Causal Analysis: An Important Key to Organizational Learning – DOE-STD-1197-2024

EFCOG QA / ISM / CAS Fall 2024 Meeting

Andy Hobbs
Consolidated Nuclear Security (CNS)
Y-12 National Security Complex

Contractor Writing Team Member for
Revision of DOE-STD-1197-2011/2024

Oct. 21-24, 2024

TS

DOE-STD-1197-2024
September 2024

DOE STANDARD

CAUSAL ANALYSIS

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

AREA SAFT

TABLE OF CONTENTS

TITLE PAGE

SUMMARY OF CHANGES. i

FOREWORD. iv

1. INTRODUCTION 1
2. PURPOSE 1
3. APPLICABILITY 1
4. REFERENCES 2
5. INCIDENT INVESTIGATION AND CAUSAL ANALYSIS 2
6. CAUSE CODE SELECTION 17

ATTACHMENT 1. CAUSAL ANALYSIS TREE 1-1

ATTACHMENT 2. CAUSAL ANALYSIS NODE DESCRIPTION 2-1

ATTACHMENT 3. DEFINITIONS 3-1

Objectives of DOE-STD-1197-2024

To understand and identify the causes that contribute to accidents or incidents so those deficiencies can be addressed and corrected to prevent/preclude recurrence

To facilitate the formulation of more effective and consistent causal analyses across the DOE complex:

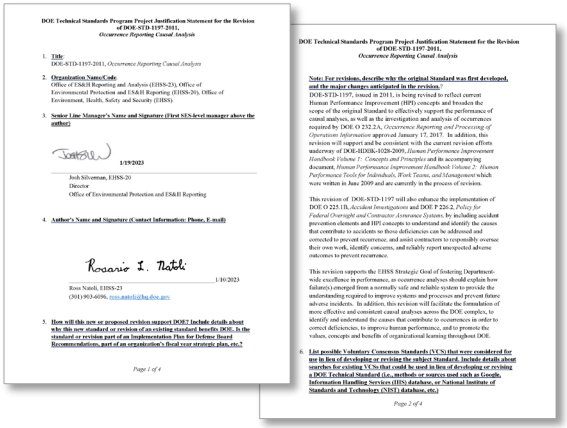
- Identify and understand the causes that contribute to occurrences in order to correct deficiencies
- Improve human performance
- Promote the values, concepts and benefits of organizational learning throughout DOE

(DOE-STD-1197-2024, p. i)

Objectives of the Revision

Project Justification (EHSS-23), Jan. 2023

- 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.
- 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 so those deficiencies can be addressed and corrected to prevent recurrence.


DOE Technical Standards Program Project Justification Statement for the Revision of DOE-STD-1197-2011, *Occurrence Reporting Causal Analysis*

1. Title:
DOE-STD-1197-2011, *Occurrence Reporting Causal Analysis*

2. Organization Name/Code
Office of ES&H Reporting and Analysis (EHSS-23), Office of Environmental Protection and ES&H Reporting (EHSS-20), Office of Environment, Health, Safety and Security (EHSS)

3. Senior Line Manager's Name and Signature (First SES-level manager above the author)

1/19/2023

Josh Silverman, EHSS-20
Director
Office of Environmental Protection and ES&H Reporting

4. Author's Name and Signature (Contact Information: Phone, E-mail)

1/10/2023

Ross Natoli, EHSS-23
(301) 903-6096, ross.natoli@hq.doe.gov

5. How will this new or proposed revision support DOE? Include details about who this new standard or revision of an existing standard benefits DOE. Is the standard or revision part of an Implementation Plan for Defense Board Recommendations, part of an organization's fiscal year strategic plan, etc.?

Page 1 of 4

DOE Technical Standards Program Project Justification Statement for the Revision of DOE-STD-1197-2011, *Occurrence Reporting Causal Analysis*

Note: For revisions, describe why the original Standard was first developed, and the major changes anticipated in the revision.

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 so those deficiencies can be addressed and corrected to prevent recurrence, and assist contractors to responsibly oversee their own work, identify concerns, and reliably report unexpected adverse outcomes to prevent recurrence.

This revision supports the EHSS Strategic Goal of fostering Department-wide excellence in performance, as recurrence analyses should explain how failure(s) emerged from a normally safe and reliable system to provide the understanding required to improve systems and processes and prevent future adverse incidents. 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 recurrences in order to correct deficiencies, to improve human performance, and to promote the values, concepts and benefits of organizational learning throughout DOE.

6. List possible Voluntary Consensus Standards (VCS) that were considered for use in lieu of developing or revising the subject Standard. Include details about searches for existing VCSs that could be used in lieu of developing or revising a DOE Technical Standard (i.e., methods or sources used such as Google, Information Handling Services (IHS) database, or National Institute of Standards and Technology (NIST) database, etc.)

Page 2 of 4

Simple Name Change, Powerful Implications

DOE-STD-1197-2011, *Occurrence Reporting Causal Analysis*

changed to

DOE-STD-1197-2024, *Causal Analysis*

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… 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

Revised Attachment 1 (Causal Analysis Tree) and Attachment 2 (Causal Analysis Node Descriptions)

Updated causal nodes to reflect current, published materials on Human and Organizational Performance Improvement information.

Added Attachment 3 (Definitions)

(DOE-STD-1197-2024, pp. i, ii, iii; emphasis added)

But just who was (were) the somebody (or somebodies), and when did that happen?

The Starting Point

- "Failures are the by-product of normal work."
- "Just finding and highlighting people's mistakes explains nothing. Saying what people did *not* do *does not* explain why they did what they did."
- "Failures can only be understood by looking at the whole system in which they took place."
- "Human error is *not* the conclusion of an investigation. It is the **starting point**."

(Sydney Dekker, *The Field Guide to Human Error* Investigations, Ashgate: 2002, pp. 12, 21, 30, 61)

A Basic Fact and Premise

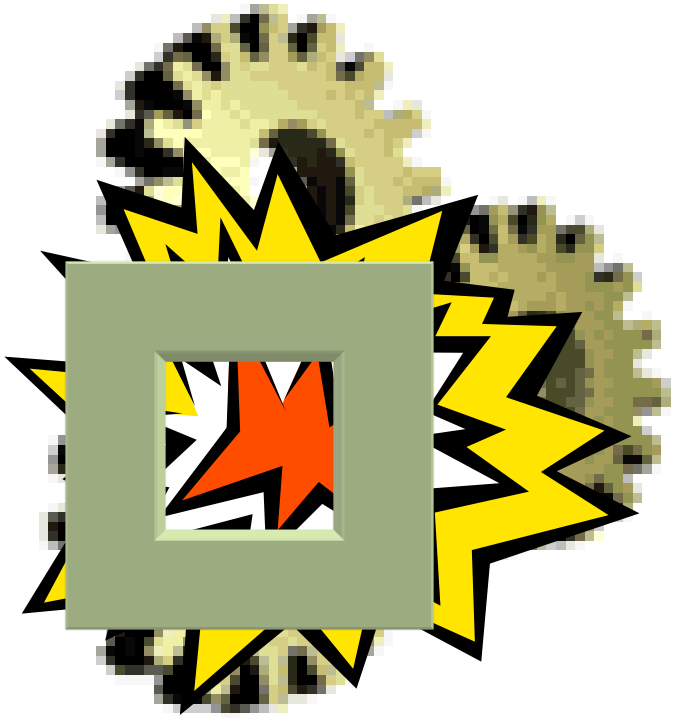
- Learning from our mistakes is a **fundamental** part of human experience.
- On occasion we *may* benefit by learning from *other people's* mistakes.
- But most of the time, **personal** experience with 'failure' is the most impactful and memorable.
- (And that is also why learning from those experiences in ways that enable us to later achieve 'success' are often the most rewarding.)

Some Principles of Organizational Learning

1. The key to improving organizational performance is by improving the performance of the people (humans) who make up the organization. (Tactics that ignore the human contribution will not result in sustained improvement.)
2. Improvement by the organization will only occur if it is a learning organization. (Errors, mishaps, and incidents are viewed as opportunities to learn by both management and workers alike, not reasons to punish the humans directly involved in the incident.)
3. Learning occurs when there is an organizational culture that promotes the open reporting and discussion of errors when they happen. (It is understood that those committing the errors will be treated justly and fairly, and that “it takes an organization” to make an accident).
4. True improvement in organizational performance will take place when efforts are taken as a normal part of doing business to both anticipate and prevent errors before they occur as well as learning from them after they occur.
5. Sustained improvement will only be achieved if workers continue to see by management’s actions that it remains committed to principles 1 through 4.

Windows of Opportunity

- We need to cultivate a continuous learning environment.
- Even small ‘failures’ need to be viewed as *windows* into systems that can spur learning.
- Incidents will happen. We can choose to learn now or we will likely be forced to learn later.



Causal Analysis: An Important Key to Org. Learning

- While we strive diligently to try to prevent incidents from occurring, sooner or later they will occur.
- If we see them as something other than opportunities to learn, grow, and improve…
- …if we are not poised to respond to these opportunities in a manner that maximizes learning at all levels…

Causal Analysis: An Important Key to Org. Learning

- …if we focus only on the “hardware” and ignore the human contribution (both positive and negative)…

- …if we are not adept at using methods and tools by which we can examine ourselves and come to understand what has now been exposed about our systems and processes…

… then, we cannot expect to be successful at preventing those incidents from recurring, or having sustained improvement in our performance.

Approaches to Managing Human Error

- We typically address human error by its type (form) and by temporal perspective.

Temporal Perspective

Before Error Occurs (Proactively)	After Error Occurs (Reactively)
Identify *potential* error precursors for this job	Identify *actual* error precursors and related facts
Identify error-likely situations for this job	Find reasons why people did what they did and why it made sense to them at the time
Select error mitigation tools and error prevention tools	Identify active and latent errors that occurred
Manage defenses in depth (layers of barriers)	Examine systems, processes, and defenses for weaknesses
Foster a culture that openly talks about errors when they occur	
Be a learning organization	

Causal Analysis: An Important Key to Org. Learning

Performed to determine causes [*after*] a workplace incident or other issue [has occurred], using a graded approach based on the significance of the incident or issue.

Can **also** be used to determine why causal conditions were not discovered sooner, or why any deficiencies in the response to the incident occurred.

May **also** identify [other] 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.

(DOE-STD-1197-2024, p. 2, emphasis added)

HPI Principles/Concepts in Causal Analysis

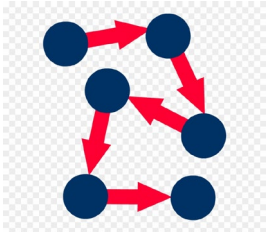
- Q: When an error is identified in the incident sequence, why is identifying the 'type' of error important?
- A: We need to first understand:

  what the error was, the nature of the error, and how, when, and why that type of error would and does occur,

  → which tells us about how the people involved contributed to the incident and why they did what they did,

  → which then points us to parts of the system/process that either prompted the error, contributed to the error, or failed to anticipate, prevent, or mitigate it,

  → which then informs us of what we need to change in the system/process (either by prevention or correction).



HPI Principles/Concepts in Causal Analysis

- Q: Why is it important to search for the errors that led to implementation inadequacies, process inconsistencies, and weaknesses in barriers/defenses?
- A: Since buildings, equipment, tools, processes, and systems don't create themselves, we need to understand

→ what the nature of the inadequacy, inconsistency, or weakness was,

→ which prompts us to find how it came to exist,

→ which in turn points us to the people who designed, made, operated, monitored, maintained, repaired, adjusted, etc., those things,

→ which in turn leads us to find the errors they made when they did so…

…and perhaps why we didn't discover it until now – or why we didn't address it if we *did* know.

HPI Principles/Concepts in Causal Analysis

- Q: How does understanding performance modes and how various types of errors occur help us?
- A: Understanding the type of error gives us a basis for:

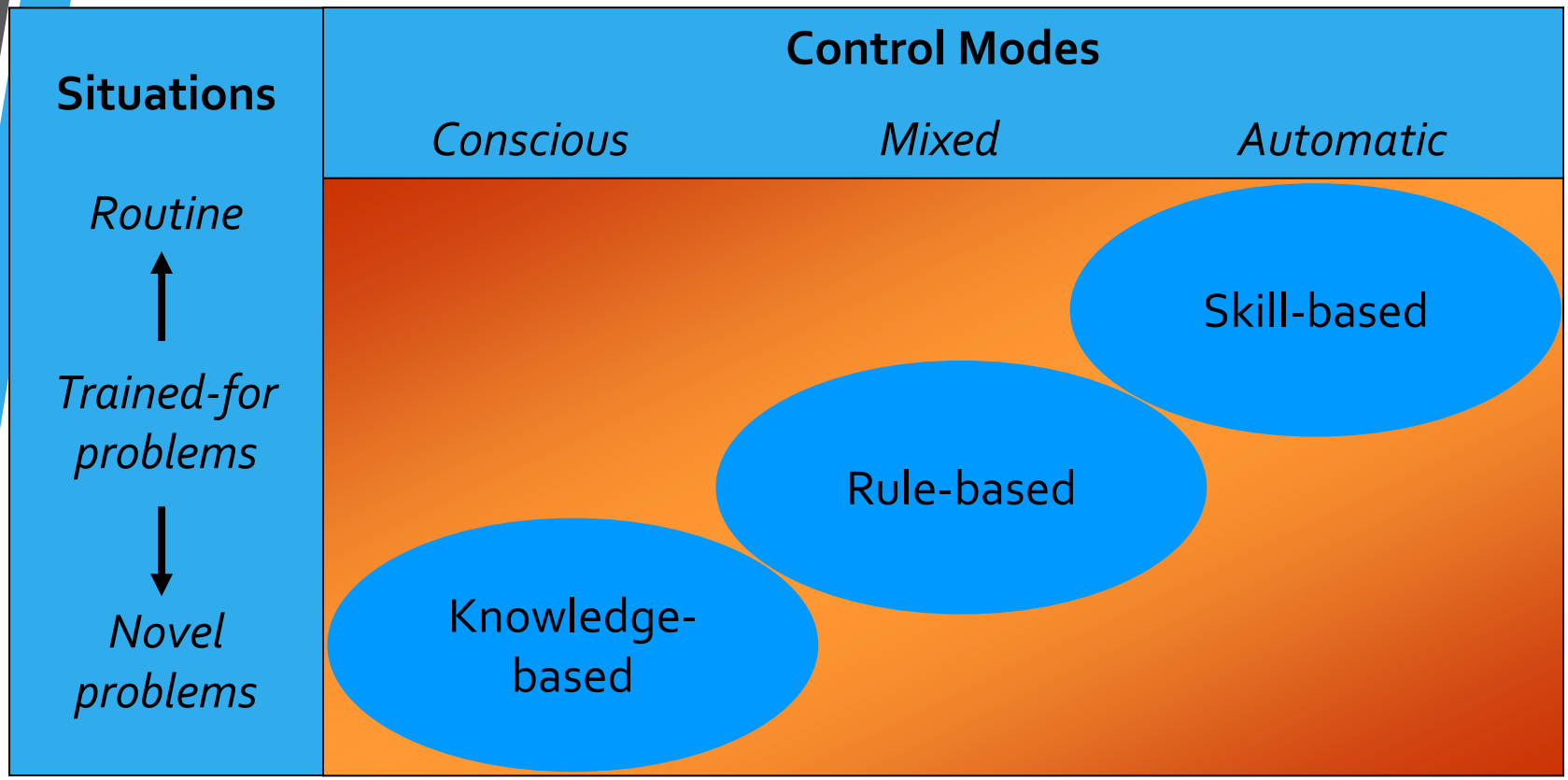
  how to address the error and what addressing it will likely entail, depending on the person's/people's:

  - stage/level of proficiency or task mastery,
  - understanding of all relevant factors,
  - assessments and assumptions made,
  - degree of autonomy, level of oversight, supervision, etc.

  and the situation's

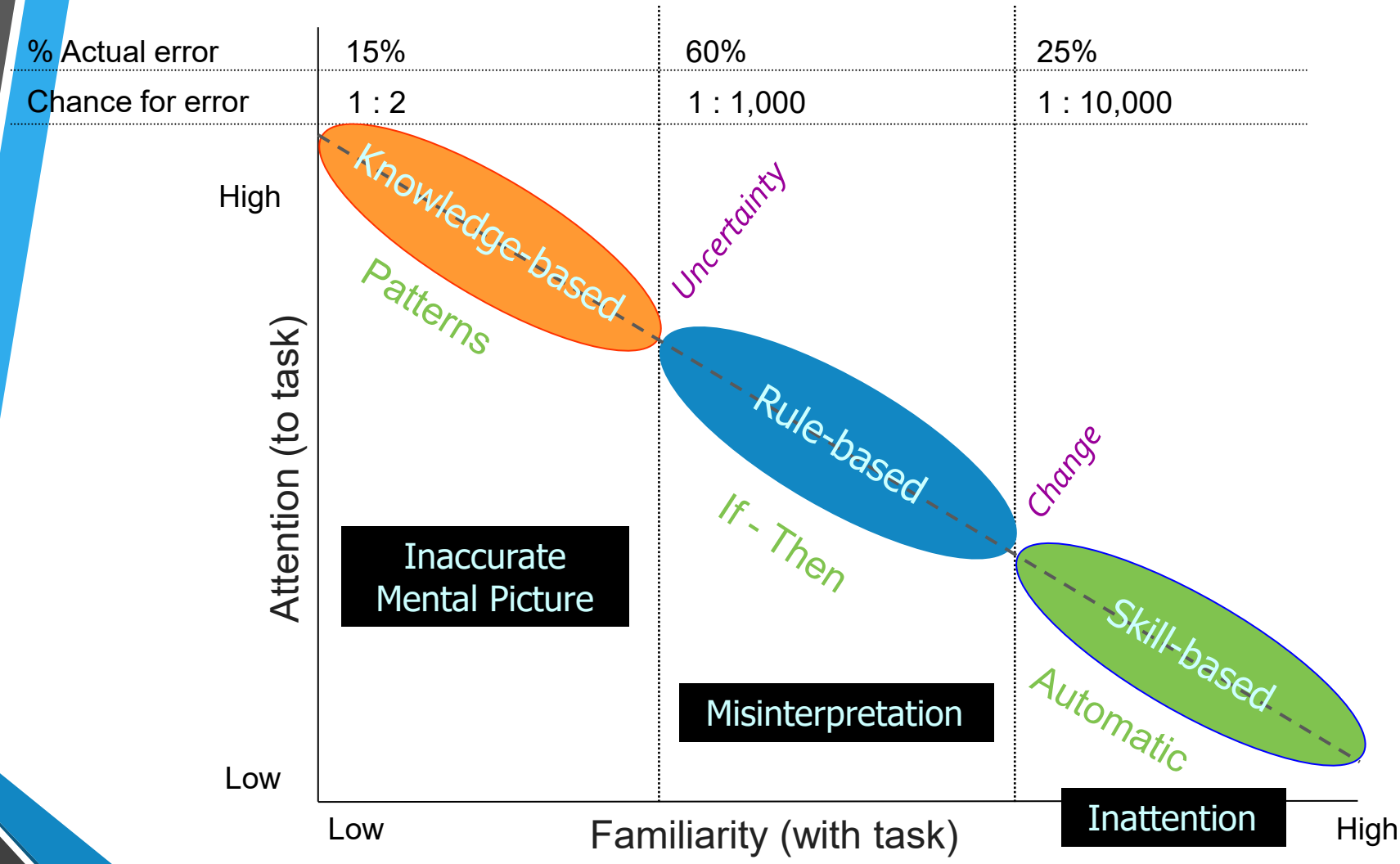
  - circumstances, and how they varied from prior ones,
  - appearance to the person/people involved, etc.

Three Levels of Performance (When Learning)



Skill-based – routine, highly-practiced task carried out automatically with occasional conscious checks on progress
Rule-based – switched to because of change in situation; applies rules on an *if-then* basis
Knowledge-based – resorted to when rule-based fails (no rule applies); trial and error

Performance Modes (Task Mastery Achieved)



What are the most common corrective actions?

- Revise the procedure
- Retrain the workers
- Increase supervision/oversight

Why?

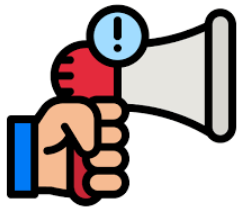
Could it be because we don't really know *what* to fix?

HPI Principles/Concepts in Causal Analysis

- For example:

> **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. (DOE-STD-1197-2024, Att. 2, pp. 2-10)

- That means, if it was a skill-based error, the person knew what to do, and is very adept at it, but for some reason, did not do what they intended to do.
- So, what good will re-training the person really do?



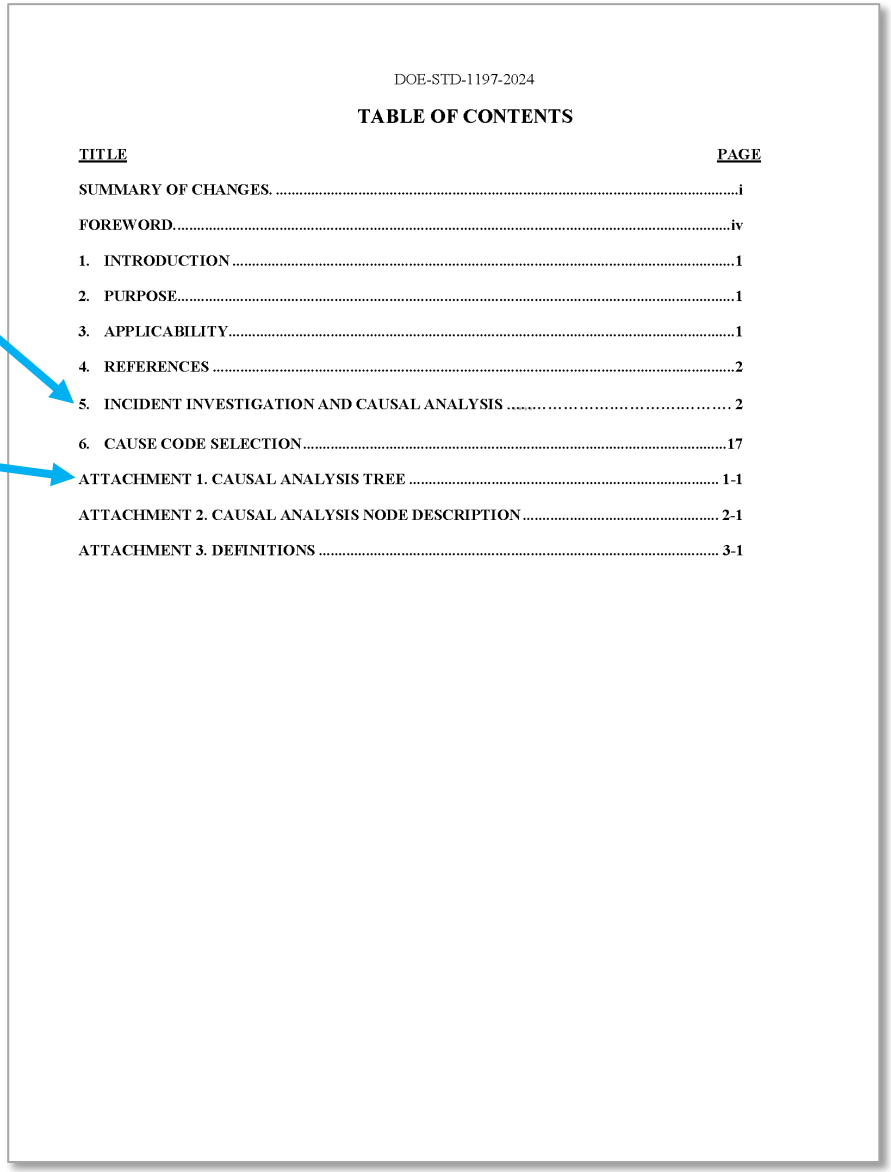
Workplace Situations

- No situation is exactly the same. While a task may be performed frequently, each time there will be some variation in the conditions that exist. The differences are often minor from one instance to another, but a situation may arise that interrupts the modes of performance and drives conscious decisions.
- In a number of different scenarios (including troubleshooting, off-normal or emergent situations), a person may take "a course of action because it was thought to be the best feasible option given the circumstances in which they found themselves." (DOE-STD-1197-2024, Att. 2, p. 2-18)
- "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." (DOE-STD-1197-2024, Att. 2, p. 2-18, 2-19)
- Humans are logical creatures. 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*.

The Standard's Essential Parts

- Commonly-used analysis methods/tools
- Cause Tree (with standardized cause codes)

All the rest is supporting instruction and guidance.



DOE-STD-1197-2024

TABLE OF CONTENTS

TITLE	PAGE
SUMMARY OF CHANGES.	i
FOREWORD.	iv
1. INTRODUCTION	1
2. PURPOSE	1
3. APPLICABILITY	1
4. REFERENCES	2
5. INCIDENT INVESTIGATION AND CAUSAL ANALYSIS	2
6. CAUSE CODE SELECTION	17
ATTACHMENT 1. CAUSAL ANALYSIS TREE	1-1
ATTACHMENT 2. CAUSAL ANALYSIS NODE DESCRIPTION	2-1
ATTACHMENT 3. DEFINITIONS	3-1

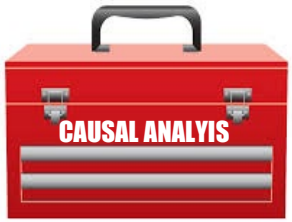
Commonly-Used Analysis Methods/Tools

- Anatomy of an Event Model
- Barrier Analysis
- Events and Causal Factor Chart
- Change Analysis

Table summarizing when to use, advantages, disadvantages, and remarks for each of the 4 methods

Section on each method provides detailed description of the theory behind it and the approach it takes, how it is performed/used, with examples for most

Brief summary of 9 other methods that are also often used



Method/Tool Example: Barrier Analysis

Theory

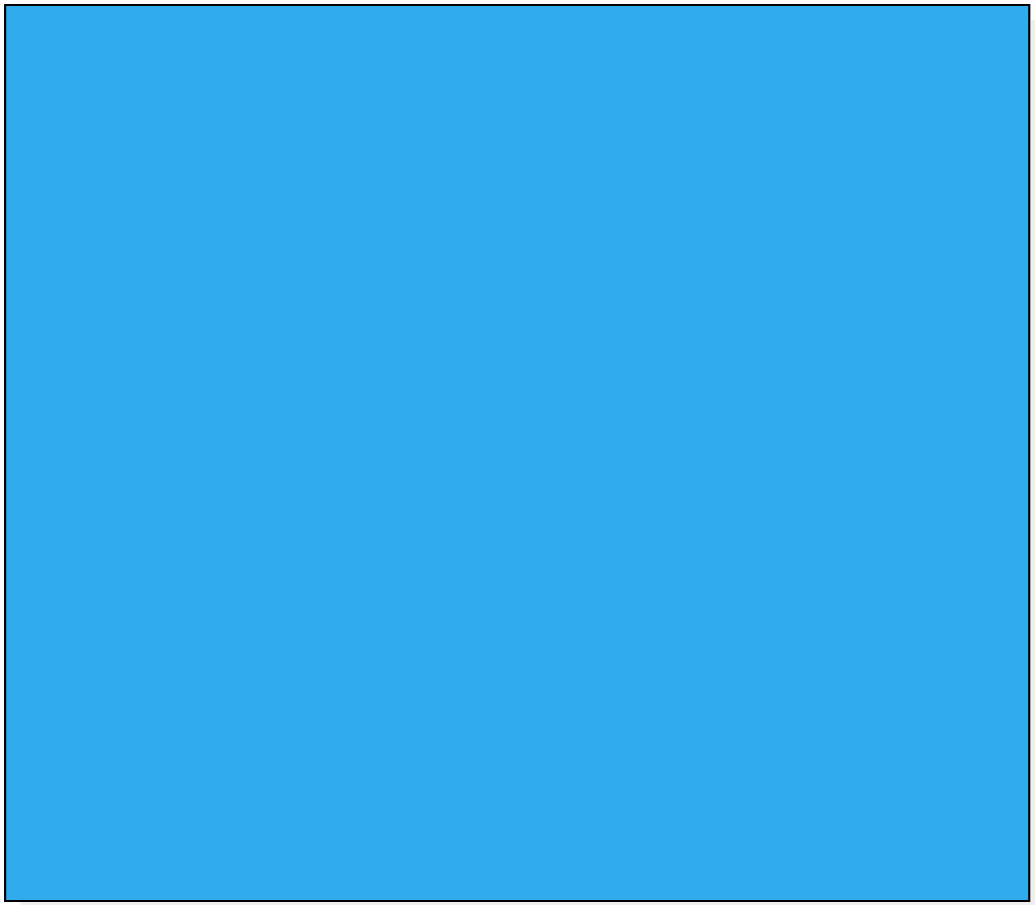
Barrier Analysis is based on the premise that incidents can result from any work process. Barriers are developed and integrated into a system or work process for multiple reasons, including protection of personnel from hazards, protection of equipment and assets, to ensure quality of products, as well 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.

(DOE-STD-1197-2024, pp. 7, 8)

Method/Tool Example: Barrier Analysis (contd.)

Theory

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….



(DOE-STD-1197-2024, p. 8)

Method/Tool Example: Barrier Analysis (contd.)

Theory

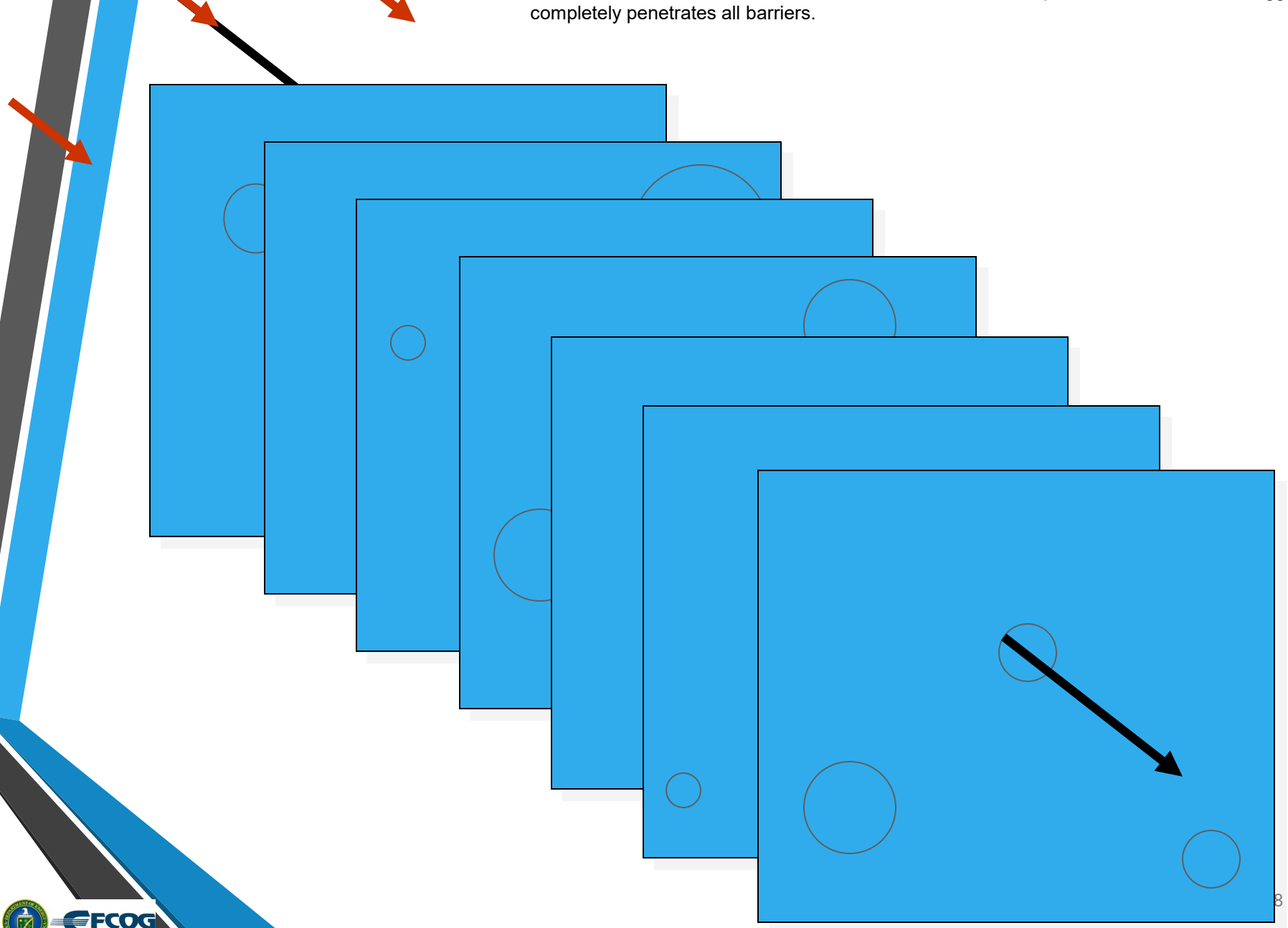
… Therefore, continuing with the visualization, ***the purpose of causal analysis is*** to determine where the holes are; what they consist of; why the holes are there in the first place; why the holes change over time, both in size and location; and how the holes came to "line up" (in this graphic) to produce the incident.

Click to go to animation

(DOE-STD-1197-2024, p. 8, emphasis added)

Local triggers

1st Click: The first barrier stops the trigger, although one hole was narrowly missed.
2nd Click: Holes appear, move and grow. The trigger penetrates a few barriers but is still stopped.
3rd Click: More fluctuation in the barriers occurs. Holes line up this time such that the trigger completely penetrates all barriers.



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

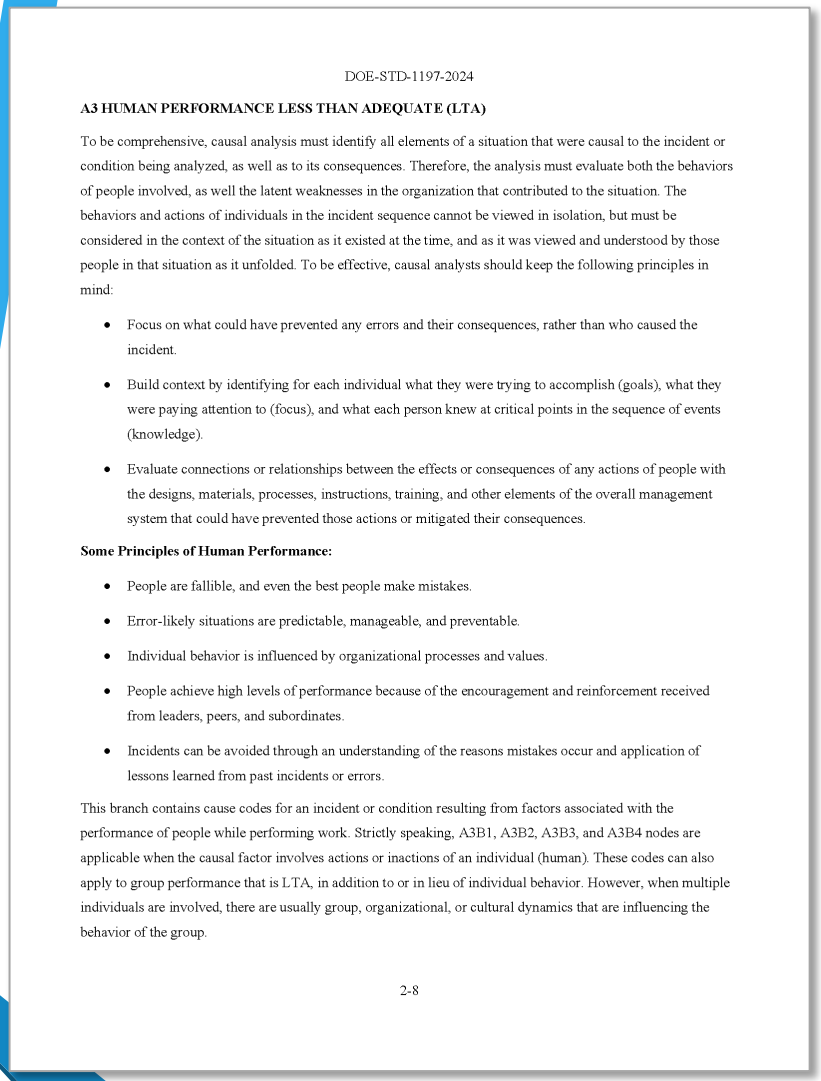
Level A nodes are underlined.

Level B nodes are in ALL CAPS.

Level C nodes are in "Sentence case."

LTA – Less than adequate

A3 Human Performance LTA



DOE-STD-1197-2024

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.

2-8

(DOE-STD-1197-2024, Att. 2, pp. 2-8 thru 2-10)

- 2.5-page introduction providing background and supporting theory for B and C nodes within A3 branch
- Guidance on “coupling”
- Guidance on mapping of retired codes for trending
- For retired codes, explanation of why code was retired also provided

A3 Human Performance LTA

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.

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

B1 SKILL-BASED ERROR

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.

B2 RULE-BASED ERROR

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.

B3 KNOWLEDGE-BASED ERROR

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.

B4 WORK PRACTICES LTA

(DOE-STD-1197-2024, Att. 1. *Causal Analysis Tree*, p. 1-1)

(DOE-STD-1197-2024, Att. 3. *Definitions*, pp. 3-1, 3-2)

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

- ½-page intro. to skill-based performance
- Codes A3B1C08 thru A3B1C14 added
- A3B1C01 thru A3B1C07 retired (removed from tree, but codes and guidance for mapping provided in node description)

(DOE-STD-1197-2024, Att. 1, p. 1-1, and Att. 2, pp. 2-10 thru 2-13)

A3 Human Performance LTA

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

- ½-page intro. to rule-based performance
- Codes A3B2C06 thru A3B1C15 added
- A3B2C01 thru A3B2C05 retired (removed from tree, but codes and guidance for mapping provided in node description)

(DOE-STD-1197-2024, Att. 1, p. 1-1, and Att. 2, pp. 2-13 thru 2-17)

A3 Human Performance LTA

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

- ½-page intro. to knowl-edge-based performance
- Code A3B3C07 added
- No codes retired (but additional explanation added to description for some codes)

(DOE-STD-1197-2024, Att. 1, p. 1-1, and Att. 2, pp. 2-17, 2-18)

A3 Human Performance LTA

B4 WORK PRACTICES LTA

C01 Erroneous performance due to limitations of an individual

C02 Intentional violation

- Introductory note expanded
- Codes A3B4C01 and A3B4C02 renamed
- Descriptions for both codes fully revised

(DOE-STD-1197-2024, Att. 1, p. 1-1, and Att. 2, pp. 2-18, 2-19)

Linking the CAT Branches

Guidance added to other nodes to facilitate coupling with A3 node, so that a complete “picture” of the cause may be captured. This provides for getting beyond apparent causes.

A1 Design / Engineering Problem

… 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.

A2 Equipment / Material Problem

… Causal analysis should consider what A3 human performance codes may be coupled with the codes in this branch to more fully explain 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.

A6 Training Deficiency

… 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 training deficiency resulted and/or was not detected during a stage of the training process, etc.

Linking the CAT Branches (contd.)

Some A3 cause codes prompt the analyst to consider contributing factors that lie in other branches of the CAT.

A3B2C15 – Wrong rule selected during assessment of situation – … 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.

A3B3C07 – Nonconformance with requirements made when person believed it was best feasible option – … as specified in operational procedures, formal rules, standards, training, etc., …

…

→ which in turn points us to the people who designed, made, operated, monitored, maintained, repaired, adjusted, etc., those things,

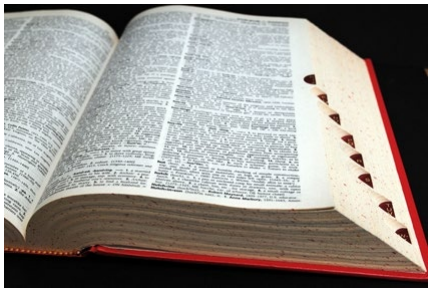
→ which in turn leads us to find the errors they made when they did so.

Attachment 3. Definitions

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

- Provides definitions of 12 key terms, some formerly in footnotes
- Provides continuity with referenced orders



The Central Message

… 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 (p. i)

Incident investigations and causal analyses are important ***learning opportunities*** that present themselves following an accident or incident… (p. 2)

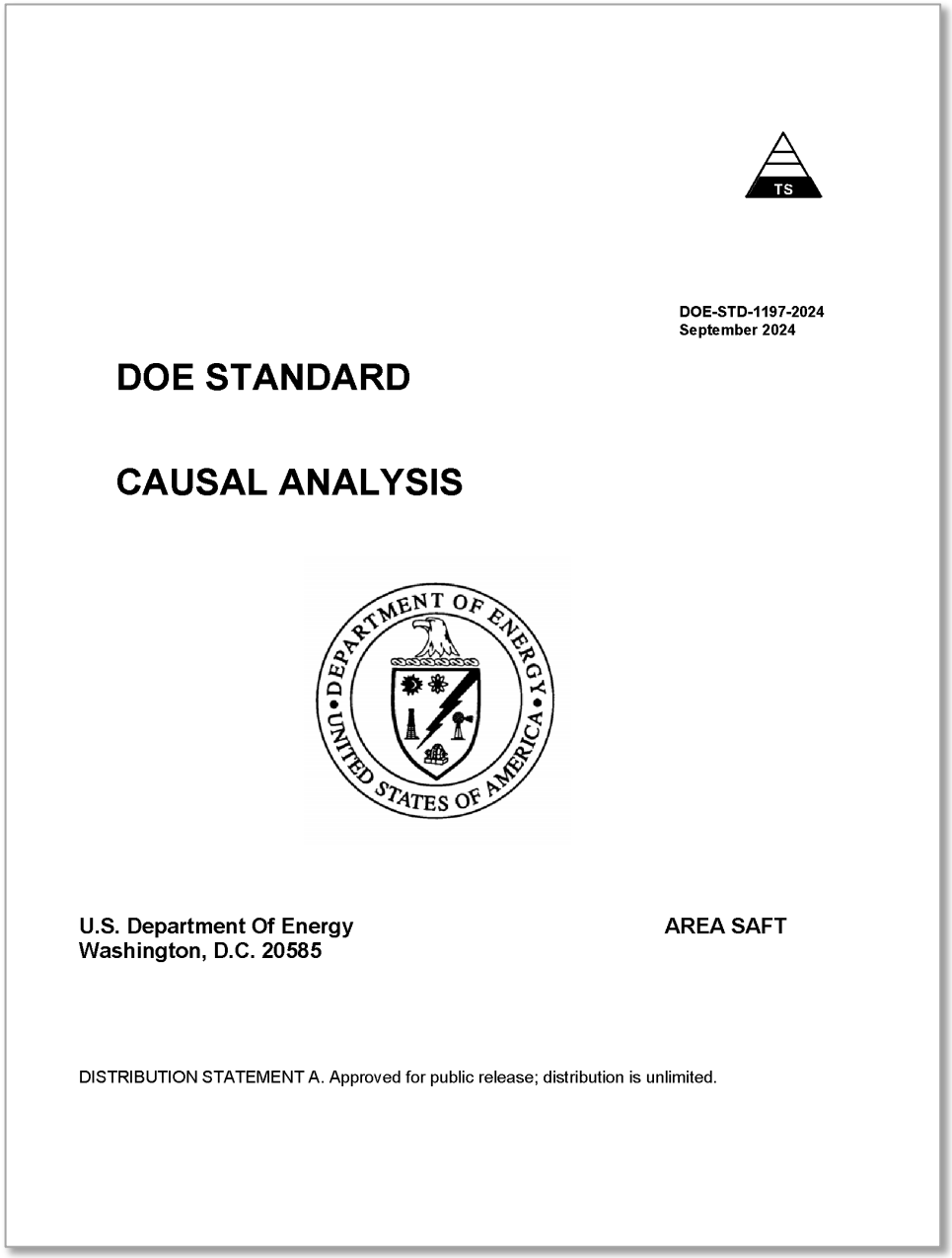
Why perform causal analysis? … Fosters a ***learning organization*** by evaluating and sharing… (p. 3)

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…. (p. 7)

Now Available!

Act now to get your own free copy today at the DOE Technical Standards website.

https://www.standards.doe.gov/


TS

DOE-STD-1197-2024
September 2024

DOE STANDARD

CAUSAL ANALYSIS

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

AREA SAFT

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

Supplemental Information

Objectives of Including HPI Principles

- By including accident prevention elements and HPI concepts:
  - to understand and identify the causes that contribute to accidents so those deficiencies can be addressed and corrected to prevent recurrence,
  - and assist contractors to responsibly oversee their own work
  - identify concerns, and
  - reliably report unexpected adverse outcomes to prevent recurrence.

  (DOE-STD-1197-2024, p. i)
- Changes made throughout to:
  - Make links/connections between sections of the standard and branches of the CAT.
  - Provide enough explanation to enable analyst to understand cause codes so they will know when to select them.

Objectives Met

- Project goal was to include human performance concepts so as to understand and identify the causes that contribute to incidents so those deficiencies can be addressed and corrected to reduce risk of recurrence.
- Expanded standard to include guidance on investigation, causal analysis, and analysis methods.
- Revised standard will effectively support the performance of causal analyses, as well as the investigation and analysis of occurrences in the DOE complex, as well as by many other industries who also use this standard.

Examples and Potential CAs Removed

… 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.

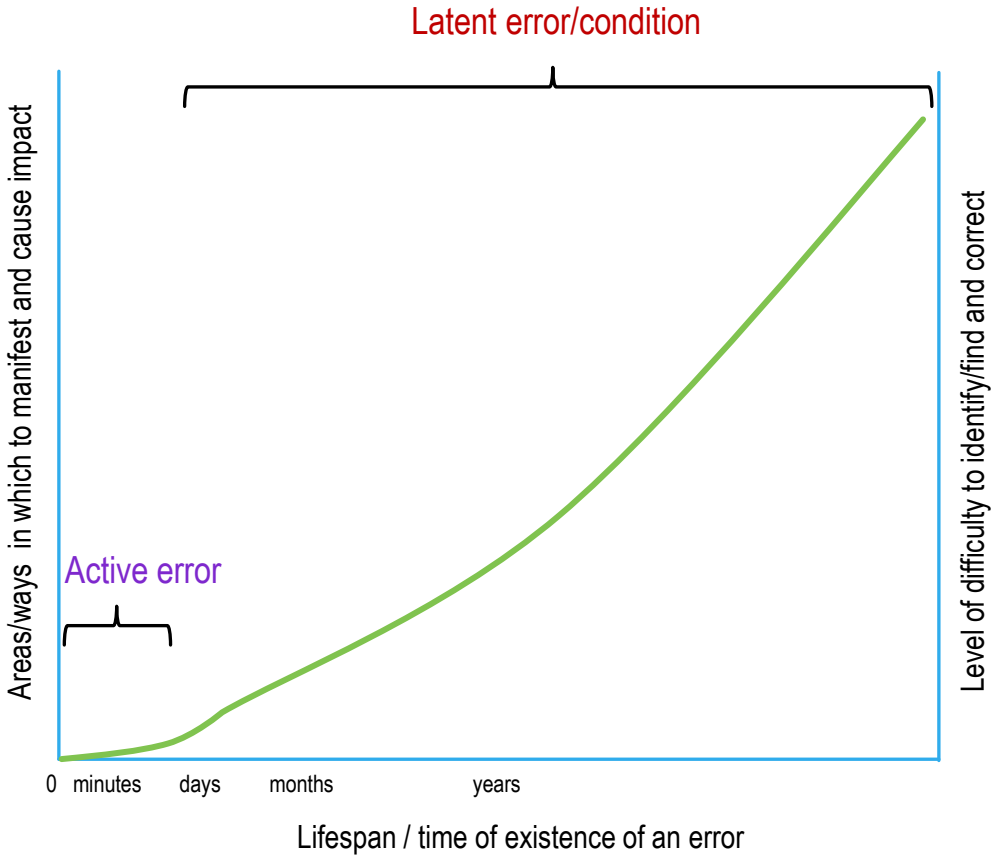
(DOE-STD-1197-2024, p. ii)

Active and Latent Errors

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. (DOE-STD-1197-2024, p. 6)

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. (DOE-STD-1197-2024, Att. 3, p. 3-2)

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. (DOE-STD-1197-2024, Att. 3, p. 3-2)



DOE-STD-1197-2024