bus. There is also photographic evidence of the results of an electrical arc. | The short caused Bkr 72-18 (Battery No. 1 ED-1) to open and the short caused Battery Chargers ED-15 and ED-17 to cease output operation. | | It is extremely unlikely that a short would spontaneously occur in the ED-13 (Metering Section W/IN MN DC Dist Bus #1) ground detection circuitry simultaneously with the electrical arc caused by the loss of physical control of the copper bar being worked in DC Distribution Panel ED-11-2. Therefore this Failure Mode is not considered to be credible. |

**Summary:** The Failure Mode: A (+) to (-) short occurred in ED-11-2 (125 VDC Panel) or any of the loads connected to this panel, was considered to be the credible failure which resulted in loss of Electrical Power to DC Bus ED-10L and ED-10R. Specifically, the short was due to the contact of opposite polarity copper stand-offs, one of which was in the process of being removed by Electrical Maintenance when the fault occurred. **References: Dwg. E-8 Sh. 1 and Operators Statements regarding the Plant Trip Notes: None**

## Attachment 3 - Failure Modes Chart




A
72-12 OPEN (CHARGER 3 IN STANDBY)
FUZ/D-11-2 DOES NOT OPEN (ED-01)
72-15 TRIPS (CHARGER 1)
72-37 TRIPS (INVERTER 1)
72-01 TRIPS (ED-01)
72-36 DOES NOT TRIP (INVERTER 3)
END
72-01 TRIPS FASTER
72-15 TRIPS FASTER
END
END
D10R VOLTS DROP
D10R VOLTS DROP
CAPACITOR DISCHARGE
D10R/ D10L FAULT
D10R/ D10L FAULT
D10R/ D10L FAULT
72-01 AUTO-TRIP
END
CONFLICT NOT CORRECTED
FSAR/ DESIGN CONFLICT
END
FAILURE MODE ANALYSIS
B


B
MAINTENANCE ON ED-11-2
OBSERVED DEFICIENCIES
END
SHORT CIRCUIT DURING ED-11-2 MAINTENANCE
WORK ON ENERGIZED PANEL
RECOGNIZED JOB SKILL
END
ORGANIZATION AND PROCESS WEAKNESSES
BARRIER ANALYSIS
CHANGE ANALYSIS

## Attachment 4 – Barrier Analysis

| GOAL | HAZARD | BARRIER | HOW BARRIER FAILED | IMPACT ON EVENT |
|---|---|---|---|---|
| Adequate information available to plan to plan and complete work | WO Task LTA | Work order planning | Work order plan did not include details for removal of bus bar with damaged threads and insulation of energized components. Used notes for instructions and was based on outdated procedure. | Contributing Cause 2 |
| | | Ops impact review | Indicated there was Plant trip concern which but that it was slight. | Root Cause 1 |
| | Plant Maintenance Procedures LTA | Procedure quality | No Plant maintenance procedures included in WO plan but the procedure referenced was outdated | Contributing Cause 2 |
| | | Maintenance feedback | EPS-E-10 has been in use but no evidence of DRNs | Contributing Cause 2 |
| | Fleet Procedures LTA | Procedure quality | HPER input that EN-IS-123 vs EN-OP-102 needs clarification per shift manager face-to-face meetings on energized equipment work | Enhancement |
| | | Incorporation of previous comments | No evidence of previous unincorporated comments | NA |

| | | | | |
|---|---|---|---|---|
| | OE References LTA | Planning development | Relevant OE30342 included in WO package | NA |
| | Inappropriate work scheduling | Risk assessment | Qualitative risk assessments at four points could have resulted in increased management attention and better decision making | Root Cause 1; see change analysis |
| | | Management oversight | Managers were not intrusive, unaware and unable to control what was going on | Root Cause 1/ LOW |
| | Feedback to correct previously known problems | Work crew review | Crew indicated concerns identified were reported and resolved | NA |
| Crew develops good plan to perform work | Shift turnover LTA | Face to face review | Breaker inspection and replacement was not turned over; continued with same crew after temporary mod was installed | NA |
| | Crew review LTA | Opportunity to review work order package on schedule | Crew review had opportunity and identified concerns | NA |
| | | Opportunity to resolve comments on work order package | Concerns related to drawing availability not resolved but crew continued with work | Root Cause 1 and Contributing Cause 4 |
| | Prejob brief LTA | Use of correct PJB form | Based on interviews, EN-HU-102 was not referenced and checklists not used; in addition, during HPER, workers indicated they were not clear about how to use EN-HU-102 flowchart for selecting prejob brief level | Root Cause 1 and Contributing Cause 4 |
| | | Correct performance of PJB | | |

| | | | | |
|---|---|---|---|---|
| | | Manager and supervisor oversight | Supervisor, duty station manager and asst maintenance manager were present at brief and should have identified failure to use checklists | Supports Contributing Cause 3 and Root Cause 1 |
| | | Use of OE | OE provided was relevant but not successfully used due to weak prejob brief | Contributing Cause 4 |
| Crew completes work as planned | Worker skills LTA | Training and experience | During HPER discussions, workers were considered and they considered themselves trained an experienced | NA |
| | Response to changes LTA | Worker regroup and rebrief | Worker decisions not to stop and regroup when deciding to remove bus connectors and to change from insulation sheets to insulating gloves violated procedures and expectations | Root Cause 1 and Contributing Cause 4; see Change Analysis |
| | Working conditions LTA | Worker and supervisor recognition | During HPER reviews, crew indicated there were no adverse impacts from working conditions | NA |
| | Oversight LTA | Manager and supervisor oversight | Weaknesses in job execution not recognized and corrected even though supervisor, duty station manager and asst maintenance manager were present and able to recognize what was going on | Contributing Cause 3 and Root Cause 1 |

## Attachment 5 - Change Analysis

| ATTRIBUTE | PROBLEM SITUATION | PRIOR SITUATION | DIFFERENCES/ CHANGES | IMPACT ON EVENT |
|---|---|---|---|---|
| Work priority decision | Decision is made to replace 72-123 | Only troubleshooting would be performed | Replacement of breaker 72-123 will involve work on energized bus of panel ED-11-2 which has EOOS orange risk factor | Weak decision making and failure to perform qualitative risk analysis support Root Cause 1 |
| Use of insulating gloves | Insulating gloves are used to remove damaged bus connectors in panel ED-11-2 | Prejob brief plan was to sheets of insulating material | There is inadequate separation between opposing phase bus connectors during repair work which increases the chance of short circuit | Failure to rebrief this change in plans reduces chances for successful completion and supports Root Cause 1 |
| Work on damaged bus connectors | Damaged bus connectors are removed from panel ED-11-2 to repair threads | Work order plans indicate bus connectors will be repaired in the panel. Task does not include the word REMOVE. | Removal reduces chances that metal chips will fall into bus which is good; removal of connectors increases risk that errors will occur because it increases the complexity of the task | Worker do not stop to change the instructions or rebrief the next steps to be completed; supports Root Cause 1 |

# Attachment 6 - Safety Culture Evaluation

## TABLE 1 – SAFETY CULTURE COMPARISON

| SAFETY CULTURE COMPONENT | DESCRIPTION | CR-PLP-2011-4822– Plant Trip During Panel ED-11-2 Maintenance |
|---|---|---|
| 1. Decision-Making | Licensee decisions demonstrate that nuclear safety is an overriding priority. | **RC1** |
| 2. Resources | The licensee ensures that personnel, equipment, procedures, and other resources are available and adequate to assure nuclear safety. | **RC1/ CC2** |
| 3. Work Control | The licensee plans and coordinates work activities, consistent with nuclear safety | **RC1** |
| 4. Work Practices | Personnel work practices support human performance. | **RC1/ CC2/ CC3** |
| 5. Corrective Action Program | The licensee ensures that issues potentially impacting nuclear safety are promptly identified, fully evaluated, and that actions are taken to address safety issues in a timely manner, commensurate with their significance. | No safety culture weakness determined for any of the identified causes |
| 6. Operating Experience | The licensee uses operating experience (OE) information, including vendor recommendations and internally generated lessons learned, to support plant safety. | No safety culture weakness determined for any of the identified causes |
| 7. Self- and Independent Assessments | The licensee conducts self- and independent assessments of their activities and practices, as appropriate, to assess performance and identify areas for improvement. | No safety culture weakness determined for any of the identified causes |

| SAFETY CULTURE COMPONENT | DESCRIPTION | CR-PLP-2011-4822– Plant Trip During Panel ED-11-2 Maintenance |
|---|---|---|
| 8. Environment For Raising Concerns | An environment exists in which employees feel free to raise concerns both to their management and/or the NRC without fear of retaliation and employees are encouraged to raise such concerns. | No safety culture weakness determined for any of the identified causes |
| 9. Preventing, Detecting and Mitigating Perceptions of Retaliation | A policy for prohibiting harassment and retaliation for raising nuclear safety concerns exists and is consistently enforced. | No safety culture weakness determined for any of the identified causes |
| 10. Accountability | Management defines the line of authority and responsibility for nuclear safety. | **RC1/CC3** |
| 11. Continuous Learning Environment | The licensee ensures that a learning environment exists. | **RC1/CC3** |
| 12. Organizational Change Management | Management uses a systematic process for planning, coordinating, and evaluating the safety impacts of decisions related to major changes in organizational structures and functions, leadership, policies, programs, procedures, and resources. Management effectively communicates such changes to affected personnel. | No safety culture weakness determined for any of the identified causes |
| 13. Safety Policies | Safety policies and related training establish and reinforce that nuclear safety is an overriding priority in that. | No safety culture weakness determined for any of the identified causes |

**NOTES**

1. Decision Making - Indicated because personnel in all parts of the Plant organization did not recognize, account for or prepare for the industrial safety and Plant operational risk involved with the panel ED-11-2 breaker maintenance. (H1a). This was described by the examples identified for RC1 and will be addressed by the corrective actions assigned to that cause and its Extent.

2. Resources - Indicated because management personnel exceeded established work hours rules and failed to follow prejob brief requirements (H2b) and because work orders used for breaker maintenance did not include details appropriate for energized, high critical equipment (H2c) Concerns will be addressed by the corrective actions for RC1 and CC2.

3. Work Control - Indicated because all parts of the Plant organization did not recognize, account for or prepare for the industrial safety and Plant operational risk involved with the panel ED-11-2 breaker maintenance. (H3a) This was described by the examples identified for RC1 and will be addressed by the corrective actions assigned to that cause and its Extent.

4. Work Practices - Oversight by managers and supervisors did not result in identification and correction (H4b) of the errors and weaknesses on the part of the Maintenance work crew (H4a) involved with the breaker inspection and maintenance work that lead to this event. Based on the evidence, the Plant organization did not recognize and account for the industrial safety and Plant trip risk involved(H4c) This will be addressed by corrective actions assigned for RC1, CC2 and CC3.

5. Accountability - Managers and supervisors did not recognize the industrial safety and Plant trip risk involved with the breaker inspection and maintenance work that lead to this event and did not reinforce safety standards among themselves or with those doing the work (A1b) . result in identification and correction (H4b) of the errors and weaknesses on the part of the Maintenance work crew (H4a) involved. This concern will be addressed by corrective actions assigned for RC1 and CC3.

6. Continuous Learning Environment - Regardless of supervisor and manager training based on SOER 10-2, none of those present at the prejob brief or at the work site, identified or corrected lapses in the conduct of the prejob brief, the lack of critical steps or the failure to stop and reconsider when the job plan changed (C2a). This concern will be addressed by corrective actions assigned for RC1 and CC3.

## TABLE 2 – DETAILED SAFETY CULTURE COMPONENT REVIEW

| | | Description | CR-PLP-2011-4822– Plant Trip During Panel ED-11-2 Maintenance |
|---|---|---|---|
| **1. Decision-Making** | | **Licensee decisions demonstrate that nuclear safety is an overriding priority. Specifically (as applicable):** | |
| **DM** | H.1(a) | The licensee makes safety-significant or risk-significant decisions using a systematic process, especially when faced with uncertain or unexpected plant conditions, to ensure safety is maintained. This includes formally defining the authority and roles for decisions affecting nuclear safety, communicating these roles to applicable personnel, and implementing these roles and authorities as designed and obtaining interdisciplinary input and reviews on safety-significant or risk-significant decisions. | Applicable to RC1. See Note 1. |
| **DM** | H.1(b) | The licensee uses conservative assumptions in decision making and adopts a requirement to demonstrate that the proposed action is safe in order to proceed rather than a requirement to demonstrate that it is unsafe in order to disapprove the action. The licensee conducts effectiveness reviews of safety-significant decisions to verify the validity of the underlying assumptions, identify possible unintended consequences, and determine how to improve future decisions. | No safety culture weakness determined for any of the identified causes |
| **DM** | H.1(c) | The licensee communicates decisions and the basis for decisions to personnel who have a need to know the information in order to perform work safely, in a timely manner. | No safety culture weakness determined for any of the identified causes |
| **2. Resources** | | **The licensee ensures that personnel, equipment, procedures, and other resources are available and adequate to assure nuclear safety. Specifically, those necessary for:** | |
| **RES** | H.2(a) | Maintaining long term plant safety by maintenance of design margins, minimization of long-standing equipment issues, minimizing preventative maintenance deferrals, and ensuring maintenance and engineering backlogs which are low enough to support safety. | No safety culture weakness determined for any of the identified causes |
| **RES** | H.2(b) | Training of personnel and sufficient qualified personnel to maintain work hours within working hours guidelines. | Applicable to RC1. See Note 2 |
| **RES** | H.2(c) | Complete, accurate and up-to-date design documentation, procedures, and work packages, and correct labeling of components. | Applicable to CC2. See Note 2. |
| **RES** | H.2(d) | Adequate and available facilities and equipment, including physical improvements, simulator fidelity and emergency facilities and equipment. | No safety culture weakness determined for any of the identified causes. |
| **3. Work Control** | | **The licensee plans and coordinates work activities, consistent with nuclear safety. Specifically (as applicable):** | |
| **WC** | H.3(a) | The licensee appropriately plans work activities by incorporating • risk insights; • job site conditions, including environmental conditions which may impact human performance; plant structures, systems, and components; human-system interface; or radiological safety; and • the need for planned contingencies, compensatory actions, and abort criteria. | Applicable to RC1. See Note 3. |

| | | Description | CR-PLP-2011-4822– Plant Trip During Panel ED-11-2 Maintenance |
|---|---|---|---|
| **WC** | H.3(b) | The licensee appropriately coordinates work activities by incorporating actions to address: \| • the impact of changes to the work scope or activity on the plant and human performance. • the impact of the work on different job activities, and the need for work groups to maintain interfaces with offsite organizations, and communicate, coordinate, and cooperate with each other during activities in which interdepartmental coordination is necessary to assure plant and human performance. • The need to keep personnel apprised of work status, the operational impact of work activities, and plant conditions that may affect work activities. • The licensee plans work activities to support long-term equipment reliability by limiting temporary modifications, operator work-arounds, safety systems unavailability, and reliance on manual actions. Maintenance scheduling is more preventive than reactive. | No safety culture weakness determined for any of the identified causes |
| **4. Work Practices** | | **Personnel work practices support human performance. Specifically (as applicable):** | |
| **WP** | H.4(a) | The licensee communicates human error prevention techniques, such as holding pre-job briefings, self and peer checking, and proper documentation of activities. These techniques are used commensurate with the risk of the assigned task, such that work activities are performed safely. Personnel are fit for duty. In addition, personnel do not proceed in the face of uncertainty or unexpected circumstances. | Applicable to CC3. See Note 4. |
| **WP** | H.4(b) | The licensee defines and effectively communicates expectations regarding procedural compliance and personnel follow procedures | Applicable to CC2 and CC3. See Note 4. |
| **WP** | H.4(c) | The licensee ensures supervisory and management oversight of work activities, including contractors, such that nuclear safety is supported. | Applicable to RC1. See Note 4. |
| **5. Corrective Action Program** | | **The licensee ensures that issues potentially impacting nuclear safety are promptly identified, fully evaluated, and that actions are taken to address safety issues in a timely manner, commensurate with their significance. Specifically (as applicable):** | |
| **CAP** | P.1(a) | The licensee implements a corrective action program with a low threshold for identifying issues. The licensee identifies such issues completely, accurately, and in a timely manner commensurate with their safety significance. | No safety culture weakness determined for any of the identified causes |
| **CAP** | P.1(b) | The licensee periodically trends and assesses information from the CAP and other assessments in the aggregate to identify programmatic and common cause problems. The licensee communicates the results of the trending to applicable personnel. | No safety culture weakness determined for any of the identified causes |
| **CAP** | P.1(c) | The licensee thoroughly evaluates problems such that the resolutions address causes and extent of conditions, as necessary. This includes properly classifying, prioritizing, and evaluating for operability and reportability conditions adverse to quality. This also includes, for significant problems, conducting effectiveness reviews of corrective actions to ensure that the problems are resolved. | No safety culture weakness determined for any of the identified causes |
| **CAP** | P.1(d) | The licensee takes appropriate corrective actions to address safety issues and adverse trends in a timely manner, commensurate with their safety significance and complexity. | No safety culture weakness determined for any of the identified causes |
| **CAP** | P.1(e) | If an alternative process (i.e., a process for raising concerns that is an alternate to the licensee's corrective action program or line management) for raising safety concerns exists, then it results in appropriate and timely resolutions of identified problems. | No safety culture weakness determined for any of the identified causes |

| | | Description | CR-PLP-2011-4822– Plant Trip During Panel ED-11-2 Maintenance |
|---|---|---|---|
| **6. Operating Experience** | | **The licensee uses operating experience (OE) information, including vendor recommendations and internally generated lessons learned, to support plant safety. Specifically (as applicable):** | |
| **OE** | P.2(a) | The licensee systematically collects, evaluates, and communicates to affected internal stakeholders in a timely manner relevant internal and external OE. | No safety culture weakness determined for any of the identified causes |
| **OE** | P.2(b) | The licensee implements and institutionalizes OE through changes to station processes, procedures, equipment, and training programs. | No safety culture weakness determined for any of the identified causes |
| **7. Self- and Independent Assessments** | | **The licensee conducts self- and independent assessments of their activities and practices, as appropriate, to assess performance and identify areas for improvement. Specifically (as applicable):** | |
| **SA** | P.3(a) | The licensee conducts self-assessments at an appropriate frequency; such assessments are of sufficient depth, are comprehensive, are appropriately objective, and are self-critical. The licensee periodically assesses the effectiveness of oversight groups and programs such as CAP, and policies. | No safety culture weakness determined for any of the identified causes |
| **SA** | P.3(b) | The licensee tracks and trends safety indicators which provide an accurate representation of performance. | No safety culture weakness determined for any of the identified causes |
| **SA** | P.3(c) | The licensee coordinates and communicates results from assessments to affected personnel, and takes corrective actions to address issues commensurate with their significance. | No safety culture weakness determined for any of the identified causes |
| **8. Environment For Raising Concerns** | | **An environment exists in which employees feel free to raise concerns both to their management and/or the NRC without fear of retaliation and employees are encouraged to raise such concerns. Specifically ( as applicable):** | |
| **ERC** | S.1(a) | Behaviors and interactions encourage free flow of information related to raising nuclear safety issues, differing professional opinions, and identifying issues in the CAP and through self assessments. Such behaviors include supervisors responding to employee safety concerns in an open, honest, and non-defensive manner and providing complete, accurate, and forthright information to oversight, audit, and regulatory organizations. Past behaviors, actions, or interactions that may reasonably discourage the raising of such issues are actively mitigated. As a result, personnel freely and openly communicate in a clear manner conditions or behaviors, such as fitness for duty issues that may impact safety and personnel raise nuclear safety issues without fear of retaliation. | No safety culture weakness determined for any of the identified causes |
| **ERC** | S.1(b) | If alternative processes (i.e., a process for raising concerns or resolving differing professional opinions that are alternates to the licensee's corrective action program or line management) for raising safety concerns or resolving differing professional opinions exists, then they are communicated, accessible, have an option to raise issues in confidence, and are independent, in the sense that the program does not report to line management (i.e., those who would in the normal course of activities be responsible for addressing the issue raised). | No safety culture weakness determined for any of the identified causes |

| | | Description | CR-PLP-2011-4822– Plant Trip During Panel ED-11-2 Maintenance |
|---|---|---|---|
| **9. Preventing, Detecting, and Mitigating Perceptions of Retaliation** | | **A policy for prohibiting harassment and retaliation for raising nuclear safety concerns exists and is consistently enforced in that:** | |
| **PDR** | S.2(a) | All personnel are effectively trained that harassment and retaliation for raising safety concerns is a violation of law and policy and will not be tolerated | No safety culture weakness determined for any of the identified causes |
| **PDR** | S.2(b) | Claims of discrimination are investigated consistent with the content of the regulations regarding employee protection and any necessary corrective actions are taken in a timely manner, including actions to mitigate any potential chilling effect on others due to the personnel action under investigation. | No safety culture weakness determined for any of the identified causes |
| **PDR** | S.2(c) | The potential chilling effects of disciplinary actions and other potentially adverse personnel actions (e.g., reductions, outsourcing, and reorganizations) are considered and compensatory actions are taken when appropriate. | No safety culture weakness determined for any of the identified causes |
| **10. Accountability** | | **Management defines the line of authority and responsibility for nuclear safety. Specifically (as applicable):** | |
| **ACC** | A.1(a) | (a) Accountability is maintained for important safety decisions in that the system of rewards and sanctions is aligned with nuclear safety policies and reinforces behaviors and outcomes which reflect safety as an overriding priority. | No safety culture weakness determined for any of the identified causes |
| **ACC** | A.1(b) | (b) Management reinforces safety standards and displays behaviors that reflect safety as an overriding priority. | Applicable to RC1 and CC3. See Note 5. |
| **ACC** | A.1(c) | (c) The workforce demonstrates a proper safety focus and reinforces safety principles among their peers. | No safety culture weakness determined for any of the identified causes |
| **11. Continuous learning environment** | | **The licensee ensures that a learning environment exists. Specifically (as applicable):** | |
| **CLE** | C.2(a) | (a) The licensee provides adequate training and knowledge transfer to all personnel on site to ensure technical competency. | Applicable to RC1 and CC3. See Note 6. |
| **CLE** | C.2(b) | (b) Personnel continuously strive to improve their knowledge, skills, and safety performance through activities such as benchmarking, being receptive to feedback, and setting performance goals. The licensee effectively communicates information learned from internal and external sources about industry and plant issues. | No safety culture weakness determined for any of the identified causes |
| **12. Organizational change management** | | | |
| **OCM** | **12. Organizational change management** | **Management uses a systematic process for planning, coordinating, and evaluating the safety impacts of decisions related to major changes in organizational structures and functions, leadership, policies, programs, procedures, and resources. Management effectively communicates such changes to affected personnel.** | No safety culture weakness determined for any of the identified causes |
| **13. Safety policies** | | **Safety policies and related training establish and reinforce that nuclear safety is an overriding priority in that:** | |
| **SP** | SP.4(a) | (a) These policies require and reinforce that individuals have the right and responsibility to raise nuclear safety issues through available means, including avenues outside their organizational chain of command and to external agencies, and obtain feedback on the resolution of such issues. | No safety culture weakness determined for any of the identified causes |
| **SP** | SP.4(b) | (b) Personnel are effectively trained on these policies. | No safety culture weakness determined for any of the identified causes |

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| **SP** | SP.4(c) | (c) Organizational decisions and actions at all levels of the organization are consistent with the policies. Production, cost and schedule goals are developed, communicated, and implemented in a manner that reinforces the importance of nuclear safety. | No safety culture weakness determined for any of the identified causes |
| **SP** | SP.4(d) | (d) Senior managers and corporate personnel periodically communicate and reinforce nuclear safety such that personnel understand that safety is of the highest priority. | No safety culture weakness determined for any of the identified causes |

# Attachment 7 - Evaluation for Organization and Programmatic Issues

Include this Worksheet as an Attachment to the report. The questions are provided to promote consideration of like symptoms, not to define a specific failure mode. O&P causal factors are symptoms of the more basic causes of the event and are typically an action or condition that shaped the outcome of the situation.
For each causal factor block checked YES:

1. Ensure it is appropriately represented in the WHY Staircase as a cause or contributor.
2. In the BARRIER ANALYSIS, tie the O&P causal factors as appropriate to Barriers that failed, were weak, missing, or ineffective.
3. Summarize in the O&P section of the report how the identified Organizational & Programmatic weaknesses caused or contributed to the event and identify the Barrier which should have prevented it.

| **O&P Worksheet** | | | |
|---|---|---|---|
| **Potential O&P Failure Modes (Causal Factors)** | **Contributed to or Caused Event?** | | **RC# AC # CC#** |
| | **YES** | **NO** | |
| 1) **OP1X - Organization to Organization Interface Weaknesses**<br>• **Inadequate interface among Organizations** (Good organizational structure but organizations don't communicate).<br>• **Excessive or lack of overlap in functions** (Overall structural design results in overlaps or holes between organizations) | | | |
| a) OP1A - Does there appear to be evidence of inadequate interface among organizations?<br>Problems in this area surface in the form of a high human error rate in tasks requiring communication among different organizations. Usually this is caused by a lack of interface formality (tailgate meetings, formal interface documentation or agreements, etc.), inadequate teamwork or trust among organizations, or inadequate physical settings. | | **N** | |
| b) OP1B – Is there evidence of excessive or lack of overlap functions between organizations?<br>Negative performance in this block is usually caused by a lack of organizational planning resulting in an inadequate definition of job functions between one or more organizations. | | **N** | |
| c) OP1C – Is there evidence that the required notifications were not made when the job was begun, interrupted or completed?<br>Describes either the failure to perform the verbal communication of status when required by the process *or* the failure to design the process to require the verbal communication of status when successful implementation of the process depended upon this communication. | | **N** | |
| d) OP1D – Is there evidence that appropriate personnel and departmental interactions were not fully considered when new processes were created during the implementation phases of the change?<br>Changes to processes created new requirements for interaction between personnel or departments that were not considered in the implementation phase of the change. | | **N** | |
| e) OP1E – Is there evidence that planning was not coordinated with inputs from walk-downs and task analysis?<br>Job plan did not incorporate information gathered during field visits or task analysis concerning the steps and conditions required for successful completion of the task. | | **N** | |
| f) OP1F – Is there evidence that planning was not coordinated with all departments involved in task<br>Interdepartmental communication and teamwork were not supported by the planned work flow. | | **N** | |
| 2) **OP2X - Organization to Program Interface Weaknesses**<br>• **Lack of commitment to program implementation** (organization never gets program off the ground)<br>• **Inadequate Program monitoring or management** (organization does not monitor or manage the program effectively)<br>• **Lack of program evaluation process** (program survives but Organization does not evaluate program, so it goes in the wrong direction)<br>**Lack of organizational authority for program implementation** (organization starves to death because no one is protecting it) | | | |
| a) OP2A – Is there evidence of a lack of commitment to program implementation?<br>Usually evidenced by slow program implementation. The failure is generally due to excessive program implementation requirements or a lack of management support of the program. | **Y** | | **RC1/ CC4** |
| b) OP2B – Is there evidence of inadequate program monitoring or inadequate management skills?<br>Indicated by a lack of program improvement over time. Usually it is caused by inadequate staffing or inadequate management skills. | **Y** | | **RC1/ LOW** |

| O&P Worksheet | | | |
|---|---|---|---|
| **Potential O&P Failure Modes (Causal Factors)** | **Contributed to or Caused Event?** | | **RC# AC # CC#** |
| | **YES** | **NO** | |
| c) OP2C – Is there evidence of a lack of a program evaluation process?<br>This area is more reactive, in that a program failure occurs before action is taken. However, the same items contribute to negative performance, i.e., inadequate management practices, inadequate staffing for program implementation, or insufficient program design. | | **N** | |
| d) OP2D – Is there evidence of a lack of organizational authority for program implementation?<br>This code usually is associated with an insufficient budget for the program or fragmented responsibility and/or accountability for the program. Potential causes include a lack of organizational planning or a lack of management commitment to program implementation. | **Y** | | **RC1** |
| e) OP2E – Is there evidence of unclear or complex wording or grammar in program implementation documents?<br>Wording, grammar or symbols fail to clearly and concisely specify the required action; instructions provided for team of users fail to specify roles of each user. | | **N** | |
| f) OP2F – Is there evidence of an omission of relevant information in program implementation documents that would have prevented an event from occurring (e.g. insufficient information in graphs, tables or illustration; lack of instructions or data sheet documentation requirements, etc.)<br>Over reliance on user's training, skills or experience; lack of detail for infrequent, complex, crucial or error-prone tasks; insufficient information in graphs, tables or illustrations; lack of instructions for data sheet documentation requirements | **Y** | | CC1, CC4, EOC |
| g) OP2G – Is there evidence of the lack of a procedure that should have been written but does not exist?<br>The process meets administrative requirements for having a procedure, but no procedure has been written. | | **N** | |
| h) OP2H – Is there evidence that policy guidance or management expectations were not well defined or understood by personnel involved in performing the task?<br>Personnel exhibited a lack of understanding of existing policy and/or expectations, or policy/expectations were not defined. | **Y** | | |
| i) OP2I – Is there evidence that job standards were not adequately defined or communicated?<br>Measurement of effectiveness could not be performed for specific job functions due to lack of defined standards. | | **N** | |
| j) OP2J – Is there evidence that personnel exhibited insufficient awareness of the impact of actions on safety and reliability?<br>Management failed to provide direction regarding safeguards against non-conservative actions by personnel concerning nuclear safety or reliability | **Y** | | |
| k) OP2K – Is there evidence that management follow-up or monitoring of activities was ineffective in identifying shortcomings in implementation?<br>l) Management's methods for monitoring the success of initiatives were ineffective in identifying shortcomings in the implementation. | **Y** | | |
| m) OP2L – Is there evidence that causes of a previous event or known problem were not determined?<br>Analysis methods failed to uncover the causal factors of consequential or non-consequential events. | | **N** | |
| n) OP2M – Is there evidence that the effects of changes on planned schedules were not adequately addressed prior to implementation?<br>Changes to processes which resulted in scheduled changes had effects on personnel or equipment that were not addressed in the change implementation. | | **N** | |
| o) OP2N – Is there evidence that the job scoping process did not properly identify potential task interruptions or environment stress?<br>Work scoping process was not effective in detecting reasonable obstructions to work flow (e.g., shift changes) or the impact of environmental conditions. | | **N** | |
| p) OP2O – Is there evidence that the job scoping process did not identify special circumstances or conditions that may be impacted or dependent on other circumstances or conditions?<br>Work scoping process was not effective in detecting work process elements having a dependency upon other circumstances or conditions. | | **N** | |
| q) OP2P – Is there evidence that the field walk down input to design was less than adequate?<br>Design change and/or field change requests as a result of inadequate field walk downs to verify actual configurations of plant components, structures and systems that interface with or affect the designs. | | **N** | |
| 3) **OP3X - Program to Program Interface Weaknesses**<br>• **Lack of interface requirements** (no formal procedures to make sure two programs talk to each other)<br>• **Conflicting program requirements** (conflicting actions required by two different programs)<br>• **Inadequate interface requirements** (information required is available but program interfaces are inadequate to get it) | | | |

| O&P Worksheet | | | |
|---|---|---|---|
| **Potential O&P Failure Modes (Causal Factors)** | **Contributed to or Caused Event?** | | **RC# AC # CC#** |
| | **YES** | **NO** | |
| a) OP3A – Is there evidence of a lack of interface requirements between two or more programs that are required to interface in that details necessary to ensure a consistent standard are not adequately covered in programmatic implementing documents?<br>Usually this is caused by inadequate program design or an inadequate work planning process. | | **N** | |
| b) OP3B – Is there evidence of conflicting program requirements where one program has different actions from another program for the same issue?<br>This codes is used when different actions are required by two or more programs for the same situation. As a result, staff efficiency and accountability is negatively impacted. | | **N** | |
| c) OP3C – Is there evidence of inadequate interface requirements in that one program specifies actions different from another program for the same issue?<br>This code is used when actions are required by one program belonging to another program that is inadequate in perform the actions. The cause is usually inadequate program design and/or inadequate work planning processes | | **N** | |
| 4) **OP4X – Programmatic Deficiencies**<br>• **Insufficient detail** (This is my first time doing this, how am I supposed to know what "use normal process" means?)<br>• **Inadequate scope** ("The procedure left out all the information on the electrical cables that need to be connected")<br>• **Excessive implementation requirements** (so many requirements that people give up and don't try to follow the procedure)<br>• **Inadequate verification process** ("We haven't really looked at our processes and given them a 'check up' for over 15 years") | | | |
| a) OP4A – Is there evidence that there are insufficient details in a procedure to perform the task?<br>When a program is vague regarding what is required in a particular situation, it is usually indicative of an inadequate program design or insufficient feedback for individuals using the procedure. | **Y** | | **CC2** |
| b) OP4B – Is there evidence of inadequate job scope (omission of necessary functions) in an implementing procedure because of an inadequate program design or inadequate feedback from the field?<br>Either inadequate program design or inadequate feedback from the field is usually taking place | | **N** | |
| c) OP4C – Is there evidence of excessive implementation requirements that result in portions of the program being ignored by the staff due to overload?<br>This can be caused by inadequate program design, lack of work prioritization, or inadequate staffing | | **N** | |
| d) OP4D – Is there evidence of an inadequate verification process (single human error, high program failure rate, poor procedure quality or inadequate program design?<br>Program breakdown by a single human error; high program failure rate, poor procedure quality. Inadequate program design | | **N** | |
| e) OP4E – Is there evidence that there is a lack of responsibility by personnel because it is not well defined or personnel are not being held accountable?<br>Responsibility for process elements (procedures, engineering, training, etc.) was not placed with individuals or accountability for failures of those process elements was not placed with individuals. | | **N** | |
| f) OP4F – Is there evidence that a response to a known or repetitive problem was untimely?<br>Corrective action for known or recurring problems was not performed at or within the proper time. | | **N** | |
| g) OP4G – Is there evidence that needed changes to the plant were not approved or funded which resulted in a plant issue?<br>Corrective actions for existing deficiencies that were previously identified were not approved or funded. | | **N** | |
| h) OP4H – Is there evidence that there was not a means or process to ensure procedures and documents were of adequate quality and up to date?<br>A process for changing procedures or other work documents to ensure quality and timeliness was nonexistent or inadequate | | **N** | |
| i) OP4I – Is there evidence that duties were not well distributed among personnel that contributed to a problem?<br>The work loading of individuals within a group or team did not adequately address training, experience, task frequency and duration, or other situational factors such that responsibility was inappropriately distributed. | | **N** | |
| j) OP4J – Is there evidence that too few workers are assigned to perform a task that contributed to an issue?<br>Job planning did not allot a realistic number of man-hours based on the scope of work described. | | **N** | |

| O&P Worksheet | | | |
|---|---|---|---|
| **Potential O&P Failure Modes (Causal Factors)** | **Contributed to or Caused Event?** | | **RC# AC # CC#** |
| | **YES** | **NO** | |
| k) OP4K – Is there evidence that an insufficient number of training or experienced workers were assigned to a task?<br>Though the overall number of personnel assigned matched the planned man-hour allotment, organization methods failed to identify that personnel assigned did not have adequate experience or training to perform the work. | | **N** | |
| l) OP4L – Is there evidence that there is a problem in perform repetitive tasks and sub tasks which contributed to a problem?<br>Work flow plan repeated tasks or sub tasks to the detriment of successful completion of the evolution. | | **N** | |
| m) OP4M – Is there evidence that there was a less than adequate process for a configuration change to a design document?<br>Documentation generated as a result of a design change which renders the as-left configuration of affected components, structures and systems indeterminate. | **Y** | | **CC1** |
| n) OP4N – Is there evidence that personnel exhibited insufficient awareness of the impact of actions on safety reliability because management failed to provide direction regarding safeguards against non-conservative actions by personnel concerning nuclear safety or reliability?<br>Management failed to provide direction regarding safeguards against non-conservative actions by personnel concerning nuclear safety or reliability. | **Y** | | Nuclear Culture Safety Assessment |
| o) OP4O – Is there evidence that the planning process was not coordinated with inputs from walk downs and task analysis?<br>Job plan did not incorporate information gathered during field visits or task analysis concerning the steps and conditions required for successful completion of the task. | | **N** | |
| p) OP4P – Is there evidence that previous industry or in-house operating experience was not effectively used to prevent problems and an event occurred because the information was not properly assimilated by the organization (missed opportunity)?<br>Industry or in-house experience relating to a current problem existed previous to the problem, but was not assimilated by the organization (missed opportunity). | | **N** | |
| 5) **OP5X - Organizational Weaknesses**<br>• **Inadequate function or structure** (poor internal organizational design that is missing vital functions)<br>• **Inadequate attention to emerging problems** (organization doesn't pay attention to what is happening within it)<br>• **Inadequate work prioritization** (organization doesn't prioritize their workloads so they waste time on unimportant things)<br>• **Inadequate communication within the organization** (communication does not get up and down the organizational ladder)<br>• **Inadequate job skills, work practices, or decision making** (organization had a problem because of its people) | | | |
| a) OP5A – Is there evidence of inadequate functions or structure which results in work not being performed due to a lack of organizational planning or inadequate staffing?<br>Specific issues or work are not performed or addressed, usually due to a lack of organizational planning or inadequate staffing. | **Y** | | **RC1** |
| b) OP5B – Is there evidence of inadequate attention to emerging problems?<br>Repetitive organizational crises in morale, work practice, or repeat events, etc. The causes are usually associated with a lack of strong self assessment, strategic planning, and root cause processes. Additionally, inadequate vertical information flow to the decision makers in the organization and inadequate prioritization of work can contribute to a breakdown in this area. | | **N** | |
| c) OP5C – Is there evidence of an inadequate work prioritization process?<br>Normally associated with staff work overload, over-run of the committed budget, and increasing backlog of work items. It is usually caused by inadequate work prioritization and inadequate vertical communication of the organization=s missions and goals. | **Y** | | **RC1/ CC4** |
| d) OP5D – Is there evidence of inadequate communication within the organization?<br>Important issues are not being addressed or a breakdown of normal work processes has occurred. Low staff morale is usually the long term result. Common causes for this include an inadequate information flow path, lack of a teamwork type of culture, or inadequate physical settings | **Y** | | **RC1** |
| e) OP5E – Is there evidence of inadequate job skills, work practices or decision making?<br>Generally evidenced by low morale and excessive human error rates. Causes usually include a punitive management style, inadequate supervision, training, staff qualification, or vertical communication, and conflicting or unreasonable organizational goals. | | **N** | |

| O&P Worksheet | | | |
|---|---|---|---|
| **Potential O&P Failure Modes (Causal Factors)** | **Contributed to or Caused Event?** | | **RC# AC # CC#** |
| | **YES** | **NO** | |
| f) OP5F – Is there evidence that corrective actions for previously identified problems or event was not adequate to prevent recurrence (failed to take meaningful corrective actions for consequential or non-consequential events)?<br>Management failed to take meaningful corrective action for consequential or non-consequential events. | | **N** | |
| g) OP5G – Is there evidence the supervisor was not properly notified of a suspected problem?<br>A problem requiring verbal communication with supervision arose, but was not verbally communicated to the supervisor. | | **N** | |
| h) OP5H – Is there evidence of that pertinent information is not being properly transmitted verbally between the transmitter and the listener and vice versa?<br>The sender failed to verbally transmit information to the listener. This requires a sender and listener to be present, and is regardless of either individual's position in management chain. | | **N** | |
| i) OP5I – Is there evidence that there are too many administrative duties assigned to supervisory staff to properly perform supervisory activities?<br>The administrative load on immediate supervisors adversely affected their ability to supervise ongoing activities | | **N** | |
| j) OP5J – Is there evidence that there is insufficient supervisory resources to provide the needed supervision to plant personnel?<br>Supervisions resource is less than that required by task analysis considering the balance of procedures, supervision and training. | | **N** | |
| k) OP5K – Is there evidence that there is insufficient manpower to support the identified goals and objectives of the plant?<br>Personnel are not available as required task analysis of goal/objective. | | **N** | |
| l) OP5L – Is there evidence that sufficient resources are not provided to ensure adequate training is provided and maintained?<br>Training resources are not available as required by task analysis. | | **N** | |
| m) OP5M – Is there evidence that there is not adequate availability of appropriate materials and tools to do the job?<br>A process for supplying personnel with appropriate materials or tools did not exist. | | **N** | |
| n) OP5N – Is there evidence that there is not a means provided for ensuring adequate equipment and quality/reliability/operability for personnel equipment?<br>A process for ensuring personnel's equipment was satisfactory did not exist. | | **N** | |
| o) OP5O – Is there evidence that personnel selection did not ensure an appropriate match to ensure a motivation for the worker?<br>Personnel selection processes failed to determine a mismatch between motivation and job description prior to task. | | **N** | |
| p) OP5P – Is there evidence that tasks and individual accountability were not made clear to the worker?<br>Tasks (and the individual accountability for the task) that were outside written guidance or training were not made clear to the worker. | **Y** | | |
| q) OP5Q – Is there evidence that the progress and status of task is not adequately tracked by supervision?<br>Supervision did not take the appropriate actions to monitor the task progress or status. | **Y** | | **RC1** |
| r) OP5R – Is there evidence that there is not an appropriate level of in-task supervision planned prior to the task being performed?<br>Supervision did not adequately assess the task for points of supervisory interaction prior to assignment to workers. | | **N** | |
| s) OP5S – Is there evidence that direct supervisory involvement in the task interfered with the overview role of supervision?<br>Supervision became so involved with the actual task steps that overall command and control were adversely affected | | **N** | |
| t) OP5T – Is there evidence that emphasis on the schedule had an impact on doing a quality job and accepted standards were not met as a result of this emphasis?<br>Accepted standards for methods were not met due to supervision's focus on completing the activity within a certain time frame. | **Y** | | **RC1** |
| u) OP5U – Is there evidence that job performance and self checking standards were not properly communicated to the organization performing the work prior to the job being performed?<br>Supervision failed to adequately communicate how standards for job performance and self-checking could be applied to the actual job at hand | | **N** | Covered by OP5P |

| O&P Worksheet | | | |
|---|---|---|---|
| **Potential O&P Failure Modes (Causal Factors)** | **Contributed to or Caused Event?** | | **RC# AC # CC#** |
| | **YES** | **NO** | |
| v) OP5V – Is there evidence that too many concurrent tasks were assigned to the worker that were beyond the individual's abilities?<br>Supervision failed to detect that concurrent job assignments for an individual exceeded the individual's abilities. | | **N** | |
| w) OP5W – Is there evidence that there is frequent job or task shuffling without adequate time to shift attention away from the previous task?<br>Supervision transferred a worker from one task to another without adequate time to shift attention away from previous task. | | **N** | |
| x) OP5X – Is there evidence that supervision did not consider the worker's need to use a higher order of skills that consider the workers talents and strengths?<br>Supervision did not consider the worker's talents or innovative strengths that could be used to perform more challenging work. | | **N** | |
| y) OP5Y – Is there evidence that worker assignments did not consider the worker's previous task?<br>Supervision did not adequately assess the previous task's impact upon the worker's ability to implement the current task. | | **N** | |
| z) OP5Z – Is there evidence that a workers assignment did not consider the worker's ingrained work patterns and necessary work patterns for successful completion of the current task?<br>Supervision failed to assess the incompatibility between worker's ingrained work patterns and necessary work patterns for successful completion of the current task. | | **N** | |
| aa) OP5AA – Is there evidence that there is too an infrequent contact with the workers to detect work habit and attitude changes?<br>Supervision not aware of deviation from desired work habits/attitudes due to lack of interaction with personnel. | | **N** | |
| bb) OP5AB – Is there evidence that supervision provides feedback on negative performance of an individual but not on positive performance?<br>Worker's performance adversely affected by supervision's focus on negative performance feedback. | | **N** | |
| cc) OP5AC – Is there evidence of a lack of teamwork as a result of inadequate training content?<br>Training content did not adequately address actions individuals must take in order for the crew or team as a whole to be successful. | | **N** | |
| dd) OP5AD – Is there evidence of a lack of evaluation of risk and consequences prior to making a change that would have an adverse impact as a result of the change?<br>Elements of the process change were not recognized as having adverse impact or increased risk of adverse impact prior to implementing the change. | **Y** | | **RC1** |
| ee) OP5AE – Is there evidence that personnel exhibited insufficient awareness of the impact of actions on safety and reliability?<br>Management failed to provide direction regarding safeguards against non-conservative actions by personnel concerning nuclear safety or reliability. | **Y** | | **RC1** |
| ff) OP5AF – Is there evidence that causes of a previous event or known problem were not determined?<br>Analysis methods failed to uncover the causal factors of consequential or non-consequential events. | | **N** | |
| gg) OP5AG – Is there evidence that a response to a known or repetitive problem was untimely?<br>Corrective action for known or recurring problems was not performed at or within the proper time. | | **N** | |
| hh) OP5AH – Is there evidence that needed changes were not approved or funded that resulted in a plant problem?<br>Corrective actions for existing deficiencies that were previously identified were not approved or funded. | | **N** | |
| ii) OP5AI – Is there evidence that a means was not provided to ensure procedures and documents are of adequate quality and up to date?<br>A process for changing procedures or other work documents to ensure quality and timeliness was nonexistent or inadequate. | | **N** | |
| jj) OP5AJ – Is there evidence that planning was not coordinated with inputs from walk downs and task analysis?<br>Job plan did not incorporate information gathered during field visits or task analysis concerning the steps and conditions required for successful completion of the task. | | **N** | |

# Attachment 8 - Maintenance Crew Statements

**Statement #1**

Date: October 5th, 2011 Event Date: September 25th, 2011
To Whom It May Concern:

I would like to start this statement by stating the fact that there have been 10 day's since the event and in that waiting period there have been lot's of speculation, misleading information, rumors, and emotional feeling's that have now affected site personnel's thoughts as well as mine. I do feel that this 10 day waiting period has been too long to clearly recall the exact event without some slight influence from conversation's and meetings on what had transpired that day. Therefore this is how the day of the event unfolded to the best of my knowledge.

Started Sunday morning 9-25-11 with turnover from nightshift on temp mod package for 72-127 we had to wait until the supervisor arrived, after supervisor arrived a prejob brief was conducted, the brief went over work instructions, critical steps, human performance tools to be used, safety concerns and was the pre job brief form that the previous shift had filled out. We went over everything that was on the pre job brief form. The brief was held with the supervisor, engineering and acting maintenance manager present, there may have been others there but I can't recall and then had a briefing with ops. The temp mod was implemented and performed without incident.

After lunch on 9-25-11 a prejob brief was performed on the three work packages for inspect and replace breakers 72-119, 72-120, 72-121 and 72-123, the prejob brief was conducted with repairmen, engineering, electrical supervisor, acting maintenance manager, the duty station manager and the NRC present. The briefing was conducted discussing detailed work instructions, safety concerns and the human performance tools to be used, however the brief was performed from memory without using a prejob briefing checklist. After the briefing everyone went out to the ED-il panel, we conducted a job site review with our yellow cards. Performed live dead live on breakers that we needed to remove sat. I determed breaker 72-120 and removed breaker, then engineering and supervisor and NRC inspected bus. I then removed breaker 72-i 19 and engineering and supervisor and NRC inspected cubicle and bus. I then removed 72-121 and engineering and supervisor and NRC inspected cubicle and bus. I then removed 72-123 and engineering and supervisor and NRC inspected cubicle and bus. 72-119 top bus bar had thread damage and the work instruction step 4.7.7 stated as needed clean and tighten bus bar connections including chasing threads and replacing fasteners, we discussed with supervisor, acting maintenance manager and engineering how to chase threads on the live bus and we were told that our work instruction step allowed us to remove bus bar stab off of the live bus because we didn't want to chase threads on a live bus and the reasons were #1 the metal shavings could short out the bus #2 we don't have an insulated thread chaser. It was discussed by repairmen how to remove the bus bar and retain positive control of the Philips head bus bar retaining screw so that it wouldn't fall into the bus, the decision was to hold the screw with an insulated screw driver and the bus bar to be held

with an insulated gloved hand. I was on the left side of _____ when he was in position to remove bus bar, he had the insulated screw driver on the retaining screw and his insulated gloved hand on the bus bar and with positive pressure on the screw to loosen, he began to loosen the screw when I saw an arc near the retaining screw and so did _____, he reacted and pulled his hands out of the panel with the thought that it was blowing up in his face, he was trying to protect his face and possibly his life, that is when the bus bars came in contact with each other and shorted out.

**Statement #2**

7:00AM 9-25-2011
Received a detailed turnover from C-shift of work to be performed, events that led up to this point.
Supervisor was scheduled to be in at 8:00AM so we waited until he arrived to brief the day's work.
Tried with help of engineering's help to find some kind of detail on panel construction, were not able to find any. Held brief with 3 electricians, supervisor and engineering on work for the day. Temp mod, breakers to be removed, engineering's role, etc. Installed temp mod, finished before lunch.
Lunch break Briefly talked about breaker removal and the points at which engineering would step in to evaluate and take pics etc.

Removed 72-120 breaker, Eng. evaluated and took pics. Noted gap between the copper bus bar and
breaker. With approval from supervisors and engineering checked breaker mounting screw to see if it
was loose, it was not.Removed 72-119 breaker noted the threads to the copper bar in question needed to be chased. This isthe point when it was decided that the bar needed to be removed and taken to shop for repairs.

We continued removing removing breakers 72-121 and 72-123 at the request of our supervisor. As with the other 2 breakers engineering did there evaluating as we removed them.
At this point we (electricians) dicussed how to to safely remove piece of busbar decided on the method we used. I then donned my low voltage gloves and insulated screwdriver and when I started to loosen screw is when I saw arcing and reacted.

**Statement #3**

Statement of events on Sunday September 25th 2011

I arrived to work at 08:00 on Sunday, and received a face to face turnover with electrical maintenance superintendent, It was discussed that we would first install a temp mod to provide alternate power to the generator voltage regulator and then the sequence of the breaker removal and install of he the DC breakers located in panel D-11-2 was discussed including the importance of insulating the positive and negative buss bar standoffs to prevent

an electrical short. The repairmen were briefed and ready to install the temp mod to provide alternate power to breaker 72-121 which provides control power to the generator voltage regulator. I then reviewed the TM to have an understanding of the work involved and had a short informal brief with the three repairmen to ensure we all understood the TM installation and what the repairmen's rolls and responsibilities would be. A briefing was then conducted in the control room with the shift manager, control room supervisor and the shift engineer to discuss our work and to establish communications with the control room in the event of an issue occurring during the work. The critical steps discussed were validating that the polarity of the DC power was the same between the temp power and the power currently feeding the voltage regulator. After the brief in the control room work commenced at the temp mod was installed
successfully at 11:00. At approximately 13:00, planning had completed the three work orders to remove and inspect the four breakers in panel D11-2. A pre-job brief was held with electrical maintenance, engineering, the acting maintenance manager, duty station manager, and the NRC to discuss the sequence of the work, safety and human performance tools to be used. It was discussed "what is the worst thing that can happen" and we discussed a short circuit event and that insulating the buss connection stabs would be the method to prevent this. After the completion of the brief, I asked around the table if anyone had any questions or concerns and no one had further input. Work shortly commenced at the D-11-2 panel after an additional brief with the control room and the work orders were taken to working. The sequence of events was to first remove breaker 72-120 and to inspect the connection points between the line side stabs of breaker 72-119 and the positive and negative bus bars and then to continue down the panel and remove breaker 72-121 and then 72-123. Upon the removal of 72-120 and a 1/16 of an inch air gap was found between the positive line stab of 72-119 and the positive buss bar stand off, this was due to a cross threaded connection screw. Breakers 72-121 and 72-123 were then removed with no additional issues found. After discussion with engineering and the repairman the decision was made to remove the positive and negative standoffs to repair the threads on the positive connection stap and then to swap the positive and negative standoffs so that breaker 72- 119 would not have a repaired mounting hole. This meant breaker 72-120 would now have the repaired hole at the connection between the negative line side stab of the breaker, this was determined because 72-120 is a spare breaker. The work instruction note stated to support or insulate the buss bar stand offs to prevent an electrical short. While it was discussed in previous briefings that insulation would be used two repairmen felt they could retain positive control of the standoff and remove it safely. This action was not discussed with me prior to removing the positive bus bar. Standing behind the work boundary I was observing _____ remove the positive bus bar when he lost control and the short occurred. At this point the plant tripped, shortly after we were asked to remove the fault from the panel D11-2 so operations could attempt to restore DC power. After the event _____ conducted a fatigue assessment and I then escorted _____ to the emergency room for fitness for dutytesting.

**Statement #4**

Plant tripped 9-25-11 statement date 10-5-11 Prejob brief attendance maintenance crew, supervisor, NRC, duty station manager, asst maint mgr, and two design engineers. talked about the job and what we were going to do, we removed 72-119 and found a cross threaded screw it was thought to be the smoking gun everybody that was in the brief came a crossed

the boundary to see even the shift manger, this went on for each breaker that was removed 4 total we didn't have any new buss stabs so we were going to swap the spare breaker stabs which had good holes with the breaker with the bad holes.  The job was going well and the NRC left we looked at the work plan and it gave us direction to support the stab and remove it, the hot stab was then supported with a tested voltage gloves and the screw loosened an arc was seen and the stab was let go of, letting the positive stab fall into negative stab at no time did any body see the danger before us or we wouldn't have done it.  My role in this job was handing tools to the teem handing tape anything that would make the job go as expected

**WHY STAIRCASE**

Problem statement: On September 25, 2011, at 1506, while performing maintenance activities on DC electric distribution panel D-11-2, a short circuit condition occurred resulting in reactor trip.

Why? Reactor tripped due to loss of power to two-of-four RPS channels
Why? Loss of left train DC Bus results loss of power to channels A & C

Why?1 Shunt trip breaker 72-01 opened
Why?1 Latent Design Issue

Why?2 D-11-2 short resulted in Bus trip
Why?2 Loose stab dropped causing short
Why?2 No insulation protection for bus
Why?2 Workers decided insulation was not needed
Why?2 Workers and supervision did not stop and question

Why?2.1 Workers rationalized “skill of craft”
Why?2.1 Workers did not recognize risk to themselves or to the plant
Why?2.1 Common practice to work on energized equipment
Why?2.1 Work on energized equipment considered low risk

Why?2.2 Supervision did not recognize risk and ensure insulation was in place
Why?2.2 Work not characterized as risk to workers or plant
Why?2.2 Plant EOOS assessment of risk incomplete
Why?2.2 EOOS result not questioned by management
Why?2.2 Management not always recognizing or managing risk
Why?2.2 Management not sensitive to risk
Why?2.2 Senior management has not ensured the plant culture is risk sensitive