NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

ERO Cause Code Assignment Process

An Event and Data Analysis Tool

February 2020

RELIABILITY | RESILIENCE | SECURITY




3353 Peachtree Road NE
Suite 600, North Tower
Atlanta, GA 30326
404-446-2560 | www.nerc.com

Table of Contents

Revision History

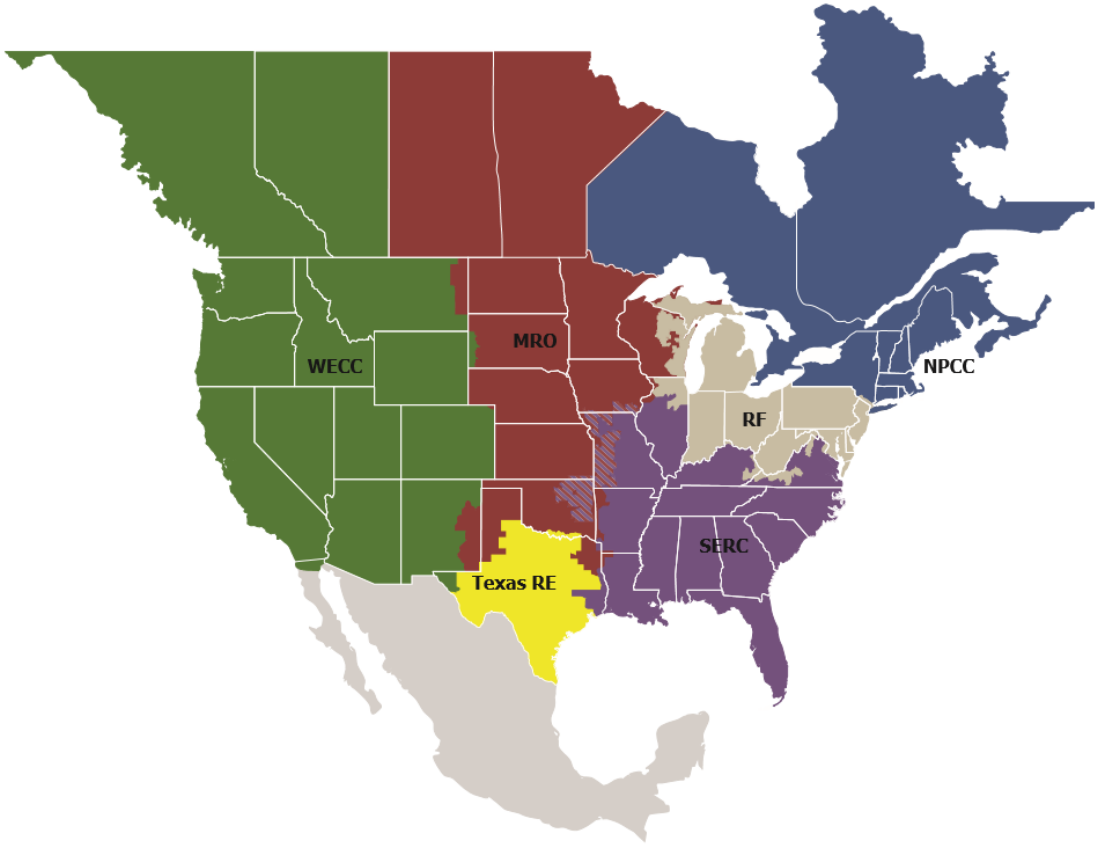
Rev.	Date	Reviewers	Revision Description
0	July 2012	Caroline Clouse, Earl Shockley	Initial Draft by James Merlo and Ben McMillan
1	February 2013	Mike Moon, James Merlo, Ben McMillan	Added A2B7-series codes; expanded AZ codes for B-level and C-level; added or clarified examples.
2	March 2014	Mike Moon, James Merlo, Ben McMillan	Addresses the use of "Primary Effects" within an event; added A7B3-series of codes (vendor codes); expanded the AZB1 codes
3	March 2015	Ben McMillan	Clarifications and examples captured in previous year's experiences; added AZB1C03 code; clarified difference between preventive maintenance (A2B2C01) and predictive maintenance (A2B2C02)
4	March 2016	Ben McMillan, James Merlo, Sam Chanoski, Jule Tate	Clarification of definitions or adding of better examples; added attribute for computer systems maintenance (upgrades/patches); expanded list of Failed Equipment after review of "Other Failed Equipment" comments
5	January 2017		Attribute updates based on on-going data analysis efforts; to provide more granularity
6	December 2017	Ben McMillan	Added EMS related attributes, included suggested changes from markup copy; added examples and potential correction actions on magnetization under contaminant (A2B6C06).
7	February 2019		Change the title from "NERC" CCAP to "ERO" CCAP; Added new attributes; included suggested changes from annual markup copy; added examples and potential corrective actions on A4B1C01.
8	February 2020		Added new attributes: Cyber Security, Extended Fault, Protection System Mis-wiring, and Unintended Relay Actuation; added examples and potential corrective actions on A2B4C02; added a new code AZB3C03 (Non NERC-registered entity cited as involved in event); updated NERC Regions map due to FRCC's dissolution.

Preface

Electricity is a key component of the fabric of modern society and the Electric Reliability Organization (ERO) Enterprise serves to strengthen that fabric. The vision for the ERO Enterprise, which is comprised of the North American Electric Reliability Corporation (NERC) and the six Regional Entities (REs), is a highly reliable and secure North American bulk power system (BPS). Our mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid.

Reliability | Resilience | Security
Because nearly 400 million citizens in North America are counting on us

The North American BPS is divided into six RE boundaries as shown in the map and corresponding table below. The multicolored area denotes overlap as some load-serving entities participate in one Region while associated Transmission Owners/Operators participate in another.



MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RF	ReliabilityFirst
SERC	SERC Reliability Corporation
Texas RE	Texas Reliability Entity
WECC	Western Electricity Coordinating Council

Purpose

The purpose of cause coding is to characterize the causes of reportable events in a structured, measurable, and continuously improvable method.

This document lays out a systematic approach to assigning cause codes after a bulk power system (BPS) event has been analyzed. Using this method will result in effective labeling, collection, and trending of causes. It will also lead to the proper application of risk management procedures to develop and implement appropriate corrective and proactive actions. Formal training and familiarity with root-cause and human performance methods is required for the efficient use of this process.

This document also presents guidance on how the NERC Reliability Risk Management (RRM) group uses cause-coding methods, a process outlined in the NERC Board of Trustees-approved ERO Event Analysis Process that applies to all levels of the ERO enterprise. The ERO Event Analysis Process has improved over the past year, thanks to the involvement of the industry. NERC has refined this manual based on input from Regional Entities and registered entities during calls to review events. This collective effort and participation is leading to a better understanding of 1) the events for which cause codes are assigned, and 2) the recognition (and subsequent clarifications) of definitions and examples used in this document. This process is designed to be a companion piece to the *Cause Analysis Methods for NERC, Regional Entities, and Registered Entities* document. It is intended to assist those responsible for labeling and trending the causal factors and latent deficiencies that lead to BPS events or failures. The ERO Event Analysis Process also provides guidance for developing corrective action plans to address causes of events or failures and preventing reoccurrence of events by using databases to systematically group and analyze the frequency of these codes. These action plans provide examples of opportunities to apply the principles of effective risk management.

Executive Summary

In the Cause Code Assignment Process (CCAP), an event[1] is defined as "an unwanted, undesirable change in the state of plants, systems, or components that leads to undesirable consequences to the safe and reliable operation of the plant or system."[2] The anatomy of an event is often driven and subsequently characterized by a multitude of attributes. These circumstances and characteristics might include deficiencies in barriers and defenses, latent organizational weaknesses and conditions, errors in human performance and environmental factors, and equipment design or maintenance issues. The cause code assignment process detailed in this report covers most of these diverse areas and threats to reliability.

The definitions, examples, and possible corrective actions cited within this document are formatted and drawn, in many instances, from works developed by the Department of Energy (DOE) in their *Occurrence Reporting Causal Analysis Guide, DOE G 231.1-2 Approved 08-20-03 US Department of Energy Office of Environment, Safety and Health* and then tailored for this industry.

This document will be reviewed annually. Changes to this publication will occur as needed, and the most up-to-date version will be maintained on the NERC public website. Persons using this publication are encouraged to submit feedback and updates to NERC at any time. All changes are thoroughly reviewed, and every effort is used to maintain the integrity of the previously established codes and definitions while expanding current codes.

The review of this document, on an annual basis, is NOT intending to result in the removal of any codes; new codes may be developed, and definitions, examples, notes, etc. may be revised for clarification, but for stability and consistency of the system, codes will not "go away".

> Note: For the purposes of the Cause Coding process, the phrase "Less Than Adequate", or "LTA", does not imply any negligence or fault for the entity; it is solely intended to say that the situation to which the "LTA" is assigned was not sufficient to prevent the undesired situation from occurring.

Authority

This publication was prepared by NERC in its capacity as the ERO, and it provides a process to review and trend reliability issues surrounding events that have occurred on the BPS. Section 215(g) of the Energy Policy Act of 2005 provides that "The ERO is to conduct periodic assessments of the reliability and adequacy of the BPS in North America.

North American Electric Reliability Corporation (NERC) is an international regulatory authority established to evaluate and improve the reliability of the BPS in North America. NERC develops and enforces reliability standards; annually assesses seasonal and long-term (10-year) reliability; monitors the BPS through system awareness; and educates, trains, and certifies industry personnel. NERC is the electric reliability organization (ERO) for North America, subject to oversight by the U.S. Federal Energy Regulatory Commission (FERC) and governmental authorities in Canada.

[1] The term "occurrence" will often be used interchangeably with event. For the purpose of this publication, an occurrence is an event that is of smaller magnitude, not meeting the criteria for Category 1 through 5, as defined in the *Electric Reliability Organization Event Analysis Process* dated February 2012.

[2] NERC. 2011. *Cause Analysis Methods for NERC, Regional Entities, and Registered Entities*.

Event Analysis

Errors and Failures

Many events can be avoided proactively by understanding the reasons mistakes occur and the active application of remedies or strategies to prevent them. Others can be avoided reactively by applying lessons learned from past events or errors and actions derived from the analysis of disturbances and system events. The combination of proactive and reactive methods is the best strategic approach for identifying and eliminating hidden organizational weaknesses and error-likely situations that can provoke human error and often degrade barriers and defenses.

Events are often initiated by errors. Errors are actions (behavior) that unintentionally depart from an expected behavior according to a standard or known procedure. Errors are factors in an event when an operator, for example, fails to achieve his or her intended outcome as a result of skill-based, perceptual, judgment, or decision-making errors leading to an undesired or unsafe situation. By definition, errors are unintended. Using the error analysis process, the event analyst must first determine if an individual or team committed an active failure. Then the event analyst must then decide if an error or violation[3] occurred. Once this is done, the event analyst can further define the error.

> The process described in this manual does not make extensive provisions for the assignment of codes for deliberate violations. While there is a cause code for "deliberate violation," it is usually an "occurrence" rather than a true cause and does not detail why the deliberate action was taken. Deliberate violations are extremely uncommon in the analysis of events on the BPS.

As described by Reason (1990), "active failures" are the actions or inactions of operators that are believed to cause the mishap. Traditionally referred to as "errors," they are the last acts committed by individuals, often with immediate and tragic consequences. For example, if a maintenance technician does not follow the proper sequence in a switching order and the result is an unintended breaker tripping or the closing of an incorrect breaker due to misreading a work order, the consequences will be relatively immediate and potentially grave. In contrast, "latent failures" or "conditions" are errors that exist within the organization or elsewhere in the supervisory chain of command that affect the tragic sequence of events characteristic of a mishap.

It is easy to understand how tasking crews or teams without regard to experience or workload can ultimately lead to errors (active failures) in the workplace. Viewed from this perspective, the actions of individuals are the end result of a chain of factors originating in other parts—often the upper echelons—of the organization. The problem is that these latent failures or conditions may lie dormant for some period of time prior to their manifestation as an event, and it is the latent failure that often leads to the event consequences becoming more extreme than expected.

The question for persons analyzing an event is how to identify and mitigate active and latent failures or conditions. One approach is the "Domino Theory," which promotes the idea that, like dominoes stacked in a sequence, mishaps are the result of a series of errors made throughout the system or organization—a perfect storm.

Another version of the Domino Theory is Reason's "Swiss Cheese" model, which describes the levels at which active failures and latent failures or conditions may occur within complex operations (see Figure 1). It is this proverbial "perfect storm" that can be avoided by the systematic analysis of an event and by deliberate and purposeful application of those lessons learned to prevent the reoccurrence.

[3] In the context of this document, the term "violation" is not a reference to any compliance determination or NERC standard. The use in this document denotes a willful or intentional action in terms of human behavior.

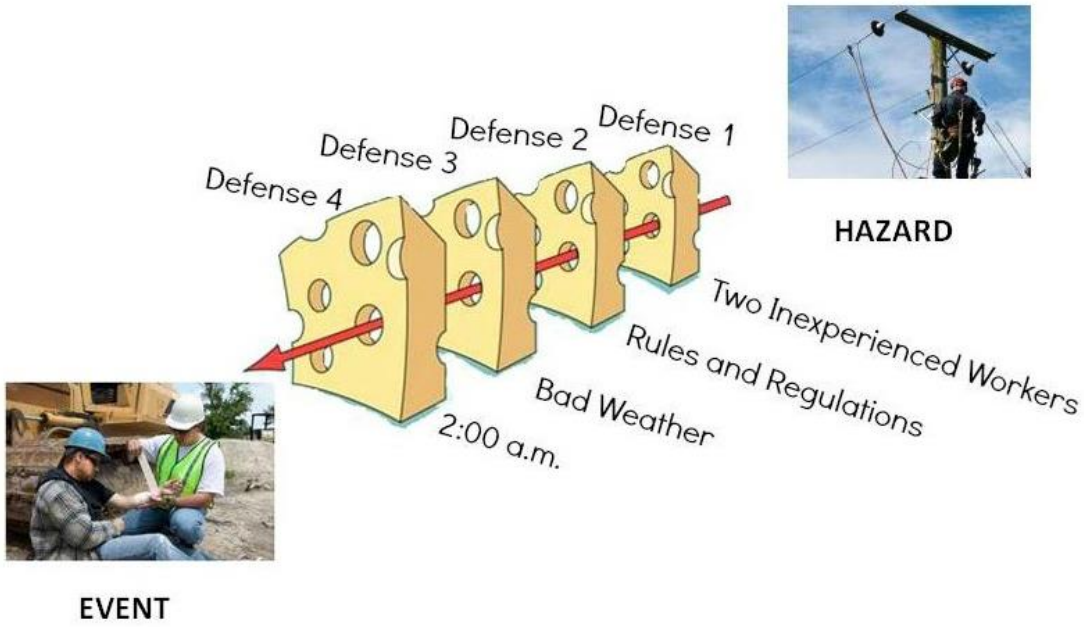


Figure 1: The "Swiss Cheese" Model (adapted from Reason, 1990). Under the wrong set of circumstances, the holes in the defense line up and result in an unwanted event.

Working backward from the mishap, the first level of Reason's model depicts those incorrect or improper actions of an individual (operator, maintainers, facility personnel, etc.) that led to an event. Traditionally, this is where most mishap investigations[4] have focused their examination of human error and is consequently where most causal factors are uncovered. After all, it is typically the actions or inactions of individuals that can be directly linked to the event. However, to stop the investigation here only uncovers part of the story.

What makes Reason's model particularly useful in an event investigation is that it forces investigators to address latent failures and conditions within the causal sequence of events. For instance, latent failures or conditions such as fatigue, complacency, illness, and the physical or technological environment all affect performance but are often overlooked by investigators. These particular latent failures and conditions are described within the context of Reason's model as *Preconditions for Unsafe Acts*. Latent failures or conditions at the supervisory level are often equally responsible for poor hazard analysis and subsequent increased reliability risk and may ultimately be a leading cause to the event. Therefore, organizational influences, like supervision, can promote unsafe conditions of operators and ultimately result in unsafe acts.

For instance, in times of fiscal constraints, funding may be short, which can lead to limited training opportunities with little to no cross-training. Supervisors are sometimes pressed to task "non-proficient," less experienced crews with complex tasks, often leaving work to be done by individuals who need assistance. Not surprisingly, unintended and unrecognized errors may appear and reliable performance will consequently suffer. As such, hazards and risks at all levels must be addressed if the event analysis process is going to be effective.

The investigation and analysis process then endeavors to detect and identify the "holes (hazards) in the cheese (defense)" (see Figure 1).

[4] In the context of this document, any reference to investigation or investigator is not intended to imply any view towards "compliance" but simply used to denote that an analysis of an event is occurring.

So how does one identify these hazards? Most events are not unique from their predecessors. In fact, most mishaps have very similar causes. They are due to the same holes in the cheese, so to speak. The hazards identified in each new event are most often not unique. Therefore, if one knows what these system failures and hazards or "holes" are one can better identify their roles in events—or, better yet, detect their presence and develop a risk mitigation strategy correcting them *before* an event occurs.

Event Characteristics or Attributes

NERC identifies characteristics, attributes, and cause codes of events and occurrences on the BPS, so the events can be systematically queried for common trends or causal factors.

Characteristics or attributes are not necessarily mutually exclusive. An event or occurrence should have as many characteristics or attributes assigned to it as are necessary to properly characterize it. For example, an event could involve a switching error during maintenance that involves a relay failure and results in a loss of load. At a minimum this event would have the following characteristics or attributes assigned: *Maintenance, Switching, Loss of Load, and Failed Equipment-Relay*. More field assignments are possible depending on the event specifics..

Table 1 illustrates the different characteristics or attributes that NERC uses to group events for further analysis.

Table 1: BPS Event Characteristics or Attributes

Characteristic or Attribute	Definition (when this characteristic or attribute applies)
Verbal Communications	The report indicates a verbal communication problem existed and caused or contributed to the event.
Evacuation	The event involved the evacuation of any BPS facility or control center.
Maintenance – Equipment/Facilities	The report indicates maintenance was taking place at the time of the event, and contributed to or caused the event; The problem may include, but is not limited to, delayed, incomplete, not performed, or incorrect maintenance during the maintenance period or activity.
Maintenance – Computer Systems	Normally, computer patches, hardware/software upgrades and backups are considered maintenance. This is used when such maintenance was taking place at the time of the event, and contributed to or caused the event.
Construction	The report indicates construction, which by intent is more deliberate, structured and methodical than most maintenance programs, was taking place at the time of the event, and contributed to or caused the event. Typically, construction includes the expansion or upgrade of new elements or facilities. A full replacement of an EMS may be viewed as Construction, while partial modifications to an EMS would normally be considered Maintenance.
Outage Coordination	An outage coordination problem existed, and caused or contributed to the event; this can be internal to one entity or between entities.
Planning Problem	Planning problems existed and caused or contributed to the event; this can be internal to one entity or between entities; normally this attribute is used for transmission planning issues.
Autoreclosing Relay Problem	The reclose function is housed in a multi-function microprocessor relay in many instances. The report indicates that a misoperation of the auto-reclose function or its supervisory function – (e.g. – time delays, synchronism checks, and voltage checks) contributed to the event. This

Table 1: BPS Event Characteristics or Attributes	
Characteristic or Attribute	**Definition (when this characteristic or attribute applies)**
	attribute excludes manual reclosing and excludes a failure to automatically reclose. (Note: this addition, and the wording of the attribute, comes from FERC Order 803, and our method of capturing this requested data)
Restoration Problem	The report indicates a problem surfaced during an event's restoration process (either restoration from an activity or situation resulted in the event, or an additional problem was uncovered during the recovery from the event under review); this can be internal to one entity or between entities.
Switching	The report indicates switching or switching orders were taking place at the time of the event, contributing to or causing the event.
Testing	The report indicates testing or troubleshooting of BPS facilities (or components thereof) occurred at the time and caused or contributed to the event.
Failed Equipment (* indicates equipment considered under the grouping of Failed AC Substation Equipment)	This whole category (Failed Equipment Type) is intended to show what type of equipment was cited as having failed. The "Other Failed Equipment" category is only to be used to indicate equipment that failed that is not on the list, and when this is used, the user needs to enter a comment as to what that "other" equipment was. Periodically, the Other category will be reviewed for common threads and the list of equipment types will be updated for those events. When this happens, the Other category will be removed from the event. Instrument Transformers are meant to be used when any of the following types of transformers fail: Potential Transformer (PT); Current Transformer (CT); Coupling Capacitor Voltage Transformer (CCVT); Voltage Transformer (VT)
Relays	
Shield Wire/Static Wire	
Splice	
Bushing	
Insulation/Insulator	
Circuit Breaker*	
Communications	
Reactor*	
Capacitor Bank*	
Transformer – Power Transformer*	
Transformer – Instrument Transformer*	
Lightning/Surge Arrestor*	

Table 1: BPS Event Characteristics or Attributes	
Characteristic or Attribute	**Definition (when this characteristic or attribute applies)**
Structure	
Auxiliary Support System (e.g., Variable Frequency Drives, Fire Alarm Control Panels, Ventilation Fans and Controls, Cooling System, Gas Supply Regulator, Instrument Air Pressure Control or Indications, Heater Drain Discharge Valves, Air Compressors)	
Controls – Network (e.g., Network Hubs/Switches, Control System cards, NIC Cards, other types of control cards for the network systems)	
Controls – Power System (e.g., Relay Control cards, GPS cards, GPS Time devices, Alarm circuits)	
Uninterruptible Power Supply (UPS) Switchgear (e.g, transfer switches, Disconnect switches, UPS Bypass switches, Line switches, as examples)	
UPS – the actual box or power supply, not the equipment to make it work (which would be the UPS Switchgear, above)	
Switch* (disconnect switch, ground switch, for the Transmission or Generation systems, as opposed to similarly designated switches found in supporting sub-systems, as examples)	
Circuit Switcher*	
Sensor/Detector (Smoke, flame, IR, level, pressure, or other detectors)	
Other Failed Equipment	
Energy Emergency Alert (EEA)	An EEA is cited in the report as being in existence at the time of the event.

Table 1: BPS Event Characteristics or Attributes	
Characteristic or Attribute	**Definition (when this characteristic or attribute applies)**
Public Appeals	A Public Appeal is cited in the report as being in existence at the time of the event.
Other BES Alerts	Any other official communication regarding emergency or abnormal conditions is cited in the report as being in existence at the time of the event.
Energy Management System (EMS)	The report indicates a problem existed with the EMS system and that it caused or contributed to the event; the problem may include but is not limited to design, testing, installation, modification, and troubleshooting; may be used for either a partial or complete EMS system problem.
Communications - EMS	Communications, specifically within an Energy Management System (EMS), are cited in the report.
Routable equipment (IP)	This attribute is used for communications problems involving routable communication traffic, usually Internet Protocol (IP) traffic, unrelated to physical equipment failure. This could include router, switch, firewall terminal, server and other computer networking issues. Also, this attribute includes switching loops.
Non-routable (Non-IP)	This attribute issued for communications problems involving non-routable communication traffic unrelated to physical equipment failure. This could include POTS (Plain Old Telephone Service), Radio, Microwave, Multiplexers, optical cards, etc.
License	This relates to events where a licensing issue has created a communication problem.
Supervisory Control and Data Acquisition (SCADA)	The report indicates a problem existed with the SCADA system and that it caused or contributed to the event; the problem may include but is not limited to design, testing, installation, modification, and troubleshooting; may be used for either a partial or complete SCADA system.
Inter-Control Center Communication Protocol (ICCP) Data	The report indicates a problem with the ICCP Data or components involved in ICCP implementation.
Inter-regional Security Network (ISN) Data	The report indicates a problem with the ISN Data.
System Tools	Time error correction, load management system, load forecasting market tools, real time contingency analysis, state estimator, or other system tools are cited in the report.
Alarm Problem	Alarms came in and were not acted upon, no alarm occurred for an alarm condition, or a condition should be alarmed, but was not, alarms activated when they should not have, or alarms could not be cleared/reset. This would include alarms that were placed in incorrect priorities, and alarms that should/should not have been audible but were not/were, and where alarms were non-functional or were disabled.
Automatic Generation Control (AGC)	A failure of the AGC system either causes or contributes to the event. Usually, the AGC will be contained in an EMS, so this attribute will normally also indicate the EMS attribute should be flagged. This attribute includes such things as economic dispatch systems, which may be used by or feed data to the AGC system.

Table 1: BPS Event Characteristics or Attributes	
Characteristic or Attribute	**Definition (when this characteristic or attribute applies)**
Diagnostic Tools Lost	Log files, temporary files, diagnostic program outputs, core dumps, relay targets, or other information displays etc. were lost during troubleshooting, reboot, or restoration, which prevents later review to determine root or contributing causes.
Failure to Converge	A tool failed to converge to a valid solution or diverges. This excludes software failure unrelated to the convergence issue, or hardware failures.
State Estimator	The State Estimator failed to converge to a valid solution or diverges. This excludes software failure unrelated to the convergence issue, or hardware failures.
RTCA	The Real Time Contingency Analysis system failed to converge to a valid solution for or diverges for any valid case being studied. This excludes software failure unrelated to the convergence issue, or hardware failures.
Study/Offline	An offline or study case failed to converge to a valid solution or diverges. This excludes software failure unrelated to the convergence issue, or hardware failures.
Time Error Correction	A time error correction either causes or contributes to the event.
Load Management System	Any failure of a load restoration or load shedding tool to perform proper load shedding or load restoration due to design or performance issues that either contributes to or causes the event.
Load Forecasting Tools	A load forecasting tool failure either causes or contributes to the event.
Modeling Error	An error exists within the model (internal and external) used to represent, display, or simulate an electric system. These cases may be in real time, future, or contingency analysis studies. This error may include things such as, but are not limited to: incorrect generator limits, incorrect line and/or transformer ratings, missing breakers, lines missing, incorrect pseudo equipment (including breakers, generators, lines, transformers, loads, etc.), incorrectly equalized sections, Incorrect parameters (physical, electrical), future equipment, incorrectly mapped SCADA control or data points, etc.
Real Time Contingency Analysis (RTCA)	A failure of RTCA either causes or contributes to the event. Usually, the RTCA will be contained in an EMS, so this attribute will normally also indicate the EMS attribute should be flagged.
State Estimator	A failure of the State Estimator either causes or contributes to the event. Usually, the State Estimator will be contained in an EMS, so this attribute will normally also indicate the EMS attribute should be flagged.
Other System Tools	A failure of any other system tools either causes or contributes to the event.
Cyber Security	The report indicates a cyber-security issue occurred. Cyber security refers to the body of technologies, processes, and practices designed to protect networks, devices, programs, and data from attack, damage, or unauthorized access.
Facility Threat	The report indicates a threat to the facility existed; either physical or cyber.

Table 1: BPS Event Characteristics or Attributes	
Characteristic or Attribute	**Definition (when this characteristic or attribute applies)**
Vandalism	The report indicates vandalism occurred.
Suspicious Activity	The report indicates suspicious activity occurred.
Sabotage	The report indicates sabotage occurred.
Copper Theft	The report indicates copper theft occurred.
Human Performance	The report indicates an individual human error occurred.
Organization Performance	The report indicates an organization/management functional issue occurred.
Process	The report indicates a process is inappropriate for the situation/circumstance or is less than adequate.
Computer/software Problem	The report indicates a computer or software problem (hardware or firmware) existed and caused or contributed to the event.
protection system misoperation	The report indicates a protection system misoperation occurred within the event, meaning either a Protection System operated when not desired, or a Protection System did not operate when desired. Definition below is only provided for reference; see latest NERC "Glossary of Terms" if needed/desired. For Event Analysis purposes only, this attribute can also be used when misoperations occur during maintenance and testing activities. However, these misoperations that occur during maintenance and testing activities would not be considered reportable Misoperations. Protection System is defined by the NERC Glossary of Terms as: • Protective relays which respond to electrical quantities • Communications systems necessary for correct operation of protective functions • Voltage and current sensing devices providing inputs to protective relays • Station DC supply associated with protective functions (including batteries, battery chargers, and non-battery-based DC supply), and • Control circuitry associated with protective functions through the trip coil(s) of the circuit breakers or other interrupting devices Misoperation is defined as: • Any failure of a Protection System element to operate within the specified time when a fault or abnormal condition occurs within a zone of protection

Table 1: BPS Event Characteristics or Attributes	
Characteristic or Attribute	**Definition (when this characteristic or attribute applies)**
	• Any operation for a fault not within a zone of protection (other than operation as backup protection for a fault in an adjacent zone that is not cleared within a specified time for the protection for that zone) • Any unintentional Protection System operation when no fault or other abnormal condition has occurred unrelated to on-site maintenance and testing activity
Incorrect Protection System Settings	The report indicates that there were settings or design related shortcomings in the protection system.
Protection System Mis-wiring	The report indicates a protection system mis-wiring problem existed and caused or contributed to the event.
Extended Fault	The report indicates that a fault exists for a significant amount of time (≥5 seconds) beyond what would be considered a normal clearing time
Unintended Relay Actuation	The report indicates a relay was unintentionally activated and operated as designed but caused problems and caused or contributed to the event
Control System Misoperation	The report indicates that there was a control system misoperation. A control system is associated with the action of shifting and/or changing positions or statuses of BPS equipment, in an attempt to reconfigure or change the system. It may or may not be part of a protection system as defined by the NERC Glossary of Terms.
SPS/RAS Unintended Operation (but operated as designed)	The report indicates an SPS (or RAS) was unintentionally activated and operated as designed but caused problems and caused or contributed to the event.
SPS/RAS Misoperation	The report indicates that an SPS (or RAS) did not operate as designed or intended and caused or contributed to the event. This category can be used when the settings are cited as incorrect.
Breaker Failure Operation – failed to operate breaker	Report or event evaluation shows that breaker failure protection operated, as a result of a breaker failing to operate when it should have operated.
Breaker Failure Operation – slow to operate breaker	Report or event evaluation shows that breaker failure protection operated, as a result of a breaker not operating within the timeframe as set in the breaker failure protection scheme.
Vendor Problem	The report indicates that a problem regarding a Vendor existed and caused or contributed to the event.
Contractor Work Problem	Work carried out by a contractor has resulted or contributed to the event. For the purposes of definition, a contractor is a person (or persons) employed directly by some other company but carrying out work (almost as a temporary worker may be doing) on the site controlled by the entity experiencing the event, or a person having remote access to an entity's systems, as part of the work; In contrast, the intent of the term vendor is that the work is carried out at the vendor's location (but not as a continuation of the work done at the contractor's facility)
Natural Phenomena	This whole category (Natural Phenomena) is intended to catalogue those events that are associated with natural phenomena. The Other category
Animal Intrusion	

Table 1: BPS Event Characteristics or Attributes	
Characteristic or Attribute	**Definition (when this characteristic or attribute applies)**
Drought	is only to be used to indicate phenomena that are not included on the list. Periodically, this Other category will be reviewed for common threads and the list of natural phenomena types will be updated for those events. At the same time, the Other category will be removed from the events.
Dust Storm	
Earthquake	
Fire	
Flooding	
Geomagnetic Disturbance	
High Winds	
Hurricane	
Ice	
Lightning	
Pandemic	
Snow	
Tornado	
Tsunami	
Vegetation	
Volcano	
Other	
Interconnection Reliability Operating Limit (IROL)/System Operating Limit (SOL) exceedances (Note – the use of this characteristic does NOT imply any violation of any standards has occurred)	IROL violation: A SOL that, if violated, could lead to instability, uncontrolled separation, or cascading outages that adversely impact the reliability of the BES. SOL violation: The value (such as MW, MVar, Amperes, Frequency or Volts) that satisfies the most limiting of the prescribed operating criteria for a specified system configuration to ensure operation within acceptable reliability criteria. SOLs are based upon certain operating criteria. These include, but are not limited to: • Facility Ratings (applicable pre- and post-contingency equipment or facility ratings) • Transient Stability Ratings (applicable pre- and post-contingency stability limits) • Voltage Stability Ratings (applicable pre- and post-contingency voltage stability) • System Voltage Limits (applicable pre- and post-contingency voltage limits)
Scheduled equipment outage	The report indicates that there was equipment scheduled for outage, leading to or contributing to the event.
Frequency Excursions	The report indicates that there were frequency excursions identified in the event that resulted in actions being taken such as the initiation of protective relays, deployment of generation reserves or other resources.

Table 1: BPS Event Characteristics or Attributes	
Characteristic or Attribute	**Definition (when this characteristic or attribute applies)**
Loss of Offsite Power	The report indicates that there was a loss of offsite power associated with the event (normally associated with a nuclear site).
Islanding	The report indicates an island of the electrical system developed.
Loss of Firm Load	The report indicates a loss of firm load happened.
Loss of Interruptible Load	The report indicates a loss of interruptible (or non-firm) load occurred.
Transmission Outage	The report indicates transmission loss occurred. These transmission losses should align with the reportable TADS elements: AC Circuits, Transformers, DC Circuits, and AC/DC Back-to-Back Converters.
Generation Outage	The report indicates that a generation outage occurred.
Common Tower/ROW	The report indicates an event where initiating action(s) resulted in loss of two or more BPS elements because of a common tower or Right-of-way (ROW) configuration or design.
Solar Farm Impact or impacted	A solar farm (Renewable source) was impacted by the event, or was a contributing factor to the event (so we can capture events where Solar was involved as a renewable generation source)
Wind Farm Impact or impacted	A wind farm (Renewable source) was impacted by the event, or was a contributing factor to the event (so we can capture events where wind farms were involved as a renewable generation source)
Grounding System	The report indicates a problem with the grounding system exists. This is not intended for indicating “stolen grounds” unless the situation results in a reportable BPS event.
Other	This is used when situations are not captured by other categories or fields. A further explanation should be cited when this category is used.

Importance of Cause Coding

From the errors of others, a wise man corrects his own. Publilius Syrus (~100 BC)

A thorough event analysis is absolutely necessary to determine the cause sequence leading to a larger event and to recommend corrective actions to prevent recurrence. This process provides the event investigator with a proven template that provides an organized disciplined approach to apply appropriate cause code(s) after an investigation[5] and subsequent analysis.

The process is sequential. Each step relies on the quality of the previous step.

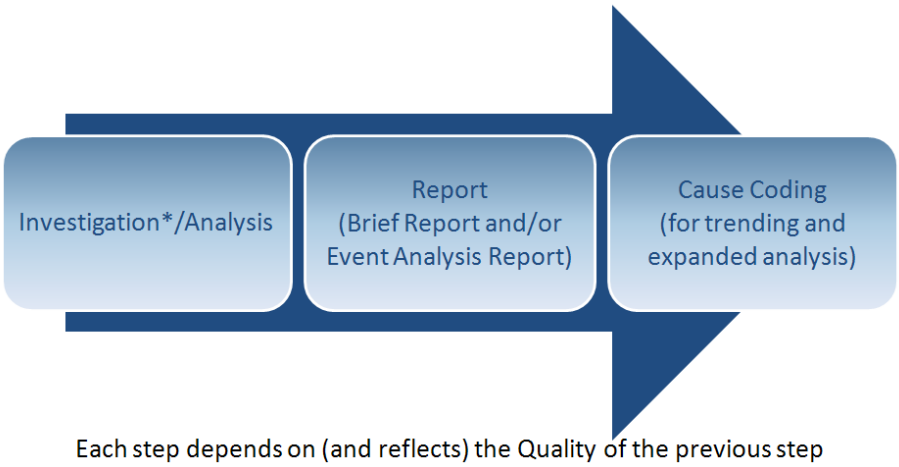


Figure 2: The Sequential Events Analysis Process

If cause codes are assigned too early, the potential for biasing (e.g., confirmation bias) the report or the investigation could occur, and thus are the last step in the sequence. The event analyst must recognize that the cause codes alone do not provide the understanding for the time sequence of events or the cause sequence of the events, and it is this causal sequence which helps determine which of many contributing causes identified may be the root cause. A recognition also must exist that simply because some identified cause "initiated the event", that does not necessarily mean it is the root cause. Many of the BPS event and occurrence collection systems code initiating and sustaining causes, which could be fundamentally different than the root cause. See the *Cause Analysis Methods for NERC, Regional Entities, and Registered Entities* for a more complete discussion.

The analyst assigning cause codes is cautioned to gauge the cause codes based on the report and evidence evaluated. One must refrain from applying personal biases and opinions and should only assign those codes that can be evidenced from the report. One of the goals of the CCAP is the achievement of a consistent code assignment regardless of the analyst.

This CCAP draws upon Reason's (1990) and Wiegmann and Shappell's (2003) concept of active failures and latent failures or conditions, the Department of Defense Human Factors Analysis and Classification System (2005), and the Department of Energy Occurrence Reporting Causal Analysis Guide (2003).

[5] The term "Investigation" as used here does not reflect or imply any "compliance determination".

The NERC CCAP describes the following main tiers of human and equipment errors or conditions:

- A1) Design or Engineering
- A2) Equipment or Material
- A3) Individual Human Performance
- A4) Management or Organization
- A5) Communications
- A6) Training
- A7) Other Factors
- A8) Open
- AN) No Causes Found
- AX) Overall Configuration
- AZ) Information to Determine Cause Less than Adequate (LTA)

The associated nodes and subnodes are defined in Appendix B. This guide is also planned to ensure uniformity across the BPS in terms of human factors definitions and data-driven analysis. The process is designed to allow "three-deep" cause coding: from the appropriate "A" level (the main nodes of the event cause), to a suitable "B," and then "C" cause code as available information allows. While it is not always possible to code three-deep with the information that is available, it is desirable to go as deep as possible in the coding process.

Lastly, as the result of a thorough analysis might dictate, it is considered acceptable to assign multiple cause codes if the event warrants. Most events will have multiple cause codes if a sufficiently thorough analysis was conducted. A small event or occurrence might have only a small number of causes. Normally, the larger the event, the more contributing causes that may be present. By definition, there is only one root cause for an event.

Cause Coding of Larger Events

Larger events, or events that involve multiple entities, demand that the analyst approach the cause coding differently. There are many ways to define the strategy. For example, one can code the event as a whole, divide the event into phases, or divide the event by the entities involved. Often, even a simple event may demonstrate different components which may be cause coded independently. This approach breaks an event into its "Primary Effects", a method to show what caused a subsection of the event to occur. Once the decision is made on how to approach the coding, consistency among the analysts is paramount. The decision of what strategy to use in cause coding any large event relies on many variables, such as the quality of the report, the size of the event, the diversity of causes across the affected entities, and the types of subsequent analysis desired. It is often useful to see if the causes of a larger event are present in emerging trends of smaller events. It is likely that the overall large event's root cause cannot be determined; however, smaller portions of the event or individual entities involvement might provide the ability to determine the root cause of that particular part of the event.

References

NERC. (2011). *Cause Analysis Methods for NERC, Regional Entities, and Registered Entities.*

NERC. (2012). *Electric Reliability Organization Event Analysis Process*.

Reason, James. (1990). *Human Error*. Cambridge University Press.

U.S. Department of Defense. (2005). Department of Defense Human Factors Analysis and Classification System; A mishap investigation and data analysis tool.

U.S. Department of Energy. (2003). Occurrence Reporting Causal Analysis Guide, DOE G 231.1-2 Approved 08-20-03 US Department of Energy Office of Environment, Safety and Health.

Wiegmann, Douglas A. and Shappell, Scott A. (1993). *A human error approach to aviation accident analysis: the human factors analysis and classification system*. Ashgate Publishing Company.

Appendix A: Cause Code Quick Reference

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Start Here

NERC CCAP
Cause Code Quick Reference

nerc.lessonslearned@nerc.net www.nerc.com

A1 Design/Engineering

- B1 DESIGN INPUT LTA
- B2 DESIGN OUTPUT LTA
- B3 DESIGN/ DOCUMENTATION LTA
- B4 DESIGN/ INSTALLATION VERIFICATION LTA
- B5 OPERABILITY OF DESIGN/ENVIRONMENT LTA

A2 Equipment/Material

- B1 CALIBRATION FOR INSTRUMENTS LTA
- B2 PERIODIC/ CORRECTIVE MAINTENANCE LTA
- B3 INSPECTION/ TESTING LTA
- B4 MATERIAL CONTROL LTA
- B5 PROCUREMENT CONTROL LTA
- B6 DEFECTIVE, FAILED, OR CONTAMINATED
- B7 EQUIPMENT INTERACTIONS LTA

A3 Individual Human Performance

- B1 SKILL BASED ERROR
- B2 RULE BASED ERROR
- B3 KNOWLEDGE BASED ERROR
- B4 WORK PRACTICES LTA

A4 Management / Organization

- B1 MANAGEMENT METHODS LTA
- B2 RESOURCE MANAGEMENT LTA
- B3 WORK ORGANIZATION & PLANNING LTA
- B4 SUPERVISORY METHODS LTA
- B5 CHANGE MANAGEMENT LTA

A5 Communication

- B1 WRITTEN COMMUNICATIONS METHOD OF PRESENTATION LTA
- B2 WRITTEN COMMUNICATION CONTENT LTA
- B3 WRITTEN COMMUNICATION NOT USED
- B4 VERBAL COMMUNICATION LTA

A6 Training

- B1 NO TRAINING PROVIDED
- B2 TRAINING METHODS LTA
- B3 TRAINING MATERIAL LTA

A7 Other

- B1 EXTERNAL PHENOMENA
- B2 RADIOLOGICAL/ HAZARDOUS MATERIAL PROBLEM
- B3 VENDOR OR SUPPLIER PROBLEM

A8 (Open)

AX Overall Configuration

- B1 INSTALLATION/DESIGN CONFIGURATION LTA
- B2 MAINTENANCE/MODIFICATION CONFIGURATION LTA

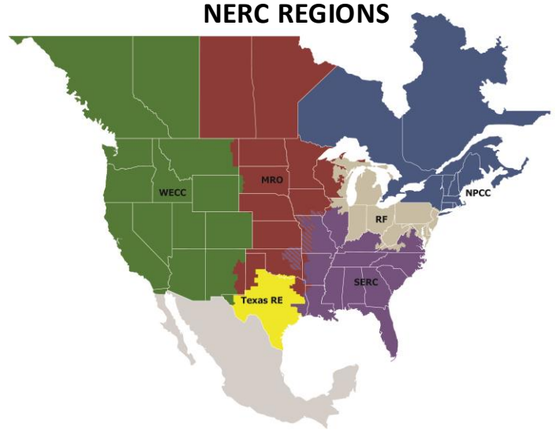
AZ – Information to determine cause LTA

- B1 UNABLE TO IDENTIFY SPECIFIC ROOT CAUSE
- B2 REPORT STOPS AT FAILURE/ERROR MODE (WHAT HAPPENED, NOT WHY IT HAPPENED)
- B3 OTHER PARTIES INVOLVED IN EVENT
- B4 CROSS-REFERENCE REQUIRED FOR OTHER SOURCES OF INFORMATION

AN – No causes found

Level A nodes are underlined
Level B nodes are in ALL CAPS
Level C nodes are in "sentence case"
LTA = Less Than Adequate

NERC REGIONS



Disclaimer: *This NERC Event Analysis document is a working document used for analyzing events in order to identify reliability risk to the North American Bulk Power System, to ensure and continuously improve reliability. This document cannot be used for compliance monitoring or enforcement purposes. Any statements or conclusions on this document will not prejudge the outcome of an event analysis or a potential compliance review associated with the same facts or circumstances. This document makes no findings regarding compliance with Reliability Standards.*

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Start Here

NERC CCAP
Cause Code Quick Reference

nerc.lessonslearned@nerc.net www.nerc.com

A1 Design/Engineering

B1 DESIGN INPUT LTA
- C01 Design input cannot be met
- C02 Design input obsolete
- C03 Design input not correct
- C04 Necessary design input not available

B2 DESIGN OUTPUT LTA
- C01 Design output scope LTA
- C02 Design output not clear
- C03 Design output not correct
- C04 Inconsistent design output
- C05 Design input not addressed in design output
- C06 Drawing, specification, or data error
- C07 Error in equipment or material selection
- C08 Errors not detectable
- C09 Errors not recoverable

B3 DESIGN/DOCUMENTATION LTA
- C01 Design / documentation not complete
- C02 Design /documentation not up-to-date
- C03 Design/documentation not controlled

B4 DESIGN/INSTALLATION VERIFICATION LTA
- C01 Independent review of design / documentation LTA
- C02 Testing of design / installation LTA
- C03 Independent inspection of design / installation LTA
- C04 Acceptance of design / installation LTA

B5 OPERABILITY OF DESIGN/ ENVIRONMENT LTA
- C01 Ergonomics LTA
- C02 Physical environment LTA
- C03 Natural environment LTA

AN – No causes found

AZ – Information to determine cause LTA

B1 UNABLE TO IDENTIFY SPECIFIC ROOT CAUSE
- C01 Multiple, parallel causal sequences exist
- C02 Context out-of-scope of analysis
- C03 No cause uncovered after exhaustive testing

B2 REPORT STOPS AT FAILURE/ERROR MODE
- C01 Apparent Cause Analysis only
- C02 No causal sequence established or identified
- C03 Attributed to weather beyond initiating cause

B3 OTHER PARTIES INVOLVED IN EVENT
- C01 Other NERC-Registered entity cited as involved in event
- C02 Vendor or contractor cited as involved in event
- C03 Non NERC-Registered entity cited as involved in event

B4 CROSS-REFERENCE REQUIRED FOR OTHER SOURCES OF INFORMATION
- C01 Requires secondary review once appropriate reports are received
- C02 Requires secondary review once additional outside investigative report is received

A2 Equipment/Material

B1 CALIBRATION FOR INSTRUMENTS LTA
- C01 Calibration LTA
- C02 Equipment found outside acceptance criteria
- C03 Coordinated tuning or adjustment of Instrumentation LTA

B2 PERIODIC/ CORRECTIVE MAINTENANCE LTA
- C01 Preventive maintenance for equipment LTA
- C02 Predictive maintenance LTA
- C03 Corrective maintenance LTA
- C04 Equipment history LTA

B3 INSPECTION/ TESTING LTA
- C01 Start-up testing LTA
- C02 Inspection / testing LTA
- C03 Post-maintenance / Post-modification testing LTA

B4 MATERIAL CONTROL LTA
- C01 Material handling LTA
- C02 Material storage LTA
- C03 Material packaging LTA
- C04 Material shipping LTA
- C05 Shelf life exceeded
- C06 Unauthorized material substitution
- C07 Marking / labeling LTA

B5 PROCUREMENT CONTROL LTA
- C01 Control of changes to procurement specification / purchase order LTA
- C02 Fabricated item did not meet requirements
- C03 Incorrect item received
- C04 Product acceptance requirements LTA

B6 DEFECTIVE, FAILED, OR CONTAMINATED
- C01 Damaged, defective or failed part
- C02 Defective or failed material
- C03 Defective weld, braze, solder joint, crimp, hinge, or other connection
- C04 End-of-life failure
- C05 Electrical or instrument noise
- C06 Contaminant
- C07 Software failure

B7 EQUIPMENT INTERACTIONS LTA
- C01 Communications path LTA
- C02 Data quality LTA
- C03 Supporting power system LTA
- C04 Undesirable operation of Coordinated Systems

A3 Individual Human Performance

B1 SKILL BASED ERROR
- C01 Check of work LTA
- C02 Step was omitted due to distraction
- C03 Incorrect performance due to mental lapse
- C04 Infrequently performed steps were performed incorrectly
- C05 Delay in time caused LTA actions
- C06 Wrong action selected based on similarity with other actions
- C07 Omission / repeating of steps due to assumptions for completion

B2 RULE BASED ERROR
- C01 Strong rule incorrectly chosen over other rules
- C02 Signs to stop were ignored and steps performed incorrectly
- C03 Too much activity was occurring and error made in problem solving
- C04 Previous success in use of rule reinforced continued use of rule
- C05 Situation incorrectly identified or represented resulting in wrong rule used

B3 KNOWLEDGE BASED ERROR
- C01 Attention was given to wrong issues
- C02 LTA conclusion based on sequencing of facts
- C03 Individual justified action by focusing on biased evidence
- C04 LTA review based on assumption that process will not change
- C05 Incorrect assumption that a correlation existed between two or more facts
- C06 Individual underestimated the problem by using past events as basis

B4 WORK PRACTICES LTA
- C01 Individual's capability to perform work LTA [Examples include: Sensory /perceptual capabilities LTA; Motor / physical capabilities LTA; and Attitude / psychological profile LTA]
- C02 Deliberate violation

A4 Management / Organization

B1 MANAGEMENT METHODS LTA
- C01 Management policy guidance or expectations are not well-defined, understood, or enforced
- C02 Job performance standards not adequately defined
- C03 Management direction created insufficient awareness of impact of actions on safety / reliability
- C04 Management follow-up or monitoring of activities did not identify problems
- C05 Management assessment did not determine causes of previous event or known problem
- C06 Previous industry or in-house experience was not effectively used to prevent recurrence
- C07 Responsibility of personnel not well-defined or personnel not held accountable
- C08 Corrective action responses to a known or repetitive problem was untimely
- C09 Corrective action for previously identified problem or event was not adequate to prevent recurrence

B2 RESOURCE MANAGEMENT LTA
- C01 Too many administrative duties assigned to immediate supervisor
- C02 Insufficient supervisory resources to provide necessary supervision
- C03 Insufficient manpower to support identified goal/ objective
- C04 Resources not provided to assure adequate training was provided / maintained
- C05 Needed resource changes not approved / funded
- C06 Means not provided to assure procedures / documents / records were of adequate quality and up-to-date
- C07 Means not provided for assuring adequate availability of appropriate materials / tools
- C08 Means not provided for assuring adequate equipment quality, reliability, or operability
- C09 Personnel selection did not assure match of worker motivations and job descriptions
- C10 Means/method not provided for assuring adequate quality of contract services

B3 WORK ORGANIZATION & PLANNING LTA
- C01 Insufficient time for worker to prepare task
- C02 Insufficient time allotted for task
- C03 Duties not well-distributed among personnel
- C04 Too few workers assigned to task
- C05 Insufficient number of trained or experienced workers assigned to task
- C06 Planning not coordinated with inputs from Walk downs/Task analysis
- C07 Job scoping did not identify potential task interruptions &/or environmental stress
- C08 Job scoping did not identify special circumstances &/or conditions
- C09 Work planning not coordinated with all departments involved in task
- C10 Problem performing repetitive tasks &/or sub-tasks
- C11 Inadequate work package preparation

B4 SUPERVISORY METHODS LTA
- C01 Tasks and individual accountability not made clear to worker
- C02 Progress / status of task not adequately tracked
- C03 Appropriate level of in-task supervision not determined prior to task
- C04 Direct supervisory involvement in task interfered with overview role
- C05 Emphasis on schedule exceeded emphasis on methods / doing a good job
- C06 Job performance and self-checking standards not properly communicated
- C07 Too many concurrent tasks assigned to worker
- C08 Frequent job or task "shuffling"
- C09 Assignment did not consider worker's need to use higher-order skills
- C10 Assignment did not consider worker's previous task
- C11 Assignment did not consider worker's ingrained work patterns
- C12 Contact with personnel too infrequent to detect work habit / attitude changes
- C13 Provided feedback on negative performance but not on positive performance

B5 CHANGE MANAGEMENT LTA
- C01 Problem identification did not identify need for change
- C02 Change not implemented in timely manner
- C03 Inadequate vendor support of change
- C04 Risks / consequences associated with change not adequately reviewed / assessed
- C05 System interactions not considered or identified
- C06 Personnel / department interactions not considered
- C07 Effects of change on schedules not adequately addressed
- C08 Change-related training / retraining not performed or not adequate
- C09 Change-related documents not developed or revised
- C10 Change-related equipment not provided or not revised
- C11 Changes not adequately communicated
- C12 Change not identifiable during task
- C13 Accuracy / effectiveness of change not verified or not validated

A5 Communication

B1 WRITTEN COMMUNICATIONS METHOD OF PRESENTATION LTA
- C01 Format deficiencies
- C02 Improper referencing or branching
- C03 Checklist LTA
- C04 Deficiencies in user aids (charts, etc.)
- C05 Recent changes not made apparent to user
- C06 Instruction step / information in wrong sequence
- C07 Unclear / complex wording or grammar

B2 WRITTEN COMMUNICATION CONTENT LTA
- C01 Limit inaccuracies
- C02 Difficult to implement
- C03 Data / computations wrong / incomplete
- C04 Equipment identification LTA
- C05 Ambiguous instructions / requirements
- C06 Typographical error
- C07 Facts wrong / requirements not correct
- C08 Incomplete / situation not covered
- C09 Wrong revision used

B3 WRITTEN COMMUNICATION NOT USED
- C01 Lack of written communication
- C02 Not available or inconvenient for use

B4 VERBAL COMMUNICATION LTA
- C01 Communication between work groups LTA
- C02 Shift communications LTA
- C03 Correct terminology not used
- C04 Verification / repeat back not used
- C05 Information sent but not understood
- C06 Suspected problems not communicated to supervision
- C07 No communication method available

A6 Training

B1 NO TRAINING PROVIDED
- C01 Decision not to train
- C02 Training requirements not identified
- C03 Work incorrectly considered "skill of the craft"

B2 TRAINING METHODS LTA
- C01 Practice or hands-on experience LTA
- C02 Testing LTA
- C03 Refresher training LTA
- C04 Inadequate presentation

B3 TRAINING MATERIAL LTA
- C01 Training objectives LTA
- C02 Inadequate content
- C03 Training on new work methods LTA
- C04 Performance standards LTA

A7 Other

B1 EXTERNAL PHENOMENA
- C01 Weather or ambient conditions LTA
- C02 Power failure or transient
- C03 External fire or explosion
- C04 Other natural phenomena LTA
- C05 Copper Theft
- C06 Vandalism

B2 RADIOLOGICAL/HAZARDOUS MATERIAL PROBLEM
- C01 Legacy contamination
- C02 Source unknown

B3 VENDOR OR SUPPLIER PROBLEM
- C01 Follow-up LTA
- C02 Vendor corrective actions LTA
- C03 Extent-of-Condition communications LTA

A8 (Open)

AX Overall Configuration

B1 INSTALLATION/DESIGN CONFIGURATION LTA

B2 MAINTENANCE/MODIFICATION CONFIGURATION LTA

Level A nodes are underlined	Level C nodes are in "sentence case"
Level B nodes are in ALL CAPS	LTA = Less Than Adequate

Appendix B: Cause Code Definitions (The User's Manual)

This page intentionally left blank

Cause Code Definitions

The sections below define the cause codes for the assignment process. When appropriate, examples are cited, as well as possible corrective actions for remediation of what has been identified as Less Than Adequate (LTA).

A1 Design/Engineering

An event or condition that can be traced to a defect in design or other factors related to configuration, engineering, layout, tolerances, calculations, etc. Note: even though engineering is only in the branch title, its use throughout this branch is implicit. Also, it is engineering as a function or process, not as a job title.

B1 Design Input LTA

Input to a design was lacking adequate information necessary for the design.

A1B1C01 – Design input cannot be met

Definition: The criteria and other requirements were so stringent that they could not be met. There were conflicting criteria. Not all of the necessary references were included.

Examples: A flow controller could not adequately control flow during an infrequent operation. The flow requirements for normal, emergency, and infrequent operation covered too wide a range for a controller to operate properly under all conditions.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Determine which mode of operations is causing the range to be too wide. Install a separate controller for that mode.

A1B1C02 – Design input obsolete

Definition: The criteria were out-of-date. An old version of a requirement or specification was used. Process requirements or conditions changed and the changes were omitted from the input.

Examples: A valve failed because it was designed to operate under the original operating requirements of the plant rather than under the revised operating requirements.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace valve with one designed for current operating requirements.

A1B1C03 – Design input not correct

Definition: The wrong standards or requirements were used. The requirements were transcribed in error.

Examples: A valve failed because the design input had incorrect information concerning the chemical concentrations in the system in which the valve would be used.

An O-ring failed because the design input defined incorrect temperatures for the system in which the O-ring was to be used. The actual temperature extremes were much greater than those stated in the design input.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace with equipment or material designed for operating environment.

A1B1C04 – Necessary design input not available

Definition: The necessary requirements, codes, standards, etc. were not available to the designer.

Examples: A valve failed because the design input (performance requirements of the system) had been changed but the revised requirements had not been given to the designer.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace with valve designed for current requirements.

B2 Design Output LTA

Inadequate design output that did not meet the customer's expectations or design requirements.

A1B2C01 – Design output scope LTA

Definition: The design did not consider all the possible scenarios. All the operating conditions—normal and emergency—were not included in the design.

Note: Scenarios where a single-point-of-failure exists or were discovered during an event often result in the use of this code. By precedence, this code is used when relay settings are not correct, from the design; if design correctly, but not translated or input to working documents, the A1B2C03 is often used

Examples: Software failed because of a conflict with other software. The software used resources that were needed by other software that was running concurrently. The design did not consider all the possible software that would be in operation during different operating conditions. An operating condition that was not considered caused the software to fail.

A protection system is set up to monitor apparent impedance on a transmission line near a power transformer. However, the threshold for the impedance relay is set at such a value that it trips the line on inrush transients when the transformer is energized.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace with software that is designed for current operating environment.
- Set up a blocking scheme to keep the impedance relay from activating during transformer inrush transients.

A1B2C02 – Design output not clear

Definition: The drawings were difficult to read. The specifications were difficult to understand. The specification could be interpreted in more than one way.

Examples: A pump did not provide the necessary cooling water during an emergency. The pump was sized incorrectly because the drawings were difficult to read and the wrong pump was ordered and installed.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Provide clearer copy of drawing and replace pump.

A1B2C03 – Design output not correct

Definition: Design scoping was performed correctly, but the drawings and/or other specifications were incorrect. The final design output did not include all changes.

Note: To help differentiate between this code and the A1B2C06 code (and both could be used in a causal sequence), this code is for the situation where the wrong drawing or wrong specification was used in the design. Where the correct drawing or specification was used, but it contained an error in it, use A1B2C06 code. To help differentiate between this code and the A1B2C01 code, if the design

actually considered a setting, but it was not provided to the documentation used for installation, this code would be used.

Examples: A pump did not provide the necessary cooling water during an emergency. The pump was sized incorrectly because the final design did not include changes identified in the safety analysis.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Install pump designed to new criteria.

A1B2C04 – Inconsistent design output

Definition: There were differences between output documents. The drawings and other design documents did not agree.

Examples: A pump did not provide the necessary cooling water during an emergency. The procurement specifications were not updated to reflect final changes to the drawings.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace with pump designed to new criteria.

A1B2C05 – Design input not addressed in design output

Definition: The specifications did not include all the requirements. Some criteria were left out of the design output.

Examples: A line ruptured due to a failed flange. The flange failed because it was constructed of the wrong materials. Some potential process upsets were not identified in the input and were not addressed in the output.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace with flange designed to all applicable criteria.

A1B2C06 – Drawing, specification, or data error

Definition: The latest drawing revision was not used. The latest vendor information was not included in the design documentation. The correct data was not noted on the design documentation.

Note: To help differentiate between this code and the A1B2C03 code (and both could be used in a causal sequence), this code is intended to be used when there was an error on the "specified" drawing or specification used for the design, or if there was no reference to which drawing or specification is to be used in the design. Where the drawing or specification was cited, but some other version or drawing/specification was used, use the A1B2C03 code.

Examples: A recent print revision reflected that a modification was made to a steam-supplied transfer pit. The print reflected that a common header, instead of a dedicated header to each system, supplied steam. The "as-found" field condition reflected that each system still had a dedicated supply header. Investigation determined that funds had run out when approximately 50 percent of the work had been completed. The system had to be modified for continued operation. The prints were never revised to reflect the modifications that were made.

During the review of the prints or drawings, errors were discovered and corrected. However, the drawing package sent out for the work being performed did not contain the corrections made during the review process.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Revise the design documentation and perform better checks of process system configuration.

A1B2C07 – Error in equipment or material selection

Definition: The correct vendor identification number was not used for procurement of equipment. The correct grade of stainless steel was not specified for the material. Error in equipment selection to obtain a desired effect.

Examples: The wrong grade of piping was specified and installed in a caustic piping system. Grade 304L Stainless Steel piping was mistakenly specified and installed in a system that contained a highly caustic solution. The use of this incorrect piping code resulted in premature failure of the newly installed system.

Relay selected for use in a protection scheme was not of the correct range (too long or too short) to achieve the desired reach into the protection zone.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace piping with the proper piping per applicable codes.
- Determine why the error was made in selection if possible and then examine the extent of condition of this equipment or material selection.

A1B2C08 – Errors not detectable

Definition: Personnel were unable to detect errors (by way of alarms or instrument readings) during or after the occurrence. A serious error went unnoticed because there was no way to monitor system status.

Note: It is unreasonable to expect all systems and equipment to have alarms; however, important safety-related equipment should have reliable error detection systems.

Examples: A tank fill was in progress. Initial tank level had been determined using the dipstick. There was no level alarm on the tank to indicate that overflow was imminent. The standard practice was to mentally time the closure of the inlet valve knowing the flow rate of the centrifugal pump. The inlet valve was on the opposite side of the tank from the dipstick. Thus, the tank overflowed.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Consider installation of tank level alarm.

A1B2C09 – Errors not recoverable

Definition: The system was designed such that personnel were unable to recover from the discovered error before a failure occurred.

Note: Important safety-related equipment should be designed so that detected errors can be alleviated before system failure occurs.

Examples: A computer operator started an automatic operating sequence, controlled by a distributed control system, before the valving lineups in the process area had been completed. Even though operators in the field called in to tell the operator to stop the operation, the computer was not programmed to allow interruption of the sequence. As a result, process flow was routed to waste.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Reprogram operating sequence to allow abort.

B3 Design/Documentation LTA

Design or documentation that did not include all of the required information and did not comply with document control and record requirements.

A1B3C01 – Design/documentation not complete

Definition: The designs and other documentation for equipment were incomplete. Items were missing from the documentation. A complete baseline did not exist.

Examples: A waste tank overheated because incompatible materials were mixed. The baseline documentation was not complete. It failed to show a line that emptied into the tank. The line apparently was installed during original construction, but the drawings did not show it.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Update drawings.

A1B3C02 – Design/documentation not up-to-date

Definition: Drawings and documents were not updated when changes were made or did not reflect the current status.

Note: Problems with this node will often be multicoded. The system for controlling documents may not be adequate. Another problem could be that changes are being made without proper authorization and are, therefore, not being entered into the system.

Examples: An acid spill occurred during a line break. Lockouts had been performed based on current drawings. The drawings were not up-to-date and did not show an acid stream that had been tied into the line.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Update drawings.

A1B3C03 – Design/documentation not controlled

Definition: The design documentation was not controlled per site requirements for document control and records.

Examples: During a recent assessment, an individual preparing some design documentation was noted using "Uncontrolled" and "Information Only" design documentation to complete a Design Change Form. When questioned he responded that he did not have to contact document control because he was the only person responsible for the system and no other changes had been made to the system since the last modifications he had completed.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Contact site document control and verify the latest revision status of necessary design documentation.

B4 Design Verification/Installation Verification LTA

Design reviews, testing, independent inspections, and acceptance were not in compliance with customer expectations or site requirements.

A1B4C01 – Independent review of design/documentation LTA

Definition: A required review was not performed on the design, or a review was not performed by an independent reviewer. The design had problems passing the functional testing.

Examples: A tank failed because it was not constructed of materials suitable for the environment in which it was installed. The designer was not familiar with the area in which the tank was to be used and did not know that it was a corrosive environment. An independent review by a knowledgeable reviewer was not conducted.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Change affected procedure(s) to insert independent verification step. Note that this would imply that another Apparent Cause was under Written Communication Content LTA [A5B2].
- Assign additional independent reviewer(s) to design function. Note that this would imply that another Apparent Cause was under Work Organization and Planning LTA [A4B3].

A1B4C02 – Testing of design/installation LTA

Definition: Testing was not included as part of the design acceptance process or the installation process. The testing did not verify the operability of the design. Design parameters did not successfully pass all testing criteria.

Note:

1. Design testing is intended to be a test of the intended design prior to it being placed onto or into an on-line or operable system (meaning a system which in normal use, can be interacting with the electrical or control systems). When the modification or upgrade is placed onto an operable system, the appropriate testing is considered to be start-up, or commissioning, testing, and code would be A2B3C01
2. For any of the testing codes, evaluation or interpretation of test results is a vital component of the test and represents a valid use of this code.

Examples: Entry of a parameter on display XXXX with a value greater than the system management parameter (SMP) defined value of 60 resulted in an invalid array index being computed in the filtering module, which caused data corruption of the data structure. In that there is a design value that if exceeded a problem arises, why was that parameter not tested above its limit at either its design testing or installation testing to determine the impact?

A filename string-length limit was defined at design and the system was placed into service. The filename string length was neither known to operators nor documented in existing records for the system. When this filename length was exceeded (by use of the entities filename convention), the system hung up. The cause was not known to the operators, and this limit was identified only when the vendor became involved. Testing of this limit at either the design phase or the installation phase was not accomplished, and thus the impact of exceeding this limit was not known nor planned for, such that an error-trap could be installed.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- The design of system testing needs to include challenges to any "boundaries" of system design or limits as built into the system. Testing of the installation or design phases of equipment needs to incorporate testing of all design limits (i.e., character format limits, string-length limits, numbers of units a system is designed to handle at one time, data-flow limits, etc.) to ensure any instances of exceeding these limits have a known impact and appropriate error messages to show the cause of the impact or error.

A1B4C03 – Independent inspection of design/installation LTA

Definition: Independent inspection attributes were not included in the design installation. Required Hold/Witness points were not verified by Quality Assurance (QA). Hold/Witness points did not pass the acceptance criteria. Commercial Grade Material was not adequately dedicated and documented.

Examples: A Safety Class designed system required QA Independent Inspections. These inspections were not conducted.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Disassemble the system and have the Owner Examiner perform the required examinations.

A1B4C04 – Acceptance of design/installation LTA

Definition: The customer had problems with acceptance of the design, testing, and/or verification. (Note: For any of the testing codes, evaluation or interpretation of test results is a vital component of the test.)

Examples: During the Operations Acceptance it was noted that the required design change documentation was not included in the completed document package.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Obtain the required design change documentation and include it as part of the completed work package.

B5 Operability of Design/Environment LTA

Personnel or environmental factors were not considered as part of the design.

A1B5C01 – Ergonomics LTA

Definition: Inadequate ergonomic design (or human factors engineering issues) contributed to the occurrence. The operator was physically incapable of performing the required task. The operator had to go too far to respond to the alarm. Personnel mobility or vision was restricted. An individual had difficulty reaching the equipment or assumed an awkward position to complete a task. The event was caused because illumination levels were not sufficient for task performance.

Note: Ergonomics is defined as the science that seeks to adapt work or working conditions to suit the worker. The design should include provisions for eliminating problems encountered by personnel performing tasks. This may also include problems resulting from physical or environmental factors.

Examples: An operator was making rounds when a response alarm activated. The supervisor requested the operator go to the alarm location. When arriving at the newly installed panel, the operator could not gain access or see the panel from where he was standing. The operator had to go around the building to gain access to the area to be in a position to provide the information requested by the supervisor. This resulted in loss of valuable time necessary to take compensatory actions.

A control room operator made a mistake in reading a meter that was placed at ceiling level. The position of the meter did not allow the operators to take readings from floor level. It was necessary to use a stepladder to take the reading.

A serious incident occurred when glare caused by improper overhead lighting prevented an operator from detecting that an important indicator light was illuminated.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Assure design includes ease of access to area and takes into consideration time and distance that a worker must travel to perform tasks due to response requirements.

- Reduce lighting in area to enhance perception.
- Replace with glare-resistant glass.

A1B5C02 – Physical environment LTA

Definition: Inadequate equipment controls or control systems (e.g., push-buttons, rotary controls, J-handles, key-operated controls, thumb-wheels, multiple switches, joysticks) contributed to the occurrence. The control failed to provide an adequate range of control for the function it performs. The control was inadequately protected from accidental activation. Similar controls were indistinguishable from one another. Controls were in too close proximity of each other. Operating conditions (e.g. room temperature, work location, physical location, restricted vision, personal protective equipment, excessive noise, arrangement or placement of equipment) affected performance of the task. Lighting was inadequate. Noise was a factor.

Examples: An operator made an error in reading a meter because of the unusual scale progression. Instead of a scale with major markings divided by units of five [i.e., 5, 10, 15, 20], the scale was divided into units of six [i.e., 6, 12, 18, 24].

Two computer systems, located side-by-side in the facility, were programmed using different color schemes. On the first system, the color red indicated flow to the process. On the second system, red indicated the lack of flow. Because of the inconsistency in color coding between the two systems, an operator who normally worked on the second system allowed a tank to overflow when he was temporarily assigned to the first system. His mindset was that red indicated lack of flow.

Affordances, such as standing on a conduit to reach a normally out-of-reach component, would be considered an example of a Physical environment scenario.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace with a meter with standard scale progression.
- Install a warning as to nonstandard scale progression.
- Select one of the two color schemes as standard. Reprogram the other unit. Retrain affected system operators.

A1B5C03 – Natural environment LTA

Definition: Exposure to heat, cold, wind, and rain was not included in the design. Earthquake-tested devices were not included in the design. System was not designed to withstand flooding, freezing, or high wind conditions. Lightning-suppressing devices were not included in the design. The event was caused by excessive exposure of personnel to a hot or cold environment.

Examples: During an extreme cold spell, a mechanic damaged an expensive piece of equipment by dropping a tool into its moving parts. Even though the mechanic was wearing gloves, his hands were so cold that he was unable to get a firm grip on the tool.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Provide portable space heaters. Note: this will not be acceptable in certain environments.

A2 Equipment/Material

An event or condition resulting from the failure, malfunction, or deterioration of equipment or parts, including instruments or material.

B1 Calibrations for Instruments LTA

Calibrations did not include all the essential elements. Equipment as-found condition was less than adequate.

A2B1C01 – Calibration LTA

Definition: The equipment involved in the incident was not included in a routine calibration program. Calibrations were performed too infrequently. The calibration did not include all the essential elements.

Examples: A tank overflowed because the level indicator was out of calibration. The instrumentation was not included in a calibration program.

A tank overflowed because of faulty liquid level instrumentation. The instrument calibration was not performed in accordance with the manufacturer's recommended frequency for calibrations.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Calibrate instrument.
- Incorporate manufacturer's recommended frequency into the calibration program.

A2B1C02 – Equipment found outside acceptance criteria

Definition: An event occurred as a result of equipment that was found to be outside of the specified acceptance criteria. The instrument calibration drift was outside of the acceptable range. Process instrumentation was outside of acceptable range criteria due to a standard that was out of calibration.

Examples: A pressure switch is required to activate when vessel coil pressure is at a high pressure of 5.83 to 5.95 pounds per square inch (psi). During a functional check, the pressure switch activated at 5.98 psi. The pressure switch had drifted outside of the acceptable calibration criteria.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Adjust the pressure switch back into calibration and re-perform the functional test.
- Replace pressure switch if warranted by adverse trend or decreased performance.
- Increase pressure switch calibration frequency to improve instrument reliability.

A2B1C03 – Coordinated tuning or adjustments of instrumentation LTA

Definition: An event occurred as a result of multiple pieces of controls for equipment or instrumentation, where adjustment of one requires the coordinated adjustment(s) of others did not occur, or was performed incorrectly.

Examples: Following the trip of a generation unit for some fault, a second unit, while trying to react to this first problem, was unable to ride through the problem because its forced draft (FD) fan responded slower than did its induced draft (ID) fan, leading to low furnace pressure and (potential) tripping of the unit.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Adjust the controls of both types of fans in a coordinated manner, so they work properly together.
- Identify and document those systems which are intended to work in a coordinated manner, and test that this coordination works as intended, during periodic maintenance programs.

B2 Periodic/Corrective Maintenance LTA

Periodic maintenance was not established for the equipment, instrument, or component. The periodic maintenance was inadequate. Corrective maintenance was inadequate to correct the problem. Equipment history did not exist for the instrument or component. The equipment history was incomplete.

A2B2C01 – Preventive maintenance for equipment LTA

Definition: An equipment malfunction was caused by a failure to perform scheduled preventive maintenance. Preventive maintenance was not established for the equipment or component that failed. Preventive maintenance was scheduled too infrequently. The preventive maintenance was incomplete. Preventive maintenance was performed on some of the components but not on others. (Note: Preventive maintenance is a maintenance program which is cyclical, it is done based on a repetitive basis based on some characteristic (numbers of operations, time, etc.))

Examples: A motor failed due to lack of lubrication. Routine maintenance had not been performed on the equipment. The lubrication should have been done every 2 years.

A motor failed due to lack of lubrication. Preventive maintenance had been performed on the equipment but on a longer frequency than recommended by the manufacturer.

Equipment failure due to inadequate scheduled preventive maintenance on breakers, transformers, switches, etc., based on the number of times the operation had occurred

Equipment failure due to inadequate scheduled preventive maintenance on Overhead Ground Wire, Down Guy wire, protection schemes, RAS or SPS schemes, cooling systems, heating system, equipment, or substation houses, based on time.

The oil should be changed in an automobile every 5,000 miles.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Repair or replace motor.
- Establish routine maintenance frequencies for failed equipment.
- Adjust preventive maintenance frequencies to correspond to manufacturer's recommendations.
- Perform benchmark of equipment for preventive maintenance according to past practices or experiences for work area or company.

A2B2C02 – Predictive maintenance LTA

Definition: Predictive maintenance was not established for the equipment. The established frequency was inadequate to prevent or detect equipment degradation. The established method used to prevent or detect equipment degradation was inadequate. (Note: Predictive maintenance is a maintenance program which is based on the analysis of some characteristic of operations or equipment, when conditions (other than those of a cyclic nature) indicate it is time to perform the maintenance.)

Examples: Vibration analysis indicated the need for maintenance on a fan, yet the bent fan shaft went undetected and generated high vibrations that caused the catastrophic failure of a building supply fan.

Gas analysis of the SF_6 breaker indicated moisture, yet no maintenance was undertaken to resolve the conditions.

The need to change the oil in a car is indicated by the analysis of the oil (as conducted by sensors in the car), yet it was not done.

The weather was unusually hot and dry, the expected rains had not arrived, so contamination of insulators resulted in increased likelihood of flashover.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Repair or replace fan components as necessary.
- Establish predictive maintenance for the failed equipment to help detect the onset of equipment problems.
- Identify the appropriate predictive maintenance strategy to better evaluate machinery condition.

A2B2C03 – Corrective maintenance LTA

Definition: Corrective maintenance was performed but failed to correct the originating problem. The equipment or component was reassembled improperly during corrective maintenance. Other problems were noted during maintenance activities that were not corrected. The actual job of performing a maintenance activity was complete, but was not performed correctly.

Examples: Corrective maintenance was performed to replace a malfunctioning time-delay relay to address problems associated with the building exhaust fans. After replacement of the relay, it was discovered that the problem still existed with the building exhaust fans.

Corrective maintenance was performed to replace a malfunctioning time-delay relay to address problems associated with the building exhaust fans. After installation of the relay, it was discovered that the relay contacts were positioned incorrectly.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace the time-delay relay per approved work instructions.
- Assure work instructions specify correct setting or position for relay contacts prior to installation.

A2B2C04 – Equipment history LTA

Definition: Equipment history or records did not exist for the equipment that malfunctioned. The history for the equipment that malfunctioned was incomplete or inadequate. The history did not contain all the information necessary to assure equipment reliability. Knowledge of equipment history would have prevented the incident or lessened its severity.

Examples: A tank overflowed because of faulty liquid level instrumentation. Previous problems had occurred with the instrumentation. This was not known by maintenance personnel because there was no equipment history available.

A tank overflowed because of faulty liquid level instrumentation. The problem had occurred on similar equipment in other facilities. This was unknown to facility personnel since the equipment history did not contain information on similar equipment.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Expand the maintenance inspection or activity to include equipment history files to collect and use historical data for Structures, Systems, and Components (SSCs).
- Establish provisions for similar equipment within equipment history program. Note: this may also indicate a weakness in the implementation of lessons learned [A4B1C06].

B3 Inspection Testing LTA

Scheduled inspection or testing did not exist for the instrument or equipment. The inspection or testing was inadequate or not performed as required. The inspection or /testing did not include all the essential elements. Note:

(1) A1B4 should be used for Design Testing. (2) For any of the testing codes, evaluation or interpretation of test results is a vital component of the test, and the use of these codes for issues involving this evaluation of test results represents valid use of these codes.

A2B3C01 – Start-up testing LTA

Definition: Functional testing did not exist for the equipment or system prior to placing them in service. Start-up testing was inadequate for the equipment or system being placed into service.

Note: Start-up testing (also referred to as "commissioning testing") is where the live system (or intended to be live system, even if not on-line at the time, such as when in standby) is verified to work or run as intended. This is different than Design testing (covered under the A1B4C02 code), where the intended design is tested on a different (not connected) system to ensure the design operates as intended.

Examples: A fire alarm system failed to activate during a fire in a process room. The system had not been functionally tested prior to being placed in service.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Functionally test fire alarm system for process room.
- Assure systems are functionally tested prior to being placed in service. Note: this may also imply an inadequate written communication [A5] or work organization/planning deficiency [A4B3] as an Apparent Cause.

A2B3C02 – Inspection/testing LTA

Definition: Required inspection or testing was not established or performed for the equipment involved in the incident. The required inspection or testing was performed at an incorrect frequency. The acceptance criteria for the required inspection or testing were inadequately defined. All essential components were not included in the required inspection or testing.

Examples: A BPS substation breaker failed to open during a fault on the system. The breaker had not been included in the routine functional testing program.

An unnecessary BPS relay trip occurred because of an incorrect setting on a substation current transformer (CT). The CT settings were not checked during the entity's routine functional testing program.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Establish routine functional testing for the breaker and current transformer.
- Review routine functional testing program to assure applicable equipment is included. Note: this corrective action strongly implies that there is at least one programmatic weakness.
- Revise the required inspection program for the breaker and current transformer to include specific inspection intervals. Note: this may also imply inadequate written communication [A5] as an Apparent Cause.

A2B3C03 – Post-maintenance/post-modification testing LTA

Definition: The post-maintenance or post-modification testing specified was not performed or was performed incorrectly. The post-maintenance or post-modification testing was completed, but the testing requirements were less than adequate. The post-maintenance or post-modification testing was not performed in accordance with the schedule for testing.

Note: Testing is intended to include inspection and pre-restoration checks, and not limited to specific technical tests.

Examples: Support Engineers installed and enabled software firewalls on the EMS servers. The firewalls had previously been installed on the EMS development system without observable impacts and all other support servers had been functioning properly with the firewalls in place for several months. Testing in the development system did not reveal any TCP port issues. The development system uses the same code as the production system, but does not entirely replicate the production system in terms of client load and connections. Therefore, while the EMS software on the development system functioned normally, it was not a full test of the EMS software with the software firewall.

The control room experienced a partial loss of SCADA functionality as a result of partial loss of ac power to some SCADA equipment. This partial loss of ac power occurred as planned work was being performed on the uninterruptable power supply (UPS) system. As a result of the loss of ac power, a pair of SCADA servers shut down and failed to automatically restart the SCADA software following the restoration of ac power. The inability to restart and fully restore the SCADA system within 30 minutes after the restoration of power was traced to a system configuration inconsistency that was introduced during recent system management activities. Had the system been tested following the "recent system management activities", where the configuration inconsistencies were introduced (post-maintenance or post-modification), the errors would have been uncovered before a problem came into existence.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Testing of installations and modifications of system—for which production-representative testing is not conducted—needs to be included following any upgrades, modifications, or maintenance. This is to ensure that (1) configurations were made correctly, (2) switches (physical or electronic switches) are in their proper positions, and (3) the system will operate as designed in a full-production environment.

B4 Material Control LTA

The problem was due to the inadequate handling, storage, packaging, or shipping of materials or equipment. The shelf life for material was exceeded. An unauthorized material or equipment substitution was made. Spare parts were inadequately stored. There was an error made in the labeling or marking.

A2B4C01 – Material handling LTA

Definition: Material or equipment was damaged during handling. Material or equipment was "mixed up" during handling.

Note: This code is for handling that occurred onsite. Problems with handling that occurred offsite are coded under Procurement Control LTA [A2B5], Management Methods LTA [A4B1], Means not provided for assuring adequate equipment quality, reliability, or operability [A4B2C08], or Written communication content LTA [A5B2].

Examples: The wrong pump was installed in a line. The mechanics were installing several pumps and had them all on a cart. They were "mixed up" and installed in the wrong locations.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Install pumps in correct line. Provide separation between distinct work packages and materials. Note: this may also imply a work organization/planning deficiency [A4B3] as an Apparent Cause.

A2B4C02 – Material storage LTA

Definition: The material, equipment, or part was stored improperly. The material, equipment, or part was damaged in storage. The material, equipment, or part had weather damage. The material, equipment, or part was stored in an environment (heat, cold, acid fumes, etc.) that damaged it. Inadequate preventive maintenance (cleaning, lubrication, etc.) was performed on spare parts. The material, equipment, or part was organized or secured improperly.

Examples: An absorption column installed to remove contaminants from solvent did not operate as designed. Investigation revealed that the absorbent material used to pack the column had been stored outside and uncovered. The damaged material reduced the efficiency of the column.

A pump failed shortly after installation—much earlier than anticipated given the life expectancy of the pump. Investigation revealed that the pump had been stored in spare parts for a long time. During the storage, no preventive maintenance, such as cleaning and lubrication, had been performed as specified in the manufacturer's instructions for storage.

Loose objects were inappropriately stored in opening. A set of drawings put in opening in front of a cabinet caused the objects to fall into energized equipment.

Objects or materials were stored improperly and because damaged due to exposure to the prevailing environment.

Objects were not properly secured or stored, allowing them to be blown into or come into contact with other devices and structures by high winds or other environmental factors.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Refill absorption column after verifying that absorbent packing material is acceptable.
- Verify remaining stock of absorbent material is stored under cover.
- Review spare parts inventories to identify and address preventive maintenance concerns, which will be included in a preventive maintenance program. Note: this may also imply that preventive maintenance was LTA [A2B2C01] as an Apparent Cause.
- Housekeeping inspections to ensure the objects were organized or secured in opening.

A2B4C03 – Material packaging LTA

Definition: Material or equipment was packaged improperly. The material or equipment was damaged because of improper packaging. Material or equipment was exposed to adverse conditions because the packaging had been damaged.

Note: This code is for packing occurring onsite. Problems with packing occurring offsite would be coded under Procurement Control LTA [A2B5], Management Methods LTA [A4B1], Means not provided for assuring adequate equipment quality, reliability, or operability [A4B2C08], or Written Communication Content LTA [A5B2].

Examples: An electronic system received water damage because it was not packaged in waterproof packaging as specified in the packaging requirements.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Repair or replace the damaged material or equipment.
- If reusable, restore material packaging to design specifications.

A2B4C04 – Material shipping LTA

Definition: The material or equipment was transported improperly. The material or equipment was damaged during shipping.

Note: This code is for shipping originating within the local organization. Problems with shipping originating at another organization would be coded under Procurement Control LTA [A2B5], Management Methods LTA [A4B1], Means not provided for assuring adequate equipment quality, reliability, or operability [A4B2C08], or Written Communication Content LTA [A5B2].

Examples: A technical limit was exceeded because several containers of nuclear material were not shipped in approved shipping containers.

Sensitive electronic equipment transported by rail was damaged.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Revise shipping procedure to include caution for using approved containers. Note: this may also imply inadequate written communication [A5] or a work organization or planning deficiency [A4B3] as an Apparent Cause.
- Repair or replace damaged equipment. Assure replacement equipment is shipped under more favorable conditions.

A2B4C05 – Shelf life exceeded

Definition: Material, equipment, or parts that had exceeded the shelf life were installed. Materials continued to be used after the shelf life was exceeded.

Note: Shelf life can be highly dependent on storage environment; in other words, this could also be a storage issue [A2B4C02].

Examples: A technical limit was violated because resin that had exceeded its shelf life was used for a separation process. When old resin is used, separation efficiency of different elements is greatly reduced.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace affected resin with material within its shelf life.
- Assure remaining resin stock is within its shelf life.

A2B4C06 – Unauthorized material substitution

Definition: Incorrect materials or parts were substituted. Materials or parts were substituted without authorization. The requirements specified no substitution.

Note: This code is for material substitution occurring onsite. Problems with material substitution occurring offsite would be coded under Procurement Control LTA [A2B5], Management Methods LTA [A4B1], Means not provided for assuring adequate equipment quality, reliability, or operability [A4B2C08], or Written Communication Content LTA [A5B2].

Examples: A valve failed and caused a spill in the environment. The valve was not the one specified in the requirements. Since the specified one was not available, a substitute valve had been installed without the proper review and authorization.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Install correct valve or get proper approval for the substitute.
- Determine why unapproved substitution was made and correct that cause.

A2B4C07 – Marking/labeling LTA

Definition: There was an error made in the labeling or marking. Equipment identification, labeling, or marking was less than adequate.

Examples: Procurement specification required that parts be stamped "304 SS" for use in a critical safety significant system. A facility was shut down because the parts did not meet marking specification.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace parts with proper marking specification to bring system into compliance.
- Evaluate procurement specification to provide additional controls for assurance and validation of parts and material used in safety-related systems.
- Determine the necessary controls to assure proper procurement and selection of materials or parts.

B5 Procurement Control LTA

The error was due to inadequate control of changes to procurement specifications or purchase orders. A fabricated item failed to meet requirements or an incorrect item was received. Product acceptance requirements failed to match design requirements or were otherwise unacceptable. Note: This is only for equipment and materials—procured services are addressed in A4B2C10.

A2B5C01 – Control of changes to procurement specification/purchase order LTA

Definition: Changes were made to purchase orders or procurement specifications without the proper review and approvals. The changes resulted in purchase of the wrong material, equipment, or parts.

Examples: A process upset occurred because the acid used was out of specifications. Investigation revealed that the purchase order had been changed without the proper review and approval.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace affected acid.
- Determine if affected acid could be used somewhere else (excess chemicals program). If not, dispose of acid in accordance with applicable regulations.

A2B5C02 – Fabricated item did not meet requirements

Definition: The item of concern was not fabricated according to the requirements specified in the procurement specifications or purchase requisition.

Examples: A pump failed because it was not fabricated with materials specified in the procurement specifications. As a result, it did not withstand the corrosive environment in which it was installed.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Contact manufacturer for replacement pump made of correct materials.

A2B5C03 – Incorrect item received

Definition: An item received was not the one ordered. The inconsistency was not recognized. The item was accepted rather than returned.

Examples: A process upset occurred because the acid used was out of specifications. When the acid was received, personnel in material receiving did not recognize that it was not what was ordered. It was accepted and sent to the operating facility for use.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace affected acid.
- Provide additional instructions to receiving inspectors on recognizing chemicals.
- Determine if affected acid could be used somewhere else (excess chemicals program). If not, dispose of acid in accordance with applicable regulations.

A2B5C04 – Product acceptance requirements LTA

Definition: The product acceptance requirements were incomplete. The product acceptance requirements did not address all the safety concerns for the item. The requirements did not address all the concerns for efficiency

Examples: A pump failed shortly after installation because it was constructed of material incompatible with the environment in which it was used. The acceptance requirements correctly addressed the size of the pump but did not address specifications for the corrosive environment in which the pump would be installed.

A pump of the wrong size was installed in the process. Investigation revealed that the acceptance requirements used when the pump was received were not the same as the design requirements.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Repair or replace the failed pump.
- Assure procedure for acceptance requirement development has sufficient cautions on incorporation of all applicable criteria. Note: this may also imply inadequate written communication [A5] as an Apparent Cause.

B6 Defective, Failed, or Contaminated

An event was caused by a failed or defective part. The material used was defective or flawed. The weld, braze, or soldered joint was defective. The component reached the end of its expected service life. There was electrical or instrument noise interference or interaction. Foreign material or contaminant caused the equipment or component to fail.

A2B6C01 – Damaged, Defective or failed part

Definition: A part or instrument lacked something essential to perform its intended function. A part (or component of a part) was damaged in the course of nearby activities, resulting in the part's inability to carry out its intended function. The degraded performance of a part or a component contributed to its failure. Note: this does not explain why the object failed or was defective. Therefore, this node should be multi-coded.

Examples: A motor on a pump that had only been in operation for six months failed due to defective windings.

A large turbine or generator bearing failed during normal equipment operation. Follow-up investigation determined that an internal oil pump contributed to the premature failure of the turbine bearing.

Insulators, arrestors, etc., on Substation bus or Transmission line fails while in service, relaying out the line or station, causing unexpected outages. (Insulator was tracking/cracked)

Relay failure on equipment such as breakers, transformers, and generators, etc., initiating backup system protection to clear faulted zone or zones. I.e. breaker failure scheme. (Relay not rated for duty, bad contacts, burned out coil(s))

A breaker was intended to open but failed to do so within the time frame intended or required because of a physical problem with the breaker

A contractor is putting in a trench for a new control run and cuts the existing control cables still in use.

A technician steps on equipment that is not designed to support weight, while trying to reach an area where work is intended to be accomplished.

An engineer spills coffee onto a computer system, causing damage to the keyboard.

A criminal sneaking into a substation to steal copper, cuts grounding cables and control cables.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace the failed components (i.e., windings, oil pump, bearings, etc.) and return the system to normal operation.
- Perform periodic inspections and testing on equipment on a scheduled basis if benchmarking has been achieved, or based on past experience.
- Repair the damaged equipment, and determine what work practice, shortcuts, or other habit resulted in the damage. Identify barriers to protect against these.

A2B6C02 – Defective or failed material

Definition: A component failed because the material used was not adequate for the application. The material used was found to be defective, flawed, or damaged. Note: this does not explain why the object failed or was defective. Therefore, this node should be multi-coded.

Examples: A steel plate on a waste storage tank leaked due to failed material. The steel from which the plate was fabricated exhibited laminations that formed during the extrusion process when the steel was rolled at the manufacturer's plant.

A wire connecting equipment shorted to ground as a result of damaged insulating material.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace the steel plate with a replacement suitable for the harsh chemical environment.

A2B6C03 – Defective weld, braze, soldering joint, crimp, hinge, or other connection

Definition: A specific weld/crimp/joint/connection defect or failure.

Note: This does not explain why the object failed or was defective. Therefore, this node should be multi-coded.

Example: A leak occurred due to cracks in a weld at the bottom of a tank. The weld cracked due to inadequate length of time allowed for pre-heating of surface prior to making the weld.

A splice failed on a static wire or transmission conductor allowing the conductor to fall.

A joint on a string of insulators failed, allowing the conductor to fall.

A wire splice or terminal lugs were incorrectly crimped, a snapped/broken bolt, or a broken hinge are other types of joint failures.

Ring and spade-type terminals come loose.

Three wires were inserted under the screw head, with mismatched sized wires; this resulted in the wires becoming loose over time due to changes in temperature, humidity, and strain.

Bolted joint thread embedment (also known as insufficient bolt-thread engagement) or vibration loosening of bolts

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Repair the weld using correct surface pre-heat procedures.
- Assure pre-heat and interpass temperatures for welding are conducted and controlled in accordance with procedures.
- Ensure splices are crimped to the proper ft lbs by calibrating crimping tools routinely.

A2B6C04 – End of life failure

Definition: The failure resulted from equipment or material having reached the end of its expected or normal service life. The failure was a result of the normal aging process for this component. In both of these, a decision was made to continue operating the equipment to failure even though the equipment was at or near the end of its expected life.

Note: For software, where it is considered to be obsolete as it is no longer supported by the vendor, this becomes a potential "Failure mode" code if the system stops operating and cannot be recovered (or has continuous or frequent "re-start" or "power cycle" needs) because of lack of support; it is what happened, not why it happened, and codes in the A4B1 and A4B2 need to be considered as the reason the situation developed. Viruses or other malicious software scenarios which impact the performance of software systems do not fall under this code.

For equipment, this is intended to distinguish between premature failure (failed at an earlier operational life than expected), rather than in a situation where it is expected to fail soon, but the decision was made to continue operating it until failure, and then replace it.

Examples: A facility had determined that it was more cost-effective to run a certain pump to failure rather than provide preventive maintenance that only yielded minimal life extension. Note: if the facility has not made this determination, then it is under A2B2.

A component exceeds the number of operations as cited by the manufacturer documentation as to its "end-of-life."

The operating system (OS) on the Energy Management System (EMS) server is no longer supported by its vendor. In addition, modifications to the software driver code for the current OS is no longer supported by its vendor. While in this situation, the EMS server stopped working.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace the failed pump.
- Upgrade the EMS to support software.

A2B6C05 – Electrical or instrument noise

Definition: An unwanted signal or disturbance that interfered with the operation of equipment.

Examples: Actuation of a radio in close proximity to instrumentation caused indication fluctuations.

The Distributed Control System (DCS) installed in the facility received erroneous alarms due to excess instrumentation noise on the system. The noise was a result of not having an adequate building grounding system installed.

Unintended DC grounds introduced into a system during troubleshooting initiates relay operations, contrary to intent or design

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Consider posting location to eliminate radio use.
- Evaluate the use of shielding for affected components.

A2B6C06 – Contaminant

Definition: Failure or degradation of a system or component due to foreign material (i.e., dirt, crud, impurities, trash in river intake, etc.) or radiation damage due to excessive radiation exposure.

Note: can be related to any material in an unwanted location.

Examples: A BES substation was physically located near a highway that was frequently treated with salt to prevent the roadway from icing in winter months. As vehicles moved over this road the salt and melted water became airborne and wind would deposit the salt–water mixture on the substation equipment. Over time this buildup of contaminants on the insulators in this station would cause flashovers that would take the BES station out of service by relay action.

Insulators gather extreme amounts of dust on them during a drought.

Magnetization of a core is an electromagnetic equivalent to contamination. Magnetization of an instrument transformer (most commonly a Current Transformer, CT) or power transformer core reduces the core's saturation margin. Magnetization occurs due to abrupt changes in current resulting in a sudden, high magnetic flux through the transformer core (faults, lightning strikes, open-circuiting the winding, etc.). If a CT is substantially magnetized, it can lead to unnecessary protection system operations, especially for differential protection. The potential for both core magnetization and in-rush saturation should be accounted for during the design of the protection system. CT core magnetization should be suspected when the test ratio is higher than the specified ratio beyond the CT's accuracy rating. [Note: if CTs (or other devices) have saturation conditions deemed to be caused by this magnetization, other contributing factors to be examined could include maintenance (A2B2 area), change management over time (A4B5C05), design output (A1B2C01), or the in-house experiences to prevent problems from occurring (A4B1C06)]

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- In areas that are prone to contaminants, an increased frequency of inspection and maintenance may be needed to periodically clean the contaminant from the equipment.
- Test and verify, in the design process, that transformer in-rush is accounted for in the protection design by the use of second harmonic restraint or other appropriate protection design.
- Perform routine comparison of the Current Transformer's output compared to a known reference, conduct demagnetization, and perform a protection system design review to determine susceptibility to CT saturation for any transformers whose readings are outside of the nominal CT ratio beyond the CT's accuracy rating.

A2B6C07 – Software failure

Definition: A situation where the controlling software failed, the system froze (or hung up) or other computer-related software issues exist. It is an "occurrence" rather than a true cause, and corrective actions should involve the vendors of the software.

Note: If it is determined that the reasons for the controlling software failure is that is no longer supported by its vendor, the A2B6C04 code may be appropriate, but pay attention to the note associated with that code.

Examples: After a restart of a critical SCADA application, processing of manually disabled SCADA records caused the critical application to abort, thereby causing an EMS failure. The error message was "Array out of Bounds" which was caused by a bug in the application software that processes the SCADA records.

An unacknowledged SCADA alarm which had an invalid key associated with it, aborted a critical SCADA application. The error message was "operating system exception", which was caused by a defect in the application that did not account for alarms having invalid keys. Also, there was another defect in the application that created the invalid key for the alarm.

A software program was creating a file on the online system and copying the file to an offline system for the use of offline applications. But because of a bug in the code, the file was not being removed from the online system, which ultimately caused the online system to fail because of non-availability of space for critical applications.

A critical AGC application stopped working because of a defect in the validation code for AGC tuning parameters. An invalid array index was generated, which aborted the program because of non-validation of tuning parameter.

The computer personnel went to the computer room to investigate a system problem and noticed the hardware failure light blinking. A hard reset was performed. Approximately five minutes later, the node came back and SCADA control and contingency analysis was restored.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Testing of software before it makes it into online production systems is very critical. All the four issues identified above could have been prevented, if appropriate testing was performed on the test or development environments. Also, vendors need to place adequate validation procedures for the software and end users need to be aware of the functionality and the limitations of the software.

B7 Equipment Interactions LTA

An event was caused by less than adequate interaction between two or more pieces of equipment within a larger system. These interactions are required or are essential for the proper operation of the system and usually do not require human intervention.

A2B7C01 – Communications path LTA

Definition: The communication path required for the normal interaction of two pieces of equipment is not allowing or is restricting or interrupting effective machine interaction for normal, efficient operation.

Note: A communication path could be a physical path (such as wired communication or data transfer connections), or wireless (such as microwave communications between stations).

Examples: A core router pair in the primary control center malfunctioned, essentially shutting down the communication network supporting the EMS.

A spanning tree protocol implementation in a network switch caused a loop which generated exceptionally high volume of traffic, shutting down the communication network supporting EMS.

A transmission line which is protected by a DCB scheme via power line carrier tripped due to a hole in the carrier signal being received. The carrier block signal was received for two (2) cycles, but then goes away for 1.5 cycles. With this hole in the block signal, the DCB scheme overtripped.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace or restore the failed physical communication components (fiber cable, wireless connections, routers, etc.) and return the system to normal operation.

- Perform periodic inspections and testing on equipment on a scheduled basis if benchmarking has been achieved or based on past experience.

A2B7C02 – Data quality LTA

Definition: The content or quality of required or essential data between two or more pieces of equipment within a system has degraded to a point that the efficiency and accuracy of the system's performance is less than adequate. Signal integrity has been degraded to a less-than-adequate level for normal operation.

Examples: EMS application servers failed to accept a configuration database because of corrupted data files in the configuration database.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- The source for the data quality degradation or corruption has to be found and fixed. In the above example, the files that were resident on the build directory were very old and never got deleted. Once the old files were deleted and the configuration database was rebuilt the application servers worked properly.

A2B7C03 – Supporting power system LTA

Definition: The power (ac or dc) required for the normal operation of the equipment or system is less than adequate. The power source(s) are under the control of the affected entity. Note: For power sources that are not under the control of the affected entity, see A7B1C02.

Examples: A rack of microprocessor relays fails to operate as designed because the required 125 VDC input power is not available due to a failure of the substation dc station service.

Loss of Potential (LOP) occurs when distance relays are lost as the result of the trip of the bus, with Bus Potential Transformers (PTs) instead of Line PTs.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Troubleshoot and repair deficiencies on the substation dc station service to ensure an adequate 125 VDC supply to the microprocessor relay rack.

A2B7C04 – Undesirable operation of Coordinated Systems

Definition: An undesirable operation occurs as a result of less-than-adequate performance of a subsystem, due to lack of coordination, not because of equipment failure. This coordination can exist within a single zone of protection (such as the backup protection operating BEFORE the primary protection can operate) and is usually in the absence of human intervention. Often this code indicates an occurrence, not a root cause, and the cause needs to be further evaluated.

Note:

1. For this code, less-than-adequate performance of a subsystem is due to lack of coordination, not because of equipment failure associated with the protective actions. If the equipment failure occurs in a secondary protection action, coordination issues may still exist and must be evaluated separately.
2. Not normally used for a bus differential misoperation, because the settings are not intentionally used for coordination.
3. The intention for this code is to capture coordination issues associated relay settings, not installation problems such as mis-wiring.

4. If the backup protection system operates BECAUSE the primary system did not operate (due to equipment failure), it is not considered a coordination issue.
5. Fail-to-failover situation (not due to equipment failure), where the backup system does not come on-line when the primary system fails or stops operating.

Examples: The line primary relay misoperates and overtrips for the C-phase to ground fault on an adjacent line via an instantaneous ground overcurrent element.

The network interface on the primary server in a redundant front end server pair failed. The backup server transitioned to the primary role and began scanning RTUs. However the faulty server failed to release its primary role and therefore also continued scanning RTUs. This resulted in operators being presented with repetitive RTU failed/online alarms.

For EMS with Primary and Backup systems, situations where both systems try to act in the capacity of Primary, or neither system assumes the position of Primary (that is, both try to be "in-charge", or both go into "Standby" so that neither is "in charge"), is a scenario where the two systems are intended to coordinate to ensure they system is working as intended. Failure to do so should be considered for use of this code.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Perform a timing test and corrective maintenance, as required, on the circuit breaker in question and verify clearing times are within tolerance for the applicable zones of protection.

A3 Individual Human Performance

People create all non-natural systems. There is no such thing as a perfect (error-free) system. All people who come into contact with any given system both affect the system and are affected by it. This applies to the designers, builders, operators, and management personnel. Although the degree or amount may vary, there is an effect. Further, the vast majority of people (more than 95 percent) do not intend to commit an error. When a human performance error occurs, it is the individual who acted incorrectly; however, the real question is what in the system failed and allowed that action. In this context, a "system" can be hardware, administrative, or mental. People essentially never deal with a single system in isolation. Similarly, the permutation or combination of impacted systems is constantly changing. This means that before the fact, analysis of all potential system interactions is basically impossible.

Thus, the intent is for A3 cause codes to be "coupled" with cause codes somewhere else on the available cause codes for each applicable causal factor. The A3 node needs to be captured to allow future root cause analysis on the human performance clusters. The other nodes are to fix the system and annotate clusters other than human performance. One cannot permanently fix the individual or prevent recurrence. There are a few cases in which it may be acceptable not to determine couplets:

- Deliberate violations (<3%). These are limited to those cases where the individual, with conscious forethought, violates the accepted norms.
- Where the individual is at $\geq$2 standard deviations (σ); i.e., is an outlier in human performance. There is no intentional error or violation in this case. For example, the individual has been repeatedly trained (for a rule or knowledge-based error) and the error recurs with that person. By definition, this is an isolated case. These are not limited to training issues.

Even here, there are ancillary issues that need to be addressed. Why didn't the supervisor know about and take action on this individual previously? What in the system broke down to allow this individual to get into this position (both

in terms of where there were untoward challenges to his or her physical capabilities or uncompensated degradation of psychological environment that challenged mental capabilities)? If the total of these exceptions starts running at more than five percent of the facility's total evaluations, it is time to investigate why the facility's application of causal analysis is faulty.

In summary, A3 is typically coupled with coding from other branches. The number of links and number of impacted systems will vary with the event significance category. However, this is not to be used as a rationale for single-coding a particular event. It is reiterated that while there is reason to believe that the nodes listed are more likely than others, there is no constraint that these are the only potential links. Similarly, while it is possible that there is no link for a particular situation, overuse of this extreme exception is indicative of other issues.

An event or condition resulting from the failure, malfunction, or deterioration of the individual human performance associated with the process. Note: strictly speaking, A3B1, A3B2, and A3B3 nodes are only applicable when "problem-solving," although this does not have to be conscious. These are not codes intended to be used to describe a situation in which one is not engaged in problem solving; e.g., falling asleep because of prescription medication (which might be A3B4C01 or A5B4C06). Further, these codes are for individual actions or the lack of individual actions. If an event has multiple occurrences of the same A3 C nodes, it is time to look for other rationale behind the behavior. There are single examples of group performance that are LTA. There is usually another explanation if there are multiple examples. For example, the control room operators at Three Mile Island mutually incorrectly diagnosed several of the accident indications and also mutually avoided application of several potential recovery paths. These errors were eventually traced to how their training had treated these potentialities.

B1 Skill Based Errors

Inattention or over-attention to performance of work affected the event.

A3B1C01 – Check of work was LTA

Definition: An individual made an error that would have been detectable and correctable if a check of the completed—or partially completed—work was performed.

Note: Corrective actions defined for this C node can be used in any combination to mitigate or prevent "Skill" errors from recurring. Suggested corrective actions are:

6. Install blocking devices between similar controls.
7. Identify critical steps of a task to increase attention.
8. Increase supervision or include additional personnel to peer check critical steps of a task.
9. Avoid multi-mode switches or controls.
10. Implement practice of rereading previous two or three steps of a procedure before proceeding with task, if distracted or interrupted.
11. Improve planning to reduce distractions or interruptions.
12. Eliminate unnecessary time pressure through scheduling.
13. Rotate individuals through various jobs.
14. Practice using skill to maintain proficiency.
15. Simplify and standardize manual checks (skill of the craft).
16. Automate some tasks less suited for human beings.

Examples: A transcription error was made when entering process data into a procedure.

A switching error was made on the BPS when a field technician incorrectly wrote down the switching order received from the system operator.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Identify critical steps of the task. Include peer checking for critical steps.
- The field technician is required by the entity's internal switching procedures to have the switching order be reviewed for accuracy by another qualified entity person.

A3B1C02 – Step was omitted due to distraction

Definition: Attention was diverted to another issue during performance of the task and the individual committed an error in performance due to the distraction.

Examples: Procedure steps were not properly completed because the performer was distracted and skipped a step in the procedure.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Implement practice of rereading previous two or three steps in the procedure before proceeding with task for affected individual.
- See note for A3B1C01.

A3B1C03 – Incorrect performance due to mental lapse

Definition: The individual knew the appropriate actions to take but failed to initiate the correct actions based on inattention or over-attention.

Examples: A routine task was incorrectly performed when an individual forgot the correct action to take.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Improve planning to reduce distractions or interruptions.
- Review the work flow to see if checks can be put into place that would catch similar mental lapses.
- See note for A3B1C01.

A3B1C04 – Infrequently performed steps were performed incorrectly

Definition: An individual was not completely familiar with the tasks required based on not frequently performing the tasks and not operating at a fluency level.

Examples: A particular method for reaching valving was used to install a lockout. Based on the Lockout Installer infrequently installing a lockout on the particular system, an incorrect method was chosen for reaching the valving, and the installer was injured in the process.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Increase supervision or include additional personnel to peer check critical steps of the task.
- See note for A3B1C01.

A3B1C05 – Delay in time caused LTA actions

Definition: An individual performed the wrong actions based on an extended length of time expiring between the time the task was defined and the time the task was completed.

Examples: A motor failed due to lack of lubrication. Routine maintenance had not been performed on the equipment. After an extended period of time, repair was made to the motor but the Preventive Maintenance was not reviewed for adequacy to assure lubrication performance. This was based on the individual not recalling the cause for motor failure.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Improve planning to reduce distractions or interruptions.
- Assure inclusion of failure cause in equipment history. Note: this would be multi-coded as Equipment history LTA [A2B2C04].
- See note for A3B1C01.

A3B1C06 – Wrong action selected based on similarity to other actions

Definition: An individual selected a wrong action out of a series of actions that appeared to be the same, but were not.

Examples: Multiple procedure steps were similarly written that required addition of the same chemical but each step varied in timing and quantity of chemical.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Install blocking devices between similar controls.
- Place an explanatory note in the procedure just before—or include in—the steps to notify the user that differences exist.
- See note for A3B1C01.

A3B1C07 – Omission/repetition of steps based on assumptions for completion

Definition: Individual made an assumption regarding completion of activity steps. Based on the perceptions, an error occurred because the incorrect decision or assumption was made.

Examples: Multiple steps that were similar and sequential in a procedure required completion. A shift change occurred and no turnover was performed. Individual did not have enough knowledge of where the previous shift left off and assumed that specific steps had been completed but had not been documented. The individual proceeded with the procedure but did not complete required steps in the procedure.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Implement practice of rereading previous two or three steps in the procedure before proceeding with task.
- Implement policy to initial, date, and time wherever a procedure is stopped prior to shift change.
- See note for A3B1C01.

B2 Rule Based Error

A misapplication of a good rule for behavior or application of a bad rule applied for behavior during the work process impacted the event. Note: application of this node is not limited to misapplication of procedures. Rules are often mental rather than written.

A3B2C01 – Strong rule incorrectly chosen over other rules

Definition: Individual chose behavior rules based on the number of times the rules had been used successfully in the past. The more times the rules were used successfully, the stronger the desire to apply the rules became.

Note: All corrective actions defined for this C node can be used in any combination to mitigate or prevent "Rule" errors from recurring. Suggested corrective actions are:

17. Clearly delineate key decision points in a procedure.
18. Eliminate procedure inconsistencies.
19. Simplify procedures.
20. Train individuals to skill-based performance mode (fluency).
21. Add "Forcing Functions" (fail-safe mechanisms that allow performance only one way—the right way).
22. Eliminate drawing and technical manual errors.
23. Improve knowledge of procedure bases.
24. Practice using multiple, alternative indications.
25. Promote practice of verbalizing intentions.
26. Practice on transition between procedures.
27. Eliminate unwise use of "Rule of Thumb."
28. Specialize on specific, safety-critical tasks (resident or subject-matter expert).
29. Improve human factors identification and layout of displays.

Examples: An individual who did not use seat belts when driving vehicles was consistently applying a strong rule to not use them but was incorrectly choosing to use that rule over another rule that, if applied, would have guided the individuals to use seat belts.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Train individuals to a skill-based performance mode (fluency).

A3B2C02 – Signs to stop were ignored and step performed incorrectly

Definition: Most activities generate indication of status (both positive and negative). The human tendency is to focus on the indications of success rather than all the indicators. The negative indicators are the "signs to stop." "Signs" are not necessarily physical.

Note: "Signs to stop" are not limited to any standardized list of error precursors. They can, and do, have an effect. The Institute of Nuclear Power Operations' short list of error precursors is built into the Causal Analysis Tree.

Examples: Time pressure is a common sign to stop for an event. When an individual is in a hurry to complete tasks and move on to additional tasks, errors in completing the tasks can occur.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Add "Forcing Functions" (fail-safe mechanisms that allow performance only one way).
- See note for A3B2C01.

A3B2C03 – Too much activity was occurring and error made in problem solving

Definition: This error was initiated when the individuals who were committing the error experienced information overload. The right set of decisions was not made because there were too many details to process mentally.

Examples: Multiple activities were taking place in the control room. The control room was required to take readings, set up transfer paths, and fill out log sheets documenting activities. In addition, a number of people were in the control room creating a distraction. When taking a reading and recording the result, the operator skipped a required step in the procedure by not focusing on the procedure completion due to other activities and distractions in the control room.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Train individuals to a skill-based performance mode (fluency).
- Establish a policy to allow only essential personnel into the control room during select or critical operations.
- See note for A3B2C01.

A3B2C04 – Previous successes in use of rule reinforced continued use of rule

Definition: Successful use of a rule in the past led to the wrong use of the rule or the rule being incorrectly applied.

Examples: In the past, chains were used to prevent ball valves from being manipulated. The recent facility practice was to use alternative valve-locking devices for the valves that had proven to be more effective in preventing the valve from being manipulated. However, the facility did not prevent the use of chains. Lockout Installers were comfortable using chains and continued to use the chains instead of the alternative locking devices.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Add "Forcing Functions" (fail-safe mechanisms that allow performance only one way).
- Develop a list of ball valves and state their best lockout device. Provide list to Installers.
- See note for A3B2C01.

A3B2C05 – Situation incorrectly identified or represented, resulting in wrong rule used

Definition: Individual interpreted facts based on training and experience that helped form stored mental knowledge from which the individual interpreted the facts. When the individual used the stored knowledge, the right set of training and experience was sometimes not selected based on the existing facts. A broader search of the stored knowledge would have been necessary to explain the existing facts.

Examples: A transfer of solutions was being made and the receipt vessel liquid levels were increasing. The situation appeared normal until an alarm was received that indicated the vessel was overflowing. A review of the situation revealed that the liquid level indicator installed in the vessel had been elevated (a different, higher position) in the vessel in the past. Although the individual taking the liquid level readings knew about the elevation change to the liquid level indicator, the information was not recalled when the transfer was performed.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Practice using multiple alternative indications.
- See note for A3B2C01.

B3 Knowledge-Based Error

The problem was solved without using stored rules for behavior. The involved personnel were in a problem-solving or troubleshooting mode. Note: some people find it easier to think of this node as "Lack of Knowledge-Based Error" since the essential gap is experiential.

A3B3C01 – Attention was given to wrong issues

Definition: Selective mental processing of information was targeted at the wrong issues. Often the individual focus was centered on what was psychologically important; instead of targeted on what was logically important.

Note: All corrective actions defined for this C node can be used in any combination to mitigate or prevent "Knowledge" errors from recurring. Suggested corrective actions are:

30. Practice, practice, practice using methodical problem-solving techniques with novel unfamiliar situations.
31. Design displays to enhance use without keyboarding.
32. Practice using team and communication skills.
33. Assign the role of devil's advocate.
34. Develop and practice lateral thinking skills.
35. Use system component knowledge and fundamental principles of physical sciences associated with plant systems and components in unfamiliar problem situations.
36. Train on and verify accuracy of system and social mental models.

Examples: Maintenance was being performed on a pump. A flex nylon-braid line was to be disconnected and replaced. This line was connected to the pump and was connected by a slip-on fit onto a barbed fitting and secured with an aviation clamp. In order to remove the line, the individual placed his foot on the pump to apply backward leverage for the purpose of pulling the line off the barbed fitting. In so doing, the individual was focused on getting the job done instead of the hazards associated with falling down if the line suddenly released from the fitting under extreme force.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Develop and practice lateral thinking skills. For this specific example, develop and practice of the thinking skills could be applied through the use of intervention concepts and practices.
- Develop a standard method for removing the line and place it in the maintenance procedure.

A3B3C02 – LTA conclusion based on sequencing of facts

Definition: An individual, when establishing a timeline or recalling step-by-step compilation of facts as they occurred in an event, sometimes reordered the sequence, which affected the conclusion based on the facts.

Examples: Chemicals added to a process vessel had to be added in a specific sequence to prevent a reaction of the chemicals. After a reaction had occurred, the individuals investigating the event inadvertently failed to recall the actual sequence of chemical additions, believing the sequence to be correct when it was not correct and overlooked the cause for a chemical reaction in the vessel.

An individual was in a problem-solving performance mode and incorrectly recalled the sequence of steps that were performed to disassemble a piece of equipment. During the reassembly, the

sequence that was recalled for disassembly was applied and the equipment could not properly be reassembled.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Train on and verify accuracy of system mental models.
- See note for A3B3C01.

A3B3C03 – Individual justified action by focusing on biased evidence

Definition: An individual was overconfident in evaluating the correctness of his or her knowledge. The chosen course of action was selected based on evidence that favored it and contradictory evidence was overlooked.

Examples: The statement, "This is the way we did it where I used to work" is often used. The problem with this mindset is that conditions, parameters, controls, etc. may be different enough from the individual's past experiences to require a different set of actions than what was required in the past.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- More practice using methodical problem-solving techniques with novel, unfamiliar situations.
- Practice using team and communication skills.
- See note for A3B3C01.

A3B3C04 – LTA review based on assumption that process will not change

Definition: Individual believed that no variability existed in the process and thus overlooked the fact that a change had occurred, leading to different results than normally realized.

Examples: Vessel concentrations of material were calculated based on a heel of material (solution left in bottom of vessel after flushing) believed to be present in the vessel. The normal flushing method provided for a specific amount of solution to be flushed through the vessel. During a flushing of the vessel, the amount of solution was less than specified for required flushing. The result was a larger heel containing more concentration of material than had been calculated.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Develop and practice lateral thinking skills.
- See note for A3B3C01.

A3B3C05 – Incorrect assumption that a correlation existed between two or more facts

Definition: Wrong assumptions were made based on the belief that two or more facts were related to each other and incorrect actions were taken based on the assumption.

Note: This also covers the case in which there is an incorrect assumption that two or more facts do not correlate when they do.

Examples: During a transfer of solutions from one vessel to the next, it was recognized that liquid levels on the chart recorder were increasing and the transfer had been initiated. However, further investigation revealed that a valve was incorrectly positioned, allowing solution from another source to flow into the receipt vessel, and the sending vessel was set up for the wrong transfer path.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Use system component knowledge and fundamental principles of physical sciences associated with plant systems and components in unfamiliar problem situations.
- See note for A3B3C01.

A3B3C06 – Individual underestimated the problem by using past events as basis

Definition: Individuals tend to oversimplify events. Based on stored knowledge of past events, the individual underestimated problems with the existing event and planned for fewer contingencies than would actually be needed.

Examples: Contamination incidents had been a regular occurrence in the past for the facility. The source of these contamination incidents had usually not been determined. The current contamination occurrence had an identifiable source but extensive surveys were required to locate it. The individual performing the surveys believed the current event was like the past events and did not perform an extended set of surveys in the facility to locate the source.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Practice skills using methodical problem-solving techniques with novel, unfamiliar situations.
- See note for A3B3C01.

B4 Work Practices LTA

The capacity to perform work was impaired. The act to incorrectly perform work was deliberate.

A3B4C01 – Individual's capability to perform work LTA

Definition: Sensory or Perceptual Capabilities LTA – The problem was due to less than adequate vision (e.g., poor visual acuity, color blindness, tunnel vision). The problem was caused by some defect in hearing (e.g., hearing loss, tone deafness). There was a problem due to some sensory defect (e.g., poor sense of touch or smell).

Motor or Physical Capabilities LTA – The causal factor was attributable to trouble with inadequate coordination or inadequate strength. The problem was due to inadequate size or stature of the individual involved. Other physical limitations (e.g., shaking, poor reaction time) contributed to the problem.

Attitude or Psychological Profile LTA – The problem was due to a poor attitude on the part of an individual. The individual involved showed signs of emotional illness. Note: the following symptoms are often warning signs of poor attitude or mental illness:

- Horseplay
- Absence from work location
- Failure to perform expected work
- Maliciousness
- Poor performance under stress
- Poor psychological health
- Use of drugs or alcohol
- Insubordination
- Failure to work well or communicate with others

- Disregard for safety rules

Note: These capabilities refer to physical and mental attributes (over which the employee has no control) or disease-related symptoms that may or may not be under the control of the individual. It may take professional diagnosis to determine if this code is applicable. Related codes are Ergonomics LTA [A1B5C01] and Job scoping did not identify potential task interruptions or environmental stress [A4B3C07]. Intentional non-compliance is A3B4C02. Also, this code relates only to a single individual; group behavior is entirely different.

Examples: Sensory/Perceptual Capabilities LTA – An operator read the wrong temperature on a chart that recorded temperature for several tanks. The chart was color-coded. The operator was partially color blind and confused the readings. He recorded a temperature as being in range when the actual temperature was out of range.

Motor/Physical Capabilities LTA – A tank overflowed because the operator could not close the valve. The valve was large and difficult to close. The operator did not have the strength to close the valve. By the time he obtained help in closing it, the tank had overflowed.

Attitude/Psychological Profile LTA – An operator failed to close a valve after filling a tank, resulting in a process upset. The operator showed symptoms of alcohol abuse and absence from his work location.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Sensory/Perceptual Capabilities LTA – Confirm color blind diagnosis and reassign to duties that do not utilize affected capabilities.
- Motor/Physical Capabilities LTA – Determine if the valve can be made easier to close (i.e., repair, replace, or increased preventive maintenance). If not, consider non-punitive reassignment of operator.
- Attitude/Psychological Profile LTA – Process through Employee Assistance Program.

A3B4C02 – Deliberate violation

Definition: The action on the part of the individual was a deliberate action to commit human error.

Note: Be very careful in the application of this code. It may take professional diagnosis to determine if the action was intentional or the result of something beyond the control of the individual [A3B3C01]. There is usually some form of personal gain associated with this code. Also, this code relates only to a single individual; group behavior is entirely different. If this code is cited in more than around five percent of the incidents for a given facility, there is most likely some other underlying cause.

Examples: An individual cut the lock on a defined lockout point for a Lockout/Tagout on a system to bypass the lockout.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Apply the Constructive Discipline program.

A4 Management / Organization

An event or condition that could be directly traced to managerial actions or methodology (or lack thereof). A management problem attributed to management methods (directions, monitoring, assessment, accountability, and corrective action), inadequate resource allocation, work organization and planning, supervisory methods, and change management practices.

Note: Apparent Cause Corrective Actions for this branch in particular easily slip into correcting the program as opposed to the implementation. Fixing the program is the realm of root causes. The analyst is cautioned to gauge Corrective Actions appropriately. Also, even though the terms "Management" and "Organization" are used in the title, use of either one separately implies the other, and neither is intended as a job title, solely as a function or process.

B1 Management Methods LTA

The processes used to control or direct work-related plant activities, including how manpower and material were allocated for a particular objective. Note: this cause section addresses management-controlled practices and policies and requires that the investigator gain familiarity with the standards or expectations that exist for performing work. [See note for A4B4.]

A4B1C01 – Management policy guidance or expectations not well-defined, understood, or enforced

Definition: Personnel exhibited lack of understanding of existing policy or expectations. Policy or expectations were not well-defined and/or enforced. Policy or expectations were not adequately developed and/or articulated/explained to ensure proper understanding and use by personnel.

Example: A key piece of equipment in a process safety system failed. The policy stated that the required maintenance and inspections were to be performed annually. Because of the difficulty and amount of the work involved, maintenance was performed the last two weeks of odd-numbered years and the first two weeks of even-numbered years. This allowed nearly two years between the required maintenance and inspections. The policy was confusing and poorly defined and left room to interpret a 24-month gap between maintenance and inspections when it was intended not to have more than a 12-month gap between the two.

During a routine inspection, containers of controlled material were found to be in violation of a safety policy regarding required information on container labels. In order to comply with the security policy concerning controlled material access, the safety policy was violated. The two policies were contradictory regarding labeling of controlled material.

A system operator made an operational decision while returning a piece of equipment to service. The operational decision reversed the exact sequence of the original switching order that removed the equipment from service. However, another switch had been placed in a different position after taking the original piece of equipment out of service. The operator was unaware that this change had taken place. Due to the new position of that switch, an airbreak switch opening, as part of the switching order, was attempting to break load resulting in a bus fault. The process for making an operational decision on switching orders was unclear such that a peer and/or supervisory review was advisable/appropriate for reversing steps to restore equipment.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Modify administrative control to stipulate maximum period of 12 months.
- Modify safety and security policies to balance concerns and still meet operational mission.
- Modify the process for making an operational decision on switching orders to assure that a peer and/or supervisory review is required for reversing previously approved steps to restore equipment.

A4B1C02 – Job performance standards not adequately defined

Definition: Measurement of effectiveness could not be performed for a specific job function due to lack of defined standards.

Example: During an extended facility outage, routine surveillance of process alarm panels was not performed. As a result, a chemical leak went undetected for two days. Facility management had not clearly defined normal surveillance standards during the extended outage.

An operator made a mistake when operating a process that was color-coded on the distributed control system. The operator was color-blind. There were no job performance standards or requirements concerning color blindness for this job even though being able to discriminate among colors was necessary to operate the process. Note: this (or similar) example should be multi-coded under A3B4C01.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Assure that job performance standards for surveillance requirements during extended outages are adequately defined.
- Reassign affected individual to position that does not require color discrimination.
- Assure medical review of job performance standards in which the ability to discern colors is essential to adequate performance of this assigned task, and modify task requirements accordingly.

A4B1C03 – Management direction created insufficient awareness of the impact of actions on safety / reliability

Definition: Management failed to provide direction regarding safeguards against non-conservative actions by personnel concerning quality, safety, or reliability.

Example: An event occurred in a waste tank because incompatible materials were mixed. The Process Hazards Review (PHR) had been performed but it failed to consider the possible sources of material that could be added to the tank.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Reexamine the baseline for the PHR to assure the specific incompatible materials have been documented and appropriate safeguards are integrated into management expectations, organizational programs, and system designs such that employees are trained and skilled in knowing operational limitations and safety parameters.

A4B1C04 – Management follow up or monitoring of activities did not identify problems

Definition: Management's methods for monitoring the success of initiatives were ineffective in identifying shortcomings in the implementation. The development of "good practices", processes, or expected behaviors that were identified as a result of prior circumstances were not implemented.

Example: Job-specific bioassay sampling program for tritium requires personnel to leave a tritium sample at the end of the work shift as required in the Radiation Work Permit. If the sample is not left prior to leaving work, the employee is in noncompliance with regulatory requirements and thereby places the company at risk for Price Anderson Amendments Act enforcement liability. The first formal opportunity to detect noncompliance is during the Radiological Controls Organization supervisor's examination of weekly employee log sheet sign-ins and sampling label checks. Multiple noncompliance events occurred over time with related corrective actions tracked and closed; however, corrective actions were ineffective in preventing the problem from recurring.

A problem was identified, and corrective actions were developed, but unintended consequences existed but not identified.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Develop bioassay sampling interventions that detect noncompliance at the point of failure.

A4B1C05 – Management assessment did not determine causes of previous event or known problem

Definition: Analysis methods failed to uncover the causal factors of consequential or non-consequential events.

Examples: The EMS Disaster Recovery system had uncleared semaphores—used in the data transfer process between EMS applications—that were locked and prevented the transfer of data packets between EMS applications on the Disaster Recovery system. These data packets became backlogged and eventually caused the Disaster Recovery system to stop. EMS staff attempted available methods of clearing the semaphores but were unsuccessful in clearing the semaphores causing the system performance issues. Ultimately the staff, with additional user privileges on the server, issued commands to clear all semaphores. After the semaphores were cleared and the Disaster Recovery system was restarted, the system performed normally and transmission operators were able to monitor and control the transmission system through SCADA. During EMS restoration efforts, an attempt was made to restart the EMS Production system as Primary; however, as the system was brought online it began experiencing the same semaphore-related issues as the Disaster Recovery system. It was not functional until UNIX staff cleared the semaphores on the Production system while the operators had SCADA monitoring and control of the transmission system via the Disaster Recovery system.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review internal event analysis procedure and ensure that it includes a consideration of not just what happened but also why it happened, in order to provide the causes.
- Determine why causal analysis was not implemented in former cases. Implement appropriate corrective actions. Establish a corrective action tracking process to close out and document the corrective actions.
- Where redundant systems are in use (production or primary and disaster recovery) troubleshooting and correct of problems on one system should be applied to all systems as required.

A4B1C06 – Previous industry or in-house experience was not effectively used to prevent recurrence

Definition: An industry or in-house experience relating to a current problem existed prior to the event but was not assimilated by the organization.

Note: This code is not necessarily limited to the site's formal lessons learned program. It can apply to any event of which the facility had been made aware.

Example: A Department of Energy (DOE) customer shared problematic issues from another DOE site concerning radiation protection issues. The site had obtained the information and discussed several corrective actions but did either did not take any action or only implemented a single action. A similar problem occurred several months later. It was evident that the organization had not fully assimilated the significance of the prior issue.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Conduct another review of the information provided—particularly actions taken at other site—and determine if actions taken were effective. Implement appropriate corrective actions.
- Assure work is prioritized to allow appropriate level of analysis to be performed on lower-level trending information as an investment in prevention.

- Assure analysis of performance trending data is comprehensive enough based on the severity of the event to employees and the business and potential consequences.

A4B1C07 – Responsibility of personnel not well-defined or personnel not held accountable

Definition: Responsibility for process elements (procedures, engineering, training, etc.) or accountability for failures of those process elements was not placed with individuals.

Example: A technical limit for the length of time allowed between airflow checks on a stack exhaust system was violated. The Operations Department considered the checks to be maintenance items; however, the Maintenance Department considered them to be an operations item. Responsibility for the checks was not defined. (Note: often this lack of defining responsibility occurs when e-mails or other correspondence methods are used to cite the need for an action to be taken, sent out to a group of people, but no one being assigned, or designated, as the person in charge, a typical "diffusion of responsibility" scenario)

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Develop memorandum of understanding to establish responsibility.
- Understand, and monitor, situations where "diffusion of responsibility communications are occurring. If observed, take action to correct the situation.

A4B1C08 – Corrective action responses to a known or repetitive problem was untimely

Definition: Corrective action for known or recurring problem was identified, with corrective actions developed, but implementation was not performed in time to prevent the problem from happening (or happening again).

Example: A tank overflowed because the liquid level instrumentation was out of calibration. Corrective measures were identified during a previous overflow of the tank but had not been implemented when the second overflow occurred.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Calibrate liquid level instrumentation. Note: this should be multi-coded under Calibration for Instruments LTA [A2B1].
- Either promptly implement corrective actions from previous event or implement compensatory measures or justify delay.

A4B1C09 – Corrective action for previously identified problem or event was not adequate to prevent recurrence

Definition: Management failed to take meaningful corrective action for consequential or non-consequential events.

Example: Over a period of time, several related Occurrence Reporting and Processing System (ORPS) events involving noncompliance with operational requirements for had been reported to DOE. With each similar event being reported, the significance category progressed from low-level performance monitoring and trending to Significance Category 2. Recommended solutions from the first reported event to the most recent event were essentially the same in regard to procedural changes and employee training.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review implementation of causal analysis technology and frequency of analyses.
- Develop new corrective actions that do not rely on procedural changes or employee training.

B2 Resource Management LTA

Evaluation of the processes whereby manpower and material were allocated to successfully perform assigned tasks. Note: B2 serves as an expansion to B1, Management Methods, since both B1 and B2 are important interrelated factors. B2 provides more in-depth causal nodes for evaluating manpower and material issues that impact performance of work-related activities.

A4B2C01 – Too many administrative duties assigned to immediate supervisors

Definition: The administrative load on immediate supervisors adversely affected their ability to supervise ongoing activities.

Note: This is a problem with the management of the supervisor, not his or her supervisory methods [A4B4]. This cause code is concerned with non-task activities—not actively supervising employees. Task overload is A4B2C02.

Example: A first-line supervisor and his experienced crew were assigned a work package to repair a leaking tank containing a hazardous chemical. The supervisor was also involved with other important activities supporting the First-Line Managers' (FLM) Council, safety program initiatives within his department, and the division golfing event for the United Way Campaign. During the maintenance repair, the crew failed to execute a critical step in the repair process that resulted in further damage to the tank. At the time of the event, the supervisor was making a formal presentation to the FLM Council on issues impacting the work environment.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Reduce non-task items assigned to affected supervisor.
- Examine work planning, scheduling and work prioritization processes, the adequacy of communications channels (oral and written) among the supervisor, the maintenance crew, and the management team in order to accommodate duties beyond direct supervisory responsibilities.

A4B2C02 – Insufficient supervisory resources to provide necessary supervision

Definition: Supervisory resources are less than required by task analysis considering the balance of procedures, supervision, and training.

Note: This is a problem with the management of the supervisor, not the supervisory methods [A4B4]. This means there are too many jobs to be actively supervised at once. Non-task (not actively supervising employees) overload is A4B2C01.

Example: The Operations Department recently restructured to new performance management contract initiatives and other company conditions. Several experienced employees retired or left the organization, and replacements were part of a new, multi-skilled job ladder. Job responsibilities and duties were redistributed to accommodate the reduced staffing and organizational consolidation. Although many job titles had remained the same during the last several years, most of the job functions had revised duties and tasks. Formal position descriptions and related job task analyses had not been reviewed for several years. Regulatory requirements had gradually become more stringent over the years, reducing the amount of time supervisors had available. Previous jobs that took an hour for the supervisor to complete now took four hours to accomplish. Therefore, even less time was spent on important job tasks where supervision was needed. Considering tasks involving procedures, training and supervisory responsibilities, supervisory resources were not adequate to meet the need.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Update position descriptions and job task analyses based on company initiatives and regulatory changes. Modify assignments based on updated documentation.
- Review department's ability to adequately plan, prioritize and staff for human resources based on changes in scope driven by changing business conditions.

A4B2C03 – Insufficient manpower to support identified goal/objective

Definition: Personnel were not available as required by task analysis of goal or objective.

Example: Changes in the site's waste generation program required increased characterization of waste streams to accommodate storage in metal storage vaults versus direct ground burial. With multiple waste streams in laboratory operations and the unpredictability of those streams, Generator Certification Official (GCO) manpower was added to staff the certification function. Other job skills were impacted by the program change. This included radiological control technicians (increased survey calculations and shipment preparation) and technical lab personnel (increased GCO training, slowdowns in performing lab-specific functions resulting from characterizing, bagging and preparing waste products for shipment). Waste-storage locations for staging characterized waste impacted facility housekeeping programs and generated additional "As Low as Reasonably Achievable" (ALARA) concerns. Appropriate task analysis had not been conducted on the manpower needed to adequately support the overall waste management program for lab operations.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review adequacy of job or task assignment. Modify task analysis or manpower loading as necessary to meet program changes.
- Reduce workload in related area to provide necessary personnel in the critical area.

A4B2C04 – Resources not provided to assure adequate training was provided/ maintained

Definition: Training resources were not available as required by task analysis.

Example: Recent site restructuring efforts reduced some program manpower resources based on the percentage of budget the organization contributed to the overall program. Additionally, as part of restructuring, early retirement and voluntary separation incentives were offered to qualified personnel to meet corporate budget targets by the end of the fiscal year. A new multi-skilled technician job ladder was introduced to accommodate certain organizational shifts in manpower and to fill some essential job functions. All the changes created movement within the workforce that required additional training to meet various mission-essential tasking. New task analysis of job functions revealed that there were not enough resources to provide adequate training for the newly restructured organization.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Provide additional training resources.
- Rotate existing training personnel from less important tasks.
- Implement compensatory actions and justify delay in resource allocation.

A4B2C05 – Needed resource changes not approved/funded

Definition: Corrective actions for existing deficiencies that were previously identified were not approved or funded.

Example: A small project experienced problems in costs and schedule. Issues and performance deficiencies with related corrective actions were being tracked by project management but—due to emphasis on schedule delays and cost overruns—some of the corrective actions were not approved or funded. Through independent management evaluation, it was determined that the project would have been able to detect its downward trend earlier and prevented further project performance degradation and reduction of scope if some of the corrective actions had been funded and approved.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review implementation of performance monitoring and trending program to assure project scope stays within acceptable parameters of performance (e.g., quality, production, schedule costs) using leading, real-time, and lagging indicators.
- Assure acceptance criteria for deviations between performance and expectations are known prior to restarting the project.
- Reexamine original baseline planning documents to assure plan is sensitive to unexpected business changes.

A4B2C06 – Means not provided to assure procedures/documents/records were of adequate quality and up-to-date

Definition: A process for changing procedures or other work documents to assure quality and timeliness was nonexistent or inadequate.

Example: A Lockout/Tagout (L/T) to perform Diesel Generator (D/G) maintenance was ready for review and approval. The Front Line Manager (FLM) for maintenance was unable to locate electrical prints for the L/T. The FLM walked down the lockout plan and checked adjacent electrical panels for other feeds that may have been associated with the D/G. No other electrical feeds were identified other than those already listed on the L/T. In addition to the Subject Matter Expert, managers from Utilities, Engineering and Operations approved the L/T. The FLM signed the approval block on the L/T. The next day the mechanic performed determination and voltage checks on the D/G and found that a 120 volts source of electricity was still present. The process for assuring appropriate documentation verified and validated that the L/T was inadequate.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Provide approved and accurate electrical prints for D/G and L/T. Determine what caused the incorrect prints to be used.

A4B2C07 – Means not provided for assuring adequate availability of appropriate materials/tools

Definition: A process for supplying personnel with appropriate materials or tools did not exist, or was less than adequate.

Example: An employee was cutting plastic with a table saw when several teeth broke off the blade, which caused material to kick back and rip off the employee's fingernail. The manufacturer produced the blade as part of their woodworking line. The carbide-tipped, 12-inch blade with 60 teeth was the site's blade of choice for general-purpose cutting. The manufacturer recommended not using the woodcutting blade for cutting plastics and recommended another blade product designed specifically for plastics. The process to assure employees were provided with the proper tools was not adequate.

In a load-shedding situation, the operator was not able to quickly determine which stations to shed when the directive to shed load was received. The tools he had available to him were not adequate to the task.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review adequacy of man-machine interface and adequacy of assumptions used in tool selection among employees and supervisors.

A4B2C08 – Means not provided for assuring adequate equipment quality, reliability, or operability

Definition: A process for assuring personnel's equipment was satisfactory did not exist.

Example: **T**he Radiation Work Permit (RWP) for a confined-space entry into a valve box to leak test an interconnecting pipeline to a low-level waste system required Personal Protective Equipment (PPE), including two sets of Tyvek (water-resistant, disposable coveralls), booties, and a respirator. Blotter paper was placed on the floor area of the pit to help control transfer of contamination while the employee was standing on the floor. The employee began to leak test piping using a leak-test soap solution. Once the leak was fixed, the employee exited the pit and removed shoe covers, harness, first layer of Tyvek, and outer gloves with assistance from the Radiological Controls Technician. Upon proceeding to the buffer area and removing the second layer of Tyvek, respirator, and inner gloves, contamination of 20,000 counts per minute (cpm) beta-gamma was discovered on the right shoe and 24,000 cpm beta-gamma was on the left pant leg. The RWP called for two sets of Tyvek and non-skid shoe covers. The work package, which included the use of liquid soap solution in a dry work environment, did not include the need for waterproof PPE. The process for assuring that reliable and operable equipment was available to adequately protect the employee was unsatisfactory.

EMS Equipment usage went well beyond the expected end-of-life cycle. The predicted end-of-life was 7 years, but the replacement upgrade was postponed due to budgetary constraints. Subsequent competing demands resulted in outdated equipment or software, leaving the system unable to reliably handle the demands placed on it.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Include guideline for waterproof PPE when working with water-based solutions. Note: this should be multi-coded under Written Communications Content LTA [A5B2].
- Review implementation of organization interfaces with focus on hazards analysis completeness.

A4B2C09 – Personnel selection did not assure match of worker motivations and job descriptions

Definition: Personnel selection processes failed to determine a mismatch between motivation and job description prior to task.

Note: Mismatch with motivations is under this code. Mismatch with skills is under A4B4C09.

Example: An employee, along with a small group, was assigned to routine production of work packages. Under the system in use at the time, each package had to be individually created in several separate databases for the different forms involved. The employee took it upon himself to integrate the various files into a single platform for work package creation for use by the entire group. This development effort detracted from the employee's work output and his manager voiced disapproval with the distraction. The manager failed to realize that the investment involved with upgrading the work process would eventually lead to vastly improved efficiency for the entire work group. The employee's motivation—increasing long-term productivity—was in conflict with management's desire for short-term increased work output.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Consider methods to increase manager's 'big picture.'
- Review implementation of management processes in assigning personnel to tasks based on proper knowledge and training required in meeting performance standards or expectations and motivation of employee in accomplishing assignment.

A4B2C10 – Means/method not provided for assuring adequate quality of contract services

Definition: The process for assuring that quality contract services were being provided was nonexistent or inadequate.

Note: The concept of oversight of any contractor extends to any subcontractor utilized by the contractor.

Example: A subcontract was awarded to a vendor for supplying low-level radioactive waste containers that met appropriate waste acceptance criteria and Department of Transportation packaging requirements. The vendor utilized welding procedures as administrative controls to assure that welding processes and qualifications met American Society of Mechanical Engineers standards. During a contract renewal assessment visit, the vendor's inspection and test records and their respective results were found to have no irregularities. However, information entered on welding procedures and their corresponding qualification records revealed discrepancies that did not meet welding code. The technical direction which was provided to the welders responsible for fabrication and assembly of the waste containers had compromised the quality of the services required by the subcontract. The process for assuring quality contract deliverables was inadequate.

The company did not specify which testing a contractor should perform on a breaker, and the testing results were not adequately reviewed. As a result, unacceptable or undesired results of the tests run were not identified, nor was the fact that desired testing was not accomplished

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review implementation of specific vendor's internal assessment methods and focus on methods for detecting and correcting discrepancies in quality.
- Details of anticipated work by a contractor should be reviewed by the company, to ensure what the contractor is intending to do matches what the company expects to be done.

B3 Work Organization and Planning LTA

Problems in how the work to be performed was organized. This would include work scope, planning, assignment, and scheduling of a task to be performed. Note: while B3 addresses the organization and planning of work, failures in this node usually imply related failures in Supervisory Methods that are addressed in B4.

A4B3C01 – Insufficient time for worker to prepare task

Definition: Scheduling of the task did not adequately address the time frame required for accepted worker preparation practices to occur.

Example: An electrical job was placed on the facility schedule, as normal, eight weeks in advance of the planned work start. Despite foreknowledge of the need for a lockout/tagout (L/T) plan to perform the work, no L/T was requested from the lockout writer until the day before the job was scheduled to begin. Given the time constraint, the lockout writer reused an old L/T plan that had been written for a similar job some months before. However, the work boundary was different on the new job and this resulted in an inappropriate isolation (i.e., the lockout plan did not adequately isolate the planned, work boundary). The lockout writer did not take the time to verify the work boundary against the lockout due to the rushed nature of the job. The time frame for scheduling the task did not adequately address the time frame required for accepted worker preparation practices to occur.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Require Work Control Supervisor to review the facility schedule on a periodic basis. Any work on the schedule should be assessed for L/T requirements.
- Review implementation of the organizational function or structure to plan and assign work consistent with priorities. Examine work planning and communication barriers that impact teaming efforts.

A4B3C02 – Insufficient time allotted for task

Definition: Scheduled duration of the task did not adequately address known conditions or account for reasonable, emergent issues.

Example: A job was planned to perform decontamination activities in an Airborne Radioactivity Area (ARA). It was scheduled in conflict with another job that also required the use of the building's breathing air system. Only one job could be accommodated at a time. In order to accommodate the other remaining breathing air work deemed critical to the facility's mission, the facility manager decided to reduce the allotted duration of the decontamination task from three to two days. During the course of the decontamination job, one of the workers fell over waste bags that were left in the area and sprained his or her wrist. The workers were under a time constraint to complete both tasks within the allotted three-day period. The removal of the waste bags prior to starting the decontamination task was not part of the initial work scope. The work plan was to make a separate entry to remove the waste bags at a later time rather than add an additional person for the decontamination entry.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review implementation of work practices and focus on shortcuts used to accelerate job completion when there is perceived pressure to complete work.

A4B3C03 – Duties not well-distributed among personnel

Definition: The work loading of individuals within a group or team did not adequately address training, experience, task frequency and duration, or other situational factors. As such, responsibility was inappropriately distributed.

Example: As part of an organizational shuffle, a new engineer was assigned as the Design Authority for the breathing air system in the facility. The engineer held a degree in electrical—not mechanical—engineering and was unfamiliar with the calculations performed on breathing air relief devices. As a result, a pressure relief calculation error was not discovered and resulted in a premature activation of the relief device, which caused a job stoppage and additional protective clothing (i.e., plastic suit) expense. The work loading process did not adequately address situational factors to assure responsibility was appropriately distributed among individuals within the group.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Provide the new engineer with training concerning the breathing air system.
- Review implementation of management processes in assigning personnel to tasks based on proper knowledge and training required in performing the job assignment.

A4B3C04 – Too few workers assigned to task

Definition: Job planning did not allot a realistic number of man hours or the number of people necessary to complete the task based on the scope of work described.

Example: A job was planned to perform a test of an electronic control system. This test typically takes two hours and involves three workers—one to manipulate controls, one to observe the time-dependent

system changes, and one to record results. The supervisor only allotted two workers, informing the second that he would have to note the system changes and record them. During the middle of the test, the observer/recorder had to abort the test as one of the test readings was missed while he was recording previous observations.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Reschedule and perform test when three workers are available.
- Put a note in the test procedure prerequisites that this test requires three people to accomplish. Note: this should be multiple coded under A5B2.

A4B3C05 – Insufficient number of trained or experienced workers assigned to task

Definition: Though the overall number of personnel assigned matched the planned man-hour allotment, organization methods failed to identify that the personnel assigned did not have adequate experience or training to perform the work.

Example: Four jobs underway were utilizing the facility breathing air system, since work was being performed in Airborne Radioactivity Areas. There was a shortage of trained and qualified operators to perform manifold attendant duties, so facility management assigned untrained operators at two of the job sites, while providing for a third "trained and qualified" operator to move between the two sites to "checkup" on the untrained coworkers. During the time the "trained and qualified" operator was unavailable to one of the untrained operators, a fluctuation in breathing air pressure was observed. This fluctuation did not trigger a breathing air alarm; however, the inexperienced operator immediately ordered the exiting of the airborne area, resulting in a costly, unnecessary work stoppage. The organization failed to assign personnel with adequate experience and training to perform the work.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Designate additional operators to become qualified as a Breathing Air System manifold attendant.
- Review implementation of work practices and focus on shortcuts used to accelerate job completion when there is perceived pressure to complete work.

A4B3C06 – Planning not coordinated with input from walk downs/task analysis

Definition: The job plan did not incorporate information gathered during field visits or task analysis that concerned the steps and conditions required for successful completion of the task.

Example: An electrical job was planned to replace a malfunctioning light fixture. This fixture was not shown on the facility drawings, so the lockout writer included all lighting circuits in the general area on the lockout, as well as a warning that the power source could not be confirmed. It was later discovered that Electrical and Instrumentation had previously determined the correct feed for the light fixture in question on a "Fix-It-Now" task, but this information was not communicated to the lockout writer or work planner. As a result, one section of the facility was without lighting for half a day, when all that was really necessary was to de-energize a single circuit. Additionally, operator time was wasted from hanging a documented lockout/tagout, when a single-point lockout/tagout installed by the work group would have sufficed.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review implementation of interface requirements required by one program but belonging to another program, focusing on program design and work planning processes for standardization between the groups (Electrical and Instrumentation, lockout writers and the work planners).

A4B3C07 – Job scoping did not identify potential task interruptions and/or environmental stress

Definition: The work scoping process was not effective in detecting reasonable obstructions to work flow (e.g., shift changes) or the impact of environmental conditions.

Note: This code applies to disruptions of circadian rhythms (biological functions based on 24-hour schedule) caused by scheduling of work.

Example: Work was conducted in the underground liquid waste transfer cells. The cells were located in an outdoor area between the facility's buildings. Workers required plastic suits and breathing air systems in this area to perform work. Previous entry to this area had been made when ambient temperatures were in the mid- to low 70s. A job required entry into this area later when ambient temperatures typically reached 90 degrees or more during the hottest part of the day. The work package, which was scheduled for a mid-morning start, required the use of ice barrels to chill breathing air being used by the six workers. During the eight-hour job, two of the six workers became ill and asked to be cut out of their suits and relieved from work. This resulted in premature termination of the job. Medical diagnosed both workers as first aid cases due to heat stress. The work scoping process did not examine other provisions or options for minimizing the impact of environmental conditions on the workers.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review implementation of work practices that could potentially lead to inadequately planning for contingencies.

A4B3C08 – Job scoping did not identify special circumstances and/or conditions

Definition: The work scoping process was not effective in detecting work process elements having a dependency upon other circumstances or conditions.

Example: Plant maintenance personnel were planning work for an upcoming unit outage period. One of the jobs involved maintenance on control valve 1A—one of two control valves that supplied general service water. Control valve 2A was already closed for scheduled planned maintenance, which was unrelated to the work on 1A. When plant personnel closed valve 1A all cooling water to the plant was lost, tripping the three online units. Neither the maintenance manager nor the maintenance personnel recognized the impact of closing the 1A to the general service water cooling system. The work scoping process did not detect the dependency the components had on other systems and circumstances.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review implementation of work planning processes, examining program-to-program interface (configuration management, work planning, operations, engineering, maintenance) requirements.
- All employees will receive a basic review of Company Generation Clearance Procedure principles, and Plant Operating Procedures and principles.
- Company Generation will consider, as part of its initial maintenance procedures/plan development, the identification of a "single-point of failure" being created due to maintenance activities (e.g., electrical, fuel, water, mechanical, etc.).

A4B3C09 – Work planning not coordinated with all departments involved in task

Definition: Interdepartmental communication and teamwork did not support the work flow being planned.

Note: The key word is "coordinated." By not getting input from affected departments, the work plan is not likely to succeed.

Example: During a planned outage, the planned work flow called for conducting lockout/tagout procedures in a specified order to support safe facility shutdown. The order of the lockouts dictated that verification of isolation was performed by Electrical and Instrumentation (E&I) personnel at the same time in three different locations to support the work as scheduled. When tasked to support the plan, E&I could not support lockout/tagout due to limited resources availability. As a result, the outage work schedule was revised and extended four hours beyond the original timeline, since one of the lockouts had to be removed and re-installed at a later time in order to accommodate the availability of E&I.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review implementation of interface requirements required by one program but belonging to another program, focusing on work planning processes between the groups (E&I, lockout writers, and the work planners).

A4B3C10 – Problem performing repetitive tasks and/or subtasks

Definition: The work flow plan repeated tasks or subtasks to the detriment of successful completion of the evolution.

Example: A lockout plan was written to install Ground Fault Circuit Interrupter (GFCI) receptacles in a room. Since these devices are polarized, it was necessary to provide a temporary lift for the lockout in order to test the polarity and verify correct installation. The lockout involved multiple points, as all receptacles in the room were being changed. Because of this, seven separate lockout plans were written to allow for lifts to take place on each of the lockouts. It would have been more efficient to install seven single-point lockouts and treat each receptacle as a separate task on the work order. Then, any number of lifts could be performed on a given receptacle without the need to install a time-consuming multiple-point lockout. The work flow plan process did not recognize the repetitive nature of the job and the subsequent impact on effective utilization of resources.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review implementation of lockout design, prioritization of work, and staffing resources, focusing on excessive implementation requirements.

A4B3C11 – Inadequate work package preparation

Definition: Though scoping and planning were adequately performed, the work package did not reflect the information gathered from these activities. The work package did not accurately reflect the work that was to be completed.

Note: the term "Work Package" is not intended to imply a detailed, complex document or package must be developed for a job, but simply whatever tools and documents the organization uses to detail what is to be done for the person(s) doing the work. A work package can be complex (and probably should be, when installing a new system) or simple (such as a simple checklist or similar instruction). The intent is that whatever method of instructing work to be done should be as complex or as simple as is needed to ensure the work to be done is properly passed to the person(s) doing the work.

Example: A job was planned to replace a defective motor on a fan. Electrical and Instrumentation (E&I) personnel had previously verified that the control voltage for the motor was fed from the control transformer in the Motor Control Center cubicle. As a result, de-energizing the single point would completely de-energize the work boundary. However, this information was not included in the work

package or the lockout order. When the work crew arrived to perform the maintenance, they refused to sign onto the lockout until the work boundary could be independently verified. Significant time was lost in confirming that the lockout did indeed properly cover the scope of the job.

A first-line supervisor prepared a detailed job plan for changing out a pump. The new pump was installed perfectly. The plan, however, did not provide instructions for handling the pump that was removed from service. As a result, the crew disassembled the pump and sent the scrap metal to the salvage yard. A significant amount of money was lost—the original pump was expensive and was to be rebuilt.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review implementation of methods to assure necessary information used in decision-making by all involved parties.
- Review implementation of work practices, examining supervisory actions or decisions that were made without assessing the entire situation.

B4 Supervisory Methods LTA

Causes that can be traced back to the immediate supervision and evaluation techniques that were used to monitor, direct, and control work assignments. Note: this is supervision as a function, not as a title. A manager can be the supervisor of another manager, or a non-supervisor (by title) can function as a supervisor. Problems with management other than immediate supervision are coded under B1, B2 or B5 (which does not mean that immediate supervision problems cannot be multi-coded under those B nodes).

A4B4C01 – Tasks and individual accountability not made clear to worker

Definition: Tasks and individual accountability for the tasks that were outside written guidance or training and were not made clear to the worker.

Example: The facility heating, ventilation, and air conditioning (HVAC) control system reported a variation in humidity control in one area of the building. The system engineer was contacted. The engineer indicated that the humidistat for that area appeared to be out of adjustment and suggested that one of the operators adjust it to the correct set point. No procedure existed for adjustments to the controls. The shift manager dispatched an operator to perform the adjustment. The operator was new and not yet qualified on the system. When the operator arrived at the HVAC unit, he observed a hand-inscribed hash mark on the adjustment knob for the instrument. He did not know that this mark was the factory setting, not the correct setting for the building. When he adjusted the instrument to the factory setting, the humidity situation worsened rather than improved, which resulted in condensation forming on the floor. This created a potential slip-and-fall hazard.

A step in the waste acceptance procedure required the waste receipt operator to compare the manifest that arrived with the waste to the manifest that was sent to the site for review and approval prior to the waste being shipped. This was done because changes were sometimes made in the waste before it was sent. The procedure did not specify what was to be compared on the two manifests. The waste receipt operator typically compared only the box numbers and weights. In one case, the box numbers and weight had not changed but the box contents were significantly different. This box of waste was put in the wrong location based on its actual contents.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review implementation of task assignments, focusing on assigning the right people to the right jobs. Note: this should be double-coded under A5B3.

- State in the waste acceptance procedure what items are to be compared between the original manifest and the manifest that arrives with the shipment. Note: this should be double-coded under A5B2.

A4B4C02 – Progress/status of task not adequately tracked

Definition: Supervision did not take the appropriate actions to monitor the task progress or status.

Example: An employee was tasked with designing and developing a new program and related information management system that would provide an assessment of team performance for the unit. The unit did not have any defined integrated process and application tool available to the supervisors and workers that could provide an assessment of the unit's overall team performance. The supervisor did not have any experience with development of administrative systems, so he left the project to the employee. Working through the details and benchmarking with other groups, the employee presented the new program to the supervisory team, only to be criticized for its perceived complexity and exposure of performance information to the management team. Supervision did not take the appropriate actions to monitor the task progress or status of the overall task.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review implementation of the supervisory and technical task assignment, examining whether the task complexities exceeded the capability of the supervisor to perform supervisory duties.

A4B4C03 – Appropriate level of in-task supervision not determined prior to task

Definition: Supervision did not adequately assess the task for points of supervisory interaction prior to assignment to workers.

Example: The work package for an evolution included full details on the work to be done but did not expressly identify hold points for supervisory intervention. During his review, the supervisor scanned the work instructions, looking for safety problems and indications that he would be able to execute the task He made a few notations to the planner about proper protective equipment, entering them on the Work Clearance Permit. However, the supervisor failed to note that, at one point in the evolution, the mechanics were asked to make adjustments to an instrument. The supervisor failed to notify the planner to include a hold point in the work package so that the supervisor could be contacted. The planner scheduled this job on a day when the supervisor who initiated the work package was on vacation. The stand-in supervisor performed a prejob brief but did not realize that the instrument adjustment needed a hold point. The work was completed without the needed supervisor's check.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review implementation of supervisory methods and work practices, focusing on supervisory actions or decisions that were made without assessing the entire situation.

A4B4C04 – Direct supervisory involvement in task interfered with overview role

Definition: Supervision became so involved with the actual task steps that overall command and control were adversely affected.

Example: During the installation of a new computer system, the immediate supervisor of the responsible crew became so interested in the technical installation of the central control unit that he started performing more of the technician duties. As a result, he was not as attentive to other members of his crew who were installing the auxiliary unit. Some important checks were missed on the auxiliary unit. Upon powering both units, the auxiliary unit failed to start and prolonged the completion of the task. Supervision became so involved with the details of the new system that they failed to maintain perspective on their overview role of the larger team performance picture.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review adequacy of supervisory methods, focusing on the supervisor's necessary perspective.

A4B4C05 – Emphasis on schedule exceeded emphasis on methods/doing a good job

Definition: Accepted standards for methods were not met due to supervision's focus on completing the activity within a certain time frame.

Example: A project called for renovation of two rooms in a facility. As part of the renovation, a new electrical panel was installed. The project experienced budget and scheduling pressures and there was an urgency to turn over the project to the operations organization before the project funding was exhausted. As a result, a new electrical panel was never energized prior to turnover and the normal startup testing was not conducted. When the electrical panel was energized for the first time, the breaker feeding it tripped immediately. It was discovered that the panel had been wired incorrectly by the contractor but the fault was never found due to the lack of start-up testing.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Rewire affected panel.
- Review implementation of supervisory methods and communications, focusing on supervisor not paying attention or supervisor taking shortcuts to secondary tasks or indications during a task of perceived tight schedule.

A4B4C06 – Job performance and self-checking standards not properly communicated

Definition: Supervision failed to adequately communicate how standards for job performance and self-checking could be applied to the actual job at hand.

Example: A transmission crew was scheduled to cut up a fallen steel transmission tower using a plasma arc cutter for the first time. The first day's activities proceeded with no problems; however, during an informal post-job review among some workers, the workers modified the assignment and sequence of setup steps to streamline the process. The only first-day duty for the fire watch was to assure that the cutter was not in danger while cutting. During the second day, the fire watch set up the work area for cutting, which included attaching the ground clamp to the piece to be cut and energizing the cutter. A rigger positioned the material to be cut, removed the grounding clamp from the material, and placed it on a metal cabinet where the energized cutter gun was resting. When the rigger looked up to locate the crane hook, he took a step back and contacted the box and the cutter gun. He trapped the gun between the box and his thigh and depressed the trigger, causing a spark. The spark slightly shocked the rigger, and burned a hole through his Personal Protective Equipment, burning his leg.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review implementation of supervisory methods in communicating adherence to job performance standards and reinforcing application of self-checking methods to the task at hand by the workers—particularly for workers not familiar with the task or associated job standards.

A4B4C07 – Too many concurrent tasks assigned to worker

Definition: Supervision failed to detect that concurrent job assignments for an individual exceeded the individual's abilities.

Example: An engineering employee was responsible for multiple tasks, including the written preparation of lockouts. Other tasks included design, development, maintenance, and upgrade of a computer

database system (used for multiple tasks in the facility); vice-chair of the facility Work Scope Review Team; scheduling of project tasks; chair of scheduling process improvement task team; point of contact for computer user support; and various ad hoc tasks assigned by management. As a result of this varied and heavy workload, the employee had developed and utilized a database that contained historical lockouts for multiple items of equipment in the facility. During a lockout incident, the engineer reused a similar, but not identical, lockout job. As a result, the work boundary was inadequate. Some of the equipment to be maintained was still energized when the mechanic tested it.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review implementation of supervisory methods and work planning prioritization practices for appropriately assessing task assignment work load of employees.

A4B4C08 – Frequent job or task "shuffling"

Definition: Supervision transferred a worker from one task to another without adequate time to shift attention away from previous task.

Example: Two mechanics, one experienced and the other with less than two years of experience, were completing a job to rewire a motor. The experienced mechanic was called away by the supervisor to perform some emergent work. He left verbal instructions with the new mechanic to "bump the motor" for rotation to assure that they had connected it correctly for purposes of phase rotation. The new mechanic did as he was told, releasing the lockout and asking the operator to energize the motor. However, the mechanic did not realize that his partner had forgotten to tape the motor leads—located inside the junction box—in his haste leaving for the emergent work. As a result, the leads were resting against the inside of the junction box, causing a ground fault explosion when the operator energized the motor.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Repair junction box and motor, as necessary.
- Review implementation of supervisory methods and work practices, examining environmental conditions and work planning processes that contribute to work overload and handling multiple tasks simultaneously where committed actions are not successfully carried out.

A4B4C09 – Assignment did not consider worker's need to use higher-order skills

Definition: Supervision did not consider the worker's talents or innovative strengths that could be used to perform more challenging work. Note: for mismatch with motivations, see A4B2C09.

Example: In an internal reorganization, three degreed engineers were changed in their job function from "engineers" to "specialists." One of the engineers, successful as a start-up engineer, was tasked to perform coordinator duties for Installed Process Instrumentation (IPI) and Radiation Monitoring Equipment (RME) as a specialist. Although the employee performed these functions extremely well, his talents were dramatically underutilized. Another of the engineers eventually left the organization and found more challenging work in another department. The third engineer remained in place and created more challenging work by designing essential information systems for monitoring, tracking and measuring business performance. While the engineers filled "specialist" work positions on the organization's staffing chart, supervision did not consider that their talents or innovative strengths could be used to perform more challenging work.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Return remaining engineers to engineering positions.

- Review implementation of normal supervisory human resource support processes and lack of teamwork culture that contribute to the under-utilization of human resources.
- Review adequacy of supervision to cultivate people, focusing on successor planning processes where task assignments were made in which the wrong people were assigned to the wrong jobs.

A4B4C10 – Assignment did not consider effects of worker's previous task

Definition: Supervision did not adequately assess the previous task's impact upon the worker's ability to implement the current task.

Example: An operator had completed a decontamination job in a hot environment. After a short break in a cool area, the supervisor asked the operator to perform a procedure checking emergency battery-operated exit lights. The procedure required the operator to climb ladders in several cases to reach the lights. Although the supervisor had given the worker a rest period, and the emergency lights were all in air-conditioned areas, the effects of several hours' work, coupled with inadequate water intake, led to heat cramps in the worker's leg muscles. The cramps caused the worker to fall from a ladder during the emergency light checks, resulting in an injury.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review supervisory work practices, focusing on the supervisory actions or decisions that were made without assessing the mental and physical task demands and work environment factors with the capabilities and limitations of workers.
- Review supervisory work practices where task complexity, scope, or depth is underestimated and contingency planning is inadequate.

A4B4C11 – Assignment did not consider worker's ingrained work patterns

Definition: Supervision failed to assess the incompatibility between a workers ingrained work patterns and necessary work patterns for successful completion of the current task.

Example: A materials storage project called for converting a crane maintenance area in a former production reactor to a warehouse-type facility to accommodate storage of other nuclear material. Painters were assigned the task of preparing the Crane Wash Area (CWA) floor for future painting activities. Preparation activities included the use of a scabbler machine to remove a thin layer of paint from the floor. The painters attended one of three pre-job briefings to address scabbling activities and noted that Radiological Control Operations (RCO) personnel were originally assigned to the job but were absent during the pre-job brief. The painters requested respiratory protection, but the supervisor explained that none was necessary as a result of the recent hazard analysis. The CWA had been posted as a Contamination Area based upon a complete hazard review of known radiological conditions. Because of the hazard review, RCO, Construction and Operations supervision decided that RCO coverage was not needed during the work activity. After each day's activities, the painters successfully exited through personnel contamination monitors. Upon completion of the work, RCO conducted surveys of the CWA in efforts to roll back the work area, and discovered fixed contamination on the floor. No transferable contamination was discovered, although a survey of the bagged paint chips revealed some low-level contamination. The fixed contamination resulted in RCO re-posting the area as a High Contamination Area. Supervision failed to assess the incompatibility of the RCO work patterns in working with known radiological conditions versus RCO analysis of unknown radiological conditions resulting from the painters' task. Supervision also failed to assess the incompatibility of the RCO response with the safety concerns expressed by the painters prior to the work activity.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review supervisory interface among organizations, focusing on formality of pre-job briefings, interface documents and communications. Promptly resolve conflicts or misunderstandings between individuals and work groups before, during, and after the task starts.

A4B4C12 – Contact with personnel too infrequent to detect work habit/attitude changes

Definition: Supervision not aware of deviation from desired work habits or attitudes due to lack of interaction with personnel.

Example: An operator working on the back shift was experiencing marital difficulties. While previously a reliable and conscientious employee, this new distraction created a somewhat indifferent attitude toward work. Since the employee was working on the back shift, he was without supervision a significant portion of the time. As a result, the employee began completing round sheets without actually looking at the equipment. It went unnoticed for several weeks, until a particular instrument was tagged out of service and the shift manager noticed that the employee had continued to report normal readings on the instrument.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Provide employee with information on Employee Assistance Program and refer employee.
- Review adequacy of formal supervisory interface with team and workers, focusing on pre- or post- job briefings and other team and individual settings.
- Review ability of supervisor to monitor and coach workers through firsthand observations, active listening, and questioning techniques that reinforce expected behaviors and resolve emerging human performance problems.

A4B4C13 – Provided feedback on negative performance but not on positive performance

Definition: Worker's performance adversely affected by supervision's focus on negative performance feedback.

Example: A mechanic frequently performed tasks ahead of schedule and without safety incursions. His jobs were always of a high quality. However, his supervisor never reinforced this positive behavior. Because the mechanic worked 10-hour days and the supervisor only worked eight hours, they did not see each other at the end of the shift. They met in the morning for the pre-job toolbox meeting, and from then on, the mechanic was essentially on his own to complete the day's tasks. As a result, there was little opportunity for reinforcement of good behavior at the end of the workday. In the morning, the focus was always on the present day's work, not a recap of the previous day. On one occasion, the mechanic made a mistake that resulted in a potential safety situation. A critique determined that the employee was at fault for the oversight. The employee was given constructive discipline (time off without pay) for the mistake. After the incident, the employee's attitude became one of avoiding punishment, not of earning rewards. As a result of the supervisor's focus on negative feedback, the worker's subsequent job performance was significantly affected.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review adequacy of supervisory behaviors that cultivate and encourage excellence in human performance; facilitate open communications; promote teamwork to eliminate error-likely situations and strengthen defenses; eliminate organizational weaknesses that create conditions for error; reinforce desired jobsite behaviors.
- Review the adequacy of management's commitment to cultivating people, focusing on supervisory training designed to provide appropriate interpersonal skills and tools for supervisors.

B5 Change Management LTA

Problems caused by the process by which changes were controlled and implemented by management as organizational needs change to accommodate new business needs. This group of codes is usually associated with non-routine change and may not always be appropriate for systems that have frequent updates or changes by design, such as routine software patches. The intent is that changes to procedures, systems, components, etc. should be controlled to ensure they are performed correctly, and unintended consequences are avoided (whenever possible). The Change Management (A4B5-series) is normally considered to be a change of a long-term nature (such as a change to a system); short term changes normally fall into the job planning (A4B3) arena.

A4B5C01 – Problem identification methods did not identify need for change

Definition: Existing problem identification methods did not recognize the difference between actual practices and expectations.

Example: A site maintained over 2,500 active pressure vessels and over 5,000 active pressure relief devices. The pressure safety program, administered by the Pressure Equipment Protection Committee (PEPC), was responsible for the initial and continued adequacy of the site's pressure equipment. Verification records were standard site documents used for systematic evaluation to determine the adequacy of pressure equipment for the intended service application. At the beginning of the year, approximately 25 percent of the total population of active pressure equipment did not have verification records, with some equipment having been in service for several years, with some being in service for several decades. An extensive one-year effort was undertaken to complete verification records for all pressure vessels and pressure relief devices. Major pressure protection inadequacies were discovered during the verification assessment. The PEPC had been in place for many years; however, the original focus was on the structure and administration of pressure protection activities and not the technical aspects of pressure protection. Existing problem identification methodologies had not recognized the significant difference between actual unsatisfactory practices and equipment and corporate safety expectations.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Develop schedule to fix major pressure protection inadequacies.
- Review organization-to-program evaluation process implementation. Examine skills and knowledge of analysts performing evaluations, use of technology-based causal analysis, and strength and weaknesses of observation and event solving teams to identify critical problem areas.

A4B5C02 – Change not implemented in a timely manner

Definition: A change in expectations was not realized in practices within an acceptable time period.

Example: A site maintained over 2,500 active pressure vessels and over 5,000 active pressure relief devices. At the beginning of the year, approximately 25 percent of the total population of active pressure equipment did not have verification records, with some equipment having been in service for several years, and some dating to the 1950s.

The corrective action plan involving major physical modifications included selection of new and relocation of existing pressure relief valves, regulators, and valves; and resizing and rerouting of piping configurations. Execution of the modifications was based on the risk associated with the pressure protection design. Problems were broadly classified as either safety or non-safety concerns, with "safety concerns" referring to personnel and equipment safety, not nuclear safety. Fewer than five percent of overpressure protection problems were categorized as safety concerns. These issues required immediate action to either resolve the issue or shut down the system. Non-safety problems did not pose an immediate safety concern, and implementation of the corrective actions was handled

through a four-year program. In order to maintain a consistent approach to pressure protection designs, the development of a detailed and comprehensive pressure protection design guide was prepared. The guide finally put pressure protection expectations into practice, although the corporate safety expectations had been reinforced significantly during the past 12 years.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review management's implementation of pressure protection regulatory implications.

A4B5C03 – Inadequate vendor support of change

Definition: Management failed to adequately assess the ability of vendors to supply products or services in support of changing expectations for a particular objective.

Note: This code is intended to address the relationships between the organization and its vendors, as well as how well the organization determined the vendor to be appropriate. Once the vendor is in place, how well the vendor performs is addressed in the A7B3-series of codes.

Examples: A batch file to fix the timing issues for communication devices was sent from the vendor to the entity. Entity runs the batch file and loses all the information coming from the communication equipment to the energy management system. Vendor and the entity engage on the phone for a few hours and after being unsuccessful in resolving the problem, vendor sends engineers to the entity and they together resolve the issue on-site. The vendor did not perform testing of the batch file before it was sent to entity and there was an incorrect command in the batch file that caused the communication failures.

A complete suite of anti-virus packages were installed on a Relational Database Management System (RDBMS) server. This caused insufficient resources for the RDBMS connection services, rendering the services unstable and sometimes unavailable. Because of the non-availability of RDBMS, application node failures occurred, thereby causing EMS failure. Vendor did not have the same level of system that the entity had, so did not get a chance to test the simultaneous performance of Anti - Virus software and RDBMS services.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Review vendor program and self-verification process, examining inspection and testing activities, sampling plans, technology-based review and verification processes, and oversight methodologies.

A4B5C04 – Risks/consequences associated with change not adequately reviewed/ assessed

Definition: Elements of the process or physical or cyber (to include software) systems changes were not recognized as having adverse impact or increased risk of adverse impact prior to implementing the changes.

Example: A new work management system affected the recording of equipment condition deficiencies found during routine inspections, by way of a mobile device. The new system requirements involved an extensive characterization of the noted deficiency, to assure that the notification was routed to the appropriate work group(s) for resolution. These requirements created some additional work for field personnel, which was understood at the time of implementation. However, due to the extensive characterization and information that had to be entered in the mobile device for the system to accept a new entry, field personnel began to record only the most serious or obvious of deficiencies, fewer than under the previous system that required less effort. As a result, over the first two years several relatively minor deficiencies were never recorded during routine inspections, but later grew into larger problems causing equipment failures and in some cases, more costly remediation.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Include whether second- and third-order changes to systems and procedures affect the way they are used in production.
- Before making changes to systems and procedures, conduct a pilot test to ensure that the new system or procedure does not have unintended consequences.

A4B5C05 – System interactions not considered or identified

Definition: Changes to processes or physical systems caused interactions with other processes or physical systems that were not identified prior to implementation.

Example: A non-safety class piping system was inadvertently routed over safety class electrical equipment. The designers did not take into account potential system interactions (failure of electrical components) from the rupture of the piping system during a design basis earthquake.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Reroute the affected piping.
- Include cautions in the appropriate manuals warning of potential interactions.

A4B5C06 – Personnel/department interactions not considered

Definition: Changes to processes created new requirements for interaction between personnel or departments that were not considered in the implementation phase of the change.

Example: A heat trace control panel was located in a wet, corrosive environment below the ash hopper of the main boiler. The designers did not take into account the potential for system interactions (failure of electrical components) from corrosion due to the daily wash down of bottom ash from the boiler.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Relocate the affected control panel to dry, non-caustic area.
- Replace electrical equipment with control panel enclosures, electrical conduits, and fittings suitable for use in corrosive environment.
- Provide timely maintenance of electrical equipment exposed to corrosive environment.

A4B5C07 – Effect of change on schedules not adequately addressed

Definition: Changes to processes that resulted in scheduled changes had effects on personnel or equipment that were not addressed in the change implementation.

Example: New waste requirements were added to the facility's workload due to reconfiguration of solid waste regulations. These new requirements consumed significant man-hours in the identification of waste streams, training personnel, dealing with rejected waste cuts, and other issues. However, facility schedules continued to show work duration as though the requirements did not exist. Work management did not follow up with waste personnel to determine what effect the change would have on jobs that were previously scheduled. As a result, several schedule failures occurred that could have been avoided by adjusting schedule requirements earlier. Changes to the schedule resulting from the new waste requirements were not addressed in the change implementation.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Adjust remaining schedules to include time for implementation of reconfigured regulations.

- Review management's implementation of regulatory changes for this case, examining the adequacy of the organizational structure in preparing for new regulations and responding to new regulatory challenges.

A4B5C08 – Change-related training/retraining not performed or not adequate

Definition: Changes to processes resulted in a need for new training or revisions to existing training activities that were not performed or were not adequate to meet the needs of the new process.

Note: Use of this code implies application of the process by which the function of training is notified that a change needs to be made. If training has been notified and the change is not incorporated, then it is A6B3C03.

Example: A new Computerized Maintenance Management System (CMMS) was implemented across the site. Due to the complexities involved in rolling out the new system and process, pilot departments were selected. However, those involved in the pilot were only given basic training on the operation of the new computerized maintenance system and no training at all on the revised workflow as a result of the new system implementation. As a result, departments involved in the pilot had dramatically degraded performance metrics for two years following the rollout. Changes to the process resulted in less-than- adequate training.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- If assessment still determines knowledge gap, provide training to pilot departments equivalent to that given to non-pilot departments.
- Review implementation of program-to-program interface requirements, examining adequacy of program design and work planning processes to assure effect of change on training activities is adequately addressed.

A4B5C09 – Change-related documents not developed or revised

Definition: Changes to processes resulted in the need for new forms of written communication, which were not created, or the need for changes to existing documents, which were not revised.

Note: See A1B3 for Engineering or Design documents.

Example: A new Computerized Maintenance Management System (CMMS) was implemented in the facility. One feature of this system involved download of maintenance data to a scheduling program. While documentation from the CMMS vendor existed on how to make the link function properly, it was not provided to the field organizations. Changes brought about by CMMS resulted in new forms of written (electronic) communications with existing software applications; however, the new format for establishing new electronic communication links was not provided.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Provide documentation of new, electronic format requirements.
- Review implementation of program-to-program interface requirements, examining adequacy of program design and work planning processes to assure effect of change on documents, forms, and records is adequately addressed.

A4B5C10 – Change-related equipment not provided or not revised

Definition: Changes to processes resulted in a need for new or revised software or hardware that was not provided or revised.

Example: Site policies are promulgated through procedural changes. Frequently, the authors of procedures—in an attempt to not dictate specific methodologies—did not provide new or updated tools for the

field organizations to comply with the procedural requirements. Specific examples included collection of performance metrics, performance and tracking of facility condition evaluations, issues management tracking, and building or facility nuclear material inventory control. In each of these cases, procedural requirements existed for the tracking of specific data and activities but no software or hardware tools were provided to the facilities to perform these functions. As a result, facilities were forced to develop in-house tools to allow them to comply with requirements, which led to different multiple information platforms that further impacted lateral integration among complex organizations. Changes to processes were not necessarily accompanied by new or revised software or hardware to support the change efficiently and effectively.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Provide single, site-wide database for selected issue tracking across the site.
- Review specific implementation of program-to-program interface requirements, examining the potential to develop a more formal, standardized process interface and, if necessary, re-engineer process to accommodate related software or hardware as necessary to support change.

A4B5C11 – Changes not adequately communicated

Definition: Changes to processes were not communicated to the affected personnel effectively.

Note: This code is for administrative controls. Written communications (detailed instructions) and Training have their own codes (A5B1C05 and A6B3C03, respectively).

Example: The engineering policy manual was revised to include software engineering requirements such as design control, documentation, and other conduct of engineering principles. Two months after a change to the policy manual was made, the facility underwent an external department assessment. During the assessment, the assessment team members identified that the facility had not implemented the new requirement for software control. When questioned, facility personnel indicated that they were unaware of the new requirements. Changes to the software engineering requirements were not effectively communicated to affected personnel.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Implement software engineering requirements.
- Review specific implementation of organization-to-program interface, focusing on designated program owners, staffing resources, and funding necessary for implementing processes brought about by change.

A4B5C12 – Change not identifiable during task

Definition: Changes to processes were not distinguishable from the previous process, such that personnel did not modify how they performed the process.

Example: A site experienced multiple bioassay sampling problems involving employees working in job-specific conditions where tritium exposure was a potential hazard. Bioassay sampling requirements were not complied with in a timely manner as directed by regulatory guidance. The program functional manager and operational managers performed extensive self-evaluations. The result was subtle changes to the bioassay sampling program. Two reportable events in separate facilities recently occurred, indicating that the program changes had not been assimilated by the facilities. Although causes and corrective actions continue to revolve around worker performance, procedures, and first-line supervision, the changes in the process had not made a distinguishable improvement in the task and performance of employees since the previous process was modified.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Create and provide briefing that clearly explicates the new requirements.
- Review implementation of supervisory behaviors that cultivate and facilitate excellence in human performance to facilitate open communications, promote teamwork to eliminate error-likely situations and strengthen defenses, search for and eliminate organizational weaknesses that create conditions for error, reinforce desired job site behaviors, and value the prevention of errors.

A4B5C13 – Accuracy/effectiveness of change not verified or not validated

Definition: Verification or validation practices for process changes failed to identify inaccurate or ineffective methods.

Example: A department developed and installed a new computer software system for developing and tracking Job Hazard Analysis (JHA) information. The designer's intent was for the general department population to enter data directly into the system. Formats for printing the JHA data prior to the review and then entering the results were provided within the software. Several months after implementation, the department JHA Review Board—in an attempt to control data input irregularities such as duplicate entries—decided to restrict data entry into the system to a few persons. As a result, field personnel were forced to develop JHA forms external to the system, often filling them out by hand before entering them into the database. The JHA Review Board failed to verify that the change in policy effectively resolved data input irregularities.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Assess effectiveness of policy decisions. On the basis of this assessment, keep, modify or reverse any detrimental policy decision. Implement administrative closure of duplicate entries and other irregularities.

A5 Communications

Inadequate presentation or exchange of information. Note: Communications is defined as the act of exchanging information. Persons on all sides of a communication link should be questioned regarding known or suspected problems. The (A5 Communication) Cause Codes are intended for written communications, such as direction, policies, or procedures, or verbal communications between people or work groups. These are not intended for machine-to-machine communications (really, data flow), which is more suitably found in the A2B7 section, where communication paths and data quality are addressed.

B1 Written Communication Method of Presentation LTA

Problems with visual attributes of accurate information.

A5B1C01 – Format deficiencies

Definitions: The layout of the written communication made it difficult to follow. The format differed from that of which the user was accustomed to using. The steps of the procedure were not logically grouped. Steps in the written communication had more than one action or direction to perform. Some steps in the written communication stated one action, but in practice, actually required several steps to perform.

Examples: An operator made a mistake on a start-up procedure. The procedure was confusing because it required the operator to complete section A, then B, then back to A, then to C, and back to A, then to D, and then E. The operator failed to go back to A after completing C.

An operator failed to close a valve, which resulted in a tank overflow. The instruction to close the valve was one of six actions required in one step of the procedure. He completed the other five actions but overlooked closing the valve, which was the fourth action in the step.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Flowchart the written communication to provide a model for the next revision.
- Revise the written communication, splitting the multi-action steps into single action.
- Instruct this operator on the changes.

A5B1C02 – Improper referencing or branching

Definitions: The written communication:

37. Referred to an excessive number of additional procedures;
38. Contained numerous steps of the type "Calculate limits per procedure XYZ."
39. Was difficult to follow because of excessive branching to other procedures;
40. Contains numerous steps of the type "If X, then go to procedure ABC. If Y, then go to procedure EFG."
41. References to the different processes and areas contributed to the event.

Note: This problem generally occurs when the same procedure is used in multiple facilities that have subtle differences.

Examples: An operator exceeded an operating limit. The primary procedure did not contain the limits but referred four other procedures to find the limits. When checking his results against the limits, the operator looked at the wrong limit in one of the referenced procedures.

The procedure stated, "Trip pump if pressure reaches 65 psig (Vessel 203) or 40 psig (Vessel 177)." The operator involved in filling Vessel 177 did not trip the pump until the pressure reached 65 psig.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Provide limits in the procedure where they are needed.
- Consider creating separate sections of the procedure specific to the particular facilities.

A5B1C03 – Checklist LTA

Definitions: An error was made because each separate action in a step did not have a check-off space provided. The checklist was confusing. Each instruction did not clearly indicate what was required. Insufficient room was provided for the response. The checklist required unique responses for each step.

Note: Use of this code implies a checklist existed. If no checklist existed, A4B3C11 may be more appropriate.

Examples: An operator failed to open a valve. The steps in the written communication required him to open seven valves. He missed one and opened the other six. There was not a separate check-off space for each valve.

An operator failed to complete one step of a procedure. The procedure required a check at the completion of each step. Since it did not require unique responses for the steps, the operator completed the procedure and then checked off all the steps at one time.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Add individual check-off spaces to the written communication.
- Modify responses so that they are unique.

A5B1C04 – Deficiencies in user aids (charts, etc.)

Definition: An error was made because graphics or drawings were of poor quality. The graphics or drawings were unclear, confusing, or misleading. Graphics, including datasheets, were not legible.

Examples: A mechanic replaced the wrong seal on a large piece of equipment. The seal that he was to remove was shaded on the drawing but he could not determine which seal was shaded because the copy was poor quality.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Provide clearer copies of the drawing.

A5B1C05 – Recent changes not made apparent to user

Definition: The user of written communication was required to carry out an action different from those he was accustomed to doing. The written communication did not identify the step for this action had been revised. The user of written communication performed the action as the previous revision specified, rather than the current revision.

Examples: An operator incorrectly completed a step of a procedure. The operator was experienced and performed the action as he always had. There was no marking on the procedure indicating that the step had recently been revised and the operator did not realize there had been a change.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Assure consistent format for identification of revisions.

A5B1C06 – Instruction step/information in wrong sequence

Definition: The instructions or steps in the written communication were out of sequence.

Examples: An operator made a mistake because the steps were out of sequence in a procedure. Step five (5) said to transfer material from Tank A to Tank B. Step seven (7) said to sample the contents of Tank A before transferring.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Modify step order.

A5B1C07 – Unclear/complex wording or grammar

Definition: Wording, grammar, or symbols fail to clearly and concisely specify the required action. Instructions provided for team of users failed to specify roles of each user. Considering the training and experience of the user, the written communication was too difficult to understand or follow. There was insufficient information to identify the appropriate written communication. The written communication was not designed for the "less practiced" user.

Examples: An instruction said to CLOSE valve WTS-XYZ. The intent was for the operator to assure that WTS-XYZ was closed.

An inexperienced mechanic made a mistake installing a piece of equipment. The mechanic did not use the correct procedure because it was long and used terminology that he did not understand.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Consider adding ASSURE or VERIFY to statement.
- Revise written communication to match experience level of the user.

B2 Written Communication Content LTA

Any written document such as procedures, work orders, memos, standing orders, manuals, surveillance, etc. used to perform work. Note: A1B3 should be used for Design or Engineering documentation. Investigation of written communications problems requires a copy of the applicable documents for review.

A5B2C01 – Limit inaccuracies

Definition: Limits were not expressed clearly and concisely. Limits or permissible operating ranges were expressed in a ± format instead of absolute numbers.

Examples: An operator thought that a temperature was in range when it was not. The procedure said 35°C ± 0.05°C. The temperature was 35.5°C. He thought it was within limits because he thought the range was 34.5-35.5°C rather than 34.95-35.05°C.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Provide permissible range (34.95-35.05°C).

A5B2C02 – Difficult to implement

Definition: Standards, Policies, or Administrative Controls (SPAC) were not followed because no practical way of implementing them existed. Implementation would have hindered production.

Examples: Although one of the safety control monitors was not operating, a process continued to operate during the night shift. The SPAC stated that permission to operate without that piece of equipment was required from management and the technical department. Since it was the night shift, getting the necessary approvals was difficult. The shift personnel made the decision to operate without the approvals because they did not want to slow production.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Assure access to responsible authorities regardless of shift considerations.

A5B2C03 – Data/computations wrong/incomplete

Definition: An error was made because of a mistake in recording or transferring data. Calculations were made incorrectly. The formula or equation was confusing or had multiple steps.

Examples: An operator made a mistake performing a calculation. The data used in the calculation came from multiple steps in the procedure. He made a mistake in transferring one of the data points from an earlier step in the procedure to the step where the calculation was performed.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Move calculation step closer to location of input data.

A5B2C04 – Equipment identification LTA

Definition: The equipment identification was too generic. Equipment identification or labeling in the field did not agree with the identification in the procedure.

Examples: An operator opened the wrong valve, causing a tank to overflow. The procedure used nomenclature for valves that was different from the labels in the field.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Change procedure nomenclature to match field labeling.

A5B2C05 – Ambiguous instructions/requirements

Definitions: The instructions in the written communication were unclear, uncertain, or interpretable in more than one way.

Different procedures related to the same task contained different requirements. There were conflicting or inconsistent requirements stated in different steps of the same procedure. Requirements were stated in different units.

Examples: An instruction said to cut XYZ rods into 10-foot-long pieces. The intent was for each piece to be 10 feet long. The person cutting the pieces made 10 pieces, each a foot long.

An operator exceeded the technical limit for the amount of uranium allowed in an evaporator. The limit was expressed as grams of uranium (total) in one step of the evaporator procedure. In another step, the limit was given as the grams of a particular isotope of uranium. The operator exceeded the technical limit when he used the limit for total uranium as his basis for the amount of the isotope he could have in the evaporator.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Include parenthetical explanation of meaning; e.g., (10').
- Pick one expression of limit to be used in both locations.

A5B2C06 – Typographical error

Definition: A typographical error in the written communication caused the event.

Examples: An operator made a mistake because the written communication contained the wrong limit. The maximum temperature was supposed to be 38°C but the procedure said 48°C. The mistake was made in typing.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Fix typographical error.

A5B2C07 – Facts wrong/requirements not correct

Definition: Specific information in the written communication was incorrect. The written communication contained outdated requirements. The written communication did not reflect the current status of equipment.

Note: This is for information that is in the written communication. A5B2C08 is for information that is not in the document.

Examples: A safety limit was violated because the written communication did not contain the current limits. The limits had been changed but the written communication had not been revised.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Revise written communication.

A5B2C08 – Incomplete/situation not covered

Definition: Details of the written communication were incomplete. Insufficient information was presented. The written communication did not address situations likely to occur during the completion of the procedure.

Note: This is for information that is not in the written communication. A5B2C07 is for information that is in the document.

Examples: A mechanic did not correctly replace a pump. The instruction simply stated "replace the pump." Numerous actions, including an electrical lockout, were required to replace the pump but the actions were not correctly performed.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Rewrite written communication to include steps for pump replacement.

A5B2C09 – Wrong revision used

Definition: The wrong revision of the written communication was used.

Examples: An operator exceeded a technical limit on a process. The limit had recently changed and the written communication had been revised to reflect the change. However, the previous revision of the written communication was still in the file for use.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Replace written communication in file with correct revision.

B3 Written Communication Not Used

Written communication was not used to do the job. Written communication did not exist for the job. The written communication system was required to be used not just for training. Note: former ORPS code for "Procedure not used or used incorrectly" should be coded under A3 for what led to the misuse.

A5B3C01 – Lack of written communication

Definition: Some form of written communication did not exist for the job being performed.

Examples: A mechanic made a mistake calibrating a piece of equipment. He performed the job without a procedure since a procedure did not exist for the task.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Create new written communication.

A5B3C02 – Not available or inconvenient for use

Definitions: The written communication was not readily available. A copy of the written communication was not available in the designated file or rack. A "master copy" of the written communication was not available for reproductions. Use of the written communication was inconvenient because of working conditions (e.g., radiation areas, tight quarters, plastic suits).

Examples: An operator made a valving error. He did not use the procedure because he was working in a radiation area. If a procedure had been taken into the area for use, it would have required checking by Radiation Protection before leaving it could be removed from the area. The operator, not wanting to go through this check, decided not to take the procedure with him.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Provide additional person to read procedure to the operator from "non-confined" position.

B4 Verbal Communications LTA

The problem was caused by the transmission or receiving of information by voice or signal (e.g., face-to-face, telephone, or radio). Note: each individual involved in the occurrence should be questioned in regard to messages he or she feels should have been received or transmitted.

A5B4C01 – Communication between work groups LTA

Definition: Lack of communication between work groups (production, technical, or support) contributed to the incident.

Note: Communication within a work group is most likely related to A4B3 or A4B4 issues.

Examples: A generating station lost offsite power while the unit was offline for maintenance because the relay technician who conducted scheduled trip testing on one of two auxiliary transformers inadvertently de-energized the one auxiliary bus that provided station service at the time. There was a misunderstanding between the relay department and the outage scheduling department over which auxiliary transformer was out of service. The relay department believed that they were performing trip checks on the out-of-service transformer while, in fact, the outage scheduling department had reversed the sequence of auxiliary transformer outages within the overall maintenance window due to replacement parts availability considerations for the other transformer. Note: there is most likely a human performance issue here as well.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Determine what is causing barriers to communication and remove the barriers.
- Conduct daily synchronization meetings between work groups during the maintenance window.
- Create a procedure to ensure all work groups are notified of and understand how changing conditions affect the execution of the work plan.

A5B4C02 – Shift communications LTA

Definitions: Lack of communication between management and employees during shift changes contributed to the incident. Management had not effectively communicated policies to the employees. Employee concerns were not communicated to management. This code extends to miscommunication between supervisors and managers.

There was incorrect, incomplete, or otherwise inadequate communication between workers during a shift. A more effective method of communication could have been used. Note: this situation usually involves the relief of one worker by another.

There was incorrect, incomplete, or otherwise inadequate communication between personnel during a shift change. Note: turnover between shifts is usually more formal than within-shift turnover. Use of log-out and log-in procedures is very helpful. Detailed instructions and other important status information should be exchanged.

Examples: A valve failed, which resulted in a process failure. Shift employees noticed problems with the valve and expressed concern to the first-line supervision but the problem was not recognized or corrected by management.

A tank transfer was in progress when Operator A went on break. He mentioned to Operator B that the transfer was going on but Operator B did not realize that he needed to stop the transfer. As a result, the tank overflowed.

A tank transfer was in progress during shift change. During the turnover, the employee going off duty did not tell the one coming on that the transfer was in progress. The tank overflowed.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Determine what is causing barriers to communication and remove the barriers. Provide assurances that all affected groups are communicating.

- Increase interventions aimed at communication protocols.

A5B4C03 – Correct terminology not used

Definition: Standard or accepted terminology was not used. The communication could be interpreted more than one way. One piece of equipment had two or more commonly used names. The terminology could have applied to more than one item.

Note: The same word or phrase can mean different things to different people. Two people can both feel that communication is accurate when in fact it is not because of inconsistent nomenclature. Regional or nonstandard speech may also present a problem.

Examples: An operator was told to verify that a solution was clear prior to adding it to a process. The operator thought that "clear" meant "not cloudy." "No color" was actually meant as color is an indication of contaminants in the solution. As a result, an out-of-specification solution was used.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Periodically provide operators with a list of standard terms and definitions.

A5B4C04 – Verification/repeat back not used

Definition: A communication error was caused by failure to repeat back a message to the sender for the purposes of verifying that the message was heard and understood correctly.

Examples: An operator was given an instruction by walkie-talkie to open a valve. The instruction was to open Valve B-2. The operator understood D-2. No repeat back or other type of verification was used.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Increase interventions aimed at communication protocols.
- Give the operators involved in the incident specific instructions on correct use of "repeat back" and the expectation that the verification method will be used.

A5B4C05 – Information sent but not understood

Definition: A message or instruction was misunderstood because of noise interference. A message or instruction was misunderstood because it was too long. The message should have been written instead of oral. The message could have been shortened or broken up.

Notes: A related code is Physical Environment LTA [A1B5C02], which addresses noise interference other than speech.

Communication can be greatly disrupted by ambient sound levels, general noise, whines, buzzes, etc. Human speech communication takes place in a narrow frequency band between 600 and 4800 Hz. This is known as the speech interference zone. Sounds can mask frequencies of speech in this zone and make communication very difficult.

Examples: An operator received instructions to open Valve D-6. He was working in an area where large motors and other equipment were operating and creating high background noise. The operator misunderstood the instruction and opened Valve B-6.

An operator was verbally instructed to open Valves A-7, B-4, B-5, C-6, D-6, D-7, D-8, and F-1. He failed to open D-6, resulting in a process upset. No written instructions were given.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Provide sound-dampened alcove to facilitate communications.

- Give instructions two to three valves at a time.
- Consider providing a written list of valves to be opened or closed.
- Increase interventions aimed at communication protocols.

A5B4C06 – Suspected problems not communicated to supervision

Definition: There was incorrect communication, incomplete communication, or lack of communication between personnel and supervision. The problem was not communicated to supervision. Different methods of communication could have been used to help personnel communicate with supervision.

Examples: An operator noticed that valve XYZ was leaking on the process system. He failed to mention the leaking valve to supervision.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Increase interventions aimed at communication protocols.
- Determine what is causing barriers to communication and remove them.
- Ensure that all affected groups are communicating.
- Instruct the operator on need to report leaking valves to supervision.

A5B4C07 – No communication method available

Definition: A method or system did not exist for communicating the necessary message or information. The communication system was out of service or otherwise unavailable at the time of the incident.

Examples: An automatic valve was stuck open. The control room operator attempted to contact the building operator by the Public Address (PA) system to have him manually close the valve. The PA system was not functioning properly and the building operator could not be contacted, resulting in overflow of a vessel.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Provide a communication method.
- Provide alternative communication methods.
- Adjust maintenance schedule for PA. Note: this implies a problem with preventive maintenance [A2B2C01].

A6 Training

An event or condition that could be traced to a lack of training or insufficient training. Note: a training deficiency is usually exposed by a human error, so the use of this branch of the CCAP is often coupled with A3B2 or A3B3.

B1 No Training Provided

A lack of appropriate training. The task had not been identified. The task had not been identified for training. The training requirements had not been identified. Training on the task had not been developed. Training had not been conducted.

A6B1C01 – Decision not to train

Definition: The decision was made not to provide specific training on a task. Some employees were not required to receive training. Experience was considered a substitute for training.

Note: Items in this area will generally have multiple codes with an additional entry under "Management/Organization." A6B1 hinges on the task analysis. If the task analysis was LTA, it is A6B1C01. If the task analysis was not completed, it is A6B2C02. If a particular individual's training was waived regardless of the task analysis because of assumed experience, it is A6B1C03.

Examples: A solvent tank overflowed because the operator did not know how to calculate the liquid level. The operator was not required to receive training because he had years of experience working in a similar facility. However, that facility did not use solvent, and the operator did not have experience with solutions having specific gravities less than that of water.

Due to the simple nature of a data-gathering task, a decision was made not to train a group of college-level co-op students on the task. Due to the diversity of techniques and lack of consistency in the final product, the task had to be repeated.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Interview other members of the group to determine the extent of the lack of knowledge.
- Perform a task analysis to determine whether or not training should be provided.
- If task analysis warrants, provide training to work group.

A6B1C02 – Training requirements not identified

Definition: Training on the task was not part of the employee's training requirements. The necessary training had not been defined for the job description.

Note: A6B1 hinges on the task analysis. If the task analysis was LTA, it is A6B1C01. If the task analysis was not completed, it is A6B2C02. If a particular individual's training was waived regardless of the task analysis because of assumed experience, it is A6B1C03.

Examples: An operator overflowed a solvent tank because he did not know how to calculate liquid levels. The operator had transferred from a similar facility, and the training required for his present assignment had not been defined. Since the other facility did not use solvent, the operator did not have experience working with the liquid level of solvent.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Establish training requirements for position and provide training to operator on calculating liquid solvent levels.
- Assess adequacy of task analysis.

A6B1C03 – Work incorrectly considered "skill-of-the-craft"

Definition: The work was not a skill that could be developed through job experience. The operator did not have appropriate training for the task. Provisions to assure operators received proper training prior to assignment to this task were not addressed.

Note: A6B1 hinges on the job or task analysis. If the task analysis was LTA, it is A6B1C01. If the task analysis was not completed, it is A6B2C02. If a particular individual's training was waived regardless of the task analysis because of assumed experience, it is A6B1C03. This does not normally apply to the work of a contractor – consider using A4B2C10 instead.

Examples: An operator overflowed a solvent tank because he did not know how to calculate liquid levels. The operator had transferred from a similar facility, and since he was "qualified" at the previous plant, it was assumed the skill was part of that qualification, a "skill of the craft" to which he was qualified.

However, since his previous facility did not use solvent, the qualification had not required this particular skill to be taught or verified.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Establish task experience requirements for job assignment.
- Test operators on task achievement before assigning them to perform this task without direct supervision.
- Train operator on calculating liquid levels of solvents.

B2 Training Methods LTA

The correct training setting was not used. There was not enough practice (or hands-on) time allotted. Testing did not adequately measure the employee's ability to perform the task. The task was not identified for refresher training. The training had inadequate instructors and facilities.

A6B2C01 – Practice or "hands-on" experience LTA

Definition: The on-the-job training did not provide opportunities to learn skills necessary to perform the job. There was insufficient on-the-job training. There was an inadequate amount of preparation before performing the activity. The employee had not previously performed the task under direct supervision.

Examples: An operator made a mistake weighing material because of incorrect use of the scale. He had received classroom instruction but no on-the-job experience using the scale.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Provide either hands-on experience in the classroom or on-the-job training for the scale.
- Assure activity is identified as a "skill" in the task analysis.
- Assess the adequacy of the proficiency program.

A6B2C02 – Testing LTA

Definition: Testing did not cover all the knowledge and skills necessary to do the job. Testing did not adequately reflect the trainee's ability to perform the job.

Examples: An operator made a mistake weighing material because of incorrect use of a scale. He had received instruction on the use of the scale but had not been tested on his ability to use the scale.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Modify qualification testing and test operators.

A6B2C03 – Refresher training LTA

Definition: Training updates were not performed. Continuing training was not performed to keep employees equipped to perform non-routine tasks. The frequency of continuing training was inadequate. The frequency of refresher training was not sufficient to maintain the required knowledge and skills.

Examples: An operator made a mistake weighing material because of incorrect use of a scale. The operator was qualified on the job, including use of the scale. However, he had not performed this task since his initial training and no training update was performed. A year had passed since completion of training and actual usage on the job.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Provide refresher training.

A6B2C04 – Inadequate presentation

Definition: The qualifications for the instructor were inadequate. The qualification did not include all that is necessary to perform training on this task. The instructor who performed the training was not qualified on this task. The training equipment was inadequate. Simulators were not used. The equipment used in training was not like that used on the job.

Examples: An operator made a mistake weighing material because of incorrect use of a scale. During the training on the task, the instructor had incorrectly taught how to use the scale or provided training on the wrong scale.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Assess the adequacy of the Instructor Qualification Program.
- Re-qualify instructor and re-train class.
- Provide training on correct scale.

B3 Training Material LTA

The program design and objective were incomplete. Job or task analyses were inadequate. The training content was inadequate. Training materials did not adequately address new work methods. Training did not adequately address normal, abnormal, and emergency working conditions. Training did not adequately address performance standards for the job or task.

A6B3C01 – Training objectives LTA

Definition: The task analysis incorrectly identified the knowledge and skills necessary to complete the task. The proper setting in which to train the operator was not identified. The objectives were not written to accurately represent the task analysis. The objective did not satisfy the needs identified in the task analysis. The objectives did not cover all of the requirements necessary to successfully complete the task.

Examples: An operator made a mistake weighing material because he used the scale incorrectly. The task analysis identified that training was required on the use of the scale but the training objectives did not include it.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Revise job or task analysis and training to include scale operation.
- Incorporate "operate scale" task into objectives and course content.
- Train operators.

A6B3C02 – Inadequate content

Definition: The lesson content did not address all the training objectives. The lesson did not contain all the information necessary to perform the job. The knowledge and skills required to perform the task or job were not identified.

Examples: An operator made a mistake weighing material because of incorrect use of the scale. The training lesson did not address training on the scale although it was in the objectives.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Modify training lesson and retrain operators on this task.

A6B3C03 – Training on new work methods LTA

Definition: Training was not provided when the work methods for this task were changed. Training on changes to the procedure for the task was not provided. Training on new equipment used to perform the task was not provided.

Note: Use this code when training has been notified that a change needs to be made and the change has not been incorporated. If it is application of the process by which the function of Training is notified that a change needs to be made, then it is A4B5C08.

Examples: An operator made a mistake weighing material because of incorrect use of a scale. The scale that he was trained on had been replaced with a newer model and no training had been provided on the new model.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Provide training on the new scale.

A6B3C04 – Performance standards LTA

Definition: The requirements for performance on a system were not stringent enough. Meeting the standards for training qualification on a task did not provide sufficient training to perform the task under normal, abnormal, and emergency conditions.

Examples: A qualified operator performed the wrong process control actions during a system upset. The qualifications standard did not require that operators demonstrate knowledge of appropriate actions to take during system transients.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Modify performance standards to the level of desired performance.
- Revise training to reflect the new performance standards.
- Conduct training on the new performance standards.

A7 Other

The problem was caused by factors beyond the control of the organization, legacy radiological material, or legacy hazardous material.

B1 External Phenomena

An event or condition caused by factors that were not under the control of the reporting organization.

A7B1C01 – Weather or ambient conditions LTA

Definition: Unusual weather or ambient conditions, including hurricanes, tornadoes, flooding, earthquake, and lightning, was cited as a direct cause of something which happened.

Note: This is actually a "nature of occurrence" rather than a true apparent cause. In other words, this is what happened rather than why it happened. If the event did not take into account the effects of weather or ambient conditions on the facility, use Design Input LTA [A1B1], Operability of Design or Environment LTA [A1B5], or Change Management LTA [A4B5]. Avoid using this in the "dark and

stormy night" or "weather was in the area" scenario, when the weather conditions are mentioned, but not directly attributable to the event.

Examples: The facility was evacuated due to an oncoming hurricane. Note: In this case, the event" is loss of ability to perform the facility's mission. There are no corrective actions that can be taken in this circumstance.)

The facility received a direct lightning strike. The facility had previously taken all reasonable, cost-effective measures to mitigate lightning strikes. This potential was known and accepted. Note: This could be A1B1C03 since the lightning potential was known but it was not cost-effective to prevent all strikes; thus, the selected design criteria were intentionally not correct.

A7B1C02 – Power failure or transient

Definition: Special cases of power loss that are attributable to outside supplied power.

Note: This is actually a "nature of occurrence" rather than a true apparent cause. In other words, this is what happened rather than why it happened. **There are no examples or potential corrective actions for this node.** If the event did not take into account the effects of an external power failure or transient on the facility, use Design Input LTA [A1B1], Operability of Design or Environment LTA [A1B5], Management Methods [A4B1], or Change Management LTA [A4B5].

A7B1C03 – External fire or explosion

Definition: An external fire, explosion, or implosion.

Note: An external fire, explosion, or implosion, to include any fire or explosion within the BPS that extends the event to other elements of the BPS. Note: this is actually a "nature of occurrence" rather than a true apparent cause. In other words, this is what happened rather than why it happened. If the event did not take into account the effects of an external fire or explosion on the facility, use Design Input LTA [A1B1], Operability of Design/Environment LTA [A1B5], Management Methods [A4B1], or Change Management LTA [A4B5].

Examples: An entity experienced the tripping of a high voltage transmission line due to smoke in the area from a nearby forest fire. [Note: Also consider A2B6C06 Contaminant.]

A7B1C04 – Other natural phenomena LTA

Definition: This node covers all natural phenomena not addressed by A7B1C01; for example, animal intrusion.

Note: This is actually a "nature of occurrence" rather than a true apparent cause. In other words, this is what happened rather than why it happened. It is included here to round out the logic of the Causal Analysis Tree. **There are no examples or potential corrective actions for this node.** If the event did not take into account the effects of other natural phenomena on the facility, use Design Input LTA [A1B1], Operability of Design/Environment LTA [A1B5], Management Methods [A4B1], or Change Management LTA [A4B5].

A7B1C05 – Copper theft

Definition: This node is an "occurrence" rather than a true apparent cause. In other words, this is what happened rather than why it happened. It is included here for completeness. **There are no examples or potential corrective actions for this node.**

A7B1C06 – Vandalism

Definition: This node is an "occurrence" rather than a true apparent cause. In other words, this is what happened rather than why it happened. It is included here for completeness. **There are no additional examples or potential corrective actions for this node.**

B2 Radiological/Hazardous Material Problem

An event related to radiological or hazardous material contamination that could not be attributed to any of the other causes.

A7B2C01 – Legacy contamination

Definition: Radiological or hazardous material contamination attributed to past practices.

Note: This is closer to a "nature of occurrence" than a true apparent cause. In other words, this is more of what happened rather than why it happened. It usually takes a review of work history or isotopic analysis to determine if the material is actually legacy.

Examples: Traces of PCBs were found during a routine environmental survey. The location had been previously used as a storage site for transformers. The transformers had leaked. The leakage was unknown or undiscovered at the time the transformers were removed.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Barricade the contaminated area.
- Remove contaminated soil and dispose of it as hazardous waste.
- Resurvey the contaminated area and remove additional soil as necessary.

A7B2C02 – Source unknown

Definition: Radiological or hazardous material contamination where the source cannot be reasonably determined.

Note: This is actually a "nature of occurrence" rather than a true apparent cause. In other words, this is what happened rather than why it happened. This node is used when a review of work history or isotopic analysis fails to determine if the material is actually legacy and no corrective action other than control is planned.

Examples: During a radioactive material transportation accident drill (staged with uncontaminated equipment), a spot of radioactive material was discovered. The drill site was thoroughly surveyed and no additional contamination was found. The contaminated material was bagged and sent to the laboratory. Analysis determined that it was transuranic. While the roadway was used for transport of transuranic material in the past, there was no indication which shipment could have been at fault.

Potential Corrective Actions: [These are only examples; this is not an exhaustive list.]

- Dispose of transuranic waste in accordance with site procedures.

B3 Vendor or Supplier Problem

An event related to vendor or supplier issues, to include communications, follow-up, testing or other undefined interactions.

A7B3C01 – Follow-up LTA

Definition: Vendor has been made aware of a problem, or discovered the problem in some manner, yet the follow-up to address the problem is LTA.

Note: While how a vendor reacts to, or even investigates, a problem is beyond the control of an organization, the vendor is still expected to take appropriate actions. The purpose of this code is to identify those vendor actions which are beyond the control of the organization.

A7B3C02 – Vendor corrective actions LTA

Definition: Corrective actions taken by a vendor did not resolve the problem; actions address symptoms, and not the underlying problem. Root cause analysis (RCA) not undertaken by vendor, or at least was not communicated to the organization subject to the problem being addressed.

Note: While how a vendor reacts to, or even investigates, a problem is beyond the control of an organization, the vendor is still expected to take appropriate actions. Problems for which a vendor is made aware are expected to be corrected, and appropriately communicated to users of the product/services. The purpose of this code is to identify those vendor actions which are beyond the control of the organization.

A7B3C03 – Extent-of-Condition communications LTA

Definition: Vendor has been made aware of a problem, or discovered the problem in some manner, yet the extent to which this problem exists is not determined (or at least communicated to those using the product).

Note: While how a vendor reacts to, or even investigates, a problem is beyond the control of an organization, the vendor is still expected to take appropriate actions. These actions should include purposefully identifying how large the problem may be, and notifying those organizations which may be affected. The purpose of this code is to identify when an appropriate extent-of-condition evaluation has not been conducted (or at least communicated) to appropriate parties who may be affected.

A8 (Open)

This is the first open category for the A-level coding. The intent is to expand into this category as required. It is an unassigned category at the time of this publication.

AX Overall Configuration

Situations where switch positions, mechanical component positions, or software settings are found to be incorrect, which results in undesirable actual or potential results.

B1 Installation/Design Configuration

Definition: An event related to switch positions, mechanical component positions, or software settings that were incorrectly set, calculated, or input during installation.

Note: This is actually a "nature of occurrence" rather than a true apparent cause. In other words, this is what happened rather than why it happened. If the event did not take into account the effects of the installation, design, or maintenance, try Design Input LTA [A1B1], Operability of Design/Environment LTA [A1B5], Management Methods [A4B1], or Change Management LTA [A4B5].

Examples: During installation, the blocking terminal of a relay was shorted, either purposefully or inadvertently, and never corrected before being placed into service. As a result, the relay did not function as desired when all other system conditions were met.

EMS software was installed with the switch-based failover mechanism and auto-negotiation feature disabled. However, the default gateways on many of the servers across the network were configured to reflect a router-based failover mechanism. Because of this, the EMS with the newly installed software failed and became unavailable following loss of communication with the backup control center due to excessive broadcasts from the front-end processor.

During breaker testing, the breaker status contacts were found to not be wired according to the record drawing.

B2 Maintenance/Modification Configuration

Definition: Maintenance or modification results where switches, mechanical components, or software settings were placed or left in an incorrect status resulting in potential or actual undesirable results.

Note: This is actually a "nature of occurrence" rather than a true apparent cause. In other words, this is what happened rather than why it happened. If the event did not take into account the effects of the installation, design, or maintenance, try Design Input LTA [A1B1], Operability of Design/Environment LTA [A1B5], Management Methods [A4B1], or Change Management LTA [A4B5].

Examples: During a routine test procedure, the blocking terminal of a relay was shorted and never corrected before being placed into service. As a result, the relay did not function as desired when all other system conditions were met.

During an EMS software upgrade, the switch-based failover mechanism and auto-negotiation feature were disabled. However, the default gateways were not changed across all servers on the network to reflect the altered failover mechanism. Because of this, the EMS with the newly upgraded software failed and became unavailable following loss of communication with the backup control center due to excessive broadcasts from the front-end processor.

AN No Causes Found

No cause codes can be attributed to this event or for the entity that owns the event. This code is designed to be used when the overall event being evaluated involved multiple entities and some of the entities were found not to be a contributor to the event.

AZ Information to Determine Cause LTA

The report is considered less than adequate because the information provided is not sufficient to determine a cause. While the root cause for every event cannot always be determined, it is important to code these events for queries that question events for root cause or contributing causes. The "AZ"-series of codes address the quality of information contained in the report, and thus the inability to determine a root cause. These codes are not to be used as "contributing causes" of the event

Notes:

The analyst is cautioned to gauge the cause codes based on the report and evidence evaluated. The purpose of the subcodes in this category is the opportunity for the analyst to identify potential shortcomings of the report or areas that, if the report provided more details, might have led to another more detailed cause codes.

There are no "Potential Corrective Actions", as the deficiency is with the information contained in the report, not a problem on the BPS.

B1 Unable to Identify Specific Root Cause

This code is used when the analyst is unable to identify specific root cause, even though multiple contributing causes (or Primary Effects) may have been identified. When multiple contributing causes are present and it cannot be discerned from the report which cause was the root cause, this series –of codes is used.

AZB1C01 – Multiple, parallel causal sequences exist

Definition: Multiple effects or sequences exist which led to the event, and no common cause of these sequences can be identified. As a result, no distinct root cause can be determined.

Example: During a period of cold weather or other extensive situations, many components which operate in the system failed. Combined, these failures combined to cause the event, but no single root cause could be identified**.**

AZB1C02 – Context out-of-scope of analysis

Definition: In reviewing the event, it was determined that the specific root cause cannot be easily determined as there are historical issues/decisions indicated, and the context of those issues/decisions are missing or cannot be evaluated.

Note: This is intended to recognize that decisions may have been made in the past, for business, engineering, or other technical/financial reasons, which are beyond the scope of the current regime of the organization.

Example: Decisions to install certain equipment for a purpose was made in the past, but since that time, the capability of the equipment has been exceeded. While the selection of this particular equipment may have been the best available at the time of the installation, the decision should not be questioned without understanding the context within which the decision was made. The context is no longer available, as it was made in the historical past and the rationale and documents associated with those decisions are no longer reasonably available.

Relay settings were made 20 years ago, and the person(s) and reasons for the particular design are no longer with the company to be evaluated for reasonableness.

AZB1C03 – No cause uncovered after exhaustive testing

Definition: After complete and thorough testing and inspection of mechanical and/or computer systems, no specific cause could be identified**.**

Example: A digital relay fails to operate as intended in a manner not anticipated by the OEM supplier and entity. After thousands of test iterations attempting to recreate the failure mode in a laboratory setting with direct and active collaboration between the entity and the OEM vendor, the specific failure mode is unable to be replicated thereby confounding further analysis.

SCADA system fails requiring hard reset of system, which deletes logs and prevents detailed analysis of evidence, and extensive testing cannot duplicate problems. (Note, in this example, this is a situation where possible poor design of the system results in loss of data, preventing further analysis; an A1 code should be considered as well as a contributing cause)

B2 Report Stops at Failure or Error Mode (what happened, not why it happened)

Often a report stops at the failure or error mode versus the objective of cause analysis, which is the failure or error mechanism. The C-level nodes for this area are used to further detail why the analysts believe the mode versus the mechanism is described.

AZB2C01 – Apparent cause analysis only

Definition: An apparent cause is defined as a determination based on the evaluator's judgment and experience. The emphasis of an apparent cause analysis is primarily to correct a particular event or problem without a special effort to identify the underlying system or process problems that may have contributed to the problem. A proper corrective action plan often cannot be determined based on apparent causes. By only looking at apparent causes, the underlying root cause may be overlooked allowing a reoccurrence of the deficiency leading to the event.

Note: If report states weather as more than an initiating cause, AZB2C03 might be appropriate.

Example: The analysis provided in the report stops at the failure of the equipment and does not address the issues or causes associated with the failure.

AZB2C02 – No causal sequence established or identified

Definition: This code is used when the root cause cannot be identified due to the report not having a causal sequence established or identified. This code can also be used when the time sequence is used incorrectly because the cause sequence is different.

Example: The report identifies several causes and does not establish a causal sequence to allow understanding of "what caused what".

AZB2C03 – Attributed to weather beyond initiating cause

Definition: This code is used when non-extreme weather events (such as lightning) are attributed for cause beyond the system design. This code is not appropriate for extreme weather that exceeds normal system design (tornados, hurricanes, etc.).

Example: Lightning strikes a single line yet results in a multiple line outage. The system should be able to contain a single lightning strike.

B3 Other Parties Involved in Event

The report indicates, or cites, that the problem was caused by some other identified or unidentified party, not the entity making the report. This other party is not under the control or direction of the reporting entity, thus the report is not able to result in solutions which meet the requirements of a "good solution" (not under the control of the entity). The sub-codes for this area are used to further detail characteristics of this other party (or parties).

AZB3C01 – Other NERC-Registered entity cited as involved in event

Definition: The report cites that some other NERC-registered entity was a contributing party to this event, and that entity is responsible for taking corrective actions.

Example: Multiple entities are involved in an event. The report from one of the NERC-registered entities cites requirements for other entities to take action.

AZB3C02 – Vendor or contractor cited as involved in event

Definition: The report cites that some vendor or contractor was a contributing party to this event, and that party is responsible for taking corrective actions.

Example: The report cites a contractor doing tree trimming caused a line outage.

The report cites a communication card was faulty, resulting in problems. The vendor has not determined causes for the card fault.

AZB3C03 – Non NERC-Registered entity cited as involved in event

Definition: The report cites that non NERC-registered entity was a contributing party to this event, and that entity is responsible for taking corrective actions.

Example: Multiple entities are involved in an event. The report cites a non NERC-Registered entity engaged in electrical generation/distribution/etc. contributed to the event

B4 Cross-reference required for other sources of information

The report indicates, or cites, other sources of information where information may be reviewed, which is not contained within the report or supporting documentation. This is a code that could be used if the report states further investigation is being undertaken or that something occurred during this event (such as a misoperation) for which other reports are required. The sub-codes for this area are used to further detail other data or information sources to be reviewed when the data becomes available (some future time frame).

AZB4C01– Requires secondary review once appropriate reports are received

Definition: The report cites (or implies from its content) that some additional reporting will be taking place in the future but is not available for the current report. For completeness, a secondary review will be needed once appropriate reports—such as a misoperation report as part of PRC-004 process or entity-cited additional investigation report—are received.

Example: The report cites a protection system misoperation occurred during the event. Knowledge of this occurrence leads the analyst to believe more information may become available once the required reports under the misoperation reporting system are received.

AZB4C02– Requires secondary review once additional outside investigative report is received

Definition: The report cites (or implies from its content) that some additional investigation is taking place and a follow-up report from that investigation may shed light on this event. This investigation is not completed and its results are not included in this Event Analysis (EA) report. For completeness, a secondary review will be needed once this outside report is received.

Example: The report cites that the software vendor is conducting further analysis of the operation of the software to check for its proper operation. The details of that investigation, outside the control or timeline of the entity, are not known at the time the EA report is submitted. Follow up will be needed.