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DOE-STD-1197-2024
September 2024

DOE STANDARD

CAUSAL ANALYSIS

U.S. Department Of Energy
Washington, D.C. 20585

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Summary of Changes

DOE-STD-1197, issued in 2011, is being revised to reflect current Human Performance Improvement (HPI) concepts and broaden the scope of the original Standard to effectively support the performance of causal analyses, as well as the investigation and analysis of occurrences required by DOE O 232.2A, *Occurrence Reporting and Processing of Operations Information* approved January 17, 2017. In addition, this revision will support and be consistent with the current revision efforts underway of DOE-HDBK-1028-2009, *Human Performance Improvement Handbook Volume 1: Concepts and Principles* and its accompanying document, *Human Performance Improvement Handbook Volume 2: Human Performance Tools for Individuals, Work Teams, and Management* which were written in June 2009 and are currently in the process of revision. This revision of DOE-STD-1197 will also enhance the implementation of DOE O 225.1B, *Accident Investigations* and DOE P 226.2, *Policy for Federal Oversight and Contractor Assurance Systems,* by including accident prevention elements and HPI concepts to understand and identify the causes that contribute to accidents or incidents so those deficiencies can be addressed and corrected to prevent/preclude recurrence, and assist contractors to responsibly oversee their own work, identify concerns, and reliably report unexpected adverse outcomes. In addition, this revision will facilitate the formulation of more effective and consistent causal analyses across the DOE complex, to identify and understand the causes that contribute to occurrences in order to correct deficiencies, to improve human performance, and to promote the values, concepts and benefits of organizational learning throughout DOE.

Major Content Changes Made to DOE-STD-1197-2011 during 2023 Revision Effort

- Added **Section 5. INCIDENT INVESTIGATION AND CAUSAL ANALYSIS**

  This section was added to broaden the scope of the original Standard to effectively support the performance of causal analyses for incidents and accidents as well as the investigation and analyses of occurrences required by DOE O 232.2A, *Occurrence Reporting and Processing of Operations Information*. The body of the Standard was expanded to:

  - Outline the objectives and reasons for conducting causal analyses.
  - Provide a detailed overview of four commonly used methods including:
    - Anatomy of an Event Model
    - Barrier Analysis
    - Events and Causal Factor Chart
    - Change Analysis
  - Provide a brief summary of nine other methods that are also often used.

  Much of this material was condensed from DOE Human Performance Improvement (HPI) Handbook, Vol. 1. (2009 ed.).

- Changes to **ATTACHMENT 1 – CAUSAL ANALYSIS TREE (CAT)**
    - Updated **causal nodes** in the **CAT** to reflect current, published materials on Human and Organizational Performance Improvement information.
    - Removed retired codes from the **CAT.**
    - 3 Human Performance LTA node was updated:
    - A3B1 Skill-based Error
        - A3B1C01 through A3B1C07 retired
        - Seven new causes defined (A3B1C08 through A3B1C14)
    - A3B2 Rule-based Error
        - A3B2C01 through A3B2C05 retired
        - 10 new causes defined (A3B2C06 through A3B2C15)
    - A3B3 Knowledge-based Error
        - No causes retired; text changes to descriptions of some causes
        - One new cause defined (A3B3C07)
    - A3B4 Work Practices LTA
        - No causes retired or added; both cause codes renamed with new descriptions
- Changes to **ATTACHMENT 2. CAUSAL ANALYSIS NODE DESCRIPTION**
    - Guiding principles for changes to A3 branch of the CAT:
        - Have causes that are consistent with HPI literature.
        - Describe the cause (and associated node) as clearly as possible so that the analyst can readily understand how and why that error would occur (as compared to another one).
        - The better the analyst understands the human performance element, the more likely that connections to other branches of the tree will be understood and made.
        - The better the full causes are understood, the more likely that effective corrective actions will be developed.
    - Addition of text to descriptions of branches A1, A2, A4, A5, and A6 to prompt analysts to make ties between management-system causes and human-performance causes.
    - Descriptions of A3 branch and A3B1, A3B2 and A3B3 nodes revised and expanded to help the analyst understand the performance modes, the relationships between the modes, and the nature of errors/causes in each mode.
    - Retired codes retained but labeled as ‘Retired’; notes explaining why each code was retired were included.
    - Possible mapping to equivalent codes provided for retired codes to facilitate trending that includes existing A3 cause-code data.
    - Examples and potential corrective actions removed throughout Attachment 2. The rationale of the team was that if the analyst is struggling to come up with corrective actions, it is likely that actionable causes were not identified. If specific and actionable causes have been identified, it should not be difficult to identify actions to correct those causes. (It may not be easy to implement those changes, but what needs to be corrected/addressed should be clear from the causes.)

Additional Changes Made to DOE-STD-1197-2011 during 2023 Revision Effort

- On the cover page, changed title of 1197 Standard from "**OCCURRENCE REPORTING CAUSAL ANALYSIS"** to "**CAUSAL ANALYSIS"** to reflect causal analysis applications beyond ORPS. Changed DOE-STD-1197-2011 to DOE-STD-1197-2024.
- In the **FOREWORD**, updated appropriate office to Office of ES&H Reporting and Analysis (EHSS-23), Office of Environment, Health Safety and Security. Deleted last two paragraphs.
- Updated **TABLE OF CONTENTS** to reflect current sequence of sections and attachments. Deleted **ACRONYMS** and page vii. Added **Section 5. INCIDENT INVESTIGATION AND CAUSAL ANALYSIS**.
- Deleted **ACRONYMS** on page vii.
- Updated Sections 1-4 and Section 6, including the Section 1. **INTRODUCTION,** Section 2 **PURPOSE,** Section 3. **APPLICABILITY,** Section 4. **REFERENCES** and Section 6. **CAUSE CODE SELECTION**.
- Deleted previous **ATTACHMENT 2: INPO ERROR PRECURSORS (SHORT LIST) VERSUS CAUSAL ANALYSIS TREE LEVEL C NODES** on page 2-1 and previous **ATTACHMENT 3. CAT BRANCH A3 MATRIX** on page 3-1**.**
- On page 3-1, created **ATTACHMENT 3. DEFINITIONS** with definitions of causal analysis terms used throughout standard, including some HPI terms.
- Added captions to tables, where appropriate throughout the document.
- Changed "event(s)" to "incident(s)" where appropriate throughout the document.
- Changed "plant(s)" to "facility (facilities)" where appropriate throughout the document.
- Removed gender pronouns throughout the document.
- Replaced **CONCLUDING MATERIAL** Section with **ACKNOWLEDGEMENTS** section.

FOREWORD

This Department of Energy Standard is for use by all DOE elements.

Beneficial comments (recommendations, additions, and deletions) and any pertinent data that may improve this document should be mailed to:

Office of ES&H Reporting and Analysis (EHSS-23)

Office of Environment, Health, Safety, and Security

U.S. Department of Energy

19901 Germantown Road

Germantown, MD 20874

DOE Technical Standards do not establish requirements. However, all or part of the provisions in this Standard can become requirements under the following circumstances:

- They are explicitly stated to be requirements in a DOE requirements document; or,
- The organization makes a commitment to meet a standard in: (a) a contract or (b) an implementation plan or program plan of a DOE requirements document.

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TABLE OF CONTENTS

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1 INTRODUCTION

The purpose of causal analysis is to identify and to understand all causes (both individual and organizational) that led to an occurrence in order to correct deficiencies and minimize the likelihood of recurrence. DOE O 232.2A, *Occurrence Reporting and Processing of Operations Information*, requires the investigation and analysis of occurrences in accordance with local procedures. This technical standard (Standard) can be used to implement the causal analyses necessary in accident investigations, occurrence reports, and Contractor Assurance System (CAS) issues, which are collectively referred to, herein, as incidents. This Standard should be used in conjunction with the corrective action process. Causal analysis of incidents must go beneath the surface to identify how the underlying sources of operational vulnerability combined to produce unintended or undesired results. A causal analysis should explain how failure(s) emerged from a normally stable and reliable system and should also provide the understanding required to improve systems and processes and reduce the risk of future unintended or undesired results.

DOE O 232.2A accommodates a graded approach to the scope of the investigations and analyses performed, as well as in the resultant corrective action taken, which are based on locally approved quality and issues management procedures. While this flexibility enables sites to select a causal analysis methodology as required by the Occurrence Reporting Model in Attachment 4 of DOE O 232.2A, a common framework must be used to report the causes of the occurrences into the Occurrence Reporting and Processing System (ORPS), so that others can learn from reported causes. This Standard describes causal analysis tools and provides examples of when the tools may be useful. The Causal Analysis Tree (CAT) described in this standard provides for consistent cause coding.

2 PURPOSE

This Standard provides an overview of some commonly used causal analysis methods and tools, and examples of when they could be used. This Standard does not introduce or impose any new requirements and is only intended for use in performing causal analysis and identifying cause codes.

Attachment 1 contains the CAT. Attachment 2 defines and provides descriptions for each node in the CAT. Once the causes are fully understood, the most appropriate cause codes can be selected and used for reporting.

3 APPLICABILITY

This Standard can be used by any DOE or contractor organization to perform causal analysis for all incidents leading to accident investigations, occurrence reporting, and Contractor Assurance System (CAS) issues.

4 REFERENCES

DOE O 210.2A, *DOE Corporate Operating Experience Program,* 4-8-11

DOE O 225.1B, *Accident Investigations,* 3-4-2011

DOE O 226.1B, *Implementation of Department of Energy Oversight Policy*, 05-03-2022

DOE O 232.2A, *Occurrence Reporting and Processing of Operations Information*, 1-17-2017

DOE-HDBK-1028-2009, *DOE Standard Human Performance Improvement Handbook, Volume 1: Concepts and Principles*, June 2009

DOE-HDBK-1028-2009, *DOE Standard Human Performance Improvement Handbook, Volume 2: Human Performance Tools for Individuals, Work Teams, and Management*, June 2009

5 INCIDENT INVESTIGATION AND CAUSAL ANALYSIS

Incident investigations and causal analyses are important learning opportunities that present themselves following an accident or incident. They allow for an exchange of information and provide management and staff the ability to promote collaborative decision making with the opportunity to determine the best path forward to reduce the risk of recurrence or to minimize the consequence of similar incidents in the future. The overarching aim of an incident investigation is to understand and identify the causes (both individual and organizational) that contributed to the incident so those deficiencies can be addressed and corrected.

Causal analysis is performed to determine causes of a workplace incident or other issue, using a graded approach based on the significance of the incident or issue. Causal analysis can also be used to determine why causal conditions were not discovered sooner, or why any deficiencies in the response to the incident occurred. Apparent and root cause analysis may also identify conditions and/or latent organizational weaknesses that may need to be addressed to minimize the severity of incidents or reduce the risk of their recurrence.

As each DOE facility is unique, each must develop its own internal processes and procedures to establish an effective causal analysis program as part of its efforts to continuously improve operations and minimize operational upsets. The information below is provided to give general guidance on the principles that underly the DOE CAT (Attachment 1) and how it facilitates identifying causes of operational upsets when they occur.

Why perform causal analysis?

- Provides a structured and systematic approach to analyzing and solving issues.
- Identifies latent weaknesses in an organization’s management systems that can affect the execution of work and its successful outcomes.
- Develops actions to correct deficiencies and reduce the risk of recurrence.

- Fosters a learning organization by evaluating and sharing:
    - Incidents
    - Operational Upsets
    - Accidents/Injuries/Exposures
    - Operating Experience and Actions Taken
    - ORPS Reporting

Causal Analysis

A balanced or graded approach to causal analysis should be applied based on the complexity of the issue and the extent of the associated condition(s). The rigor applied during the causal analysis should be commensurate with the seriousness of the issue and its potential and/or actual consequences, the extent of the condition that the issue represents, and the risks associated with that extent. Oftentimes, following an initial incident investigation (e.g., fact-findings, critiques, safety investigations), enough data is available to understand the basics of why the incident occurred. However, for more significant incidents, additional investigation and analysis will be necessary to identify all the causal factors that not only led to the unwanted condition, but also failed to prevent it from having such a significant effect or to mitigate its serious consequences. Depending on the complexity and severity of the incident or accident, investigations and causal analysis might be performed by an individual analyst or using a team approach with multiple analysts and subject matter experts with technical understanding of the various elements of the incident scenario. Many different techniques or methods are available that can be used to evaluate incidents in order to identify active errors and latent organizational weaknesses that contributed to or exacerbated an incident. Identifying causes using a systematic approach provides a basis for developing actions to reduce the risk, likelihood of recurrence, and any management-system factors that facilitated its occurrence. The methods listed in this section are not the only strategies available; however, they represent proven analytical methods for evaluating problems such as technical failures, administrative or programmatic failures, and equipment or human performance problems.

Table 1, *Summary of Commonly Used Causal Analysis Methods and Models,* shown below, describes analytical techniques that can be used to evaluate incidents, determine causal factors, and identify possible solutions or issues needing to be addressed by management. Examples of each method are provided following the table.

Table 1, *Summary of Commonly Used Causal Analysis Methods and Models*

Methods/Models	When to Use	Advantages	Disadvantages	Remarks
Anatomy of an Event (also known as HPI Analysis) *Note: This model is an illustration of the elements that exist before a typical incident occurs, and can be used in conjunction with the methods listed below.*	Provides a structured model for analyzing incidents that involve human performance, especially to provide context for the actions of personnel involved.	Considers multiple elements of an incident scenario that could have triggered the incident or influenced the actions of personnel.	Can be time-consuming if all elements of the model are to be investigated and analyzed.	Requires familiarity with human performance improvement (HPI) principles and terminology.
Barrier Analysis *Note: This method can be used in conjunction with the model illustrated in Figure 2.*	Most useful for structured processes where barriers are intentionally placed and their designed preventive elements are defined.	Provides systematic approach to problem analysis by evaluating intended mechanisms of prevention.	Requires some familiarity with the process/system involved to be effective.	May also be used for fluid or variable processes where multiple functions are involved.
Events and Causal Factors Chart	Use for multi-faceted problems such as system or facility incidents. Also good for evaluating equipment failures.	Provides for visualization of the individual events and conditions in the sequence leading up to the issue being investigated. Identifies probable contributors to the issue in context within the sequence of events.	Time-consuming and requires some familiarity with process/system involved to be effective.	Requires broad perspective of the incident to identify conditions causal to the issue but not immediately apparent. Helps to identify where deviations from acceptable work methods occurred.

Methods/Models	When to Use	Advantages	Disadvantages	Remarks
Change Analysis	Use to examine planned or unplanned changes that caused undesired outcomes. Useful in identifying obscure contributing causes of incidents that result from changes in a system.	This process is useful for evaluating how change may have affected the condition which allowed the issue to occur, as compared to previous instances where an incident did not occur or had a different outcome. Using the Change Analysis can provide additional insights for the Barrier Analysis.	Could have limited value if subtle changes are not recognized.	A singular technique that can be used in support of a larger investigation.

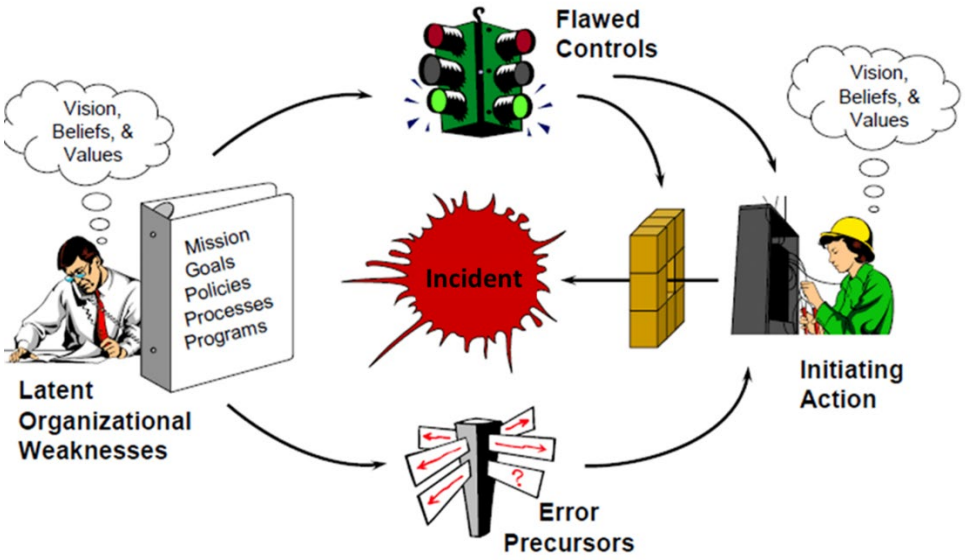
Anatomy of an Event

Note: Throughout this document we refer to "event" as "incident."

Incidents are usually triggered by human action. In most cases, the human action causing the incident was in error. However, the action could have been directed by a procedure or it could have resulted from a violation - a shortcut to get the job done. In any case, an act initiates the undesired consequences.

Figure 1 below, provides a model of the elements that exist before a typical incident occurs. Breaking the linkages may prevent incidents.

Figure 1. Elements Before an Incident [1]



Incident – an unwanted, undesirable change in the state of facility structures, systems, or components, or in human/organizational conditions (health, behavior, administrative controls, environment, etc.) that exceeds established significance criteria.

Initiating Action – an action by an individual, either correct or incorrect, that results in a facility incident.

- Error – an action that unintentionally departs from anticipated or expected behavior.
- Violation – an action taken contrary to known requirements, standards, or direction when such requirements, standards, or direction are known without the intent to cause harm or damage.
- Active Error – an error that has immediate, observable, undesirable outcomes and can be either acts of commission or omission. If not identified soon after it occurs, it turns latent (i.e., a latent error) and thus becomes part of the system and can create weaknesses in the organization. Most initiating actions are active errors. Therefore, a strategic approach to preventing incidents should include the anticipation and prevention of active errors.

Flawed Controls – defects that, under the right circumstances, may inhibit the ability of defensive measures to protect facilities, equipment, or people against hazards, or fail to prevent the occurrence of active errors. Controls or barriers are methods that:

- Protect against various hazards (such as radiation, chemical, heat).
- Mitigate the consequences of the hazard (for example, reduced operating safety margin, personal

[1] From DOE-HDBK-1028-2009, Human Performance Improvement Handbook Volume 1: *Concepts and Principles,* p. 1-14.

injury, equipment damage, environmental contamination, cost).

- Promote consistent behavior.

When an incident occurs, there may be either a flaw with existing controls or appropriate controls are not in place.

Error Precursors – unfavorable conditions that may be present when and/or where work is performed that increase the probability for error during a specific action; that is, error-likely situations. For example, an error-likely situation can exist when the demands of the task exceed the capabilities of the individual or when work conditions aggravate the limitations of human nature.

Latent Organizational Weaknesses – latent errors and deficiencies in management control processes or values that create unintended workplace conditions, which in turn can provoke errors (error precursors) and degrade the integrity of controls (flawed controls). Latent organizational weaknesses can include system-level weaknesses that may exist in procedure development and review, engineering design and approval, procurement and product receipt inspection, training and qualification system(s), and so on.

Examples of deficiencies in management control processes can include strategy, policies, work control, training, and resource allocation. Examples of deficiencies in values can include shared beliefs, attitudes, norms, and assumptions.

The decisions and activities of managers and supervisors determine what is done, when it is done, and how well it is done, either contributing to the health of the system(s) or further weakening its resistance to error. Preventing incidents should include the identification and elimination of latent organizational weaknesses by using causal analysis that goes beyond the direct cause (initiating action). This is vital to organizational learning and to strengthening related processes and systems.

Barrier Analysis is based on the premise that incidents can result from any work process. Barriers are developed and integrated into a system or work process for multiple reasons, including protection of personnel from hazards, protection of equipment and assets, to ensure quality of products, as well as to prevent unacceptable operational conditions. For an incident to occur, there needs to be at least one missing or failed barrier, but an incident often occurs as a result of more than one failed barrier. Although barriers are intended to be impenetrable, in reality, they are not. Barriers can fail due to being defeated or bypassed by alternate paths in the process, or by being intentionally or unintentionally disengaged or deactivated by personnel involved in the process. They also can be rendered ineffective by unforeseen conditions or can fail to act as intended due to flaws inherent in the barrier – all represented as “holes” in the diagram below. Because of this, a layering of barriers is typically employed to provide defense in depth, such that if one barrier fails, one or more other barriers will still prevent a significant incident from occurring. A workplace incident can be visualized as the “holes” in the barriers “lining up” to allow the triggering condition to result in the incident being investigated.

Figure 2. Barriers and Gaps [2]

While **Figure 2**, above, is a static, two-dimensional illustration, the existence of barriers in a system is dynamic and multi-dimensional. This means that not only do barriers have holes or gaps, those holes or gaps can appear, disappear, and reappear; they can shrink and expand; they can move or change location in the defensive layer; and the layers of barriers are not always static, constant, or independent. The barriers themselves can interact, support, or erode each other. Therefore, continuing with the visualization, the purpose of causal analysis is to determine where the holes are; what they consist of; why the holes are there in the first place; why the holes change over time, both in size and location; and how the holes came to "line up" (in this graphic) to produce the incident.

Barriers to consider during an analysis:

- Engineering or Physical Barriers such as guards, shielding, insulation, fences, personal protective equipment, building ventilation, etc.
- Management Barriers such as work planning and authorization, change management, supervision, training,

[2] From DOE EIP-400 Accident Investigation Course (DOE National Training Center, version 02.01), Module 2: Accident Investigation Framework, p.108, slide 33.

line management oversight, etc.

- Administrative Barriers including training and qualification programs, hiring practices, supervisory skills, requirements rolldown, procedures, feedback and improvement, etc.
- Employee Expectations such as fitness for duty, procedure compliance, questioning attitude, communications, known limitations, etc.

An example of a Barrier Analysis is shown in **Table 2** below:

Table 2. Barrier Analysis

Hazard: 13.2 kV Electrical Cable		**Target: Acting Pipefitter**	
What were the barriers?	**How did each barrier perform?**	**Why did the barrier fail?**	**How did the barrier affect the incident?**
Engineering drawings	This barrier, though in place, failed to provide personnel with accurate field conditions for which corresponding level of hazards could be adequately planned.	Engineering drawings and construction specifications were not procured. Drawings used were preliminary. No as-built drawings were used to identify location of utility lines.	Barrier did not provide workers with any knowledge of an electrical cable being located within the work boundary, increasing the likelihood it would be struck while excavating.
Indoor excavation permit	Without an indoor excavation permit being pulled, requirements and processes normally provided by this barrier were never invoked.	Pipefitters and planner were unaware of indoor excavation requirements	Opportunity to identify existence of the cable was missed, increasing the likelihood that the electrical cable would be struck while excavating.
Personal protective equipment	As the worker did not elect to wear appropriate PPE commensurate for the risk involved with conducting the work, this barrier was incapable of and therefore ineffective in providing the designed level of protection normally afforded by this barrier.	No hazard controls were required for jack hammering.	Pipefitter was not protected from electrical shock.

Events and Causal Factors (E&CF) Charting is useful in identifying the multiple causes and graphically depicting the triggering conditions and events necessary and sufficient for an incident to occur. E&CF charting is

a graphical display of the incident's chronology and is used primarily for compiling and organizing evidence to portray the sequence of events leading up to the occurrence or workplace incident. In cases where there was a delay in the discovery of the incident after it occurred, the chart should include the events leading up to the actual time when the incident or its consequences were discovered. In other cases, if the response to the incident was later believed to be lacking, the E&CF chart may also include events and conditions related to the response of the incident so that the causes of the inadequate response can also be analyzed.

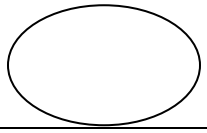
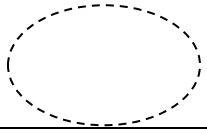
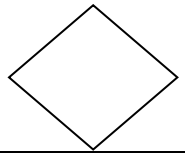
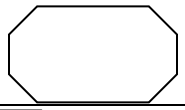
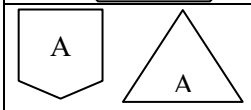
E&CF charting is an iterative process performed throughout the investigation and causal analysis. An analyst can pinpoint specific causal factors by carefully tracing the actions and conditions that caused or allowed the incident to occur. Recurrence could be prevented if identified causal factors are addressed through appropriate corrective actions. The benefits of E&CF charting include:

- Illustrating and validating the sequence of events leading to the incident and the conditions affecting these actions.
- Showing the relationship of immediately relevant actions and conditions to those that are associated but less apparent – portraying the relationships of organizations and individuals involved in the incident.
- Directing the progression of additional data collection and analysis by identifying information gaps.
- Linking facts and causal factors to organizational issues and management systems.
- Validating the results of other analytic techniques.
- Providing a structured method for collecting, organizing, and integrating collected evidence.
- Conveying the possibility of multiple causes.
- Providing an ongoing method of organizing and presenting data to facilitate communication among the investigators.
- Clearly presenting information regarding the incident that can be used to guide report writing.
- Providing an effective visual aid that summarizes key information regarding the incident and its causes in the causal analysis report.

Constructing an E&CF chart should begin immediately after the incident is discovered; however, the initial chart will only be a skeleton of the final product. Additional events and conditions will be discovered as the investigation proceeds. Keeping the chart up-to-date helps ensure that the analysis proceeds smoothly, that gaps in information are identified, and that investigators have a clear representation of incident chronology.

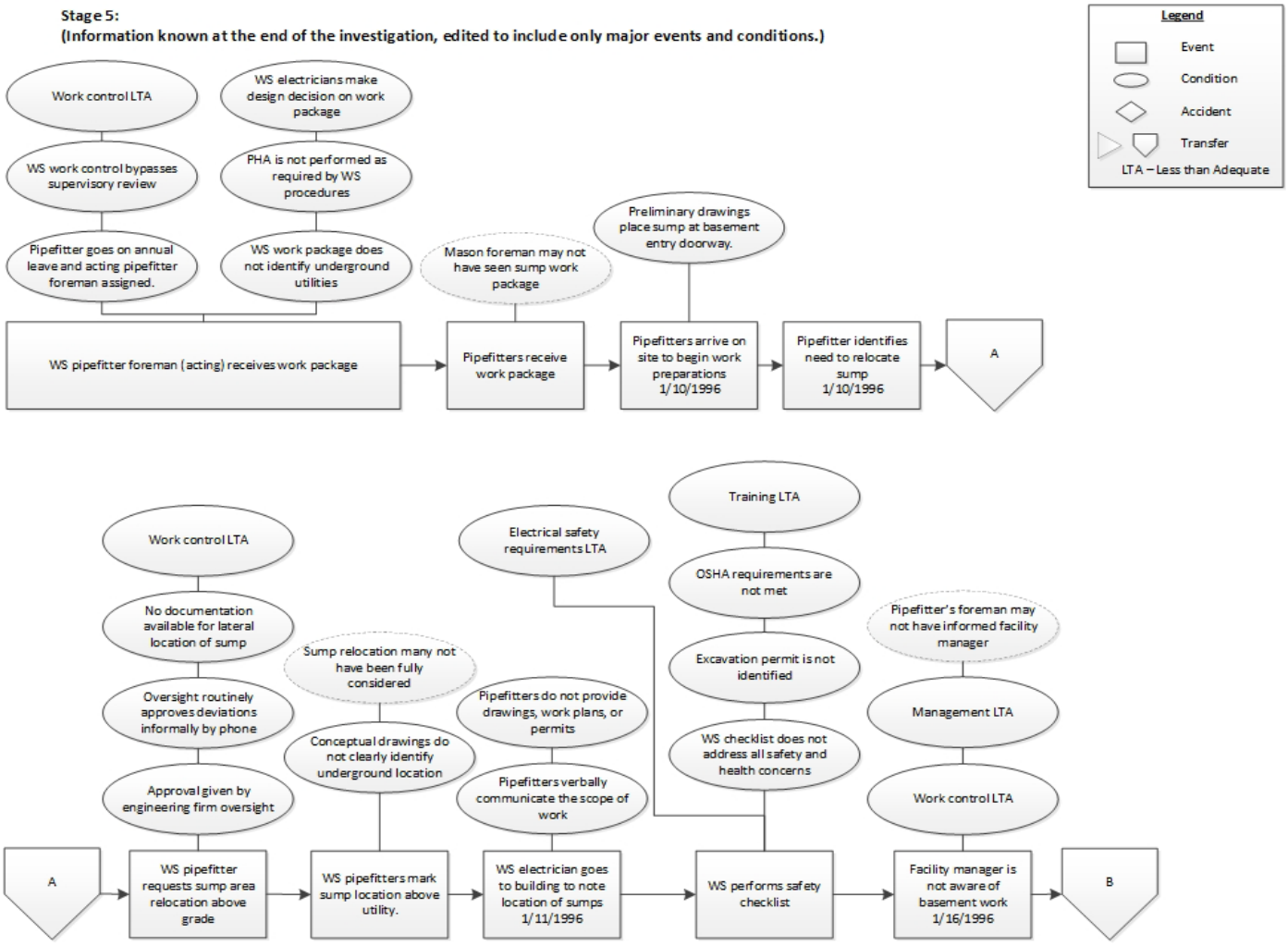
Standard symbols should be used when constructing the E&CF chart. Various shapes can be used as long as the reader understands what they symbolize. Some standard symbols are included in **Table 3** below:

Table 3. E&CF Chart Standard Symbols

	A rectangle is typically used to indicate an **event**. A brief description of the event is written within the symbol as well as the date and time at which the event occurred. Events are arranged in a line in chronological order from left to right.
	**An event that is assumed** to have occurred, but for which no validated evidence exists or has yet been collected, may be indicated by a rectangle outlined with dashed lines.
	An oval is typically used to indicate a **condition**. A brief description of the condition is written within the oval and the condition is placed above the event it affected on the chart.
	A **condition that is assumed** to have existed, but for which no validated evidence exists or has yet been collected, is indicated by an oval outlined with dashed lines.
	A diamond is used to indicate the **occurrence of interest**, such as a significant event.
	Arrows are used to **connect events** and to connect conditions to events.
	An octagon may be used to indicate a **causal factor** and is placed above the events or conditions it caused.
	A triangle or similar shape is used to connect event lines that must be broken when, for example, the entire sequence of events will not fit on a page.

An example of a portion of an E&CF chart is shown in **Figure 3** below:

Figure 3. E&CF Chart Example



Change Analysis

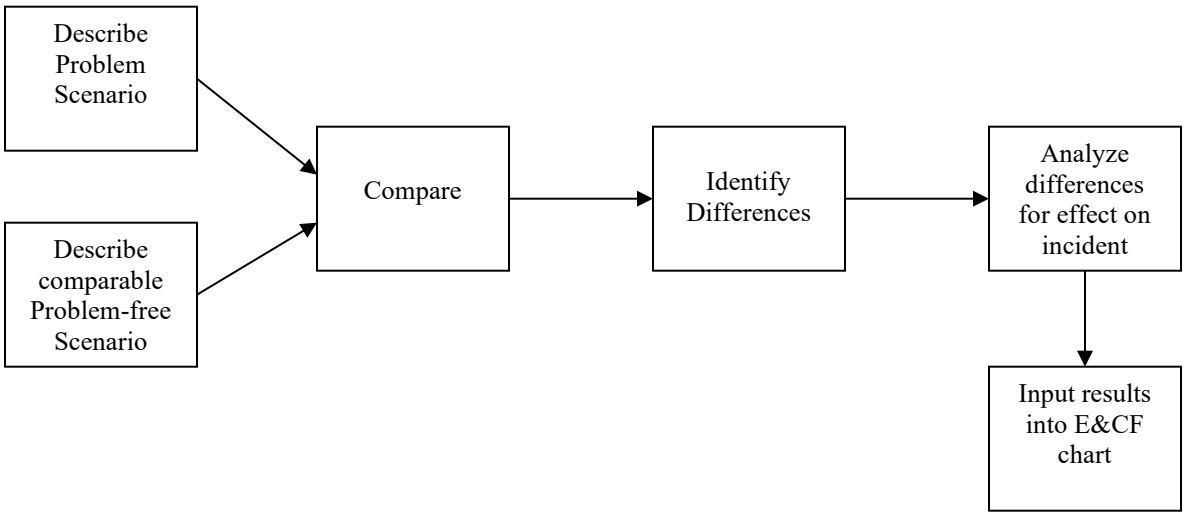
Change analysis is a technique that looks for change, which is anything that disturbs the balance of a system operating as planned. Change is often the source of deviations in system operations. Change can be planned, anticipated, and desired. Change can also be unintentional and unwanted. Workplace change can cause incidents, although change is an integral and necessary part of daily business. Changes to standards or directives, for example, may require policies and procedures to change. Turnover and retirement of an aging workforce will change, over time, the workers who perform certain tasks. Change can be desirable to improve equipment reliability or to enhance the efficiency or safety of operations. Uncontrolled or inadequately analyzed change can have unintended consequences resulting in issues or incidents. Change analysis may be useful in identifying less than obvious contributing causes.

Change analysis examines planned and/or unplanned changes that may have affected desired outcomes. This

technique is used to analyze the difference between what was expected to occur or occurred before, and the actual sequence of actions. The causal analyst identifies conditions common to both the problem-free and problem scenarios, and looks for specific differences between them – in other words, what changed. These differences are evaluated to determine whether they caused or contributed to the issue or incident. For example, why would a system that operated correctly 99 times before, fail to operate as expected on the 100th time?

Change analysis is relatively simple to use. **Figure 4** below illustrates the steps in the process. The last step, in which causal analysts combine the results of the comparison with the results from other techniques, is critical to developing a comprehensive understanding of the causal factor, which is a change that had an effect and thus resulted in the incident.

Figure 4. Change Analysis Steps



A causal analysis can identify changes as well as the impact of those changes. The distinction is important. Identifying only the results of change may not prompt cause analysts to identify all causal factors of an issue. The results of a change analysis can stand alone; however, they are most useful when combined with results from other techniques. The cause analyst needs to start with the baseline situation. This baseline situation can be the situation before the problem arose (e.g., previous shift, last week, or last month) or a model or ideal situation (i.e., as designed or engineered).

It is generally recommended that the analysts compare the incident sequence to the same situation in a problem-free state – that is, the operation prior to the incident – to determine differences and thereby identify causal factors contributing to the issue. Analysts must have sufficient information regarding this baseline situation to be effective in making the comparison.

- Analysts should categorize the changes according to the questions shown in the left-hand column of the worksheet. The analysts should then determine whether the change pertains to a difference in:

- **What** conditions, activities, or equipment were present in the incident situations that were not present in the baseline (incident-free, prior, or ideal) situation (or vice versa).
- **When** an action or condition occurred or was detected in the incident situation versus the baseline situation.
- **Where** an action or condition occurred in the incident situation versus where an action or condition occurred in the baseline situation.
- **Who** was involved in planning, reviewing, authorizing, performing, and supervising the work activity in the incident versus the incident-free situation.
- **How** the work was managed and controlled in the incident versus the incident-free situation.

An example of a Change Analysis Worksheet is shown in **Table 3** below:

Table 3. Change Analysis Worksheet Example

Factors	Incident Situation	Prior, Ideal, or Incident-Free Situation	Difference	Evaluation of Effect
What: Conditions, occurrences, activities, equipment	Design and ES&H reviews were not performed. Established review process was bypassed. Hazards associated with work being performed were not identified. No review of as-built drawings.	Project design and ES&H review are performed by appropriate groups to ensure adequate review and the safety and health of employees. Construction packages are approved by facilities project delivery group. Preliminary hazard analysis is performed on all work.	Environmental Group (EG) assumed design role and removed ES&H review from task. EG approved work packages. No preliminary hazard analysis performed.	Design and ES&H reviews were not performed, contributing to the incident. Construction packages were not approved by facilities group. Hazards were not identified, contributing to the incident.
When: Occurred, identified, facility status, schedule	Configuration changes were made to electrical distribution system without engineering drawings updated to reflect current field conditions.	Configuration changes were made to electrical distributions with corresponding updates completed on engineering drawings.	There was no avenue available for changes made in the field to be communicated to personnel tasked with updating engineering drawings.	Workers were only provided with outdated drawings that failed to adequately reflect field conditions in which they were working in.

Factors	Incident Situation	Prior, Ideal, or Incident-Free Situation	Difference	Evaluation of Effect
Where: Physical location, environmental conditions	Sump location was placed above 13.2 kV electrical line.	Sump is placed in a non-hazardous location.	Inadequate design allowed sump to be placed above 13.2 kV line.	Sump location was placed above an electrical line, which was contacted by a worker jackhammering in the area.
Who: Staff involved, training, qualification, supervision	EG assumed line responsibility for project.	EG serves as oversight/support organization to assist line management in project.	Support organization took responsibility of line function for project management.	Lack of oversight on project.
How: Control chain, hazard analysis monitoring	Management allowed EG to oversee construction tasks.	Management assures that work is performed by qualified groups.	Hazards analysis was not conducted.	Hazards were not identified, contributing to incident.

Other Analysis Methods – Several other causal analysis methods exist and can be used to identify causal factors associated with incidents or conditions. These include but are not limited to:

- **8D Problem Solving** – a method used to identify, correct, and eliminate recurring problems, making it useful in product and process improvement and in causal analysis. It is a tool used to drive systemic change, often improving an entire process to not only fix the immediate problem but to address other issues that may arise from systemic failures.
- **Affinity Diagram** – a collection of large amounts of data that is organized into groups or themes based on their relationships. This process is appropriate to make sense of insights gathered during research, as well as to organize ideas generated during brainstorming sessions.
- **Factor Tree Analysis** – similar to Fault Tree Analysis (see below), but the emphasis is placed on Actions and Conditions instead of faults. The idea is that specific conditions must be present for an action to result in an undesirable effect, and that causes and effects form an infinite chain where the cause of the top-level effect is a 2nd level effect itself with a cause that is a 3rd level effect, etc.
- **Failure Mode and Effects Analysis (FMEA)** – a step-by-step approach for identifying all possible

failures in a design, a manufacturing or assembly process, or a product or service. Failure modes refer to the ways, or modes, in which something might fail. Failures are any errors or defects, especially ones that affect the customer, and can be potential or actual. Effects analysis refers to studying the consequences of those failures. FMEA can be an excellent tool for analyzing a system post-incident using the additional or correct information that the incident has revealed.

- **Fault Tree Analysis** – a methodology for starting with an undesirable incident or fault in a defined system and then tracing all of the initiating faults that must occur first in order for the top-level fault to occur.

- **Fishbone Diagram** – a visualization tool for categorizing potential causes of a problem and is helpful in identifying a problem's root cause(s). As the name suggests, the diagram resembles a fish skeleton with the problem or incident documented at the head of the diagram and the causes laid out as ribs. Sub-branches of the causes help define root cause(s).

- **Human Performance Culpability Evaluation** – conducted using a decision tree management tool intended to help determine the culpability of an individual or team whose involvement in a workplace incident is in question. The evaluation seeks to determine the degree to which culpability for the resulting consequences lies with the individual or team versus the organization and its management systems and processes.

- **Missed Opportunity Matrix** – a method for organizing and analyzing causal factors from the time that they occurred or came into effect, and the opportunities that existed to identify them, with the premise that had they been identified then, they would have been corrected or mitigated, and thus would not have existed or had effect later when the final occurrence or workplace incident occurred. The matrix considers aspects of each factor within the situation being analyzed, opportunities for identification/discovery, expected result of that opportunity, potential impact on the incident sequence, and likelihood of that opportunity having that impact, as contrasted with the actual result in the situation being analyzed.

- **Why Tree or Five Why's Analysis** – uses an iterative questioning technique to search for causes of problems. The tool is used by asking "Why" at least five times as the analyst works through various levels of detail. The probing is considered sufficient once it becomes difficult to respond to the next why question. Using this technique, a causal analyst may find factors that cause or produce not only the original symptom, but also can affect the entire organization when tracing the "why's" back to the original symptoms. This methodology is useful for an Apparent Cause Analysis but is not a preferred method to use when determining root causes.

6 CAUSE CODE SELECTION

The Causal Analysis Tree (CAT) (Attachment 1) should be used to determine the appropriate cause codes for each cause identified during causal analysis. Cause codes on the CAT are written in concise language. Causal Analysis Node Descriptions are provided in Attachment 2 and must be used to ensure that the analyst correctly understands the full meaning of the cause code to properly select the appropriate cause codes for the causal factor being analyzed. Sites may also use the cause codes on the CAT for performing analysis to detect system, program, and organizational trends using cause data from multiple incidents and other issues.

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ATTACHMENT 1. CAUSAL ANALYSIS TREE

A1 Design / Engineering Problem

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/ VERIFICATION INSTALLATION 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

A2 Equipment / Material Problem

B1 CALIBRATION FOR INSTRUMENTS LTA
- C01 Calibration LTA
- C02 Equipment found outside acceptance criteria

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 specifications/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 Defective or failed part
- C02 Defective or failed material
- C03 Defective weld, braze, or soldering joint
- C04 End of life failure
- C05 Electrical or instrument noise
- C06 Contaminant

A3 Human Performance LTA

B1 SKILL-BASED ERROR
- C08 Description error – action performed on wrong object
- C09 Automatic action caused by external trigger
- C10 Intrusion of internal thoughts or associations
- C11 Loss of cue that initiated action
- C12 Action wrong due to different device mode
- C13 Routine action took over unfamiliar activity
- C14 Improper sequence of actions performed

B2 RULE-BASED ERROR
- C06 Strong rule misapplied during first encounter of exception to rule
- C07 Indication of exception to rule not recognized or acknowledged
- C08 Strong rule selected over weak rule during assessment of situation
- C09 Common indicator chosen over uncommon indicator as basis for course of action
- C10 Previously-successful solution selected despite limited number or variety of situations experienced
- C11 Previously-successful solution favored over other available solutions
- C12 Misapplication of rule during learning stage
- C13 Misapplication of rule due to misunderstanding of underlying principles
- C14 Application of rule without consideration of limitations or risks in dissimilar situations
- C15 Wrong rule selected during assessment of situation

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
- C07 Nonconformance with requirements made when person believed it was best feasible option

B4 WORK PRACTICES LTA
- C01 Erroneous performance due to limitations of an individual
- C02 Intentional violation

A4 Management Problem

B1 MANAGEMENT METHODS LTA
- C01 Management policy guidance/ expectations 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 incident 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 supervisors
- 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 for 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/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 and/or environmental stress
- C08 Job scoping did not identify special circumstances and/or conditions
- C09 Work planning not coordinated with all departments involved in task
- C10 Problem performing repetitive tasks and/or subtasks
- 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 effects of 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 methods did not identify need for change
- C02 Change not implemented in a timely manner
- C03 Inadequate vendor support of change
- C04 Risks/consequences associated with change not adequately reviewed/assessed
- C05 System interactions not considered
- C06 Personnel/department interactions not considered
- C07 Effect 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 revised
- C11 Changes not adequately communicated
- C12 Change not identifiable during task
- C13 Accuracy/effectiveness of change not verified or not validated

A5 Communication LTA

B1 WRITTEN COMMUNICATION 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 COMMUNICATIONS NOT USED
- C01 Lack of written communication
- C02 Not available or inconvenient to use

B4 VERBAL COMMUNICATIONS 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 Deficiency

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 Problem

B1 EXTERNAL PHENOMENA
- C01 Weather or ambient conditions
- C02 Power failure or transient
- C03 External fire or explosion
- C04 Other natural phenomena

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

B3 LEGACY
- C01 Legacy issues that are not related to radiological or hazardous material

B4 NO CAUSE IS APPLICABLE

Level A nodes are underlined.

Level B nodes are in ALL CAPS.

Level C nodes are in "Sentence case."

LTA – Less than adequate

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ATTACHMENT 2. CAUSAL ANALYSIS NODE DESCRIPTION

A1 DESIGN / ENGINEERING PROBLEM

An incident or condition that can be traced to a defect in design or other factors related to configuration, engineering, layout, tolerances, calculations, etc. Note that as used here, engineering is a function or process, not a job title. Causal analysis should consider what A3 human performance codes may be coupled with the codes in this branch to more fully explain how the design deficiency resulted and/or was not detected during the review/verification steps of the design process.

- **B1 Design Input Less Than Adequate (LTA)** – Input to a design that was lacking adequate information that was necessary for the design.
- **B2 Design Output LTA** – Inadequate design output that did not meet the customer's expectations or design requirements.
- **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.
- **B4 Design Verification / Installation Verification LTA** – Design reviews, testing, independent inspections, and acceptance were not in compliance with customer expectations and/or site requirements.
- **B5 Operability of Design / Environment LTA** – Personnel or environmental factors were not considered as part of the design.

A1B1C01 – Design input cannot be met – 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.

A1B1C02 – Design input obsolete – The criteria were out-of-date. An old version of a requirement or specification was used. Process requirements/conditions changed, and the changes were omitted from the input.

A1B1C03 – Design input not correct – The wrong standards or requirements were used. The requirements were transcribed in error.

A1B1C04 – Necessary design input not available – The necessary requirements, codes, standards, etc., were not available to the designer.

A1B2C01 – Design output scope LTA – The design did not consider all the possible scenarios. All the operating conditions (normal and emergency) were not included in the design.

A1B2C02 – Design output not clear – The drawings were difficult to read. The specifications were difficult to understand. The specification could be interpreted in more than one way.

A1B2C03 – Design output not correct – The drawings and other specifications were incorrect. The final design output did not include all changes.

A1B2C04 – Inconsistent design output – There were differences between different output documents. The drawings and other design documents did not agree.

A1B2C05 – Design input not addressed in design output – The specifications did not include all the requirements. Some criteria were left out of the design output.

A1B2C06 – Drawing, specification, or data error – The latest drawing revision was not referenced. The latest vendor information was not included in the design documentation. The correct data was not noted on the design documentation request.

A1B2C07 – Error in equipment or material selection – The correct vendor identification number was not used for procurement of equipment. The correct grade of stainless steel was not specified for the material.

A1B2C08 – Errors not detectable – 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.

A1B2C09 – Errors not recoverable – The system was designed such that personnel were unable to recover from error discovered before a failure occurred.

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

A1B3C01 – Design / documentation not complete – The designs and other documentation for equipment were incomplete. Items were missing from the documentation. A complete baseline did not exist.

A1B3C02 – Design / documentation not up-to-date – Drawings and documents were not updated when changes were made. Documents/drawings did not reflect the current status.

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

A1B3C03 – Design / documentation not controlled – The design documentation was not controlled per site requirements for documents and records.

A1B4C01 – Independent review of design / documentation LTA – A required review was not performed on the design. The review was not performed by an independent reviewer. The design had problems passing the functional testing.

A1B4C02 – Testing of design / installation LTA – Testing was not included as part of the design acceptance process. The testing did not verify the operability of the design. Design parameters did not successfully pass all testing criteria.

A1B4C03 – Independent inspection of design / installation LTA – 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.

A1B4C04 – Acceptance of design / installation LTA – The customer had problems with acceptance of the design, testing, and/or verification.

A1B5C01 – Ergonomics LTA – Inadequate ergonomic design 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 incident 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.

A1B5C02 – Physical environment LTA – 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.

A1B5C03 – Natural environment LTA – 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 incident was caused by excessive exposure of personnel to a hot or cold environment.

A2 EQUIPMENT / MATERIAL PROBLEM

This branch is used for coding elements of an incident or condition resulting from the failure, malfunction, or deterioration of equipment or parts, including instruments or material. Causal analysis should consider what A3 human performance codes may be coupled with the codes in this branch to more fully explain, for example, how the deficiency or problem with the equipment/material occurred or was not detected previously in the processes for procurement, testing, inspection, acceptance, storage, maintenance, or periodic checks of the equipment/material, etc.

- **B1 Calibration for Instruments Less Than Adequate (LTA)** – Calibrations did not include all the essential elements. Equipment as-found condition was less than adequate.
- **B2 Periodic / Corrective Maintenance LTA** – Periodic maintenance was not established for the equipment, instrument, or component. Periodic maintenance was inadequate. Corrective maintenance was inadequate. Equipment history did not exist for the instrument or component. Equipment history was incomplete.
- **B3 Inspection / Testing LTA** – Scheduled inspection/testing did not exist for the instrument or equipment. Inspection/testing was inadequate or not performed as required. Inspection/testing did not include all the essential elements. *Note: A1B4 should be used for Design Testing.*
- **B4 Material Control LTA** – Problem was due to inadequate handling, storage, packaging or shipping of materials or equipment. Shelf life for material was exceeded. Unauthorized material or equipment substitution was made. Spare parts were inadequately stored. Error was made in labeling or marking.
- **B5 Procurement Control LTA –** Error was due to inadequate control of changes to procurement specifications or purchase orders. Fabricated item failed to meet requirements or 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.*
- **B6 Defective, Failed or Contaminated** – Incident was caused by failed or defective part including suspect counterfeit items. Material used was defective or flawed. Weld, braze, or soldered joint was defective. Component reached the end of its expected service life. Electrical or instrument noise interference or interaction. Foreign material or contaminant caused equipment or component to fail.

A2B1C01 – Calibration LTA – 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.

A2B1C02 – Equipment found outside 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.

A2B2C01 – Preventive maintenance for equipment LTA – An equipment malfunction was caused by a failure to carry out scheduled preventive maintenance. Preventive maintenance was not established for the equipment or component that failed. Preventive maintenance was scheduled too infrequently. Preventive maintenance was incomplete. Preventive maintenance was performed on some of the components but not on others.

A2B2C02 – Predictive maintenance LTA – 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.

A2B2C03 – Corrective maintenance LTA – 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 completed but was not performed correctly.

A2B2C04 – Equipment history LTA – Equipment history/records did not exist for the equipment that malfunctioned. The history for the equipment that malfunctioned was incomplete/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.

A2B3C01 – Start-up testing LTA – Functional testing did not exist for the equipment or system prior to placing in service. Start-up testing was inadequate for the equipment or system being placed into service.

A2B3C02 – Inspection / testing LTA – Required testing/inspection was not established or performed for the equipment involved in the incident. The required testing/inspection was performed at an incorrect frequency. The acceptance criteria for the required testing/inspection were inadequately defined. All essential components were not included in the required testing/inspection.

A2B3C03 – Post-maintenance / post-modification testing LTA – 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.

A2B4C01 – Material handling LTA – Material/equipment was damaged during handling. Material/equipment was “mixed up” during handling.

Note: This code is for handling occurring onsite. Problems with handling 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).

A2B4C02 – Material storage LTA – 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.

A2B4C03 – Material packaging LTA – 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).

A2B4C04 – Material shipping LTA – The material/equipment was transported improperly. The material/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).

A2B4C05 – Shelf life exceeded – Material, equipment, or parts that had exceeded the shelf life were installed. Materials continued in use after the shelf life was exceeded.

Note: Shelf life can be highly dependent on storage environment, i.e., this could be a storage issue (A2B4C02) instead or as well.

A2B4C06 – Unauthorized material substitution – Incorrect materials or parts were substituted. Material or parts were substituted without authorization. The requirements specified no substitution.

Note: This code is for material substitution occurring onsite. Problem 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).

A2B4C07 – Marking / labeling LTA – There was an error made in the labeling or marking. Equipment identification, labeling, or marking was less than adequate.

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

A2B5C02 – Fabricated item did not meet requirements – The item of concern was not fabricated according to the requirements specified in the procurement specifications/purchase requisition.

A2B5C03 – Incorrect item received – An item received was not the one ordered. The inconsistency was not recognized. The item was accepted rather than returned.

A2B5C04 – Product acceptance requirements LTA – The product acceptance requirements were incomplete. The product acceptance requirements did not address all the safety concerns for the item. The product acceptance requirements did not address all the concerns for efficiency. The product acceptance requirements did not address all the safety concerns for the items.

A2B6C01 – Defective or failed part – A part/instrument lacked something essential to perform its intended function. The degraded performance of a part or a component contributed to the failure of the component, equipment, or system.

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

A2B6C02 – Defective or failed material – 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 multiple coded.

A2B6C03 – Defective weld, braze, or soldering joint – A component failed due to a specific weld/joint defect or failure.

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

A2B6C04 – End of life failure – The failure resulted from equipment or material having reached the end of its expected/normal service life. The failure was a result of the normal aging process for this component.

A2B6C05 – Electrical or instrument noise – An unwanted signal or disturbance interfered with the operation of equipment.

A2B6C06 – Contaminant – Failure or degradation of a system or component was due to foreign material (e.g., dirt, crud, impurities, trash in river intake, etc.) or radiation damage due to excessive radiation exposure.

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

A3 HUMAN PERFORMANCE LESS THAN ADEQUATE (LTA)

To be comprehensive, causal analysis must identify all elements of a situation that were causal to the incident or condition being analyzed, as well as to its consequences. Therefore, the analysis must evaluate both the behaviors of people involved, as well the latent weaknesses in the organization that contributed to the situation. The behaviors and actions of individuals in the incident sequence cannot be viewed in isolation, but must be considered in the context of the situation as it existed at the time, and as it was viewed and understood by those people in that situation as it unfolded. To be effective, causal analysts should keep the following principles in mind:

- Focus on what could have prevented any errors and their consequences, rather than who caused the incident.
- Build context by identifying for each individual what they were trying to accomplish (goals), what they were paying attention to (focus), and what each person knew at critical points in the sequence of events (knowledge).
- Evaluate connections or relationships between the effects or consequences of any actions of people with the designs, materials, processes, instructions, training, and other elements of the overall management system that could have prevented those actions or mitigated their consequences.

Some Principles of Human Performance:

- People are fallible, and even the best people make mistakes.
- Error-likely situations are predictable, manageable, and preventable.
- Individual behavior is influenced by organizational processes and values.
- People achieve high levels of performance because of the encouragement and reinforcement received from leaders, peers, and subordinates.
- Incidents can be avoided through an understanding of the reasons mistakes occur and application of lessons learned from past incidents or errors.

This branch contains cause codes for an incident or condition resulting from factors associated with the performance of people while performing work. Strictly speaking, A3B1, A3B2, A3B3, and A3B4 nodes are applicable when the causal factor involves actions or inactions of an individual (human). These codes can also apply to group performance that is LTA, in addition to or in lieu of individual behavior. However, when multiple individuals are involved, there are usually group, organizational, or cultural dynamics that are influencing the behavior of the group.

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 affect the system and are affected by it. This applies to the designers, builders, operators, and management. Although the degree/amount of effect may vary, there is an effect.

Broadly speaking, *human error* is the failure of planned actions to achieve their desired ends. However, human error can take many forms, depending on, for example, the intent of the individual. When an individual *error* (unintended action) occurs, it is the individual that acted differently than intended; however, the real question is: What in the system(s) allowed that action to occur or failed to prevent its consequences? Weaknesses within the organization that are hidden (latent) in various management control processes create workplace conditions that can provoke errors and degrade the integrity of controls that are intended to protect against hazards, or even to mitigate consequences of anticipated error.

In regard to behavior, humans control their actions through various combinations of two means– conscious and unconscious (automatic). Conscious control is limited by people's ability to actively "focus on" or "pay attention to" one thing at a time, while multiple things can be controlled automatically at the same time. Human performance improvement describes a framework consisting of three performance modes in which humans operate. These modes are useful for identifying the types of error likely to occur in different operational situations, or within different aspects of the same task where different types of information-processing demands on the individual may occur. These modes are differentiated in terms of the degree of conscious and unconscious control that the individual uses to complete a task. In terms of the span of time in which the steps of a task are performed, these modes can all "exist" concurrently. The performance modes are labeled as *skill-based*, *rule-based*, and *knowledge-based*, to which the first three B-nodes of the A3 branch of the CAT correspond. Additional information on the basic concepts underlying the different types of errors that can occur is given in the B-level sections below. For more information about human error and performance modes, refer to DOE-HDBK-1028-2009, *Human Performance Improvement Handbook, Volume 1: Concepts and Principles* (or current version), as well as other resources referenced in the Handbook.

Thus, the intent is for A3 cause codes to be "coupled" with cause codes somewhere else on the CAT to more fully describe the cause for each applicable causal factor. By coupling A3 cause codes with other codes from other branches, a complete "picture" of the cause may be captured. It is recognized that the number of couplets to impacted branches of the CAT will vary with the significance of the incident or situation being analyzed. While it is reasonable that some branches are more likely than others for a given type of situation, there is no constraint that those will be the only potential couplets for all instances of that type of situation.

Note: This branch of the CAT has been significantly revised to more closely align with published subject matter references for the types of human error that occur to enable the causal analyst to understand how the behavior occurred or was initiated – thus helping to "paint" a more accurate and complete "picture" that can serve as a basis for developing corrective actions that take into account the full context of the behavior of persons involved.

New cause codes have been added to the B1, B2, and B4 nodes, with changes also made to some supporting text to causes on the B3 node. In order to provide for historical continuity, the existing cause codes A3B1C01-C07 and A3B2C01-C05 have been denoted as "Retired" to indicate that these have been superseded and to eliminate future use in causal analysis.

If mapping of the retired causes is desired for better quality of trending/analysis, a list of other potential causes is provided following each retired cause. As none of these retired causes has a single cause to which it can be properly mapped, review of the details of previous incidents/occurrences will likely be necessary in order to determine an appropriate fit for mapping.

A3B1 – Skill-based Error

Skill-based performance is behavior associated with highly-practiced actions in a familiar situation usually executed from memory without significant conscious thought and with only intermittent checks on progress by conscious attention. Skill-based errors are commonly referred to as *slips* or *lapses*. A *slip* is a physical action different than was intended. A *lapse* is an error due to a failure of memory or recall. Also included in this node are *perceptual* errors, which occur when a person misrecognizes some object or situation, in large part due to expectation and habit.

Performance of a task often involves a person doing several things simultaneously, such as with their hands, feet, eyes, and ears when driving a car or playing a piano. Once the person has mastered the skill, physical movements are controlled subconsciously, and conscious attention is focused on higher-level aspects of the task such as finesse, smoothness of movements, timing and rhythm, as well as confirming expected conditions and monitoring of changes in conditions in the environment that might impact execution. Events in the environment may automatically trigger (activate) an action, but internal thoughts (and memories) can also trigger an action or interrupt the flow of execution of actions.

[Retired: A3B1C01 through A3B1C07]

A3B1C08 – Description error – action performed on wrong object – The correct action was performed on the wrong object because its description (e.g., characteristics such as shape, size, color, location, etc.) was similar to another object. The intended action had much in common with others that were possible. Because the action sequence was not completely and precisely specified, the intended action fit several possibilities. The more the wrong and right objects have in common, and the nearer the two objects are to each other, the more likely it is that this type of error will occur.

A3B1C09 – Automatic action caused by external trigger – Automatic actions driven by data intrudes/interrupts the current activity. This occurs when automatic actions are triggered by the arrival of certain sensory data. In these cases, the data-driven response/behavior intrudes/interrupts an ongoing action sequence, causing behavior that was not intended, and which may be detrimental to the success of the current activity.

A3B1C10 – Intrusion of internal thoughts or associations – Just as external data can trigger (activate) certain actions, so, too, can internal thoughts and associations. Associations from thoughts and ideas, often accompanied by strong emotion, intrude into the current activity resulting in an action that is not what was intended, either partially or fully.

A3B1C11 – Loss of cue that initiated action – The cue or activator that starts or started the behavior was lost or forgotten. This kind of error happens when an individual starts an activity with a clear and specific goal, but after they had engaged in the task, they "lose sight of" the goal because what initiated (activated) the action is no longer present. The individual might, in fact, continue the task, but with little awareness of the rationale for progress toward the goal.

A3B1C12 – Action wrong due to different device mode – The action taken would have been right/correct, but the device was in a different *mode* than the person believed it was in. This error can occur when working with a device that has different modes of operation. The individual believed the system was in one state (mode) when it was actually in another. The action taken would have been appropriate for the proper/correct mode, but it had a different meaning and effect in the actual/current mode.

A3B1C13 – Routine action took over unfamiliar activity – A familiar or routine activity took over (captured) an unfamiliar (or less familiar/practiced) activity. This occurs when two different action sequences have their initial stages in common, with one sequence being unfamiliar and the other being well practiced. The individual unconsciously transitioned from the original activity to the steps of the more familiar activity at a step or series of steps that are part of both activities.

A3B1C14 – Improper sequence of actions performed – Misordering, omissions, or repeating of steps based on assumptions for completion are versions of the same error relative to the proper sequence of actions/steps in a task:

- Components (steps) of an action sequence were performed out of the proper order (mis-ordered).
- Component in the sequence was skipped (omitted).
- Component was performed in its proper sequence, but then subsequently and unnecessarily performed again, possibly due to interruption or delay.

[Retired A3B1C01 – Check of work was LTA – Retirement Note: A "self-check" of a step or multiple steps performed, or to assess/confirm overall task progress, is by definition not a skill-based error, but instead a rule-based error, regardless of whether a check of work by the performer is required by procedure or has become part of their routine in performing the task. Because humans have difficulty in recognizing their own errors, a self-check as a means of ensuring correct performance is inherently prone to be erroneous. When an error is later discovered to have occurred, it is only with "hindsight bias" that it could be said that had a check of work been

performed (in the moment) and had that check identified that an error had occurred, the resulting incident or consequence would likely have been prevented.]

A3B2 Codes That Could Be Used as Equivalent for Data Analysis:

- Indication of exception to rule not recognized or acknowledged (Rule-based Error).
- Common indicator chosen over uncommon indicator as basis for course of action (Rule-based Error).

[Retired A3B1C02 Step was omitted due to distraction – Retirement Note: This cause has been retired because it focuses less on the nature of the error itself and more on only one possible result of one type of trigger. Distractions can be generated internally due to one's own thoughts or due to external stimuli (triggers).]

A3B1 Codes That Could Be Used as Equivalent for Data Analysis:

- Automatic action caused by external trigger (Skill-based Error).
- Intrusion of internal thoughts or associations (Skill-based Error).
- Misordering, omission, or repeating of steps (Skill-based Error).

[Retired A3B1C03 – Incorrect performance due to mental lapse – Retirement Note: Multiple skill-based errors are the result of a mental lapse. This cause has been retired because it is too general to provide insight into how the error occurred with respect to the individual and the situation or environment in which the task was being performed.]

A3B1 Codes That Could Be Used as Equivalent for Data Analysis:

- Loss of cue that initiated action (Skill-based Error).
- Action wrong due to different device mode (Skill-based Error).
- Improper sequence of actions performed (Skill-based Error).

[Retired A3B1C04 – Infrequently performed steps were performed incorrectly – Retirement Note: This cause has been retired because it attributes more to the person performing the task than to other factors that can affect performance. Incomplete knowledge of steps to be performed, either due to inexperience or due to an extended time since previous performance of the task, is likely to result in errors at the rule-based level. Causes in other branches that should ensure/confirm proficiency should also be considered.]

A3B2 Codes That Could Be Used as Equivalent for Data Analysis:

- Indication of exception to rule not recognized or acknowledged (Rule-based Error).
- Strong rule selected over weak rule during assessment of situation (Rule-based Error).
- Misapplication of rule during learning stage (Rule-based Error).

[Retired A3B1C05 – Delay in time caused LTA actions – Retirement Note: This cause has been retired because it describes a broader condition that may have provoked erroneous performance, but focuses on factors associated with the pausing and restarting of tasks that would come into play at the rule-based level.]

A3B1 and B2 Codes That Could Be Used as Equivalent for Data Analysis:

- Improper sequence of actions performed (Skill-based Error).
- Strong rule selected over weak rule during assessment of situation (Rule-based Error).
- Common indicator chosen over uncommon indicator as basis for course of action (Rule-based Error).

[Retired A3B1C06 – Wrong action selected based on similarity with other actions – Retirement Note: This cause has been retired because it broadly describes the result of a rule-based error, but the error could be of multiple types.]

A3B1 and B2 Codes That Could Be Used as Equivalent for Data Analysis:

- Improper sequence of actions performed (Skill-based Error).
- Previously-successful solution selected despite limited number or variety of situations experienced (Rule-based Error).
- Previously-successful solution favored over other available solutions (Rule-based Error).

[Retired A3B1C07 – Omission / repeating of steps based on assumptions for completion – Retirement Note: While this cause sounds similar to one of the new skill-based causes, the added aspect that the problem resulted from "assumptions" being made about which steps had been completed can indicate an error at the rule-based level.]

A3B1 and B2 Codes That Could Be Used as Equivalent for Data Analysis:

- Improper sequence of actions performed (Skill-based Error).
- Strong rule selected over weak rule during assessment of situation (Rule-based Error).
- Indication of exception to rule not recognized or acknowledged (Rule-based Error).

A3B2 – Rule-based Error

People switch back and forth from skill-based to rule-based performance mode when they notice a need to modify their largely pre-programmed behavior, because they have to take into account some change in the situation (*if* this, *then* do that). A rule-based error is one type of what is commonly called a *mistake* (not a lapse of memory).

Rule-based mistakes are errors that were committed because the intent of the act was incorrect for the work situation, typically defined by the condition of the physical work environment or an object in it that the work involves. The error is often misapplication of a "good" rule or application of a "bad" rule during the execution of work. Note that "rule" as used here is not limited to written instructions and procedures – rules are often learned as a result of personal experience, interaction with the facility or equipment, formal training, or by working with experienced workers, as well as from the local and general organizational culture. "Good" as used here merely means that, for the individual involved, the rule has been proven to be useful in a particular situation; "bad" in this context can range from the "just plain wrong" to those that may simply result in clumsy, inelegant, or inefficient, yet successful performance.

Although the actual structure and hierarchy of a person's rules framework is very specific to the individual, in general, multiple rules can be active (available for selection) at a given stage of task execution, along with, for each rule, associations to various situations, as well as exceptions to when the rule would apply – the variety and complexity of which are a function of retention and experience.

[Retired: A3B2C01 through A3B2C05] –

A3B2C06 – Strong rule misapplied during first encounter of exception to rule – This type of error is highly likely to occur on the first occasion that the individual encounters a situation where there is an exception to a general rule. During learning or when experience is limited, it is through the occurrence of this type of error that the hierarchy (i.e., strength) of rules develops.

A3B2C07 – Indication of exception to rule not recognized or acknowledged – The individual did not recognize/neglected to acknowledge indications that the situation was an exception to the rule they believed would/should apply. The way/form in which indications are manifest can affect recognition, especially if this differs from what is expected or has been previously experienced.

A3B2C08 – Strong rule selected over weak rule during assessment of situation – The individual selected one rule over another because of the selected rule's strength. Factors that influence a person's assessment of a situation include assumptions about the conditions of the situation, the level of confidence in their assessment of the conditions, as well as ties between indicators and when given rules would apply. Situations with unpleasant outcomes can also cause a sudden change in strength and level of a rule, which could be favored the more recently the prior situation occurred.

A3B2C09 – Common indicator chosen over uncommon indicator as basis for course of action – The individual chose a more frequently-encountered indicator as a basis for their course of action even though another indicator was present which should have driven a different course of action. Indicators can be both those that satisfy some or all of the person's conditions for use of a rule or those that indicate an exception to a

rule, as well as those that do not relate to any rule (i.e., noise). The more complex and dynamic a situation is, the more indictors there will be that can claim the individual's attention.

A3B2C10 – Previously-successful solution selected despite limited number or variety of situations experienced – While conscious of the limited number of or variety in previous situations encountered that were similar to the present situation, the individual opted to employ a solution that had previously shown itself to yield a successful outcome (i.e., heuristics).

A3B2C11 – Previously-successful solution favored over other available solutions – The individual defaulted to employing a course of action that has proven successful in many previous situations rather than evaluating other available solutions through assessment of the present situation to see what rules would apply and determining the most appropriate approach.

A3B2C12 – Misapplication of rule during learning stage – While still learning to master the performance of a task, the individual misapplied a rule to a situation with which they had some familiarity. Having this limited experience, and because the individual had discretion on performance of certain steps, the error was likely attributable to the continued formation of the individual's rules-framework hierarchy.

A3B2C13 – Misapplication of rule due to misunderstanding of underlying principles – The individual applied a rule that they believed was correct based on prior experience and successes until the current situation revealed an incomplete understanding of the underlying principles that would dictate when the rule would not apply.

A3B2C14 – Application of rule without consideration of limitations or risks in dissimilar situations – The individual applied a rule in a situation that was recognized as being different from previous situations encountered, thus being aware (to some degree) of the limitations in its application as well as the implied risks of applying a rule that might prove to be incorrect in a dissimilar (new) situation.

A3B2C15 – Wrong rule selected during assessment of situation – The individual opted to apply a rule that was considered "wrong." As discussed above, the rule may have been deemed "bad" or "wrong," though rules considered to be such can range from those that may simply result in clumsy, inelegant, or inefficient performance, to those that are inadvisable, may be "wrong" in one situation (but not in another), or that are "just plain wrong" – yet all of which will result in successful (but possibly incorrect) performance. This cause code is placed here, rather than under the B2 – Rule-Based Error node, because of the wide range of factors that can influence the selection of such rules by an individual, including desire (or impetus) to complete the task (get the job done), prior training (formal) and/or coaching (informal), experience, management expectations, cultural norms within a trade, discipline, or organization, how recently "good" or "right" rules were reinforced, etc.

[Retired A3B2C01 – Strong rule incorrectly chosen over other rules – **Retirement Note**: This cause has been retired because it generally describes a rule-based error involving conflicting rules, but is too broad to provide a clear basis for understanding the behavior in order to develop effective corrective actions. Multiple new rule-based causes have been provided that may be selected based on the relevant facts of the situation.]

A3 Codes That Could Be Used as Equivalent for Data Analysis:

- Strong rule misapplied during first encounter of exception to rule.
- Strong rule selected over weak rule during assessment of situation.
- Previously successful solution favored over other available solutions.

[Retired A3B2C02 – Signs to stop were ignored and step performed incorrectly – **Retirement Note**: This cause has been retired because it can lead to using "hindsight bias" as a basis for evaluating the individual's behavior. A sign or indicator that performance of the task "should" have been stopped would first need to be observed and then recognized as such because a rule exists in the individual's mental rules framework associating that indicator with that rule. Causal analysis would also need to ascertain if criteria have been established for the task with some level of formality that dictate when the task is to be stopped for such to be considered an error (or possibly a violation).]

A3 Codes That Could Be Used as Equivalent for Data Analysis:

- Common indicator chosen over uncommon indicator as basis for course of action.
- Previously successful solution selected despite limited number or variety of situations experienced.
- Application of rule without consideration of limitations or risks in dissimilar situations.

[Retired A3B2C03 – Too much activity was occurring and error made in problem solving – Retirement Note: This cause has been retired because it broadly describes, as the example illustrates, a situation in which a number of error types could occur. Specific facts would be needed for the analysis to determine if the error in a particular case was skill-based or rule-based. Newer causes have been provided that will better allow for identifying the aspects of the situation needed to determine which type of error occurred.]

A3 Codes That Could Be Used as Equivalent for Data Analysis:

- Previously-successful solution selected despite limited number or variety of situations experienced.
- Previously-successful solution favored over other available solutions.
- Individual justified action by focusing on biased evidence.

[Retired A3B2C04 – Previous successes in use of rule reinforced continued use of rule – Retirement Note: This cause has been retired because it generally describes a rule-based error involving applicability/validity of

rules in an individual's rules framework, but is too broad to provide a clear basis for understanding the behavior in order to develop effective corrective actions. Multiple new rule-based causes have been provided that may be selected based on the relevant facts of the situation.]

A3 Codes That Could Be Used as Equivalent for Data Analysis:

- Previously-successful solution selected despite limited number or variety of situations experienced.
- Previously-successful solution favored over other available solutions.

[Retired A3B2C05 – Situation incorrectly identified or represented resulting in wrong rule used – **Retirement Note:** Because it employs the term "wrong" with respect to a rule, this cause has been retired as it is too narrow in its description, as well as being vague as to whether an error or a violation has occurred. Several new causes have been provided in both this as well as the A3B4 node that may be selected based on the relevant facts of the situation.]

A3 Codes That Could Be Used as Equivalent for Data Analysis:

- Common indicator chosen over uncommon indicator as basis for course of action.
- Previously-successful solution selected despite limited number or variety of situations experienced.
- Misapplication of rule due to misunderstanding of underlying principles.
- Application of rule without consideration of limitations or risks in dissimilar situations.
- Wrong rule selected during assessment of situation.

A3B3 – Knowledge-based Error

Knowledge-based errors are another type of *mistake*, and occur during response to what is, or has become, a totally unfamiliar situation – no skill, rule, or pattern is recognizable to the individual. These errors occur during continued problem-solving that relies on personal understanding and knowledge of the system, the system's present state, and the scientific principles and fundamental theory related to the perceived situation at hand. Knowledge-based errors can occur in situations where the individual realizes that none of their repertoire of rule-based solutions is adequate to cope with the problem. This is especially true in industrial settings when operators respond to abnormal situations and have realized that further analytical reasoning is needed.

The inability of the individual to pause or stop performance of a task contributes to the probability of a knowledge-based error occurring. For example, in continuous-control tasks, adverse incidents may progress regardless of the actions of operators. On the other hand, with non-paced tasks such as maintenance, a person who encounters a novel situation which requires knowledge-based problem solving is in the position of being able to stop and think about it or refer to a colleague for help.

A3B3C01 – Attention was given to wrong issues – Selective mental processing of information was focused at the wrong features of the situation rather than the correct ones. Often the individual focus was centered around what was perceived to be important instead of what was logically important.

A3B3C02 – LTA conclusion based on sequencing of facts – In interpreting the features/aspects of the situation, the individual drew a conclusion that was biased by either the order in which the facts had been presented and/or processed, or by those aspects that matched their mental model.

A3B3C03 – Individual justified action by focusing on biased evidence – An individual was overconfident in evaluating the correctness of their knowledge. The selection was based on evidence that favored the chosen course of action and any contradictory evidence was overlooked. Known as confirmation bias, the individual is less likely to abandon a current course of action even though there is conflicting information. This bias orients the mind to "see" evidence that only supports the original determination and to ignore conflicting data.

A3B3C04 – LTA review based on assumption that process will not change – The individual believed that no variability existed in the process and overlooked the fact that a change had occurred leading to differing results than normally realized.

A3B3C05 – Incorrect assumption that a correlation existed between two or more facts – Wrong assumptions were made based on the belief that two or more facts are related to each other and incorrect actions were taken based on the assumption.

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

A3B3C06 – Individual underestimated the problem by using past incidents as basis – Individuals tend to oversimplify incidents. Based on stored knowledge of past incidents, the individual underestimated problems with the existing incident and planned for fewer contingencies than were actually needed.

A3B3C07 – Nonconformance with requirements made when person believed it was best feasible option – This cause code encompasses multiple scenarios in which the individual intentionally deviated from expected behavior as specified in operational procedures, formal rules, standards, training, etc., where damaging or adverse consequences occurred but were not intended. The person took the course of action because it was thought to be the best feasible option given the circumstances in which they found themselves.

A3B4 – Work Practices LTA – The individual was unable to, or did not perform, the assigned work as expected.

> **Note:** Be careful in the application of the causes in this subnode. As with the other B-level nodes on this branch, finding the other system-related causes to couple with this code will be essential to fully describing the causes for the situation. On occasion, there may be some form of personal gain associated with this type of behavior. However, it most often occurs that the situation drove

the person to a decision point and they believed that the course of action chosen, though possibly different than prescribed, was the best thing to do in that circumstance. In the pursuit of determining causal factors, it is vital to determine why people did what they did and why it made sense to them at the time. If motives of individuals (or groups/teams) involved in workplace incidents where these types of problems are believed to have occurred are in question, a systematic approach should be used to evaluate the behaviors so as to determine the degree to which the organization is responsible for the behavior vs. the individual (or group/team).

A3B4C01 – Erroneous performance due to limitations of an individual – Task performance was erroneous or unsuccessful due to unrecognized/unknown cognitive, sensory, psychomotor, or physical limitations (e.g., fitness for duty) of the individual. This code should only be used when cause or presence of the limitation has been substantiated by professional evaluation or diagnosis.

A3B4C02 – Intentional Violation – Willful or Deliberate Misconduct that results or could result in damage to property or harm to individuals. The individual acted with the intention of initiating or causing specific consequences that they understood would be unpleasant, disruptive, detrimental, or even damaging to the process, equipment, system, or area involved.

A4 MANAGEMENT PROBLEM

An incident 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/or change management practices. Causal analysis should also consider what A3 human performance codes may be coupled with the codes in this branch to more fully explain how or why the problem occurred.

- **B1 Management Methods Less Than Adequate (LTA)** – Processes used to control or direct work-related facility activities, including how manpower and material was 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.)*

- **B2 Resource Management LTA** – 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 inter-related factors. B2 provides more in-depth causal nodes for evaluating manpower and material issues impacting performance of work-related activities.*

- **B3 Work Organization & 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 addressed in B4.

- **B4 Supervisory Methods LTA** – Causes that can be traced back to the immediate supervision and evaluated 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 be functioning as a supervisor. Problems with other than immediate supervision are coded under B1, B2, or B5 (which does not say that immediate supervision problems cannot be multiple coded under those B nodes).*

- **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.

A4B1C01 – Management policy guidance / expectations not well-defined, understood, or enforced – Personnel exhibited a lack of understanding of existing policy and/or expectations, or policy/expectations were not well-defined or policy/expectation is not enforced.

A4B1C02 – Job performance standards not adequately defined – Measurement of effectiveness could not be performed for a specific job function due to lack of defined standards.

A4B1C03 – Management direction created insufficient awareness of the impact of actions on safety/reliability – Management failed to provide direction regarding safeguards against non-conservative actions by personnel concerning quality, safety, or reliability.

A4B1C04 – Management follow-up or monitoring of activities did not identify problems – Management's methods for monitoring the success of initiatives were ineffective in identifying shortcomings in implementation.

A4B1C05 – Management assessment did not determine causes of previous incident or known problem – Analysis methods failed to uncover the causal factors of consequential or non-consequential incidents.

A4B1C06 – Previous industry or in-house experience was not effectively used to prevent recurrence – Industry or in-house experience relating to a current problem that existed prior to the incident, 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 incident of which the facility had been made aware.

A4B1C07 – Responsibility of personnel not well defined or personnel not held accountable – Responsibility for process elements (procedures, engineering, training, etc.) was not placed with individuals, or accountability for failures of those process elements was not placed with individuals.

A4B1C08 – Corrective action responses to a known or repetitive problem was untimely – Corrective action for known or recurring problem was not performed at or within the proper time.

A4B1C09 – Corrective action for previously identified problem or incident was not adequate to prevent recurrence – Management failed to take meaningful corrective action for consequential or non-consequential incidents.

A4B2C01 – Too many administrative duties assigned to immediate supervisors – 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 their supervisory methods (A4B4). This is related to non-task activities (not actively supervising employees). Task overload is A4B2C02.

A4B2C02 – Insufficient supervisory resources to provide necessary supervision – Supervision resource is less than that 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 is related to too many jobs to be actively supervised at once. Non-task (not actively supervising employees) overload is A4B2C01.

A4B2C03 – Insufficient manpower to support identified goal / objective – Personnel were not available as required by task analysis of goal/objective.

A4B2C04 – Resources not provided to assure adequate training was provided / maintained – Training resources were not available as required by task analysis.

A4B2C05 – Needed resource changes not approved/funded – Corrective actions for existing deficiencies that were previously identified were not approved or funded.

A4B2C06 – Means not provided to assure procedures / documents / records were of adequate quality and up-to-date – A process for changing procedures or other work documents to assure quality and timeliness was nonexistent or inadequate.

A4B2C07 – Means not provided for assuring adequate availability of appropriate materials / tools – A process for supplying personnel with appropriate materials or tools did not exist.

A4B2C08 – Means not provided for assuring adequate equipment quality, reliability, or operability – A process for assuring personnel's equipment was satisfactory did not exist.

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

A4B2C10 – Means / method not provided for assuring adequate quality of contract services – A process for assuring quality contract services was being provided was nonexistent or inadequate.

A4B3C01 – Insufficient time for worker to prepare task – Scheduling of the task did not adequately address the time frame required for accepted worker preparation practices to occur.

A4B3C02 – Insufficient time allotted for task – Scheduled duration of the task did not adequately address known conditions or account for reasonable emergent issues.

A4B3C03 – Duties not well-distributed among personnel – The work loading of individuals within a group/team did not adequately address training, experience, task frequency and duration, or other situational factors such that responsibility was inappropriately distributed.

A4B3C04 – Too few workers assigned to task – 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.

Note: This should be multiple coded under A5B2.

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

A4B3C06 – Planning not coordinated with inputs from walkdowns / task analysis – The job plan did not incorporate information gathered during field visits or task analysis concerning the steps and conditions required for successful completion of the task.

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

A4B3C08 – Job scoping did not identify special circumstances and/or conditions – The work scoping process was not effective in detecting work process elements having a dependency upon other circumstances or conditions.

A4B3C09 – Work planning not coordinated with all departments involved in task – 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 likely not to succeed.

A4B3C10 – Problem performing repetitive tasks and/or subtasks – The workflow plan repeated tasks or subtasks to the detriment of successful completion of the evolution.

A4B3C11 – Inadequate work package preparation – 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.

A4B4C01 – Tasks and individual accountability not made clear to worker – Tasks (and the individual accountability for the task) that were outside written guidance or training were not made clear to the worker.

A4B4C02 – Progress / status of task not adequately tracked – Supervision did not take the appropriate actions to monitor the task progress or status.

A4B4C03 – Appropriate level of in-task supervision not determined prior to task – Supervision did not adequately assess the task for points of supervisory interaction prior to assignment to workers.

A4B4C04 – Direct supervisory involvement in task interfered with overview role – Supervision became so involved with the actual task steps that overall command and control were adversely affected.

A4B4C05 – Emphasis on schedule exceeded emphasis on methods / doing a good job – Accepted standards for methods were not met due to supervision's focus on completing the activity within a certain timeframe.

A4B4C06 – Job performance and self-checking standards not properly communicated – Supervision failed to adequately communicate how standards for job performance and self-checking could be applied to the actual job at hand.

A4B4C07 – Too many concurrent tasks assigned to worker – Supervision failed to detect that concurrent job assignments for an individual exceeded the individual's abilities.

A4B4C08 – Frequent job or task "shuffling" – Supervision transferred a worker from one task to another without adequate time to shift attention away from previous task.

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

A4B4C10 – Assignment did not consider effects of worker's previous task – Supervision did not adequately assess the previous task's impact upon the worker's ability to implement the current task.

A4B4C11 – Assignment did not consider worker's ingrained work patterns – Supervision failed to assess the incompatibility between worker's ingrained work patterns and necessary work patterns for successful completion of the current task.

A4B4C12 – Contact with personnel too infrequent to detect work habit / attitude changes – Supervision was not aware of deviation from desired work habits/attitudes due to lack of interaction with personnel.

A4B4C13 – Provided feedback on negative performance but not on positive performance – Worker's or team's behavior adversely affected by inconsistent or unbalanced feedback, overly or overtly negative feedback, or lack of any positive feedback.

A4B5C01 – Problem identification methods did not identify need for change – Existing problem identification methods did not recognize the difference between actual practices and expectations.

A4B5C02 – Change not implemented in a timely manner – A change in expectations was not realized in practices within an acceptable time period.

A4B5C03 – Inadequate vendor support of change – Management failed to adequately assess the ability of vendors to supply products or services in support of changing expectations for a particular objective.

A4B5C04 – Risks / consequences associated with change not adequately reviewed / assessed – Elements of the process change were not recognized as having adverse impact or increased risk of adverse impact prior to implementing the change.

A4B5C05 – System interactions not considered – Changes to processes or physical systems caused interactions with other processes or physical systems that were not identified prior to implementation.

A4B5C06 – Personnel / department interactions not considered – Changes to processes created new requirements for interaction between personnel or departments that were not considered in the implementation phase of the change.

A4B5C07 – Effect of change on schedules not adequately addressed – Changes to processes that resulted in scheduled changes had effects on personnel or equipment that were not addressed in the change implementation.

A4B5C08 – Change-related training / retraining not performed or not adequate – 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 has not been incorporated, then it is A6B3C03.

A4B5C09 – Change-related documents not developed or revised – Changes to processes resulted in a need for new forms of written communication which were not created or changes to existing documents which were not revised.

> **Note:** See A1B3 for Engineering or Design documents.

A4B5C10 – Change-related equipment not provided or not revised – Changes to processes resulting in a need for new or revised software/hardware that was not provided or revised.

A4B5C11 – Changes not adequately communicated – Changes to processes were not communicated to affected personnel effectively.

> **Note:** This code is for administrative controls. Written Communications (detailed instructions) and Training have their own codes (A5B1C05 and A6B3C03, respectively).

A4B5C12 – Change not identifiable during task – Changes to processes were not distinguishable from the previous process such that personnel did not modify how they performed the process.

A4B5C13 – Accuracy / effectiveness of change not verified or not validated – Verification/validation practices for process changes failed to identify inaccurate or ineffective methods.

A5 COMMUNICATIONS LESS THAN ADEQUATE (LTA)

Inadequate presentation or exchange of information. Note: "Communications" here simply refers to the act of exchanging information. Perspectives from persons on all sides of a communications exchange should be obtained when LTA communication is believed to be causal to the situation being analyzed. Causal analysis should also consider what A3 human performance codes may be coupled with the codes in this branch to more fully explain how the LTA communication resulted.

- **B1 Written Communication Method of Presentation LTA** – Problems with visual attributes of accurate information.
- **B2 Written Communication Content LTA** – Any written document used to perform work such as procedures, work orders, memos, standing orders, manuals, surveillance, etc. *Note: A1B3 should be used for Design/Engineering documentation. Investigation of written communications problems requires a copy of the applicable document(s) for review.*
- **B3 Written Communications Not Used** – Written communication was not used to do the job. Written communication did not exist for the job. Written communication system was required to be used and was 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.*
- **B4 Verbal Communications LTA** –Problem was caused by transmission or receiving of information by voice or signal (e.g., face-to-face, telephone, and radio). *Note: Each individual involved in the occurrence should be questioned regarding messages they feel should have been received or transmitted.*

A5B1C01 – Format deficiencies – The layout of the written communication made it difficult to follow. The format differed from that which the user was accustomed to using. The steps of the procedure were not logically

grouped. Step(s) in the written communication had more than one action or direction to perform. Some step(s) in the written communication stated one action, which in practice actually required several steps to perform.

A5B1C02 – Improper referencing or branching – The written communication referred to an excessive number of additional procedures. The written communication contained numerous steps of the type "Calculate limits per procedure XYZ." The written communication was difficult to follow because of excessive branching to other procedures. The written communication contained numerous steps of the type "If X, then go to procedure ABC. If Y, then go to procedure EFG." References to the different processes and areas contributed to the incident.

Note: This problem generally occurs when the same procedure is used in multiple facilities that have subtle differences.

A5B1C03 – Checklist LTA – 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.

A5B1C04 – Deficiencies in user aids (charts, etc.) – 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.

A5B1C05 – Recent changes not made apparent to user – The written communication required to carry out an action was different from what user was accustomed to doing. The written communication did not identify that the step for this action had been revised. The written communication user performed was the action as the previous revision specified rather than the current revision.

A5B1C06 – Instruction step / information in wrong sequence – The instructions/steps in the written communication were out of sequence.

A5B1C07 – Unclear / complex wording or grammar – Wording, grammar, or symbols failed 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.

A5B2C01 – Limit inaccuracies – Limits were not expressed clearly and concisely. Limits or permissible operating ranges were expressed in a plus-or-minus (±) format instead of absolute numbers.

A5B2C02 – Difficult to implement – Standards, Policies or Administrative Controls (SPAC) were not followed because no practical way of implementing them existed. Implementation would have hindered production.

A5B2C03 – Data / computations wrong / incomplete – The 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.

A5B2C04 – Equipment identification LTA – The equipment identification was too generic. Equipment identification or labeling in the field did not agree with the identification in the procedure.

A5B2C05 – Ambiguous instructions / requirements – 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.

A5B2C06 – Typographical error – A typographical error in the written communication caused the incident.

A5B2C07 – Facts wrong / requirements not correct – 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.

A5B2C08 – Incomplete / situation not covered – 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.

A5B2C09 – Wrong revision used – The wrong revision of the written communication was used.

A5B3C01 – Lack of written communication – Some form of written communication did not exist for the job task being performed.

A5B3C02 – Not available or inconvenient for use – 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).

A5B4C01 – Communication between work groups LTA – 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.

A5B4C02 – Shift communications LTA – Lack of communication between management and the shifts contributed to the incident. Management had not effectively communicated policies to the employees. Concerns of employees were not communicated to management. *Note: 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.*

A5B4C03 – Correct terminology not used – 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 non-standard speech may also present a problem.

A5B4C04 – Verification / repeat back not used – 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.

A5B4C05 – Information sent but not understood – 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. *Note: A related code is Physical Environment LTA (A1B5C02), which addresses noise interference other than speech.*

> **Note:** Communication can be greatly disrupted by ambient sound levels, general noise, whines, buzzes, and the like. 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, thereby making communication very difficult.

A5B4C06 – Suspected problems not communicated to supervision – There was incorrect, incomplete, or other lack of communication between personnel and their supervision. The problem was not communicated to

supervision. Different methods of communication could have been used to help personnel communicate with supervision.

A5B4C07 – No communication method available – 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.

A6 TRAINING DEFICIENCY

An incident or condition that could be traced to a lack of training or insufficient training to enable a person to perform a desired task adequately. Causal analysis should consider what A3 human performance codes may be coupled with the codes in this branch to more fully explain how the training deficiency resulted and/or was not detected during a stage of the training process.

- **B1 No Training Provided** – Lack of appropriate training. Task had not been identified. Task had not been identified for training. Training requirements had not been identified. Training on the task had not been developed. Training had not been conducted.
- **B2 Training Methods Less Than Adequate (LTA)** – Correct training setting was not used. Not enough practice (or hands-on) time allotted. Testing did not adequately measure the employee's ability to perform the task. Task was not identified for refresher training. Training had inadequate instructors and facilities.
- **B3 Training Material LTA** – Program design and objective were incomplete. Job/task analyses were inadequate. Training content was inadequate. Training materials did not adequately address new work methods. Training did not adequately address normal and abnormal/emergency working conditions. Training did not adequately address performance standards for the job/task.

A6B1C01 – Decision not to train – 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 Problem." A6B1 hinges on the Job Task Analysis (JTA). If the JTA was LTA, it is A6B1C01. If the JTA was not completed, it is A6B2C02. If a particular individual's training was waived regardless of the JTA because of assumed experience, it is A6B1C03.

A6B1C02 – Training requirements not identified – 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 Job Task Analysis (JTA). If the JTA was LTA, it is A6B1C01. If the JTA was not completed, it is A6B2C02. If a particular individual's training was waived regardless of the JTA because of assumed experience, it is A6B1C03.

A6B1C03 – Work incorrectly considered "skill-of-the-craft" – 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 have received proper training prior to assignment to this task were not addressed.

Note: A6B1 hinges on the Job Task Analysis (JTA). If the JTA was LTA, it is A6B1C01. If the JTA was not completed, it is A6B2C02. If a particular individual's training was waived regardless of the JTA because of assumed experience, it is A6B1C03.

A6B2C01 – Practice or "hands-on" experience LTA – 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.

A6B2C02 – Testing LTA – 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.

A6B2C03 – Refresher training LTA – 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.

A6B2C04 – Inadequate presentation – 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.

A6B3C01 – Training objectives LTA – 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.

A6B3C02 – Inadequate content – The lesson content did not address all the training objectives. The lessons 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.

A6B3C03 – Training on new work methods LTA – 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 of this code is 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.

A6B3C04 – Performance standards LTA – 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.

A7 OTHER PROBLEM

The problem was caused by factors beyond the control of the organization, including situations involving the discovery of radiological or hazardous materials from legacy operations conducted by prior site-management organizations.

- **B1 External Phenomena** – Incident or condition caused by factors that were not under the control of the reporting organization.
- **B2 Radiological / Hazardous Material Problem** – Incident related to radiological or hazardous material contamination that could not be attributed to any of the other causes.
- **B3 Legacy** – Incident or condition resulting from legacy operations
- **B4 No Cause Is Applicable** – No cause was found for the incident

A7B1C01 – Weather or ambient conditions – Unusual weather or ambient conditions, including hurricanes, tornadoes, flooding, earthquake, and lightning.

> **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 incident did not take into account the effects of weather or ambient conditions on the facility, try Design Input LTA (A1B1), Operability of Design/Environment LTA (A1B5), or Change Management LTA (A4B5).

A7B1C02 – Power failure or transient – 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. If the incident did not take into account the effects of an external power failure or transient on the facility, try Design Input LTA (A1B1), Operability of Design/Environment LTA (A1B5), Management Methods (A4B1), or Change Management LTA (A4B5).

A7B1C03 – External fire or explosion – An external fire, explosion, or implosion.

> **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 incident did not take into account the effects of an external fire or explosion on the facility, try Design Input LTA (A1B1), Operability

of Design/Environment LTA (A1B5), Management Methods (A4B1), or Change Management LTA (A4B5).

A7B1C04 – Other natural phenomena – 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. This is not part of the original ORPS cause codes. It is included here to round out the logic of the CAT. If the incident did not take into account the effects of other natural phenomena on the facility, try Design Input LTA (A1B1), Operability of Design/Environment LTA (A1B5), Management Methods (A4B1), or Change Management LTA (A4B5).

A7B2C01 – Legacy contamination – Radiological or hazardous material contamination attributed to past practices.

Note: This is closer to a "nature of occurrence" rather 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.

A7B2C02 – Source unknown – 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.

A7B3C01 – Legacy issues that are not related to radiological or hazardous material – The cause is a legacy issue but is unrelated to a radiological/hazardous material.

A7B4C01 – No cause is known for this incident – Using appropriate causal analyses, no cause can be determined for occurrence being analyzed.

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ATTACHMENT 3. DEFINITIONS

1. **Apparent Cause** – the most probable cause(s) that explains why the incident happened, that can reasonably be identified, that local or facility management has the control to fix, and for which effective recommendations for corrective action(s) to remedy the problem can be generated, if necessary.

2. **Apparent Causal Analysis** – applies a basic analytical approach to determine the apparent causes of an issue using readily available facts established during a limited investigation. A less formal and rigorous approach than root cause analysis, applied to issues which require analysis to a cause, but are not significant conditions.

3. **Causal Factor** – a condition, action, or discrete, real-time event that existed or took place in the sequence of events leading up to an incident or issue that either led to the incident/issue occurring or significantly influenced its severity or significance.

4. **Contributing Cause** – an event or condition that collectively with other causes increases the likelihood of an incident but that individually did not cause the incident.

5. **Direct Cause** – the immediate events or conditions that caused the incident.

6. **Error** – a general type of human error which was an unintentional deviation from expected behavior:

    a. Skill-based Error – error associated with highly-practiced actions in a familiar situation usually executed from memory without significant conscious thought or with little attention. In terms of failing to achieve the intended goal, the plan was adequate, but the action(s) failed to go as planned.

    b. Rule-based Error – error associated with behavior based on selection of stored rules derived from one's recognition of the situation; it follows an If (symptom X)/Then (situation Y) logic. In terms of failing to achieve the intended goal, actions conformed to the plan, but the plan was inadequate to achieve its intended outcome due to misinterpretation.

    c. Knowledge-based Error – error associated with behavior in response to a totally unfamiliar situation (no skill, rule, or pattern recognizable to the individual). Usually arises as a problem-solving situation that relies on personal understanding and knowledge of the system, the system's present state, and the scientific principles and fundamental theory related to the system. In terms of failing to achieve the intended goal, actions conformed to the plan, but the plan was inadequate to achieve its intended outcome due to an inaccurate mental picture.

7. **Event** – something observable that happened, occurred or resulted in the incident sequence, as well as actions by people, conditions and/or latent organizational weaknesses that existed or developed, which may or may not have been visible or observable at the time their effects were first manifested or

registered. (In this Standard, the resulting outcome that is being analyzed for causes is referred to as an incident, not an event.)

8. **Human Error** – the failure of planned actions to achieve their desired ends. Most human error is the result of unintentional deviations from what was planned or expected, but intentional deviations do also occur which most often were believed to be the best feasible option at the time.

9. **Latent Condition** – an undetected situation or circumstance created by latent errors that are embedded in the organization or production system lying dormant for periods of time doing no apparent harm.

10. **Latent Organization Weakness** – weaknesses resulting from unrecognized, uncorrected latent conditions which become hidden deficiencies in management control processes (such as strategy, policies, work control, training, or resource allocation) or values (shared beliefs, attitudes, norms, and assumptions) creating workplace conditions that can provoke error and degrade the integrity of established barriers.

11. **Root Cause** – Root causes are the causal factors that, if corrected, would prevent recurrence of the same or similar incidents. Root causes may be derived from or encompass several contributing causes. They are higher-order, fundamental causal factors that address classes of deficiencies, rather than single problems or faults. Correcting root causes could not only prevent the same incident from recurring, but would also solve line management, oversight, and management system deficiencies that could cause or contribute to other incidents.

12. **Root Cause Analysis** – a formal, rigorous approach using recognized methodologies to determine the root cause(s) of a workplace incident or other issue.

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