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Title: OSH-PI-SAT-001 (Course Number – 33627) Human Performance Improvement for Practitioners

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Lesson Plan

Organization Name
ALDESHQSS

Course Title
Human Performance Improvement for Practitioners

Course Number
33627

Revision Number
3

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TITLE PAGE

Course Title Human Performance Improvement for Practitioners

Course Number: 33627

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Course Length: 16 Hours

Lesson Plan Originator: Michael Petrowski

Initial Date of Preparation: 8/02/2016

Date of Revision(s)

- Revision 1: 9/29/2016
- Revision 2: 4/19/2018
- Revision 3: 10/01/2019

Date of Next Review

10-01-2021

Training Setting

Classroom

Target Audience

These courses are intended for all HPI practitioners at LANL. After the initial pilot deliveries, these course will either be mandated by an institutional qualification standard or required by institutional policy. The target audience would be similar to that receiving any SI-ITS training. Education and experience levels will vary greatly, and the audience will have a variety of organizational norms from various organizations across LANL.

Optimum Training Location

TBD

INSTRUCTIONAL GOAL AND OBJECTIVES

TERMINAL OBJECTIVE:

Throughout this module, trainees will gain awareness-level knowledge of basic, introductory HPI concepts and apply that knowledge to various instructor-provided scenarios, receiving feedback from other attendees and the instructor.

- ***Enabling Objective 1:*** *Trainees will gain awareness level knowledge of the terms and definitions of HPI.*
    - *What is HPI (Terms and Definitions)*
    - *ISM Core Functions and how they relate to HPI*
    - *Origins of Events*
    - *A Strategic Approach*
    - *Principles of Human Performance*

- ***Enabling Objective 2:*** *Throughout this module, trainees will gain awareness-level knowledge of HPI concepts*
    - *Human Fallibility and Vulnerability*
    - *Performance Modes*
    - *Error-Likely situations*

- ***Enabling Objective 3:*** *Throughout this module, trainees will gain awareness-level knowledge of HPI Error Prevention Tools and techniques*
    - *Individuals*
    - *Teams*
    - *Management*

- ***Enabling Objective 4:*** *Throughout this module, trainees will gain awareness-level knowledge of Managing Controls and Defenses*
    - *Strategic Approach and Desired Results*
    - *Key Leadership Practices*
    - *Employee Engagement*
    - *Learning Teams*
    - *Reducing Errors*
    - *Defense in Depth*
    - *Investigating Events - Case Studies*

EVALUATION TECHNIQUES AND PROCEDURES

Trainees will be informally evaluated using various scenarios delivered throughout each of these modules. They may be videos, paper scenarios, etc. There is no formal course evaluation other than the Level I trainee reaction form. Attendance constitutes completion.

ITEMS AND MATERIALS

Instructor Materials:

- PowerPoint presentations (with instructor notes)
- HPI Practitioner description (enclosed)
- Scenarios, Exercises, and Case Studies
    - GEMS EXERCISE – Determine the performance mode: Skill, Rule or Knowledge
    - Tenerife CASE STUDY – View video to identify error precursors
    - Defense-In-Depth EXERCISE
    - EXERCISE: Pick the individual HPI tool for the condition
    - EXERCISE: Pick the team HPI tool for the condition
    - EXERCISE: Pick the management HPI tool for the condition
    - Observation ACTIVITY – Basketball teams & Gorilla
    - Therac 25 CASE STUDY (enclosed)
    - Culpability EXERCISE (enclosed)
- Level I evaluations
    - Case Study: Therac 25 student response guide (enclosed)

Student Materials:

- Trainees do not need to bring any materials to class. All materials are instructor-provided.
- Power Point handout (with "Defense-In-Depth" answer slide hidden and student slide included)
- DOE-HDBK-1028-2009 - Human Performance Improvement Handbook, Volume 1, Concepts and Principles
- DOE-HDBK-1028-2009 - Human Performance Improvement Handbook, Volume 2, Human Performance Tools
- LANL Human Performance Reading List (Obtained from HPI webpage)
- End of Course Evaluation (Feedback) form
- Culpability Decision Tree Exercise – Instructor hands out for exercise
- Therac 25 Case Study – Instructor hands out for case study

SAFETY/SECURITY RESTRICTIONS AND REQUIREMENTS

"Classroom environment with no safety/security documentation required"

OUTLINE OF ACTIVITIES

NOTE:
Each module has instructor notes embedded into the PowerPoint presentation. Use these notes as additional information, reference material, and as necessary to facilitate the presentation.

NOTE:
Unless otherwise specified, "DOE volume 1 or 2" references DOE-HDBK-1028-2009 - Human Performance Improvement Handbook

1. **Introduction**
    a. Classroom Protocols (Before we start)
        i. In case of an emergency
        ii. Introductions

iii. Classroom protocols
iv. Training material

b. HPI Practitioner (What is a HPI Practitioner at LANL)
c. Review Course Objectives
d. HPI at LANL - DOE Vol 1 Preface

2. DOE Volume 1, Chapter 1: Introduction to Human Performance

a. Overview
   i. Human Performance - DOE Vol 1 Pg. 1-1 and 1-12
      1. What is HPI
      2. Performance = Behaviors + Results
   ii. Integrated Safety Management System - DOE Vol 1, Pg. 1-2 thru 1-9
      1. ISM Core Functions <u>and</u> HPI - DOE Vol 1, Pg. 1-4
      2. Define the Scope of Work - DOE Vol 1 Pg. 1-6
      3. Analyze the Hazards - DOE Vol 1 Pg. 1-7
      4. Develop and Implement Hazard Control - DOE Vol 1 Pg. 1-7
      5. Performance Work within Controls - DOE Vol 1 Pg.1-8
      6. Provide Feedback and Contiguous Improvement - DOE Vol 1 Pg. 1-9
      7. ISM at LANL: Integrated Safety management Webpage and SD100
      8. Human Performance can affect each stage of the ISM Work Process
   iii. What is really causing events (Organizational vs individual) - DOE Vol 1 Pg. 1-10
b. Anatomy of an Event - DOE Vol 1 Pg. 1-14
c. Strategic Approach ($R_e + M_c \rightarrow \Phi E$) - DOE Vol 1 Pg. 1-16
   i. Reducing Error (R_e)- DOE Vol 1 Pg. 1-16
   ii. Managing Controls (M_c) - DOE Vol 1 Pg. 1-17
d. Principles of Human Performance
   i. People are fallible, and even the best people make mistakes - DOE Vol 1 Pg. 1-19
      1. PRIMARY Story and/or Video
         a. VIDEO: When Good Alligators Go Bad
         b. **https://www.youtube.com/watch?v=cwemXuIHyVM&t=872s**
         c. An alligator trainer gets his head caught in a gator's mouth during his grand finale.
         d. Message: There are dangers is your work location that you feel confident working with/around. Your experiences and knowledge are applied in a manner that makes you successful in the dangerous environment. You know the do's and don'ts. However, sometimes, a mistake happens and a consequence occurs.
      2. Other Options
         a. Why We Make Mistakes and how we can avoid them (8:52, Good message from CBS Sunday Morning)
      3. So why are we fallible – Human Nature
   ii. Error-likely situations are predictable, manageable, and preventable - DOE Vol 1 Pg. 1-19
      1. PRIMARY Story and/or Video
         a. VIDEO: 2017 Lexus commercial
         b. https://www.youtube.com/watch?v=2Ix_3872Rs4
         c. Message: Nobody's perfect. That's why the Lexus RX comes with our most advanced safety features—standard. Experience it now, at your Lexus dealer.
      2. Other Options

a. A Gator Bite to the Head is No Joke | Gator Boys (3:50, another alligator head chomp video)

iii. Individual behavior is influenced by organizational processes and values - DOE Vol 1 Pg. 1-19
1. PRIMARY Story and/or Video
a. Prudential: Everybody's Doing It (2:31, Elevator behavior experiment) https://www.youtube.com/watch?v=BgRoiTWkBHU
b. Candid Camera actors in an elevator cause unknowing participants to follow their lead. People will conform to the behaviors of those around them.
2. Other options:
a. Things That Influence Your Everyday Behavior (2:24, good examples of behavior being influenced)
b. Top motivational speaker Jeff "Odie" Espenship on Leaders Influence behaviors of others (1:52, value of leadership influence)
c. Peer Influence and Adolescent Behavior (4:04, inherent rewarding of peers changes behaviors – more risk taking)

iv. People achieve high levels of performance based largely on the encouragement and reinforcement received from leaders, peers, and subordinates - DOE Vol 1 Pg. 1-20
1. PRIMARY Story and/or Video
a. The Power of Positivity | Brain Games - See firsthand how positive and negative reinforcement can affect a player's game on the court.
b. https://www.youtube.com/watch?v=kO1kgl0p-Hw
2. Other options:
a. encouragement! (0:54, kid plays piano with concert pianist)
b. https://www.youtube.com/watch?v=zb8U3l9XHdY

v. Events can be avoided through an understanding of the reasons mistakes occur and application of the lessons learned from past events (or errors) - DOE Vol 1 Pg. 1-20
1. PRIMARY Story and/or Video
a. 02 | How We Can Learn From Incidents (3:46, Swiss Air Force Investigations: why it made sense to that person, applying lessons learned, improving margin of safety) https://www.youtube.com/watch?v=NaXE5pbLI0E
b. Swiss Air video that explains principle #5
2. Other options:
a. Mistakes to Avoid as a Beginner Photographer (3:52)

vi. Review "Principles of Human Performance"

3. **DOE Volume 1, Chapter 2: Reducing Error**
a. Human Fallibility and Vulnerability
i. Examples of Fallibility and vulnerability – Phrase recall exercise
ii. Common traps of Human Nature - DOE Vol 1 Pg. 2-1
1. Stress - DOE Vol 1 Pg. 2-1
2. Avoidance of Mental Strain - DOE Vol 1 Pg. 2-2
a. Biases, or shortcuts, that help us avoid mental strain
b. VIDEO: Focus (LANL Safety Video – Human Beings #2 – What happens before mistakes?)
i. http://www.lanl.gov/safety/videos/humanbeings/human-beings2.shtml
ii. https://youtu.be/8V2hhtNw8vU
3. Limited Working Memory - DOE Vol 1 Pg. 2-2

4. Limited Attention Resources - DOE Vol 1 Pg. 2-2
    a. Tools in October – Video shows the consequences of assembling nail gun while being distracted by watching the World Series.
        iii. https://www.youtube.com/watch?v=HOkU3fP1xPs
5. Mindset - DOE Vol 1 Pg. 2-3
6. Difficulty seeing one's own error - DOE Vol 1 Pg. 2-3
7. Limited Perspective - DOE Vol 1 Pg. 2-3
8. Susceptibility to Emotional / Social Factors - DOE Vol 1 Pg. 2-3
9. Fatigue - DOE Vol 1 Pg. 2-3
10. Presenteeism - DOE Vol 1 Pg. 2-3

iii. Unsafe Attitudes (DOE uses the phrase: Unsafe Attitudes and At-Risk Behaviors) - DOE Vol 1 Pg. 2-4
1. At-Risk Behaviors - DOE Vol 1 Pgs. 2-5 thru 2-7
2. VIDEO: Bloody Ladder Fall
    a. https://www.youtube.com/watch?v=MwCyVku1HvI

iv. Black line – Blue Line – Red Line exercise
1. BASIS: IM-2018-45
   IAS 2016-459 HPI POFMR OFI-04: The HPI element is based in error management and could be further improved by broadening its philosophy and practices to include positive elements such as building adaptive capacity, "human as hero", and "people keep the system safe".

v. Drift and Accumulation

vi. Slips. Lapses, Mistakes, Errors and Violations - DOE Vol 1 Pg. 2-8, 2-10
1. Errors, Slips, Lapses, and Mistakes - DOE Vol 1 Pg. 2-8
2. What can happens when error occur? (Discussion about LANL event caused by human error)
    a. TA-53 Arc Flash event
    b. WIPP Waste drum "AN organic vs. INorganic" event
    c. Plutonium Shipping event
3. Active error and Latent error - DOE Vol 1, Pg. 2-8
4. Inappropriate Action
    a. **NOTE:** Inappropriate Action is NOT in the DOE HPI Handbook
5. Violations - DOE Vol 1, Pg. 2-10
    a. General types of violations
        i. Situational Violations
        ii. Routine violations
        iii. Organizational-induced violations

vii. Dependency and Team Errors - DOE Vol 1 Pg. 2-11
1. Equipment Dependencies
2. Team Errors - DOE Vol 1 Pg. 2-12
    a. Halo Effect
    b. Pilot/Co-Pilot
    c. Free Riding
    d. Groupthink
    e. Diffusion of Responsibility – "Risky Shift"
3. Antidotes to Team Errors - DOE Vol 1 Pg. 2-15

b. Performance Modes
   i. Human information processing - DOE Vol 1 Pg. 2-16, 2-18
      1. NOTE: Illustration is from INPO 06-003
      2. Video: Fast Brain / Slow Brain thinking
         a. https://www.youtube.com/watch?v=JiTz2i4VHFw
   ii. Attention / Inattention to detail - DOE Vol 1 Pg. 2-19
   iii. Generic Error Modeling System (GEMS) – Performance Modes - DOE Vol 1 Pg. 2-21
      1. Skill-Based Performance - DOE Vol 1 Pg. 2-21
         a. VIDEO: Teeth anyone
            i. This video demonstrates skill based error when husband and wife get wear each other's dentures
            ii. https://www.youtube.com/watch?v=rg4GiKXkSys
         b. VIDEO: Bill Dance
            i. This video demonstrates Multiple Skill based errors by fishing show host Bill Dance
      2. Rule-Based Performance - DOE Vol 1 Pg. 2-23
         a. VIDEO: Pole Climbing FAIL
            i. This video demonstrates the consequences of a rule based error when the lineman deviates from the rule and "cuts" the rope.
         b. VIDEO: Accident Caught on Tape
            i. This video records a "Crash at intersection caught on camera" where one of the drivers does not follow the rule (yield the right of way) prior to entering the intersection. Distractions and truck blocking view contribute to the event.
      3. Knowledge Based Performance - DOE Vol 1 Pg. 2-25
         a. VIDEO: Funniest double speak ever
            i. This video demonstrates the various levels of things you know used to make decisions.
            ii. https://www.youtube.com/watch?v=QaxqUDd4fiw
         b. VIDEO: Know your limitations navy captain
            i. This video demonstrated knowledge based error when a navy crew sees an object on the radar that it thinks is another ship…but turns out to be a lighthouse.
            ii. https://www.youtube.com/watch?v=ajq8eag4Mvc
         c. VIDEO: The Exploding Whale (www.theexplodingwhale.com)
            i. This video demonstrates an explosives expert applying his trade to a dead whale on the beach.
            ii. https://www.youtube.com/watch?v=1_t44siFyb4
         d. Examples of Knowledge Based Errors
            i. Three Mile Island
            ii. Bhopal, India 1984 - 2500 people died (100,000 injuries)
            iii. Challenger Shuttle 1986; 7 people died
            iv. Chernobyl Nuclear Power Station 1986; 30 people died
            v. Herald of Free Enterprise, Zeebrugge 1987; 193 people died
      4. GEMS **EXERCISE** – Determine the performance mode: Skill, Rule or Knowledge
         a. NOTE: Ensure students recognize that each person will be in a different mode depending on their familiarity/experience with the topic

5. How Performance Modes can be used - DOE Vol 1 Pg. 2-27
    a. Ensure students recognize that each person will transition between the three modes as their day progresses.
6. Mental Models - DOE Vol 1 Pg. 2-28
7. Assumptions - DOE Vol 1 Pg. 2-29

c. Error-Likely Situations - Job Site Vulnerabilities - DOE Vol 1 Pg. 2-30
    i. Error Precursors (TWIN Model) - DOE Vol 1 Pg. 2-31
    ii. Common Error Precursors - DOE Vol 1 Pg. 2-32
        1. **NOTE**: A more extensive list of error precursors and error precursor descriptions is provided in Attachments A and B of DOE HU Handbook, volume 1, Chapter 2, attachments A & B.
    iii. Personality Conflict
        1. **DISCUSS**: Why is it a "Work Environment" precursor? Incompatibility between two or more individuals working together on a task causing a *distraction from the task* because of preoccupation with personal differences
        2. Relate to LANL "Active Bystander – From Silence to dialog" effort
    iv. Top 10 Error Traps - DOE Vol 1, Attachment B
        1. Tenerife **CASE STUDY** – View video to identify error precursors
            a. https://en.wikipedia.org/wiki/Tenerife_airport_disaster
            b. https://www.youtube.com/watch?v=4MferspAuv4
            c. https://www.youtube.com/watch?v=VhVo32AjTZc (19 minutes – good detail)
            d. https://www.youtube.com/watch?v=kjLrZ2SDDaU (5 minutes – highlights major points)

4. **DOE Volume 1, Chapter 2: Managing Controls**
    a. Controls - DOE Vol 1 Pg. 3-1
        i. Severity of Events - DOE Vol 1 Pg. 3-3
        ii. Defense Functions - DOE Vol 1 Pg. 3-4
        iii. Reliability of Controls - DOE Vol 1 Pg. 3-4
    b. Defense-In-Depth - DOE Vol 1 Pg. 3-5
        i. Defense-In-Depth **EXERCISE**
            1. **NOTE**: One slide is hidden and do NOT print in student handout
    c. Performance Model - DOE Vol 1 Pg. 3-12
        i. Relate this to HPI Principle #3
    d. Managing Controls: Performance Improvement Model - DOE Vol 1 Pg. 3-15
        i. **NOTE:** These will be discussed during the Volume 2, HPI Tools for Management section

5. **DOE Volume 2: Human Performance Tools and Techniques**
    a. Before using any HPI Tool - DOE Vol 2 Pg. 1
        i. What these tools will do for us
        ii. How DOE DOE-HDBK-1028-2009 - Human Performance Improvement Handbook, Volume 2, Human Performance Tools are presented - DOE Vol 2 Pg. 1
            1. Overview
            2. Use of the Tool
            3. Recommended Practices
            4. At-Risk Practices

b. What must go right (*LANL HPI Focus area*)
    i. Risk important actions: procedure steps or actions that expose products, services, or assets to the potential for or actual harm.
    ii. Critical Steps (Definitions: Volume 2 Page 128: Actions that will trigger immediate, irreversible harm if done incorrectly (with error))
    iii. What is harm?
        1. What is HARM?
            a. To Personal
                i. Death, disabling injury, overexposure to ionizing radiation
            b. To the Mission
                i. Inability to achieve the mission, Asset damage/loss, Damage to LANL reputation
            c. To Safety and Security
                i. Loss of program/regulatory safety functions, significant safeguards, physical security, information security and/or cyber security event
            d. To the Environment
                i. Harm to the environment, Non-Compliance regulatory violation
    iv. VIDEO: No time to think
        1. https://www.youtube.com/watch?v=k8QCTk7B0tE
        2. This video pauses a scenario where a motorcycle drive has made a decision (critical step) to pass a truck, for which that action becomes irreversible and consequential.
    v. Selecting Critical steps
    vi. Example of Critical Step (IWD Writers guide)
c. Situational Awareness - DOE Vol 2 Pg. 5
d. Individual Error prevention techniques (and their bases) - DOE Vol 2 Pg. 5
    i. Task Preview (SAFER) - DOE Vol 2 Pg. 6
        1. Summarize the critical steps
        2. Anticipate Error-likely Situations
        3. Foresee Consequences
        4. Evaluate Controls or contingencies
        5. Review Operating Experience
        6. VIDEO: Task-Preview from LANL ViewIT
    ii. Job-site Review (Take 2-4 You) - DOE Vol 2 Pg. 8
        1. VIDEO: "Take 2 – 4 You" from LANL ViewIT
    iii. Questioning Attitude - DOE Vol 2 Pg. 10, 13
        1. At the activity level - DOE Vol 2 Pg. 10
        2. Work Planning and Preparation - DOE Vol 2 Pg. 13
        3. VIDEO: Prison Break - New Guy in prison life insurance commercial
            a. This video demonstrates an new inmate having a questioning attitude about a draft in his cell block
            b. https://www.youtube.com/watch?v=DKBdiVs6fjY
    iv. Pause/Stop when unsure (DOE: Pause when unsure) (Pause Work @ LANL) - DOE Vol 2 Pg. 16
        1. P101-18: Procedure for Pause/Stop Work
        2. Ability to pause or stop work is critical worker right
        3. The Laboratory's pause/stop work procedure contains requirements for all workers who perform any and all work tasks at the Laboratory, including managers and supervisors who are responsible for worker safety.

4. The right of workers at the Laboratory to pause or to stop work implements a critical worker right under 10 CFR 851, Worker Safety and Health Program, Section .20(b)(8) and (9).
5. The Industrial Hygiene and Safety Division provides direct support to those with questions or concerns associated with how and when to implement pause/stop.
6. LANL Video on demand – Human Performance Improvement Videos – STOP/Pause Work

v. Self-Checking (STAR) - DOE Vol 2 Pg. 18
   1. P315, Conduct of Operations Manual;
   2. Self-checking techniques (Appendix 10-C) provide a list of expectations related to individuals performing actions and independently verifying those actions. These expectations should be clearly understood by all personnel involved in the IV program and included in IV training.
   3. VIDEO: Self-Checking from LANL ViewIT

vi. Procedure use and adherence - DOE Vol 2 Pg. 20
   1. P315, Conduct of Operations Manual - Attachment 16
   2. Procedural systems vs. adaptive systems; including examples
   3. VIDEO: *Officer* Asks Lady To Step To Roadside Seconds Before Crash
      a. This video demonstrates an officer requesting a driver to follow the protocol of getting out of the car because her car may get hit…and it does.
      b. https://www.youtube.com/watch?v=oxXX3lt7JDM
   4. VIDEO: How to outsmart robbers
      a. This video demonstrates a person robbing a liquor store. The attendant is thoughtful enough to ask for ID…per the sign (e.g., following the procedure).
      b. https://www.youtube.com/watch?v=oxXX3lt7JDM

vii. Validate Assumptions - DOE Vol 2 Pg. 22
   1. VIDEO: "You're being robbed"
      a. This video demonstrates how a store clerk hears one side of the conversation when a Man is talking on a hands-free cell phone. The conversation is about paying too much for a service. The clerk assumes the customer intends to rob the store.
      b. https://www.youtube.com/watch?v=YEJ6HBHjt1g

viii. Signature - DOE Vol 2 Pg. 24

ix. Effective Communication
   1. Three-part communication practices - DOE Vol 2 Pg. 26
      a. P315, Conduct of Operations Manual - Attachment 4, Communications
      b. VIDEO: Copper Clappers
         i. "A Johnny Carson skit that demonstrates three-way communication technique.
         ii. https://www.youtube.com/watch?v=sKGtb1t9iVw
   2. phonetic alphabet - DOE Vol 2 Pg. 28
      a. P315, Conduct of Operations Manual -Attachment 4, Communications - Appendix 4-A, Phonetic Alphabet

x. Place-keeping - DOE Vol 2 Pg. 29
   1. DOE-STD-1029-92, WRITER'S GUIDE FOR TECHNICAL PROCEDURES - Section 4.13, Action Steps with Placekeeping and Sign Offs

xi. Do not disturb sign - DOE Vol 2 Pg. 31

xii. Application of Individual HPI Tools - DOE Vol 2 Pg. 3

xiii. **EXERCISE**: Pick the individual HPI tool for the condition

e. Team Error prevention techniques (and their bases) - DOE Vol 2 Pg. 33
   i. Pre-Job Briefing - DOE Vol 2 Pg. 34
      1. P300, Integrated Work Management - 3.1.4.b Pre-Job Briefings
      2. P300.1, Integrated Work management for R&D - 3.3.12.c Pre-Job Brief
      3. LANL Pre-job Brief Guide
         a. IWM Toolbox website http://int.lanl.gov/safety/integrated_work_management/toolbox/_assets/docs/pre-job-guide.pdf
   ii. Technical Task Pre-Job Briefing - DOE Vol 2 Pg. 38
   iii. Checking vs. Verification - DOE Vol 2 Pg. 41
      1. Peer Checking - DOE Vol 2 Pg. 42
         a. VIDEO: Peer-Checking from LANL ViewIT
      2. Concurrent Verification - DOE Vol 2 Pg. 44
         a. VIDEO: Concurrent Verification from LANL ViewIT
         b. P315, Conduct of Operations Manual - 10.3.6 Concurrent Dual Verification
      3. Independent Verification - DOE Vol 2 Pg. 46
         a. VIDEO: Independent Verification from LANL ViewIT
         b. P315, Conduct of Operations Manual - Attachment 10
   iv. Peer Review - DOE Vol 2 Pg. 49
      1. SD601, Conduct of Research and Development - 3.5 Researcher as a Professional and Peer Reviewer
   v. Flagging – Robust Operational Barriers - DOE Vol 2 Pg. 51
      1. NOTE: DOE Vol 2, pg. 51 does NOT talk about Robust Operational Barriers. ROB information is found in INPO 06-002 Human Performance Tools for Workers
   vi. Turnover - DOE Vol 2 Pg. 52
      1. P315, Conduct of Operations Manual - Attachment 12, Operations Turnover
   vii. Post Job Review
      1. In the field - DOE Vol 2 Pg. 54
      2. Technical Task - DOE Vol 2 Pg. 56
      3. Work Life Cycle - DOE Vol 1 Pg. 3-13
      4. P300, Integrated Work Management - Form 2104, IWD Part 4, Feedback/Post-Job Review
      5. P300.1 Integrated Work management for R&D
      6. After Action Review (AAR) concept
         a. What surprised us?
         b. BASIS: IM-2018-41 (Screening Approved) - IAS 2016-459 HPI POFMR PF 4: Post job reviews
            i. a. Discussion: Some people reported doing post job reviews which consisted of discussing what went well and what could be improved. Post job or After Action Reviews can be one of the most influential practices to develop competence in people and teams. These reviews can also help people notice how often and what type of surprise occurs with their work.
            ii. b. Recommendations: Expand use of informal post job reviews for the purpose of developing people. Include additional questions such as "what surprised us?"

7. Pre-Job and Post-Job Review VIDEO
    a. http://int.lanl.gov/safety/integrated_work_management/toolbox/_assets/video/pre-job.html
8. IWM Toolbox
    a. http://int.lanl.gov/safety/integrated_work_management/toolbox/pre-post-job-reviews.shtml

viii. Project Planning - DOE Vol 2 Pg. 58
1. LANL : PADCAP>>ADPM>>key services

ix. Problem Solving - DOE Vol 2 Pg. 61

x. Decision Making - DOE Vol 2 Pg. 63
1. Conservative Decision Making: INPO 07-006, Human Performance Tools for Managers and Supervisors, page 27
2. P315, Conduct of Operations Manual - 1.4 Principles of Conservative Operation

xi. Project Review Meetings - DOE Vol 2 Pg. 66

xii. Vendor Oversight - DOE Vol 2 Pg. 68

xiii. Application of Team HPI Tools - DOE Vol 2 Pg. 3

xiv. **EXERCISE**: Pick the Team HPI tool for the condition

xv. HPI Life Cycle – review how it all fits together

xvi. HPI videos may be found on LANL Videos on Demand

f. Management Error prevention techniques (and their bases) - DOE Vol 2 Pg. 70

i. Benchmarking - DOE Vol 2 Pg. 71

ii. Observations - DOE Vol 2 Pg. 73
1. LANL resources
    a. P328-4: Management Observation and Verification
        i. Field Interactions
        ii. General MOVs
        iii. Monitored Evolution
        iv. LANL MOV Website**:** http://int.lanl.gov/performance-assurance/performance-center/mov/index.shtml
        v. MOV Overview**:** https://saestandards.lanl.gov/mobile/lanlmobile/Lists/MOV/overview.aspx
    b. ObserveIT (Behavior Based Safety):
        i. http://int.lanl.gov/org/padops/adesh/integration-office/behavior-based-safety/index.shtml
        ii. Behavior Based Safety: http://int.lanl.gov/org/padops/adesh/integration-office/timely-observation-measures/index.shtml
2. Observation **ACTIVITY** – Basketball teams & Gorilla
    a. VIDEO: Attention Selective Attention Test
        i. This video is used to create "tunnel vision" or to purposefully "limit the perspective" of people watching the video
        ii. https://www.youtube.com/watch?v=vJG698U2Mvo

iii. Self-Assessments - DOE Vol 2 Pg. 75
1. PD 328, LANL Assessment Program

iv. Performance Indicators - DOE Vol 2 Pg. 77
1. PD324, Institutional Metrics Program

2. LANL Executive Dashboard: https://int.lanl.gov/org/ddops/aldeshqss/quality-performance-assurance/performance-assurance/dashboard.shtml

v. Independent Oversight - DOE Vol 2 Pg. 80
vi. Work Product Review - DOE Vol 2 Pg. 83
vii. Investigating events triggered by human error - DOE Vol 2 Pg. 85
    1. P322-4, Issues Management (pdf)
    2. P322-3, Performance Improvement from Abnormal Events (pdf)
    3. Accident Models (DOE-HDBK-1208-2012, Accident and Operational Safety Analysis)
        a. Sequence of Events Model
        b. Epidemiological or Latent Failure Model (Swiss cheese model)
        c. Systemic Model
        d. Anatomy of an Event - DOE Vol 2 Pg. 88
            i. **CASE STUDY**: Therac 25 (enclosed)
viii. Operating Experience - DOE Vol 2 Pg. 90
    1. PD323, LANL Operating Experience Program (pdf)
    2. P323-1, Operating Experience and Lessons Learned Process (pdf)
    3. OPEX at LANL (http://opex.lanl.gov/) may be accessed from the Inside LANL home page in three ways:
        a. Safety – OPEX at LANL
        b. Security – OPEX at LANL
        c. Toolkit - Lessons Learned
ix. Change Management
x. Reporting errors and Near Misses - DOE Vol 2 Pg. 95
    1. P322-4, Issues Management
    2. Culpability Decision Tree - DOE Vol 2 Pg. 99
        a. **EXERCISE**: Culpability Scenarios
        b. SOURCE: LANL Human Performance Improvement Concepts Guide (October 2006) page 27 (LA-UR-07-0176)
xi. Employee Surveys - DOE Vol 2 Pg. 101
xii. **EXERCISE**: Pick the Management HPI tool for the condition
xiii. ISM and HPI Tools
xiv. Alternatives to HPI tools – Human factors and systems-based thinking

6. **DOE Volume 1, Chapter 4: Culture and Leadership**
    a. Organizational Culture - DOE Vol 1 pg. 4-1
        i. DOE Elements of Culture video - http://int.lanl.gov/computing/communications/video-streaming/viewit/vod/browse-videos/elements-of-culture.shtml
    b. Safety Culture - DOE Vol 1 Pg. 4-2
        i. SD100, Integrated Safety Management System
        ii. DOE Guide 450.4-1C, Integrated Safety Management System Guide, Attachment 10
        iii. Safety Culture Focus Areas and Associated Attributes
            1. Leadership DOE Vol 1 pg. 4-6
                a. Accountability
                b. BASIS: IM-2018-44 - IAS 2016-459 HPI POFMR OFI-03: There is a varied understanding and application of accountability as it is used in Operational Leadership. An effort should be undertaken to further refine, communicate and apply a definition of accountability consistent with the Lab's core values.

        2. Employee/Worker Engagement DOE Vol 1 pg. 4-8
        3. Organizational Learning - DOE Vol 1 pg. 4-9
    iv. [Battelle] Safe Conduct of Research principles
c. Key Leadership Practices - DOE Vol 1 Pg. 4-13
    i. Facilitate open Communication - DOE Vol 1 Pg. 4-13
    i. Promote Teamwork - DOE Vol 1 Pg. 4-13
        1. Employee Involvement Continuum
        2. LANL Learning Team overview and examples
    ii. Reinforce Expectations - DOE Vol 1 Pg. 4-14
    iii. Eliminate Latent Organizational Weaknesses - DOE Vol 1 Pg. 4-16
    iv. Value the Prevention of Error - DOE Vol 1 Pg. 4-17
        1. VIDEO: (Medical Mistakes.wmv, 43.6 MB)
            a. This video is of a "simulator" where operating crews can learn from their mistakes
            b. VIDEO: https://www.facebook.com/MedicalSimulation/videos/217208851646834/
b. Create a Just Culture
    i. The Blame Cycle - DOE Vol 1 Pg. 4-23
    ii. Elements of a Healthy Culture
        1. NOTE: Take the opportunity to promote Active Bystander (From Silence to Dialog)
    iii. The Foresight Test - DOE Vol 1 Pg. 4-24
    iv. The Substitution Test - DOE Vol 1 Pg. 4-25
    v. The Culpability Decision Tree - DOE Vol 1 Pg. 4-25 (*this was explained in a previous section*)
c. Human Performance is Important
    i. VIDEO: 2007 Palo Verde Nuclear Plant Switchgear near-miss
    ii. Several LANL Incidents/events have common root causes that can be addressed using Operational Leadership
        1. LA-UR-17-25477, Type B Plutonium Shipping Event Causal Analysis and Expanded Common Cause Analysis of Related Events.
    iii. TA53 Arc-Flash Accident JAIT Report (LANL Event) – *Human Performance elements only*

7. **DOE Volume 1, Chapter 5: Human Performance Evolution**
    a. The contents of this chapter provides background information on the examples of key research and concepts that have influenced the HPI approach discussed in the DOE HPI handbook
        i. NOTE: Encourage students to read this section of the DOE HPI Handbook

8. **Conclusion**
    a. TRIAD
        i. Simultaneous Excellence
        ii. LANL Laboratory agenda – HPI connection
    b. HPI at LANL
        i. REPEAT – What **IS** HPI @ LANL
    d. LANL HPI Strategy
    e. How does HPI fit in at LANL
    f. Achieving Excellence in HPI – Four key elements (INPO 06-003)
    g. Questions

REFERENCES

1. DOE-HDBK-1028-2009 - Human Performance Improvement Handbook, Volume 1, Concepts and Principles
2. DOE-HDBK-1028-2009 - Human Performance Improvement Handbook, Volume 2, Human Performance Tools
3. DOE-HDBK-1208-2012, Accident and Operational Safety Analysis
4. DOE National Training Center: Human Performance Improvement Training, SAF-340DV, NELT: Human Performance Improvement – Video of a 2011 Nuclear Executive Leadership Training presentation by Mike Schoener (President at MAS Consultants Inc.)
5. INPO 05-002 (Rev1) Human Performance for Engineers and other Knowledge Workers
6. INPO 06-002 Human Performance Tools for Workers
7. INPO 06-003, Human Performance Reference Manual
8. INPO 07-006, Human Performance Tools for Managers and Supervisors
9. INPO 15-008, Achieving High Levels of Human Reliability
10. INPO Human Performance Fundamentals Course Reference (Revision 6, December 2002)
11. INPO Report on Human Performance Excellence (March 2016)
12. LA-UR-07-0176 – Human Performance Improvement Concepts Guide (October 2006)
13. *LA-UR-17-25477, Type B Plutonium Shipping Event Causal Analysis and Expanded Common Cause Analysis of Related Events*

Los Alamos National Laboratory (LANL)
Human Performance Improvement (HPI) Practitioner

Human Performance Improvement (HPI) practitioners are division-, group-, and/or team-level advocates who possess a level of Human Performance knowledge, skills, and understanding that allows them to apply concepts within their organization to affect positive outcomes.

HPI practitioners are an important part of the Laboratory's overall HPI strategy. Their role is to leverage opportunities to integrate—rather than add-on—HPI techniques and principles into their organization to prevent events and improve the systems in which employees must work. They also serve as a conduit to the rest of the HPI networking community at the Laboratory

General functions:

- This may/may not be a full-time responsibility. The level of support required will vary depending on the organization's needs.
- Interface with management and employees to ensure best practice HPI aspects are communicated, understood, and incorporated into local practices.
- Share internal *Best Practices* externally; and external *Best Practices* internally.
- Assess support needs of the organization to identify and reduce performance issues.
- Mentor, offer suggestions, and provide hands-on, engaged support for HPI improvement initiatives.
- Seek out opportunities to integrate HPI concepts and practices into normal business activities.
- Interface with the LANL HPI Practitioners *Community of Practice.*
- Promote and facilitate HPI initiatives, presentations, and workshops, as necessary.

Technical Skills:

- Demonstrated skill and knowledge with applicable Human Performance concepts and practices found in DOE-HDBK-1028-2009 (and other publications as applicable).
- Demonstrated understanding of current organizational processes/systems, ability to recognize improvement opportunities, and ability to develop/provide recommendations.
- Ability to effectively participate in and/or lead meetings.

Behavioral Skills:

- Interpersonal skills including the ability to interact with individuals and groups at various organizational levels; conduct self in polite and professional manner; actively listen to what others have to say; and restate information to ensure understanding.
- Commitment to continuous self-study and knowledge application.
- Ability to maintain confidentiality and handle sensitive material.
- Uses resources effectively to generate solutions and takes initiative when resolving problems.

Desired skills:

- Presentation and communication (oral and written) skills.
- Observation and mentoring skills.
- Ability to influence others.
- Experience with data and causal analysis.

A Case Study in Human Performance

Therac-25 (1986)

Let's take a look at an example of an accident that involves human error and computers, that of the Therac-25. The Therac-25 was a million dollar radiation machine designed to precisely aim a beam of radiation at a patient in order to treat tumors or cancerous growths. Patients were often recovering from operations that had removed the bulk of a tumor, and underwent these radiation treatments to remove what was left.

The Therac-25 was high energy radiation machine, but radiation treatment usually involved many low-energy dosages across successive treatment sessions. The machine was controlled through a computer (a terminal hooked up to an old mainframe) located in another room (as are most radiation therapy controls, in order to protect the technicians from unnecessary exposure).

There were two basic modes in which the Therac-25 could function. The first was the low-energy mode mentioned above, in which an electron beam of about 200 rads was aimed at the patient and sent off in a short burst. The second mode was an x-ray mode, which used the full 25 million electron volt capacity of the machine. When the machine was switched into this mode, a thick metal plate would get inserted between the beam source and the patient; as the beam passed through the plate, it was transformed into an x-ray which would radiate tumors and the like.

To switch to "electron mode," the technician typed "e" at the computer terminal. To switch to "x-ray mode," the technician typed "x" at the computer terminal. Simple, right?

Well, Ray Cox, a Texas oil worker went in for his usual radiation treatment for a tumor he had removed from his left shoulder. He had been here eight times before, so this was business as usual. They got him set up on the table, and the technician went down the hall to start the treatment. The technician sat down at the terminal, and hit "x" to start the process. She immediately realized she made a mistake, since she needed to treat Ray with the Electron beam, not the X-ray beam. She hit the "Up" arrow, selected the "Edit" command, hit "e" for Electron beam, and hit "Enter," signifying she was done configuring the system and was ready to start treatment.

The total time for this interaction was under 8 seconds.

It turns out that this particular sequence of actions within this time frame had never occurred in all of the testing and evaluation of the Therac-25. If it had occurred, it would have pointed out a dangerous bug in the system. The system presented the technician with a "Beam Ready" prompt, indicating it was ready to proceed; she hit "b" to turn the beam therapy on. She was surprised when the system gave her this error message. She wasn't familiar with this particular message, but these particular errors usually meant the treatment hadn't proceeded. She cleared the error to reset the Therac-25 so she could do it again. She got the "Beam Ready" prompt and again hit "b" to initiate the treatment. Same deal: an error message and the system stopped. She tried it again.

Obviously, the system itself noticed the error but the message to the user was not evocative enough to accurately reflect the condition or gravity of the error. Thus, although the technician noticed she had made a mistake, she assumed the treatment hadn't happened because that's what the error messages usually meant. Thus, her subsequent action was erroneous as well because she chose an inappropriate procedure due to her misinterpretation of the situation.

Meanwhile, back in the treatment room, Ray was feeling repeated burning, stabbing pains on his back. None of the previous treatments had been like this. Although he cried out several times, asking (first jokingly) whether the system was figured right, no one came to check on him. Finally, after the third painful burst, he pulled himself off the table, and went to the nurses station.

The problem was this: when the particular sequence of commands was executed quickly enough (e.g. in under 8 seconds), the arm correctly withdrew as it should be in Electron beam mode, but the beam switch never occurred. Although the machine told the operator it was in Electron beam mode, it was actually in a hybrid proton beam mode. As a result, the system was delivering a radiation blast of 25,000 rads with 25 million electron volts, more than 125 times the normal dose. The particular sequence of steps executed by the technician had moved the metal plate from the beam's path, but left the power setting on maximum!

Ray Cox's health deteriorated rapidly from radiation burns and other complications from the treatment overdose. He kept in good humor about his condition, joking that "Captain Kirk forgot to put his machine on stun." He died four months later.

It is worth noting that the problem wasn't actually diagnosed until 3 weeks later, when it happened again to another patient. At this point, the senior technician realized something about the sequence of steps being taken must be triggering this flaw. After investigation, he found the problem with the plate, and reported it to the manufacturer. Subsequent investigation showed that there had been similar overdoses in Georgia, Canada and Washington.

During the review of the event it was documented that there were a number of checks in the Therac-25 case that might have prevented the radiation overdose. There was an audio intercom system between the treatment room and the control room, but it was broken. There was a video hookup between the two, but the monitor was disconnected on that particular day.

Therac-25 Exercise Instructor Key

Date:_____

Barriers

Participants:_____

- ˆ Software: Metal plate inserted between beam and patient for X-Ray mode to radiate tumors
- ˆ Error message – disregarded twice
- ˆ Audio intercom between rooms (Broken)
- ˆ Video hookup between rooms (Disconnected)

Precursors

Participants:_____

- ˆ Irreversible Action - Technician hits “x” first, realizes mistake, then presses E, causing hybrid condition
- ˆ Confusing displays or controls - E=electron, x=x-ray are close to each other
- ˆ Hidden system / equipment response - Patient in another room
- ˆ Unexpected equipment conditions - Patient felt something different this treatments (pain) and cried out
- ˆ Lack of Knowledge (Faulty metal model) – Did not understand warning message
- ˆ Indistinct problem-solving skills - Cleared Error and tried a second time
- ˆ Assumptions - Original operator did not question the malfunction of the machine.
- ˆ Complacency / Overconfidence - Ray Cox – Usual radiation treatment (eight times before)
- ˆ Inaccurate risk perception - Patient finally gets up off of table to find out what is going on

Latent Organizational Weakness

Participants:_____

- ˆ Technician worked through an “Error” Message.
- ˆ Unanalyzed condition: Steps executed in short period of time (8 seconds) results in the machine in hybrid proton beam mode.
- ˆ Did not diagnose until 3 weeks later when it happened to another patient.
- ˆ Similar situations occurred in Georgia, Canada and Washington.

Items checked were identified by the students/group.

The instructor reviewed items not checked.

Culpability Decision Tree Exercise

For the following two scenarios, use the culpability decision tree to determine the intent of the worker's actions.

Scenario 1
A construction subcontractor, with an unblemished safety record and a clean bill of health, accidentally hit and damaged a conduit containing an energized 480-volt cable with a jack-hammer during excavation of a cement floor. The worker had successfully completed a planned and authorized excavation in an adjacent building ahead of schedule. He began the excavation that resulted in the damaged conduit immediately afterward. Because the second operation had not been covered in the pre-job briefing for that day, the work was not authorized. The contractor did not know that the paint markings indicating the conduit had been worn away (a problem that would have been addressed in the next day's pre-job briefing).
When investigators questioned other subcontractors assigned to the project, the majority responded that due to time constraints and deadlines they too would have worked ahead and begun the operation that was scheduled for the next day. Although the prime contractor's written policies forbade authorization to do work without a pre-job briefing, the subcontractor's policies and training made no mention of that requirement.

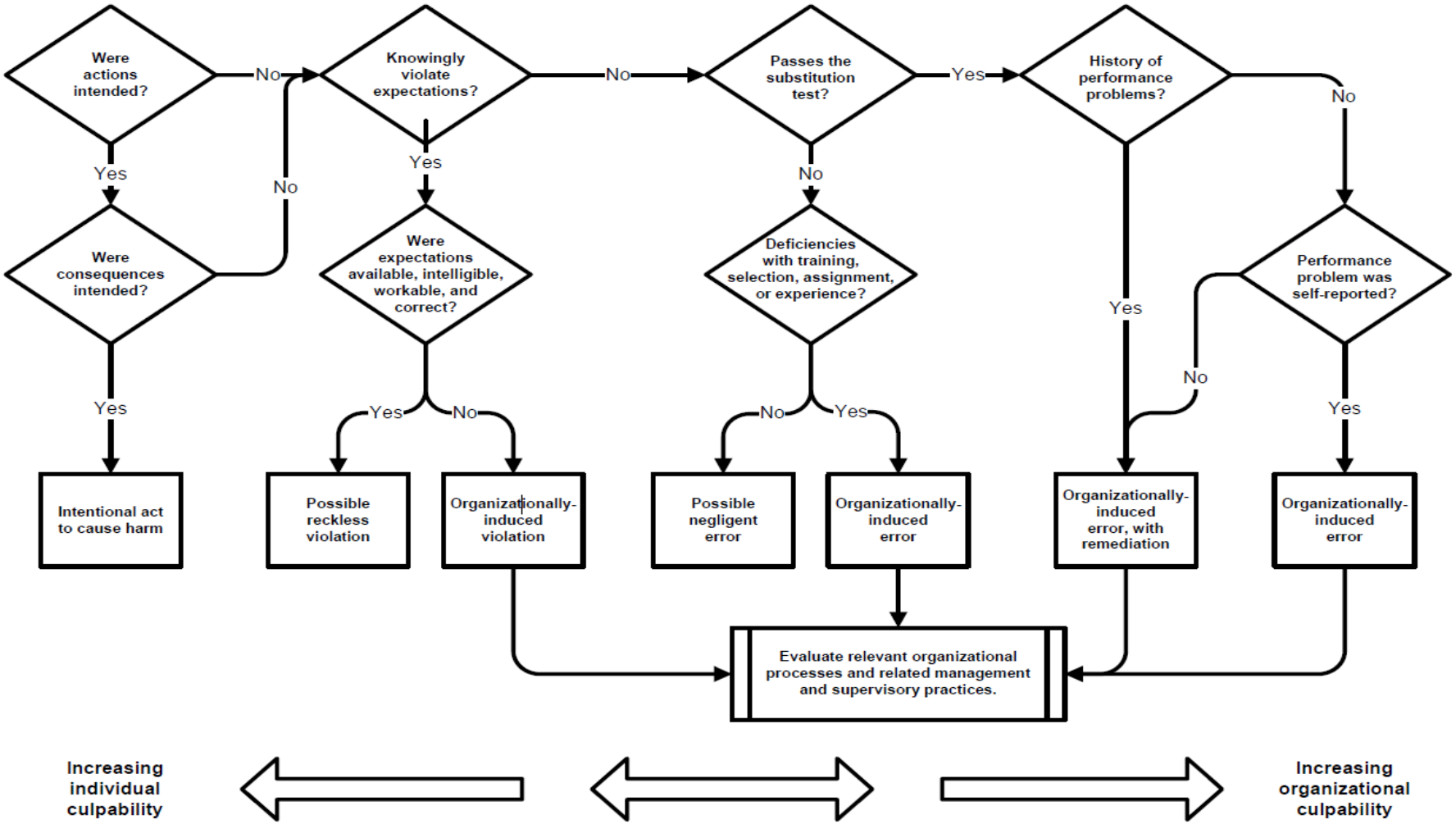
What type of error or violation did the construction subcontractor commit? _____

Scenario 2
A chemist accidentally spilled a toxic chemical during transport between two adjacent laboratory rooms. The chemical was transported in an open container without secondary containment. Although regulations and policies prohibited the chemical from being moved without proper containment and authorization, the scientist proceeded because the laboratory rooms were located next to each other and the chemical would be returned to its original location within an hour. He assumed his steady hand and expertise would protect him from having an accident. When investigators questioned other chemists at the laboratory, they unanimously responded that they would not have transported the chemical without proper containment and authorization, especially given the risks associated with the chemical and their training in proper transportation procedures. The chemist who spilled the chemical had attended training and was aware of the policies and regulations.

What type of error or violation did the chemist commit? _____

How would you respond differently to the two operational upsets? Why?

Culpability Decision Tree Exercise



Culpability Decision Tree Exercise Answer Key

SOURCE: LANL Human Performance Improvement Concepts Guide (October 2006) page 27 (LA-UR-07-0176)

EXERCISE: For the following two scenarios, use the culpability decision tree to determine the intent of the worker's actions
.

Scenario 1
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What type of error or violation did the construction subcontractor commit?
ANSWER: system educed error

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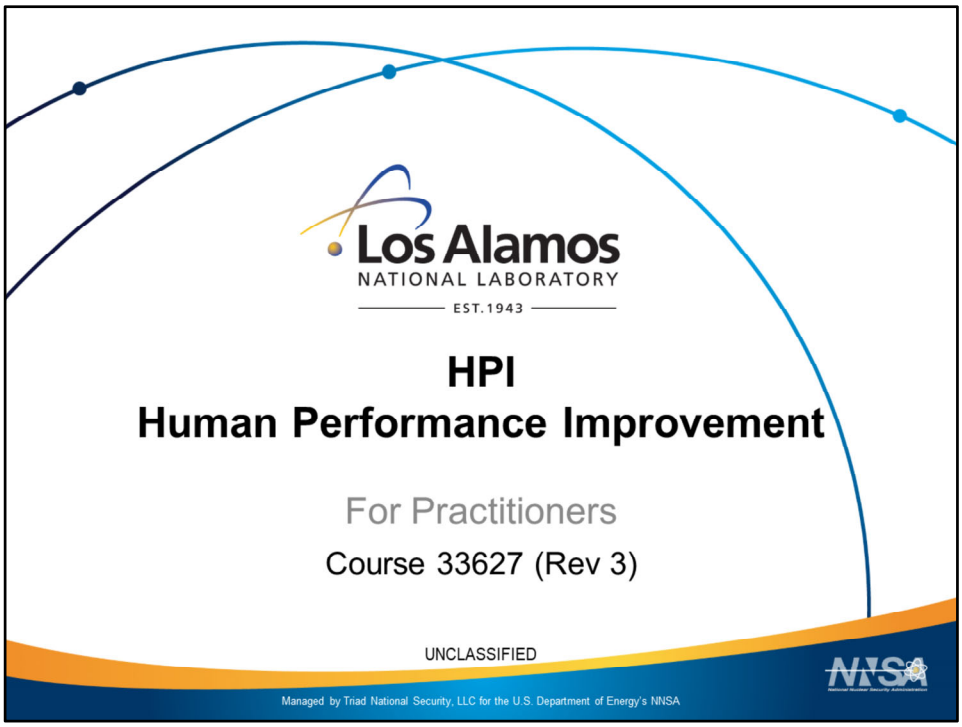
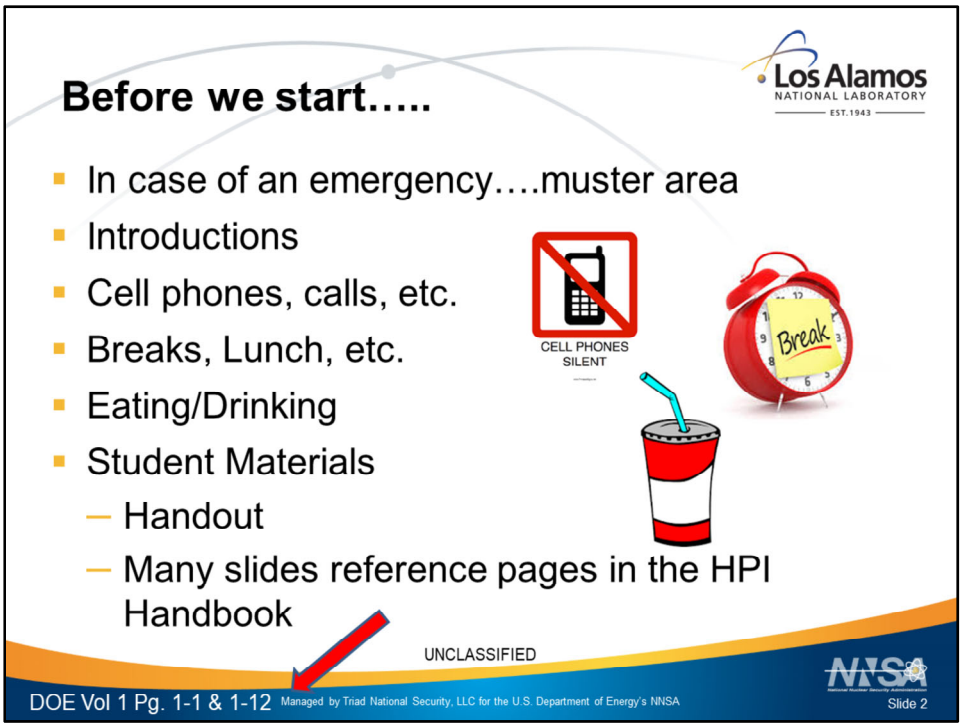
What type of error or violation did the chemist commit?
ANSWER: possible negligent error

How would you respond differently to the two operational upsets? Why?

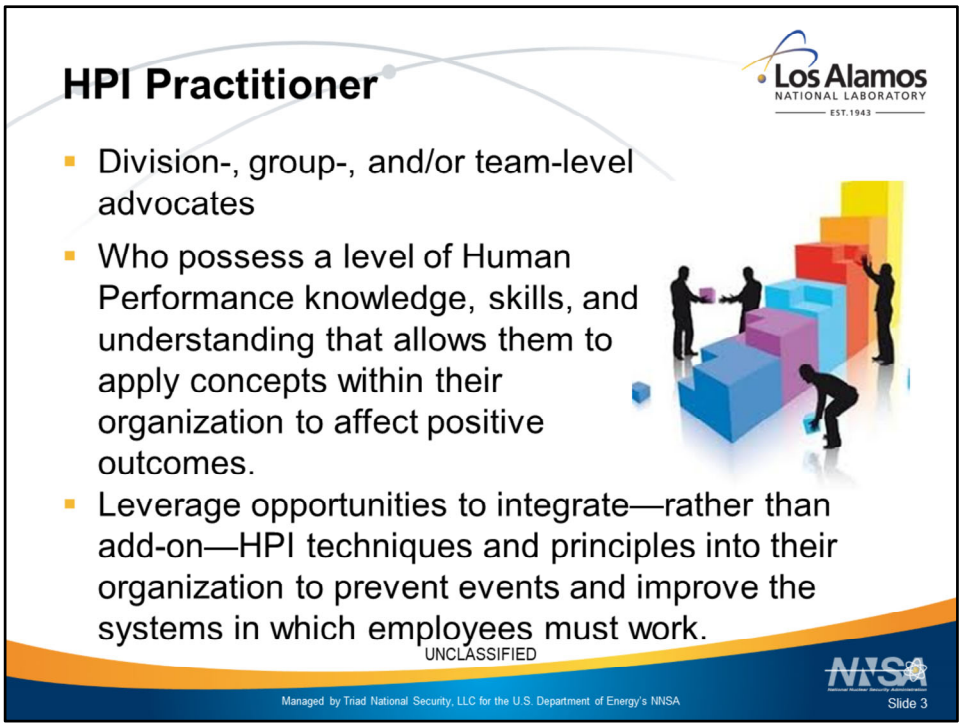


Cover Page
Display prior to starting class



I. INTRODUCTION

A. Gain student attention: Welcome students, go over the building emergency evacuation process, instructor introductions, and student introductions. Then discuss classroom protocols for cell phones, breaks, eating/drinking, and student materials.



Provide students with a copy of the HPI Practitioner Description (found on the HPI Webpage)

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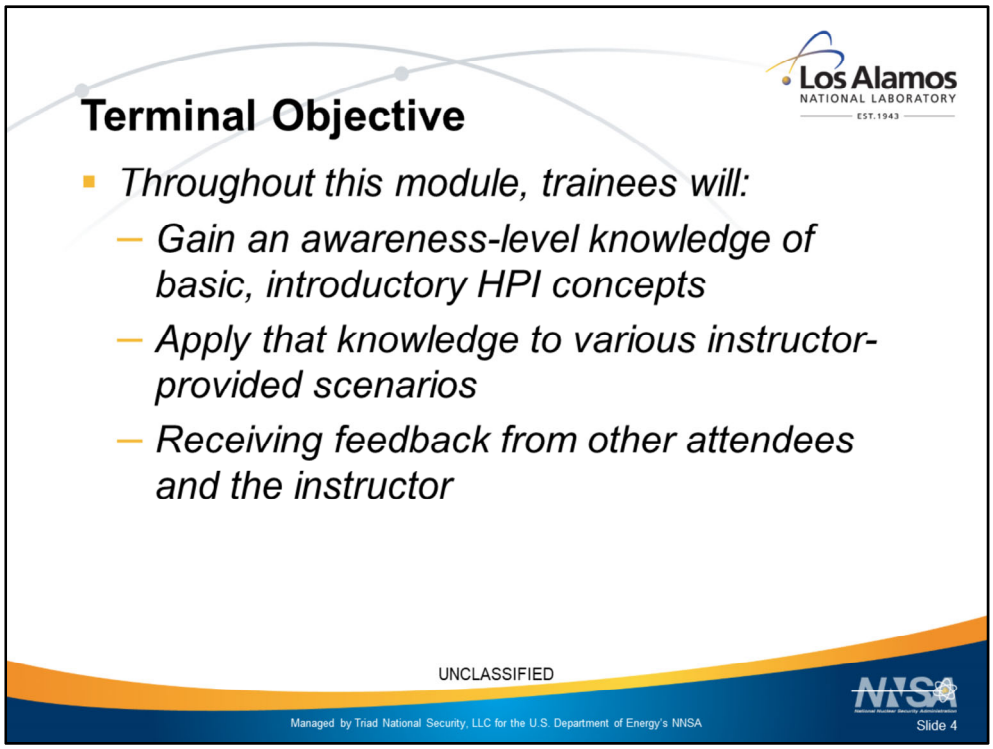
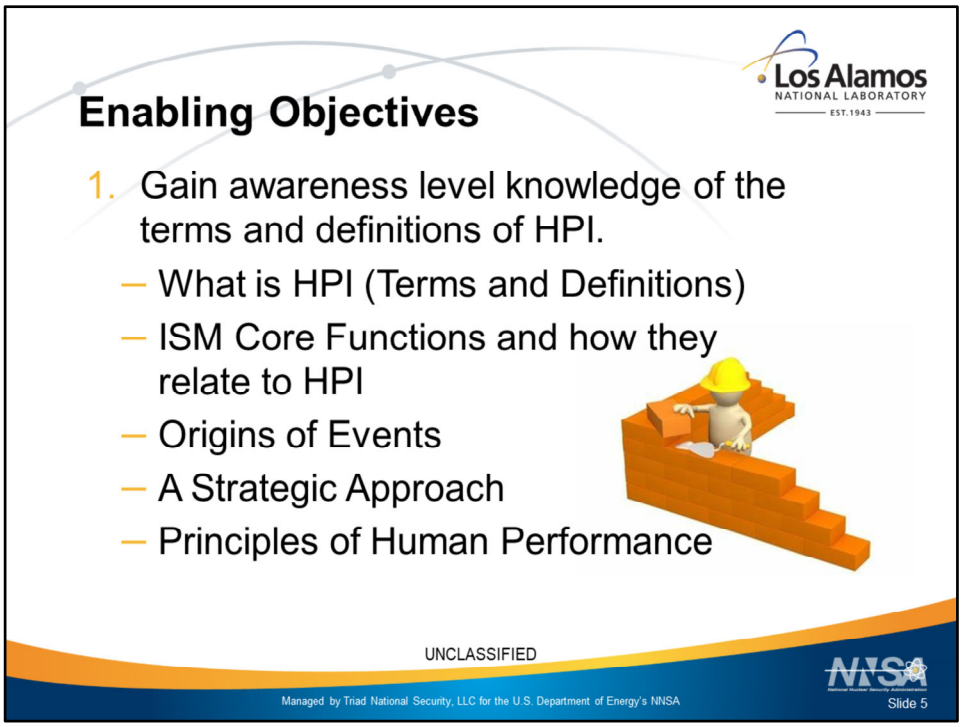


State Terminal objective

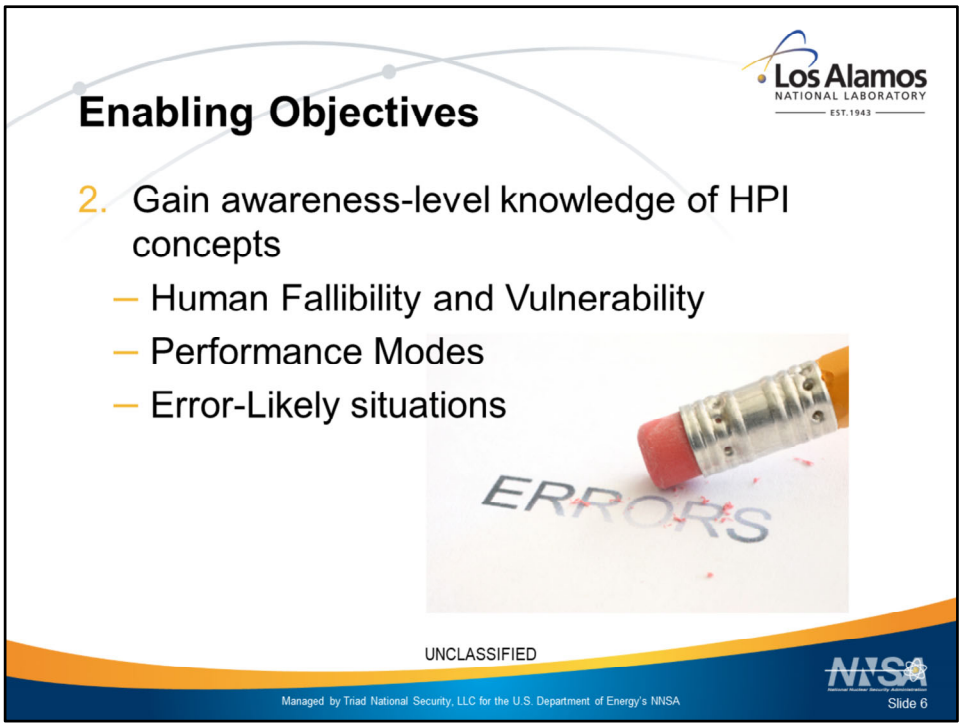
Terminal Objective: *Throughout this module, trainees will gain awareness-level knowledge of basic, introductory HPI concepts and apply that knowledge to various instructor-provided scenarios, receiving feedback from other attendees and the instructor.*
ase Studies



Review Enabling objectives

1. **#1** *Throughout this module, trainees will gain awareness level knowledge of the terms and definitions of HPI.*

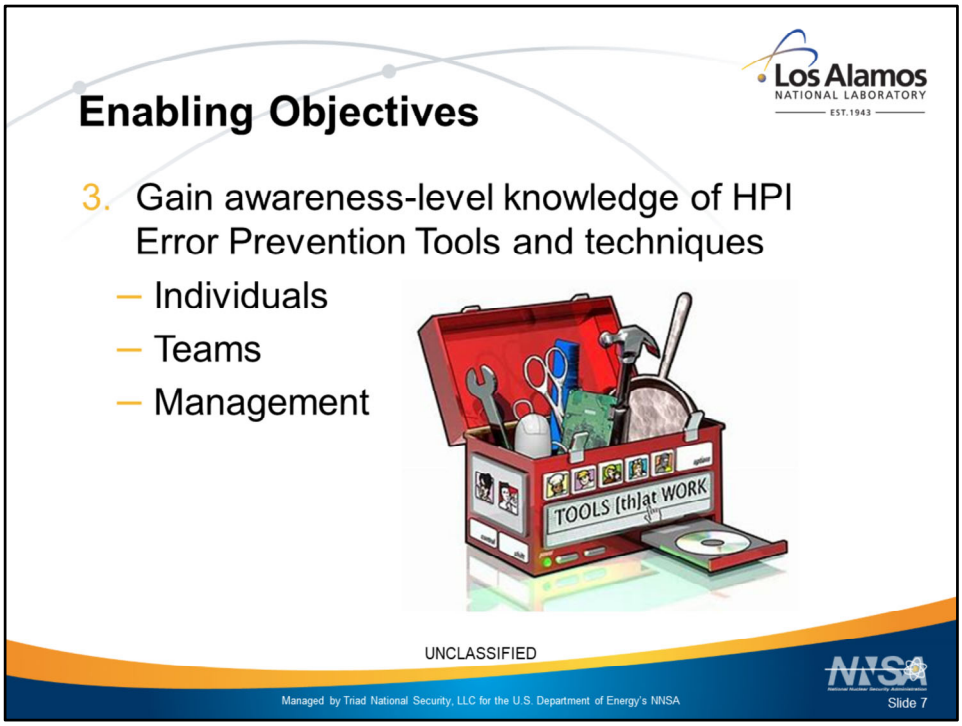
- What is HPI (Terms and Definitions)
- ISM Core Functions and how they relate to HPI
- Origins of Events
- A Strategic Approach
- Principles of Human Performance



Review Enabling objectives

2. **#2**: *Throughout this module, trainees will* gain awareness-level knowledge of HPI concepts

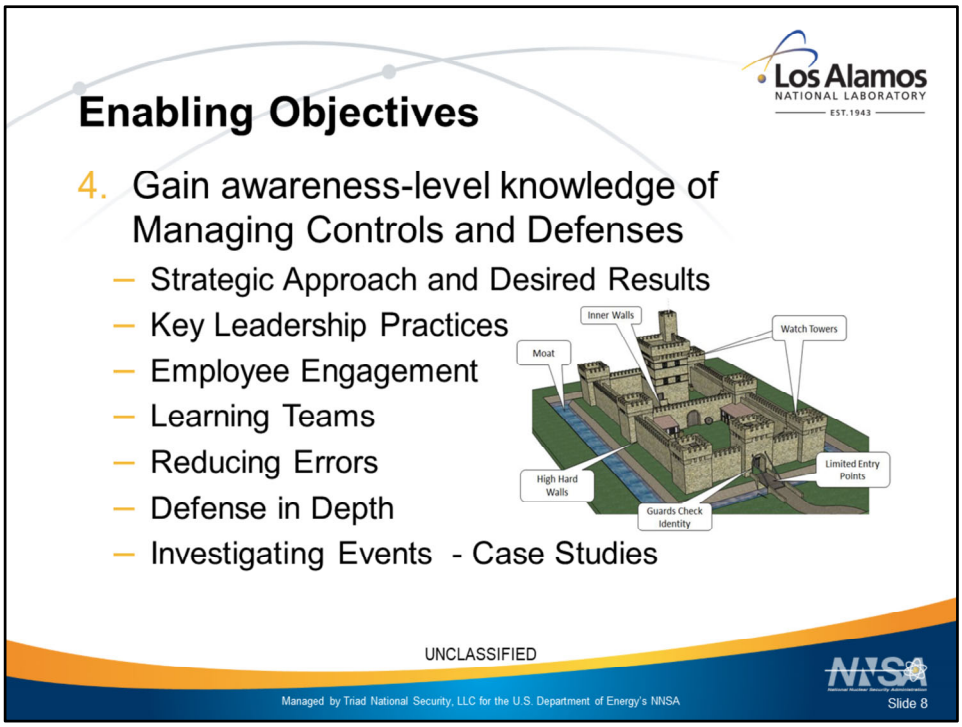
- Human Fallibility and Vulnerability
- Performance Modes
- Error-Likely situations



Review Enabling objectives

3. **#3**: *Throughout this module, trainees will gain awareness-level knowledge of HPI Error Prevention Tools and techniques*

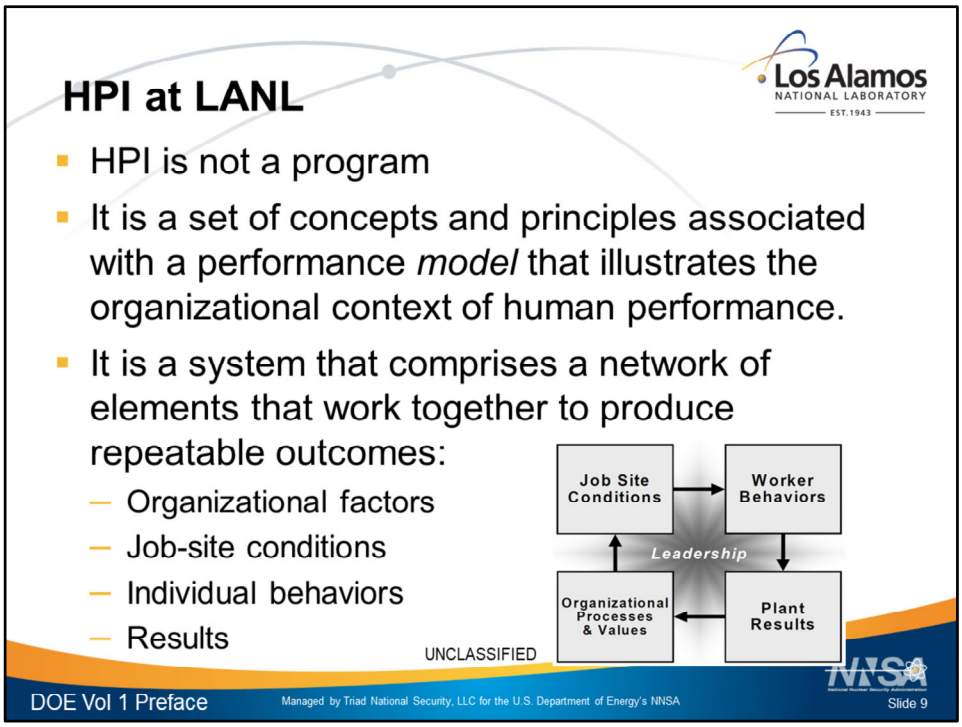
- Individuals
- Teams
- Management



Review Enabling objectives

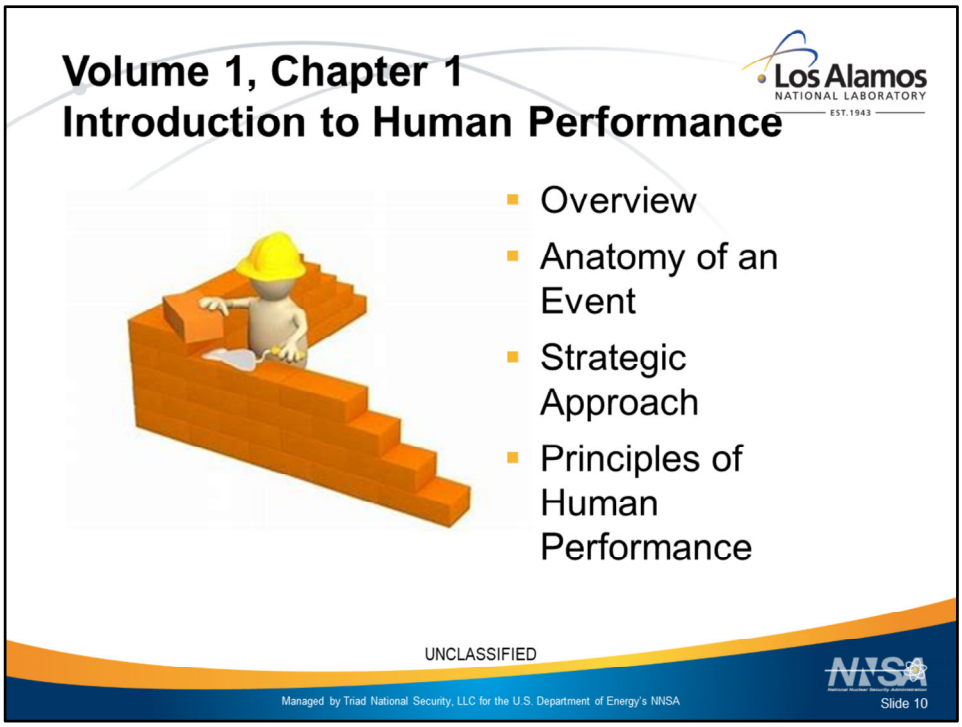
#4: *Throughout this module, trainees will* gain awareness-level knowledge of Managing Controls and Defenses

- Strategic Approach and Desired Results
- Key Leadership Practices
- Employee Engagement
- Learning Teams
- Reducing Errors
- Defense in Depth
- Investigating Events - Case Studies

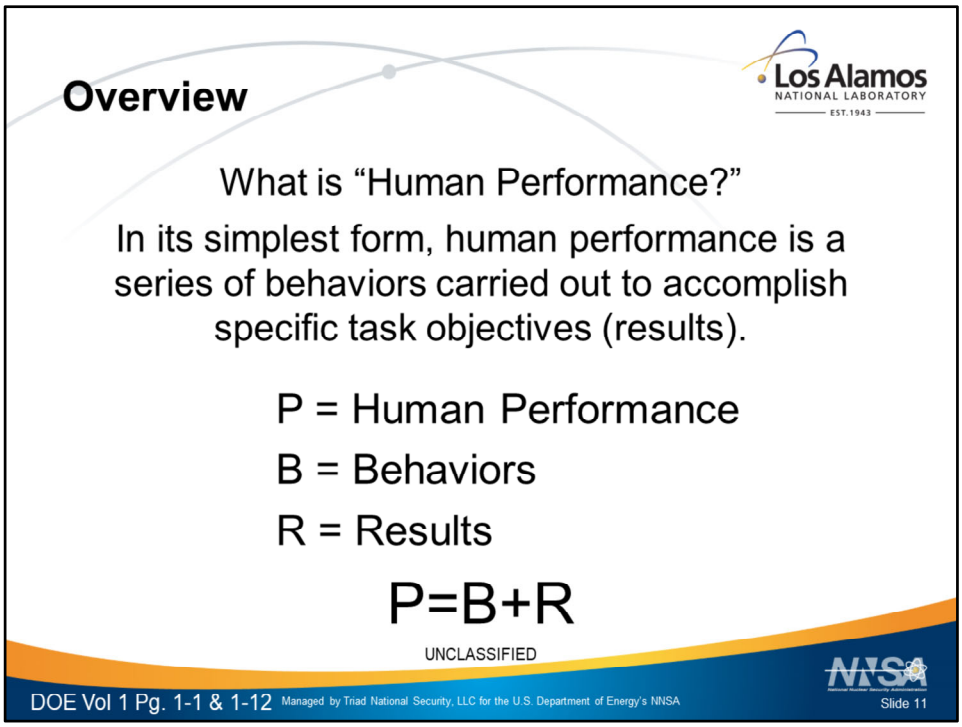


DOE, Volume 1 Preface

Human performance improvement (HPI) **is not a program per se**, such as Six Sigma, Total Quality Management, and the like. Rather, it **is a set of concepts and principles associated with a performance *model*** that illustrates the organizational context of human performance. The model contends that human performance is a system that comprises **a network of elements that work together to produce repeatable outcomes**. The system encompasses organizational factors, job-site conditions, individual behavior, and results. The system approach puts new perspective on human error: it is not a cause of failure, alone, but rather the effect or symptom of deeper trouble in the system. Human error is not random; it is systematically connected to features of people's tools, the tasks they perform, and the operating environment in which they work.



Introduction slide for Chapter 1

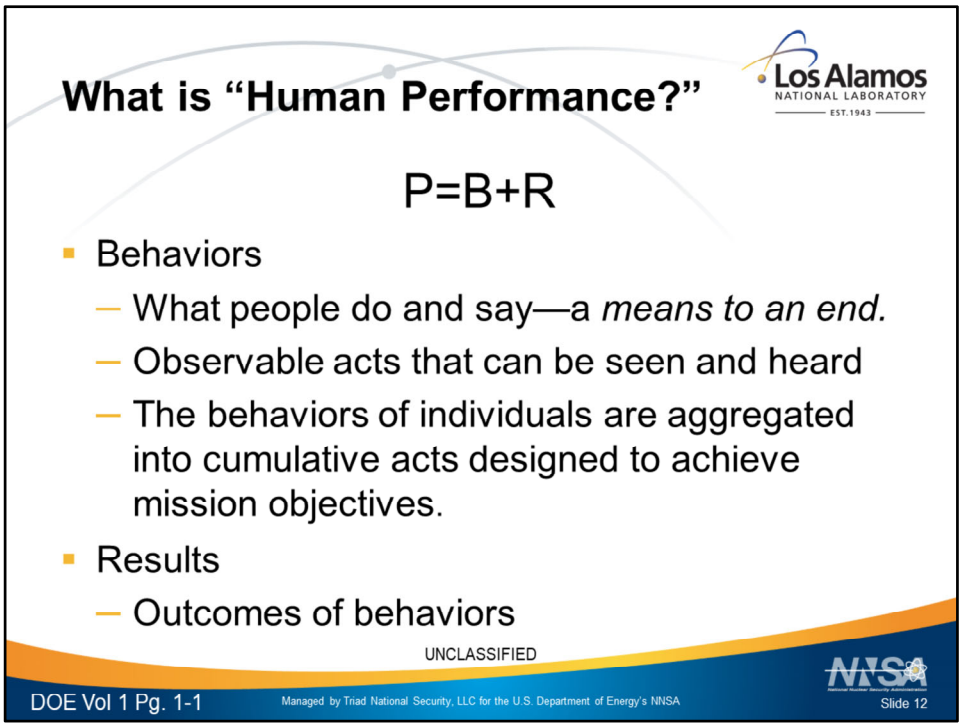


In its simplest form, **human performance is a series of behaviors** carried out **to accomplish specific task objectives (results)**. Behavior is what people do and say—it is *a means to an end*. Behaviors are observable acts that can be seen and heard. In the Department of Energy (DOE) the behaviors of operators, technicians, maintenance crafts, scientists and engineers, waste handlers, and a myriad of other professionals are aggregated into cumulative acts designed to achieve mission objectives. The primary objective of the operating facilities is the continuous safe, reliable, and efficient production of mission-specific products. At the national laboratories, the primary objectives are the ongoing discovery and testing of new materials, the invention of new products, and technological advancement. The storage, handling, reconfiguration, and final repository of the legacy nuclear waste materials, as well as decontamination, decommissioning, and dismantling of old facilities and support operations used to produce America's nuclear defense capabilities during the Cold War are other significant mission objectives. Improving human performance is a key in improving the performance of production facilities, performance of the national laboratories, and performance of cleanup and restoration.

It is not easy to anticipate exactly how trivial conditions can influence individual performance. Error-provoking aspects of facility* design, procedures, processes, and human nature exist everywhere. No matter how efficiently equipment functions; how good the training, supervision, and procedures; and how well the best worker, engineer, or manager performs his or her duties, *people cannot perform better than the organization supporting them.* Human error is caused not only by normal human fallibility, but also by incompatible management and leadership practices

and organizational weaknesses in work processes and values. Therefore, defense-in-depth with respect to the human element is needed to improve the resilience of programmatic systems and to drive down human error and events.

The aviation industry, medical industry, commercial nuclear power industry, U.S. Navy, DOE and its contractors, and other high-risk, technologically complex organizations have adopted human performance principles, concepts, and practices to consciously reduce human error and bolster controls in order to reduce accidents and events. However, performance I improvement is not limited to safety. Organizations that have adopted human performance improvement (HPI) methods and practices also report improved product quality, efficiency, and productivity. HPI, as described in this handbook and practiced in the field, is not so much a program as **it is a distinct way of thinking.** This handbook seeks to improve understanding about human performance and to set forth recommendations on how to manage it and improve it to prevent events triggered by human error.



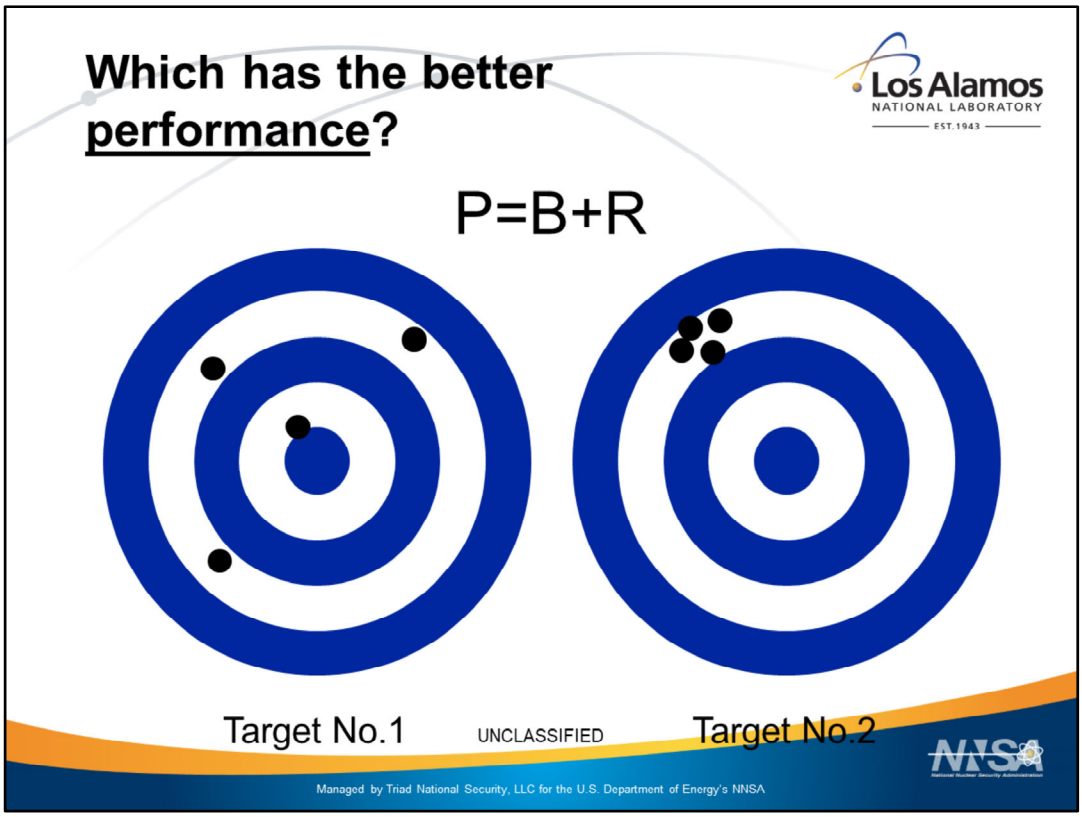
Behavior:
Behavior is what people do and say—a means to an end.

Behavior is an observable act that can be seen and heard, and it can be measured. Consistent behavior is necessary for consistent results. For example, a youth baseball coach cannot just shout at a 10-year old pitcher from the dugout to "throw strikes." The child may not know how and will become frustrated. To be effective, the coach must teach specific techniques—behaviors—that will help the child throw strikes more consistently. This is followed up with effective coaching and positive reinforcement. Sometimes people will make errors despite their best efforts. Therefore, behavior and its causes are extremely valuable as the signal for improvement efforts to anticipate, prevent, catch, or recover from errors. For long-term, sustained good results, a close observation must be conducted of what influences behavior, what motivates it, what provokes it, what shapes it, what inhibits it, and what directs it, especially when handling facility equipment.

Results:
Performance infers measurable results.

Results, good or bad, are the outcomes of behavior encompassing the mental processes and physical efforts to perform a task. Within DOE, the "end" is that set of outcomes manifested by people's health and well-being; the environment; the safe, reliable, and efficient production of

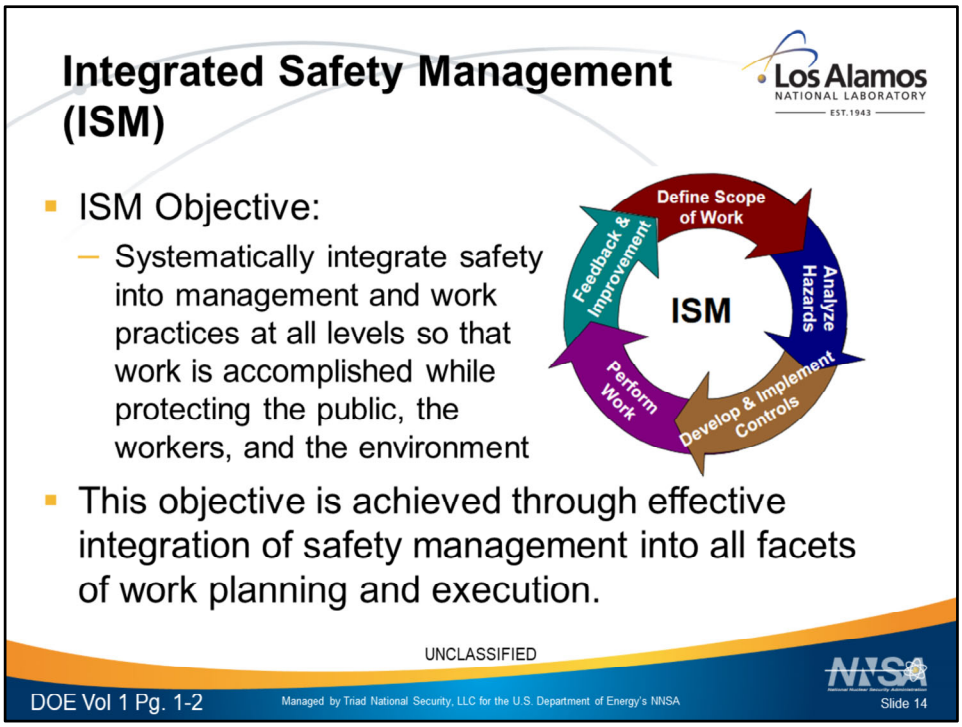
defense products; the discovery of new scientific knowledge; the invention and testing of new products; and the disposition of legacy wastes and facilities. Events usually involve such things as challenges to reactor safety (where applicable), industrial/radiological safety, environmental safety, quality, reliability, and productivity. Event-free performance is the desired result, but is dependent on reducing error, both where people touch the facility and where they touch the paper (procedures, instructions, drawings, specifications, and the like). Event-free performance is also dependent on ensuring the integrity of controls, controls, barriers, and safeguards against the residual errors that still occur.



Human performance is the combination of behavior and results

A security officer was participating in the annual firearms recertification. One of the tasks was to carefully fire six shots at the bull's-eye from the prone position with a rifle supported. No additional instructions were provided. Immediate feedback on where their shots hit the target was not provided.
Based on the results of the guard's performance as shown below on the target, develop your group's conclusions in the following areas:

observed performance (target)
performance level (procedure, skill, or knowledge?)
observable and non-observable behaviors (while firing the weapon)
potential reasons for performance
possible ways to improve performance



INTEGRATED SAFETY MANAGEMENT AND HPI

DOE developed and began implementation of Integrated Safety Management (ISM) in 1996. Since that time, the Department has gained significant experience with its implementation. This experience has shown that the basic framework and substance of the Department's ISM program remains valid. The experience also shows that substantial variances exist across the complex regarding familiarity with ISM, commitment to implementation, and implementation effectiveness. The experience further shows that more clarity of DOE's role in effective ISM implementation is needed. Contractors and DOE alike have reported that clearer expectations and additional guidance on annual ISM maintenance and continuous improvement processes are needed.

Since 1996, external organizations that are also performing high-hazard work, such as commercial nuclear organizations, Navy nuclear organizations, National Aeronautics and Space Administration, and others, have also gained significant experience and insight relevant to safety management. The ISM core function of "feedback and improvement" calls for DOE to learn from available feedback and make changes to improve. This concept applies to the ISM program itself. Lessons learned from both internal and external operating experience are reflected in the ISM Manual to update the ISM program.

The ISM Manual should be viewed as a natural evolution of the ISM program, using feedback for improvement of the ISM program itself. Two significant sources of external lessons learned have contributed to that Manual: (1) the research and conclusions related to high-reliability organizations (HRO) and (2) the research and conclusions related to the human performance

improvement (HPI) initiatives in the commercial nuclear industry, the U.S. Navy, and other organizations. HRO and HPI tenets are very complementary with ISM and serve to extend and clarify the program's principles and methods.

As part of the ISM revitalization effort, the Department wants to address known opportunities for improvement based on DOE experience and integrate the lessons learned from HRO organizations and HPI implementation into the Department's existing ISM infrastructure. The Department wants to **integrate the ISM core functions, ISM principles, HRO principles, HPI principles and methods, lessons learned, and internal and external best safety practices into a proactive safety culture where**:

- facility operations are recognized for their excellence and high-reliability;
- everyone accepts responsibility for their own safety and the safety of others;
- organization systems and processes provide mechanisms to identify systematic weaknesses and assure adequate controls; and
- continuous learning and improvement are expected and consistently achieved.

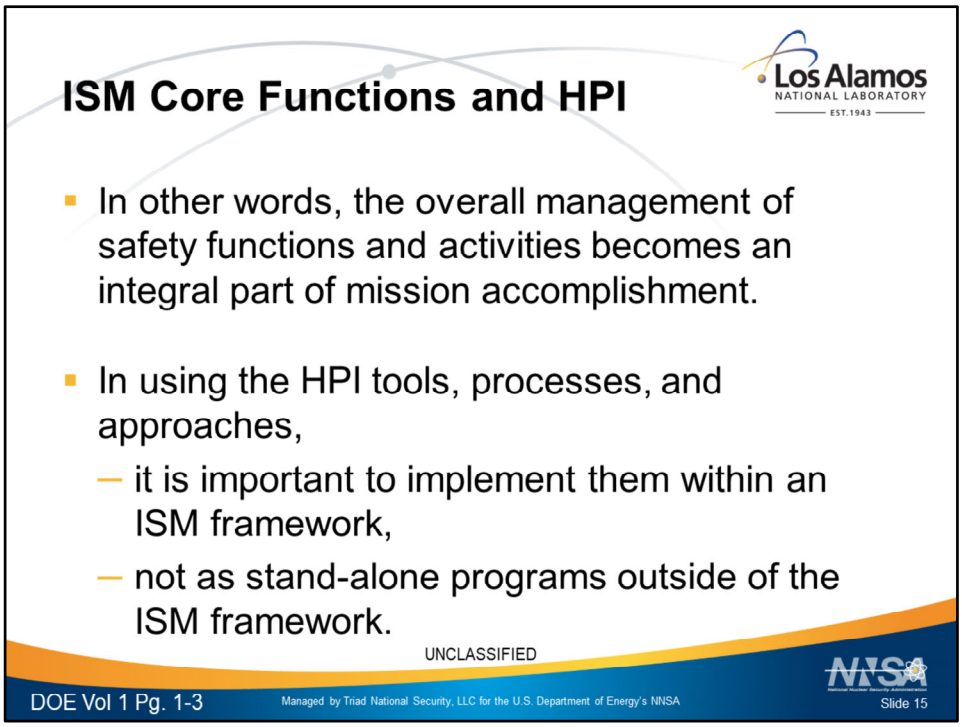
The revitalized ISM system is expected to define and drive desired safety behaviors in order to help DOE and its contractors create world-class safety performance. In using the tools, processes, and approaches described in this HPI handbook**, it is important to implement them within an ISM framework, not as stand-alone programs outside of the ISM framework. These tools cannot compete with ISM, but must support ISM.** To the extent that these tools help to clarify and improve implementation of the ISM system, the use of these tools is strongly encouraged. The relationship between these tools and the ISM principles and functions needs to be clearly understood and articulated in ISM system descriptions if these tools impact on ISM implementation. It is also critical that the vocabulary and terminology used to apply these tools be aligned with that of ISM. Learning organizations borrow best practices whenever possible, but they must be translated into terms that are consistent and in alignment with existing frameworks.

SD100

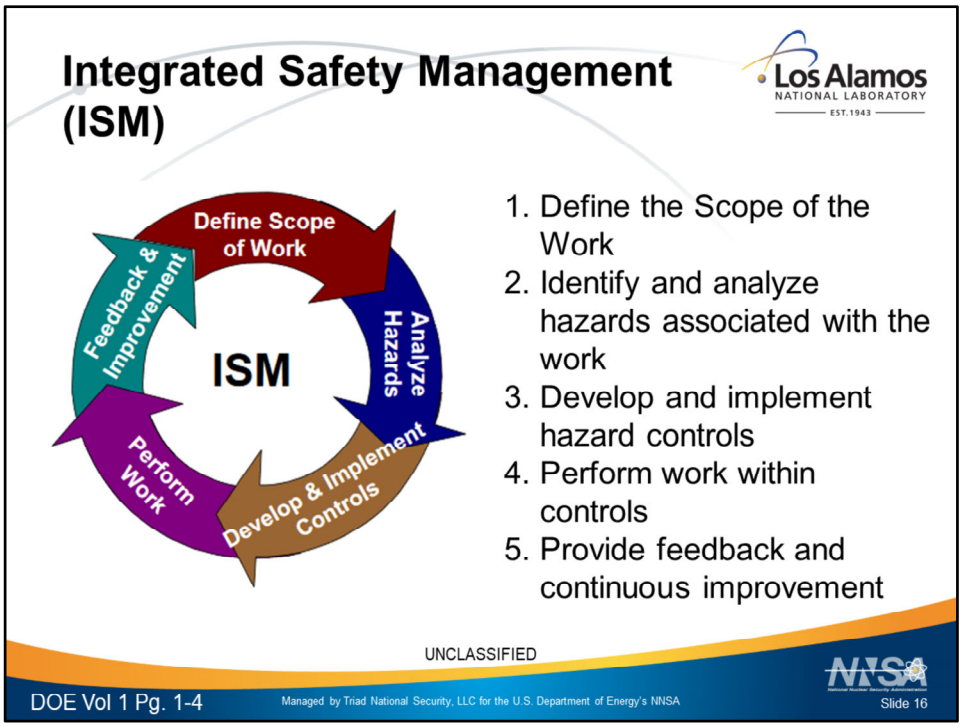
The Integrated Safety Management System (ISMS) is the Los Alamos National Laboratory (LANL or the Laboratory) system that integrates all facets of the LANL work environment into a cohesive program integrating safety, environment, security, and quality requirements. These requirements form the basis for LANL's work management processes. Integrated Safety Management (ISM) is a concept used to integrate safety into the work performed. This concept includes guiding principles and core functions outlined by the Department of Energy (DOE) for implementation at DOE sites. These guiding principles and core functions flow through the organization to the sites, facilities, and workers.

This ISMS description serves as a roadmap explaining the relationship of the various systems, processes, programs, and philosophies it is integrated with and that provide the foundation of the system. It communicates our approach for ensuring protection of the public, workers, and the environment, consistent with the Department of Energy Acquisition Regulation (DEAR) 970.5223-1, *Integration of Environment, Safety, and Health into Work Planning and Execution* (see Attachment A).

Section 3.9.1 – Human Performance Improvement



These tools cannot compete with ISM, but must support ISM. To the extent that these tools help to clarify and improve implementation of the ISM system, the use of these tools is strongly encouraged. The **relationship between these tools and the ISM principles and functions needs to be clearly understood and articulated in ISM system descriptions if these tools impact on ISM implementation**. It is also critical that the vocabulary and terminology used to apply these tools be aligned with that of ISM. Learning organizations borrow best practices whenever possible, but they must be translated into terms that are consistent and in alignment with existing frameworks.



Five core functions of ISM

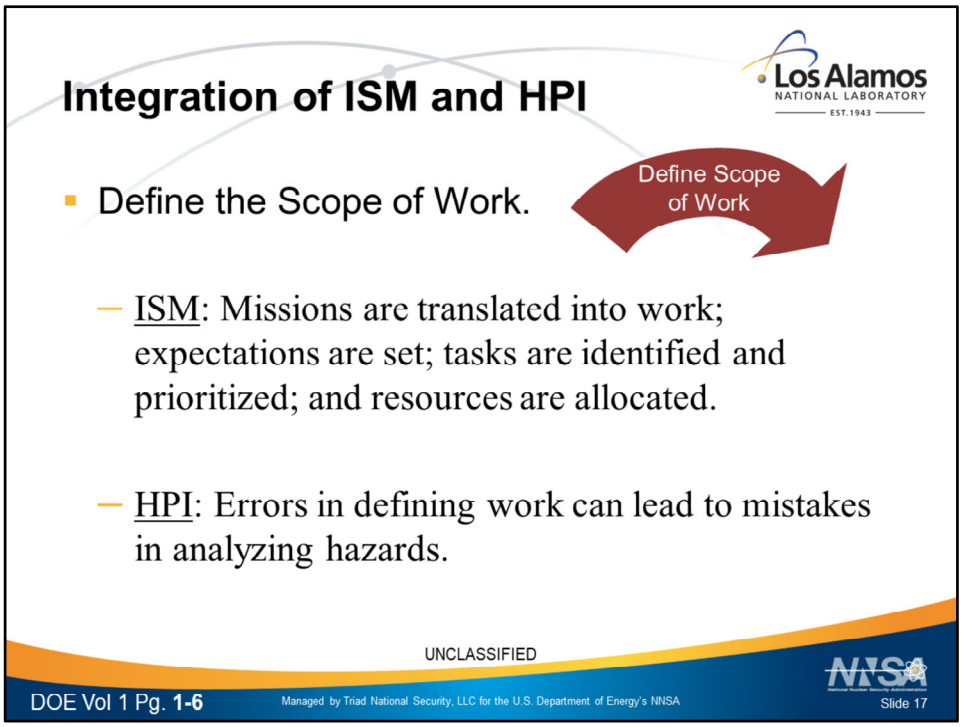
1. **Define the scope of work.** What are you going to do? Work planning should consider what might go wrong.
2. **Identify and analyze hazards associated with the work.** What are the hazards to people, environment, and equipment? Anticipate human errors and put defenses in place.
3. **Develop and implement hazard controls.** How can the hazards be eliminated/mitigated?
4. **Perform work within controls.** Follow the plan that incorporates the controls and be aware of any new hazards
5. **Provide feedback and continuous improvement.** Make sure people who need to know are aware of successes and issues.

Guiding principles of ISM

1. **Line Management Responsibility for Safety.** Create an environment that enables worker involvement and informed decision making. Verify that operations are safe before authorizing work.
2. **Clear Roles and Responsibilities**. Operational boundaries are clearly defined and interfaces among entities (e.g. organizations, facilities, laboratories) are actively managed.
3. **Competence Commensurate with Responsibilities.** Workers are aware of the limitations of their expertise and seek assistance. Multi-disciplinary teams are most effective in identifying hazards and developing controls. Involve SMEs.
4. **Balanced Priorities**. Productivity and safety can be optimized . Priorities should be set based

on objective criteria and analysis.

5. **Identification of Safety Standards and Requirements.** Line managers recognize the applicability of standards for their areas of responsibility. Workers implement requirements when planning and executing work.
6. **Hazard Controls Tailored to work being performed**. Activity level and facility level hazard analysis are implemented and safety experts are engaged in hazards identification. Unintended consequences are considered when screening hazards. Hazard controls are designed with consideration of ease of operation and understanding the potential of human error.
7. **Operations Authorization**. All work is reviewed and authorized as appropriate.
8. **Worker Involvement.** A questioning attitude that strives for risk reduction and operational efficiency. Empowerment to make informed decisions and take appropriate actions in response to an unplanned event



ISM Core Function

Define the Scope of Work

The Task Preview HPI tool supports this core function. It can be used to help eliminate error when reviewing the scope of work. During the task preview individuals who will perform the work:

- Identify the critical steps (see definition)
- Consider the possible errors associated with each critical step and the likely consequences.
- Ponder the "worst that could happen."
- Consider the appropriate human performance tool(s) to use.
- Discuss other controls, contingencies, and relevant operating experience.

This approach is intended to expand the work definition considerations and thus preclude omissions that could be overlooked during analyzing the hazards associated with the work to be accomplished.

Human Performance Improvement Strategic Approach

Reduce Human Error

When management expectations are set. the tasks are identified and prioritized,

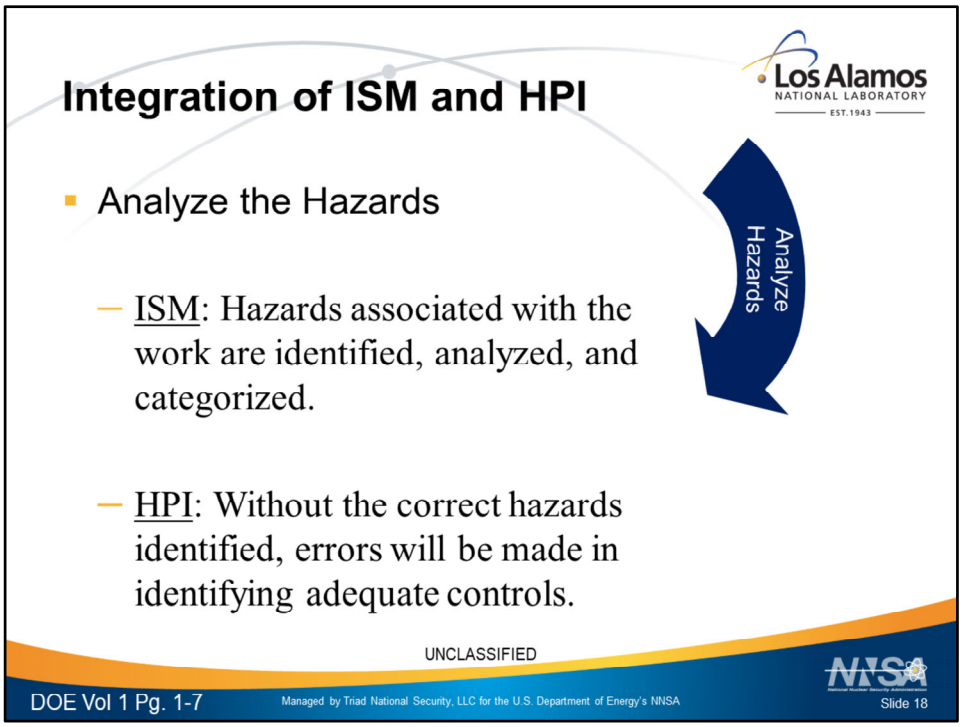
and resources are properly allocated (e.g., supervision, tools, equipment, work control, engineering support, training), human performance can flourish. These organizational factors create a unique array of job-site conditions – a good work environment – that sets people up for success**. Human error increases when expectations are not set, tasks are not clearly identified, and resources are not available to carry out the job**.

Reduce Human Error

When work scope is defined and all the preparation to complete the task is at hand, the error precursors – conditions that provoke error – are reduced. This includes things such as:

- Unexpected equipment conditions
- Workarounds
- Departures from the routine
- Unclear standards
- Need to interpret requirements

Properly managing controls is dependent on the elimination of error precursors that challenge the integrity of controls and allow human error to become consequential.



ISM Core Function

Analyze and Categorize the Hazards*

All types of hazards (e.g., nuclear, industrial, chemical) to workers, the public, and the environment.

HPI tools that support this core function including job-site review, pre-job briefing, and questioning attitude. These tools can be used to identify hazards and unsafe conditions before starting a job.

Human Performance Improvement Strategic Approach

Reduce Human Error

When hazards are properly analyzed during the ISM cycle, the results can be used to analyze the work procedure for latent weaknesses and initiate procedure changes to eliminate those weaknesses. Similarly, robust hazards analysis should consider error precursors in the work place such as:

- Adverse environmental conditions
- Unclear roles/responsibilities
- Time pressures
- High workload

- Confusing displays or controls

Reduce Human Error

- Reducing latent weaknesses in the procedures strengthens the engineering and administrative controls that are an important cornerstone of the overall defense system.
- Strong administrative and cultural controls can withstand human error. Controls are weakened when conditions are present that provoke error.
- Eliminating error precursors at the job site (in the workplace) reduces the incidences of active errors.

ISM Core Function

Develop and Implement Hazard Controls

HPI Principle 2, "Error-likely situations are predictable, manageable, and preventable," complements this ISM core function. Hazards are the markings for error-likely situations – a work situation in which there is greater opportunity for error when performing a specific action or task due to error traps. **The recognition in HPI that error-likely situations can be managed and prevented supports the ISM core function that hazards are identifiable and controllable**. HPI tools that support this core function are self-checking, peer check, procedure use and adherence.

Human Performance Improvement Strategic Approach

Reduce Human Error

The ISM core function, Implement Hazard Controls, improves conditions at the jobsite. HPI describes the job site as the location where behavior occurs during task performance and is characterized by both environmental and individual factors. Environmental factors include conditions external to the individual and often beyond his or her direct control, such as procedure quality, component labeling,

human-machine interface, heat, and humidity. Individual factors include conditions that are a function of the person assigned the task, such as knowledge, skills, experience, family problems, and color blindness.

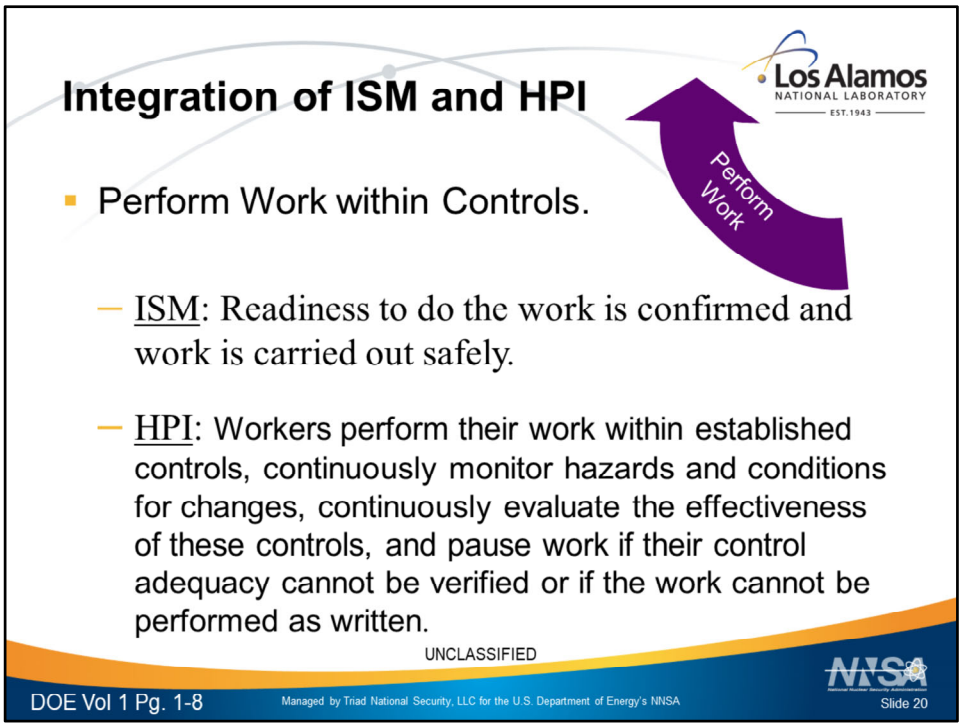
Reduce Human Error

Hazard controls initiated in the ISM framework are supplemental reinforcements to the engineered and administrative controls and barriers discussed in association with the HPI performance model. Hazard controls not only help ensure worker and environmental safety, hazard controls also relieve workers from worry, stress, and anxiety when performing work in the face of known hazards. Such conditions provoke human error and mistakes. When hazard controls are in place, worker stress and anxiety drops, human performance
improves, and human error decreases.

FROM SD100

Section 3.4.2 – Core Function 2: Identify and Analyze the Hazards

The work planning team identifies and analyzes the hazards, determines the activity hazard level, <u>anticipates human error</u>, and analyzes the impact on safety. The team's analysis is commensurate with the hazard level, potential failures of controls, equipment, utilities, facility systems, and procedures.



ISM Core Function

Perform Work

The consistent and effective use of HPI error-reduction tools when performing work **reduces the probability that an active error may cause an accident or serious event**.

Error-reduction tools include among others:

- Self-checking
- Questioning attitude
- Stop when unsure
- Effective communication
- Procedure use and adherence
- Peer-checking
- Second-person verifications
- Turnovers

Human Performance Improvement Strategic Approach

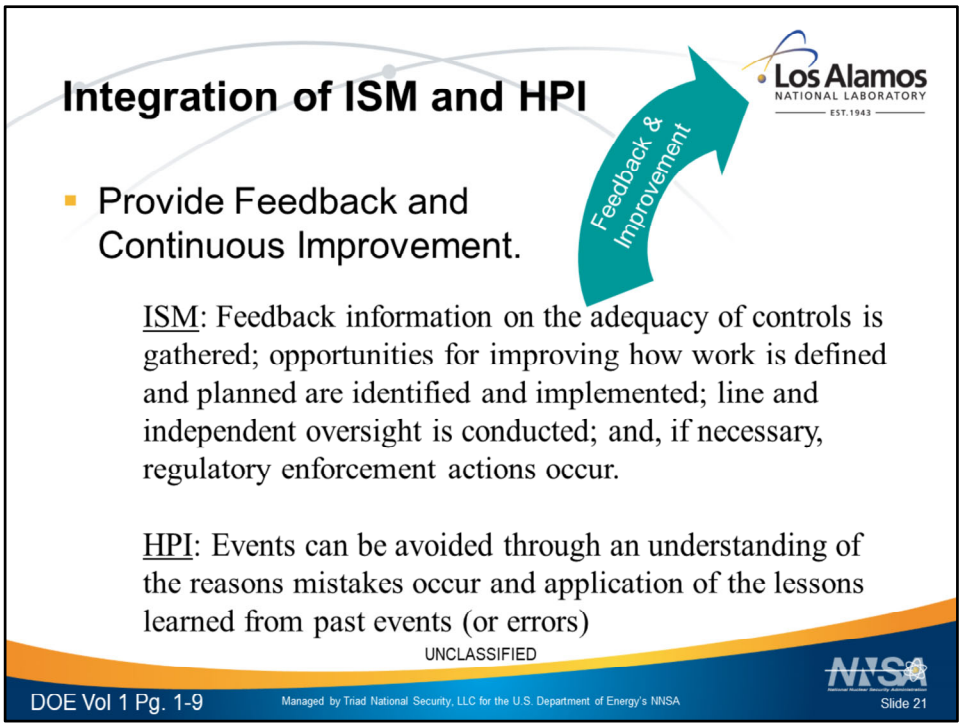
Reduce Human Error

This ISM core function supports the third HPI Principle, “Individual behavior is

influenced by organizational processes and values." When operations authorization is performed correctly, it can be used as an independent verification of the work planning and control process for specific tasks. Management can use this verification process to ensure that the organizational processes and values are in place to adequately support performance at the job-site (i.e., the task and the individuals are properly aligned and supported to successfully complete the work).

Reduce Human Error

The core value expectation that work can be performed safely is balanced by the first principle of HPI that states, "People are fallible, and even the best people make mistakes." Because people err and make mistakes, it is all the more important that controls are implemented and properly maintained.



ISM Core Function

Feedback and Improvement

The post-job review supports this ISM core function. This HPI tool can **help identify the adequacy of controls and point out opportunities for improving work planning and execution**. Topics addressed during post-job reviews includes among others:

- Surprises or unexpected outcomes.
- Usability and quality of work documents
- Knowledge and skill shortcomings
- Minor errors during the activity
- Unanticipated job-site conditions
- Adequacy of tools and resources
- Quality of work planning/scheduling
- Adequacy of supervision

Investigating Events Triggered by Human Error is an HPI **tool used to find system problems**. When a near miss or unwanted event occurs, focusing attention on problems beyond the individual – deeper within the system (e.g., engineering flaws, manufacturing flaws, weaknesses in work processes, ineffective tools, poor

work conditions, training shortfalls) helps identify latent or dormant organizational conditions, which, if left unresolved, can continue to provoke mishaps and occurrences.

Human Performance Improvement Strategic Approach

Reduce Human Error

The fifth principle of HPI is that *Events can be avoided through an understanding of the reasons mistakes occur and application of the lessons learned from past events (or errors)*.

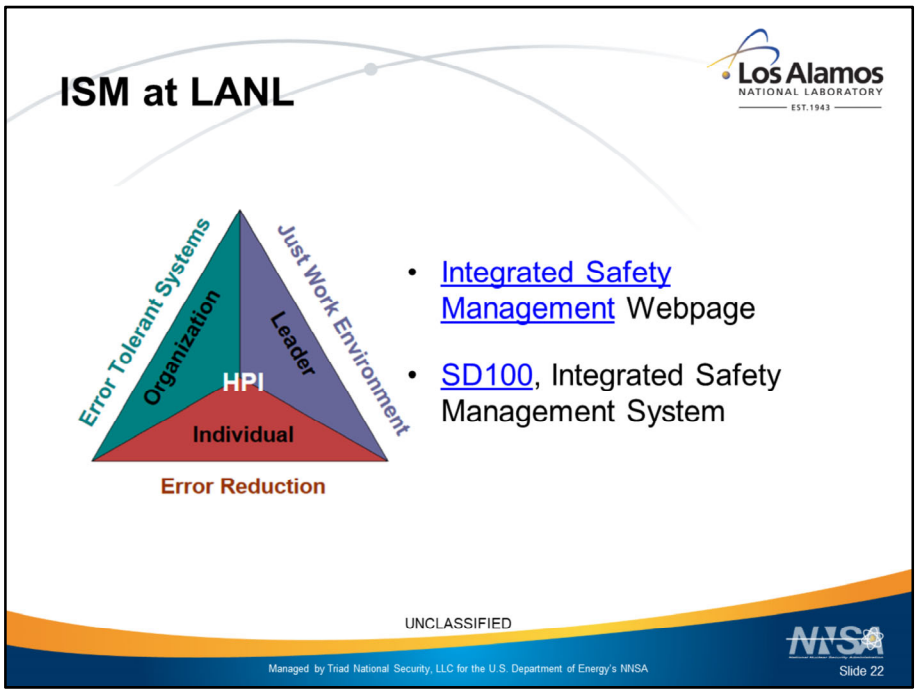
Even though errors during job performance are inevitable, they need not lead to events. Seeking to **understand the reasons non-consequential errors occur can help strengthen controls and make future performance even better**.

Line management and independent oversight are important controls that support "oversight control," the fourth line of defense in the HPI defense hierarchy, as described in Chapter 3. Volume 2, section 3, of the HPI manual describes several management tools used to identify and eliminate organizational weaknesses that weaken controls.

FROM SD100

Section 3.4.5 – Core Function 5: Provide Feedback and Continuous Improvement

Moderate-hazard and high-hazard/complex activities perform a Post-Job Review soon after completion to close out the job. The Post-Job Review and collection of lessons learned should involve a discussion among workers and the PIC to capture the positive aspects of the activities, including Human Performance Improvement concepts; identify inefficiencies, problems during the activity, procedural deficiencies, coordination issues, unanticipated conditions, and near misses; and develop recommendations for improvement.



Review SD100, section 3.9.1

3.9.1
Human Performance Improvement (HPI) HPI moves beyond traditional human error causation to an understanding that off normal events are learning opportunities. With this mind-set, human error is seen as a leading indicator that provides valuable data for predicting and preventing undesirable events and accidents and limiting the consequences if an event does occur. HPI is based on the following five principles:
1. People are fallible, and even the best people make mistakes.
2. Error-likely situations are predictable, manageable, and preventable.
3. Individual behavior is influenced by organizational processes and values.
4. People achieve high levels of performance based largely on the encouragement and reinforcement received from peers, leaders, and subordinates.
5. Events can be avoided by understanding the reasons mistakes occur and applying Lessons Learned from past events.

By applying these five principles, HPI aims to reduce operational upsets and

minimize consequences when mistakes do occur, by using human and organizational performance
concepts and principles, applying them to specific areas of expertise, improving human capabilities and reliability, conducting Learning Teams, and applying other concepts to enhance organizational resilience. This objective is expressed by the equation:

Reducing Errors + Managing Defenses→Zero Events

Re+ Md→ØE

HPI promotes an error-tolerant work environment where processes and systems are designed so that inevitable human errors (unintentional deviations from preferred behaviors) become inconsequential. Error-tolerant processes and systems are achieved by building and maintaining defenses against error and mitigating or eliminating error-provoking conditions.

The ISMS, like any system executed by human beings, is fallible and can fail to meet its objective if not defended against human error. Consider the following core functions of the ISMS.

▪ Define the Scope of Work: mistakes in defining work lead to mistakes in analyzing hazards.

▪ Identify and Analyze the Hazards: not identifying the correct hazards means controls and defenses may be ineffective.

▪ Develop and Implement Controls: without effective controls and defenses, normally inconsequential mistakes can become major operational upsets.

▪ Perform Work within Controls: Workers perform their work within established controls, continuously monitor hazards and conditions for changes, continuously evaluate the
effectiveness of these controls, and pause work if their control adequacy cannot be verified or if the work cannot be performed as written.

▪ Provide Feedback and Continuous Improvement: Learn from past operational upsets and best practices to improve performance

At each stage of the ISMS core function process, individuals, leaders, and the organization have specific behaviors that ensure the integrity and error tolerance of the ISMS, as shown in Fig. 6 and Table 1.

Individuals are all people whose work affects the organization. If their efforts contribute to the performance of the organization, their errors can ultimately lead to operational upsets. Within HPI, the objective of individuals is to identify where they are more likely to make errors and practice behaviors that reduce or mitigate them.

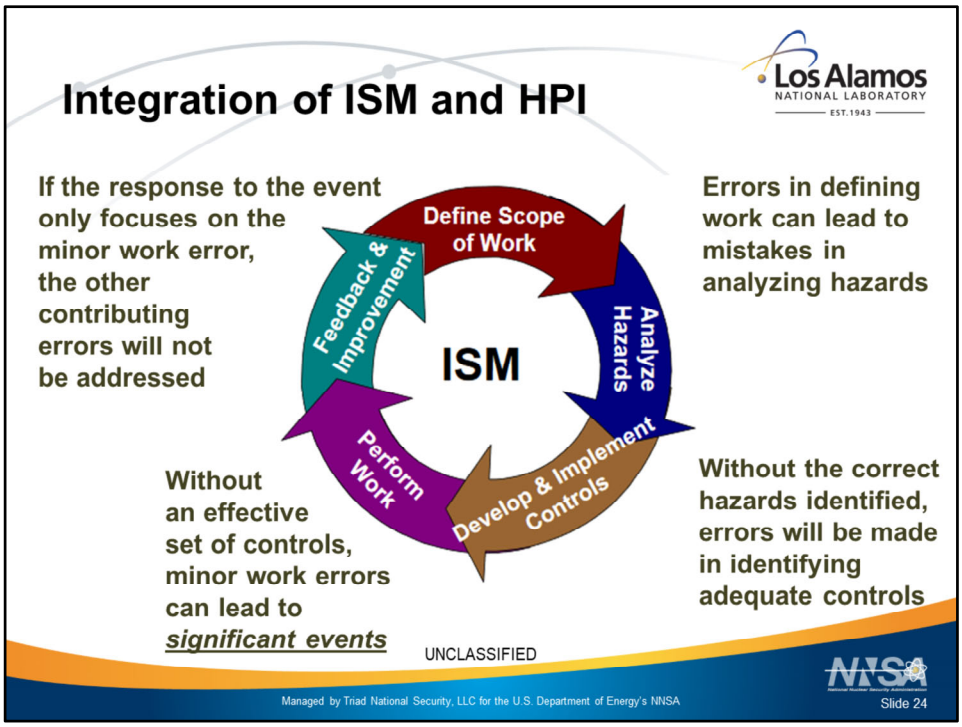
Leaders are responsible for the performance of the organization. They influence its values and policies and make decisions that shape its systems and processes. The leadership
objective within the HPI program is to create a just work environment where leaders'

embraced values encourage safe behaviors and where individuals feel safe in observing and reporting their errors.

The Organization consists of both individuals and leaders. It strives to achieve performance goals by influencing behavior and improving processes, systems, and values. Within HPI, the objective of the organization is to build and implement error-tolerant systems by identifying where errors are likely to happen and building defenses against them.

ISM at LANL

SD100: Table 1. Human Performance Improvement (HPI) Behavior			
ISMS Core Functions	Individual	Leader	Organization
Define the Scope of Work	Recognize capabilities and limitations and plan work accordingly	Communicate expectations and results	Verify that organizational goals, policies, and priorities consider workers and human performance
Identify and Analyze the Hazards	Recognize hazardous attitudes and error precursors and mitigate error-likely situations	Anticipate and identify error precursors, and mitigate error-likely situations.	Foster a culture that values prevention and recognizes error as leading data
Develop and Implement Hazard Controls	Actively identify flawed defenses and confirm layers of defenses	Anticipate flawed defenses and build layers of defense to create error-tolerant systems	Strengthen the integrity of defenses to prevent or mitigate the consequences of error.
Perform Work within Controls	Use error-reduction tools to minimize mistakes	Value the identification and reporting of errors as leading data and opportunities to learn	Preclude the development of error-likely situations
Provide Feedback and Continuous Improvement	Report errors and communicate Lessons Learned	Promote a reporting culture and communicate Lessons Learned	Create a learning environment that promotes continuous improvement



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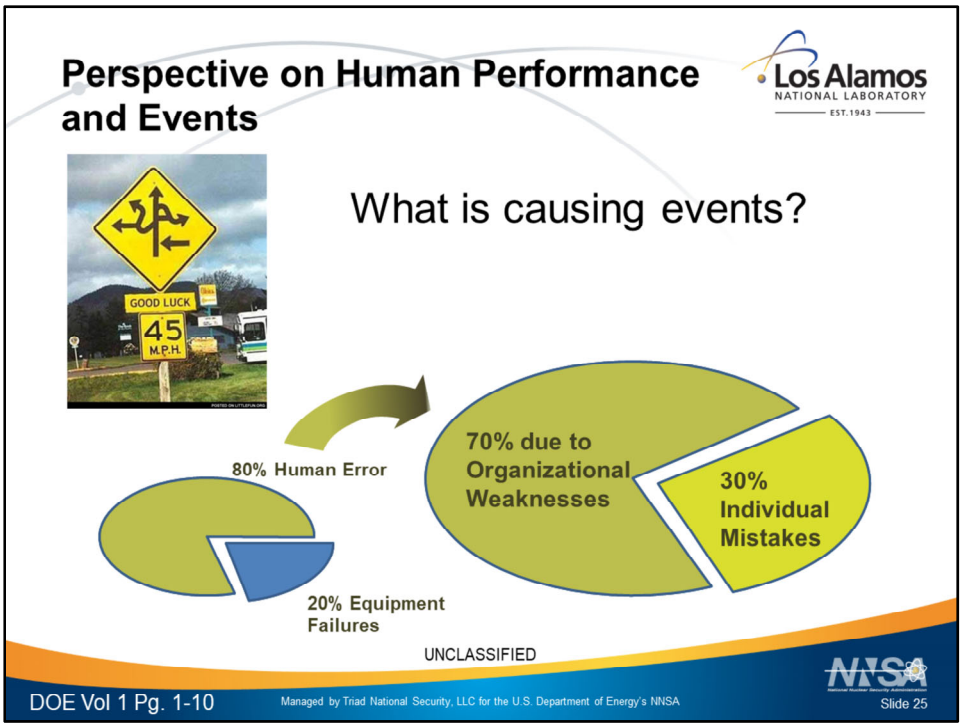


"Events are not so much the result of error-prone workers as they are the outcome of error-prone tasks and error-prone work environments, which are controlled by the Organization."

James Reason, Managing the Risks of Organizational Accidents

The graphic illustrates what is known about the role of human performance in causing events.

About 80 percent of all events are attributed to human error. In some industries, this number is closer to 90 percent. Roughly 20 percent of events involve equipment failures. When the 80 percent human error is broken down further, it reveals that the majority of errors associated with events stem from latent organizational weaknesses (perpetrated by humans in the past that lie dormant in the system), whereas about 30 percent are caused by the individual worker touching the equipment and systems in the facility. Clearly, **focusing efforts on reducing human error will reduce the likelihood of events**.

An analysis of significant events in the commercial nuclear power industry between 1995 and 1999 indicated that three of every four events were attributed to human error, as reported by INPO. Additionally, a Nuclear Regulatory Commission review of events in which fuel was damaged while in the reactor showed that human error was a common factor in 21 of 26 (81 percent) events. The report disclosed that *"the risk is in the people—the way they are trained, their level of professionalism and performance, and the way they are managed."* Human error leading to adverse consequences can be very costly: it jeopardizes an organization's ability to protect its

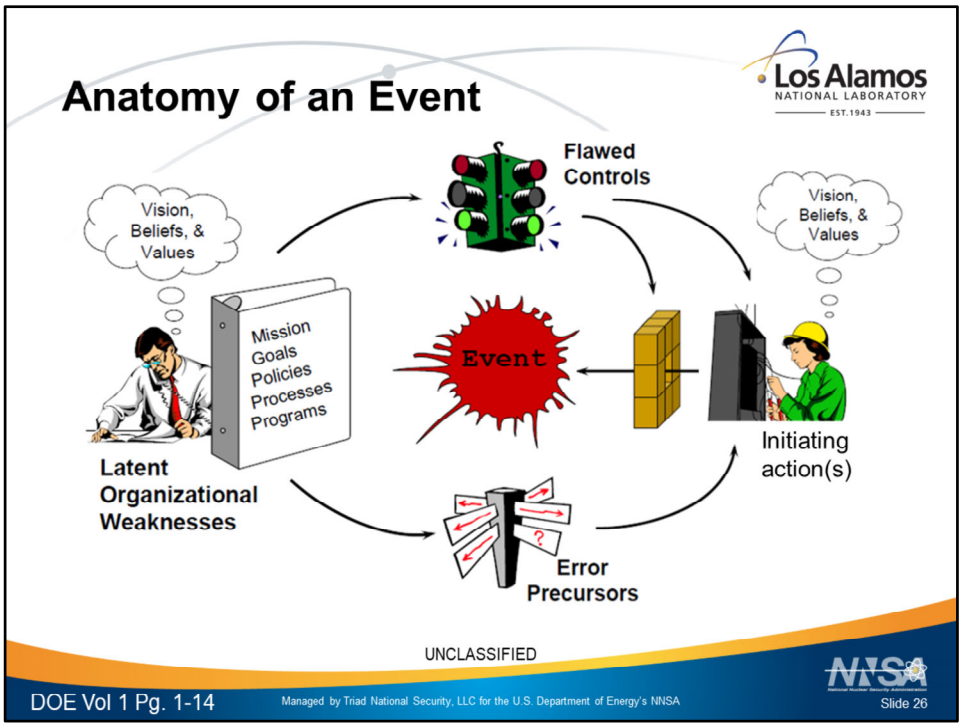
workforce, its physical facility, the public, and the environment from calamity. Human error also affects the economic bottom line. Very few organizations can sustain the costs associated with a major accident (such as, product, material and facility damage, tool and equipment damage, legal costs, emergency supplies, clearing the site, production delays, overtime work, investigation time, supervisors' time diverted, cost of panels of inquiry). It should be noted that costs to operations are also incurred from errors by those performing security, work control, cost and schedule, procurement, quality assurance, and other essential but non-safety-related tasks. Human performance remains a significant factor for management attention, not only from a safety perspective, but also from a financial one.

A traditional belief is that human performance is a worker-focused phenomenon. This belief promotes the notion that failures are introduced to the system only through the inherent unreliability of people—*Once we can rid ourselves of a few bad performers, everything will be fine. There is nothing wrong with the system*. However, **experience indicates that weaknesses in organizational processes and cultural values are involved in the majority of facility events.** Accidents result from a combination of factors, many of which are beyond the control of the worker. Therefore, the organizational context of human performance is an important consideration. **Event-free performance requires an integrated view of human performance** from those who attempt to achieve it; that is, how well management, staff, supervision, and workers function as a team and the degree of alignment of processes and values in achieving the facility's economic and safety missions.

Human Performance for Engineers and Knowledge Workers

Engineers and other knowledge-based workers contribute differently than first-line workers to facility events. A recent study completed for the Nuclear Regulatory Commission (NRC) by the Idaho National Engineering and Environmental Laboratory (INEEL) indicates that human error continues to be a causal factor in 79 percent of industry licensee events. Within those events, there were four latent failures (undetected conditions that did not achieve the desired end(s) for every active failure. More significantly, design and design change problems were a factor in 81 percent of the events involving human error. Recognizing that engineers and other knowledge-based workers make different errors, INPO developed a set of tools specific to their needs. Many of these tools have been incorporated into DOE's *Human Performance Tools* manual.

With engineers, specifically, the errors made can become significant if not caught early. As noted in research conducted at one DOE site, because engineers as a group are highly educated, narrowly focused, and have personalities that tend to be introverted and task-oriented, they tend to be critical of others, but not self-critical. If they are not self-critical, their errors may go undetected for long periods of time, sometimes years. This means that it is unlikely that the engineer who made the mistake would ever know that one had been made, and the opportunity for learning is diminished. Thus, human performance techniques aimed at this group of workers need to be more focused on the errors they make while in the knowledge-based performance mode as described in DOE Human Performance Handbook Chapter 2.



Typically, events are triggered by human action. In most cases, the human action causing the event 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. **The "Anatomy of an Event" graphic provides an illustration of the elements that exist before a typical event occurs**. Breaking the linkages may prevent events.

Event

An event, as defined earlier, is an unwanted, undesirable change in the state of facility structures, systems, or components or human/organizational conditions (health, behavior, administrative controls, environment, etc.) that exceeds established significance criteria. Events involve serious degradation or termination of the equipment's ability to perform its required function. Other definitions include: an outcome that must be undone; any facility condition that does not achieve its goals; any undesirable consequence; and a difference between what is and what ought to be.

Initiating Action

The initiating action is an action by an individual, either correct, in error, or in violation,

that results in a facility event. An *error* is an action that unintentionally departs from an expected behavior. A *violation* is a deliberate, intentional act to evade a known policy or procedure requirement and that deviates from sanctioned organizational practices. Active errors are those errors that have immediate, observable, undesirable outcomes and can be either acts of commission or omission. The majority of initiating actions are active errors. Therefore, a strategic approach to preventing events should include the anticipation and prevention of active errors.

Flawed Controls

Flawed controls are defects that, under the right circumstances, may inhibit the ability of defensive measures to protect facility 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 injury, equipment damage, environmental contamination, cost); and
- promote consistent behavior.

When an event occurs, there is either a flaw with existing controls or appropriate controls are not in place.

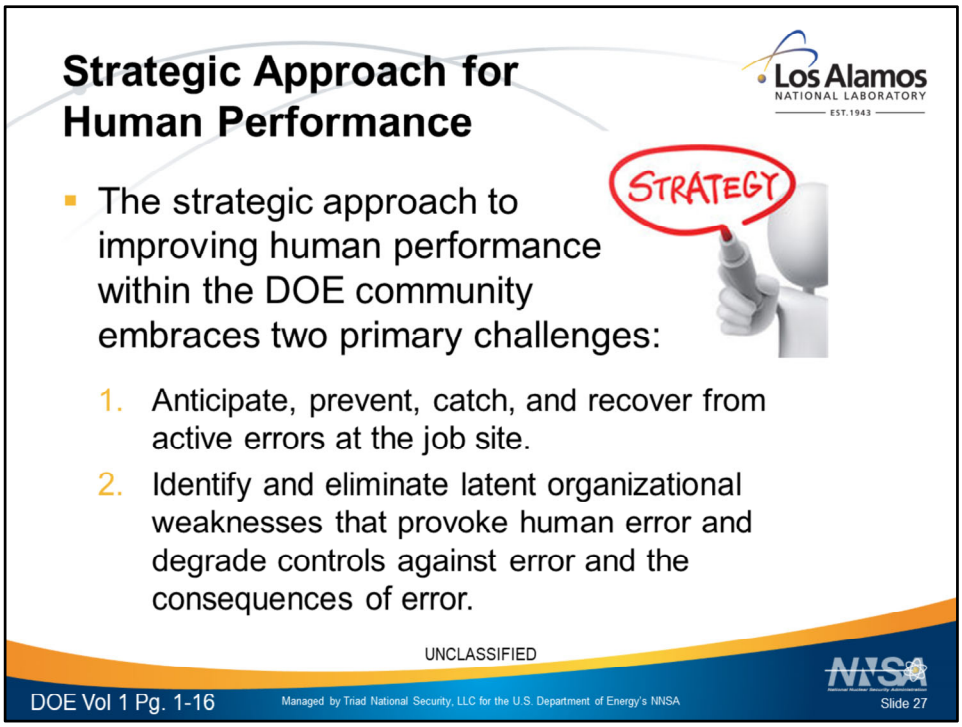
Error Precursors

Error precursors are unfavorable prior conditions at the job site that increase the probability for error during a specific action; that is, error-likely situations. An error-likely situation—an error about to happen—typically exists when the demands of the task exceed the capabilities of the individual or when work conditions aggravate the limitations of human nature. Error-likely situations are also known as error traps.

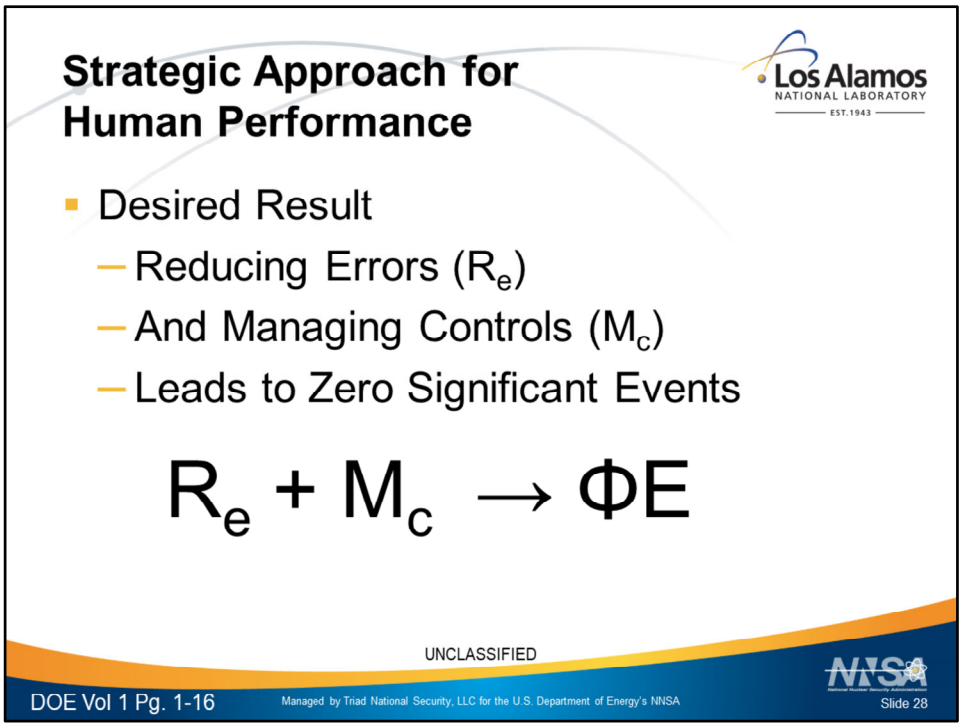
Latent Organizational Weaknesses

Latent organizational weaknesses are hidden deficiencies in management control processes (for example, strategy, policies, work control, training, and resource allocation) or values (shared beliefs, attitudes, norms, and assumptions) that create work place conditions that can provoke errors (precursors) and degrade the integrity of controls (flawed controls). Latent organizational weaknesses 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. The decisions and activities of managers and supervisors determine what is done, how well it is done, and when it is done, either contributing to the health of the system(s) or further weakening its resistance to error and events. System-level weaknesses are aggregately referred to as latent organizational weaknesses. Consequently, managers and supervisors should perform their duties

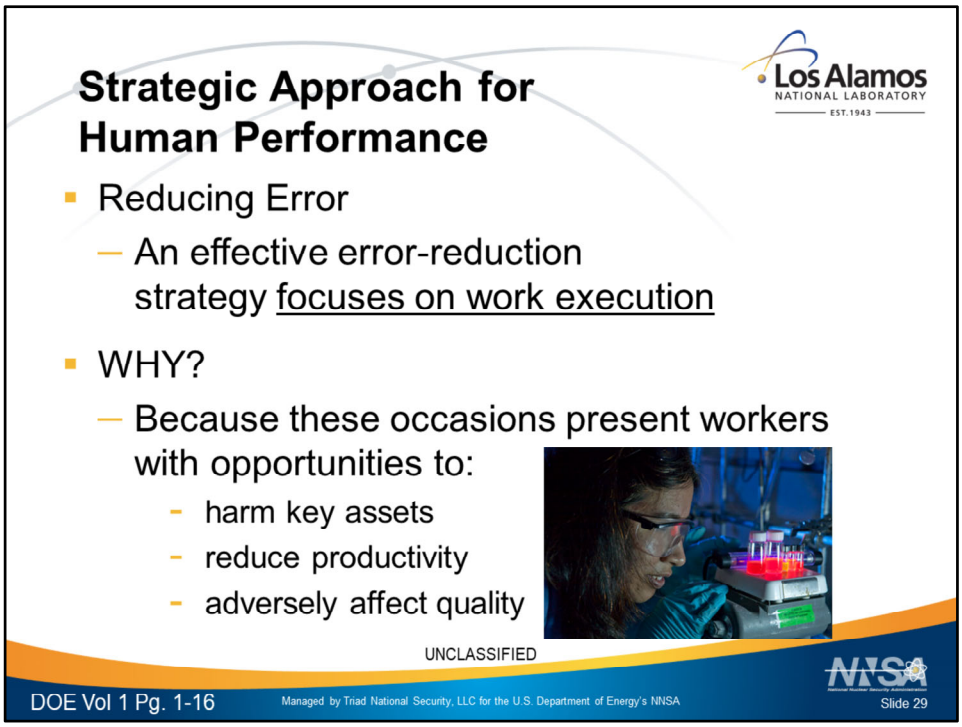
with the same uneasy respect for error-prone work environments as workers. A second strategic thrust to preventing events should be the identification and elimination of latent organizational weaknesses.



If opportunities to err are not methodically identified, preventable errors will not be eliminated. Even if opportunities to err are systematically identified and prevented, people may still err in unanticipated and creative ways. Consequently, additional means are necessary to protect against errors that are not prevented or anticipated. Reducing the error rate minimizes the frequency, but not the severity of events. Only controls can be effective at reducing the severity of the outcome of error. Defense-in-depth—controls, or safeguards arranged in a layered fashion—provides assurance such that if one fails, remaining controls will function as needed to reduce the impact on the physical facility.

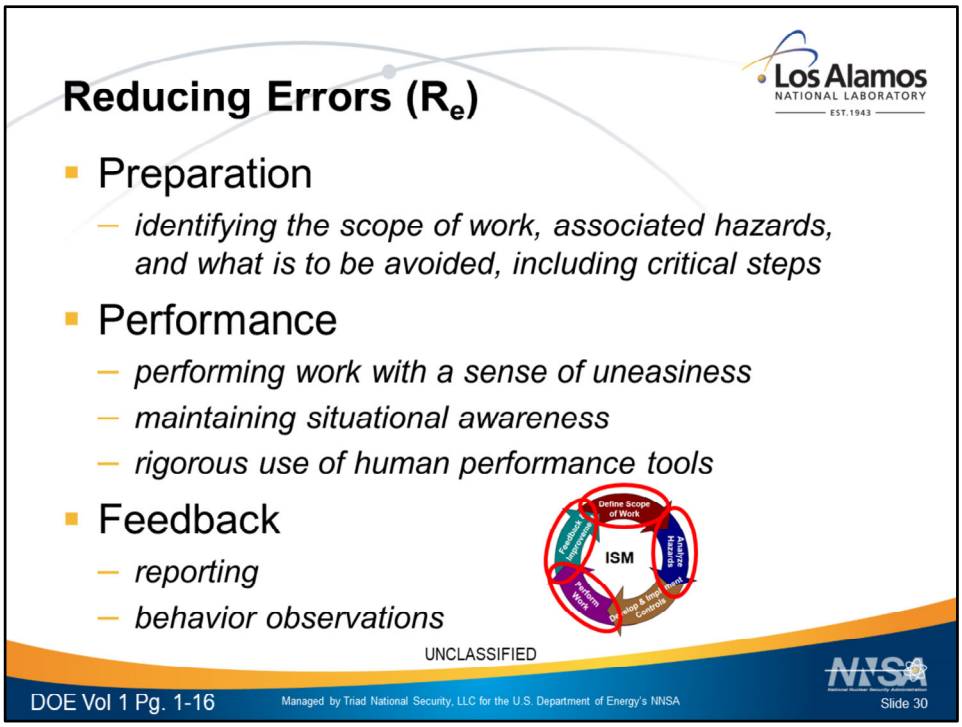


To improve human performance and facility performance, efforts should be made to (1) reduce the occurrence of errors at all levels of the organization and (2) enhance the integrity of controls, or safeguards discovered to be weak or missing. Reducing errors (Re) and managing controls (Mc) will lead to zero significant events (ØE). The formula for achieving this goal is **Re + Mc → ØE**. Eliminating significant facility events will result in performance improvement within the organization.



An effective error-reduction strategy focuses on work execution because these occasions present workers with opportunities to harm key assets, reduce productivity, and adversely affect quality through human error.

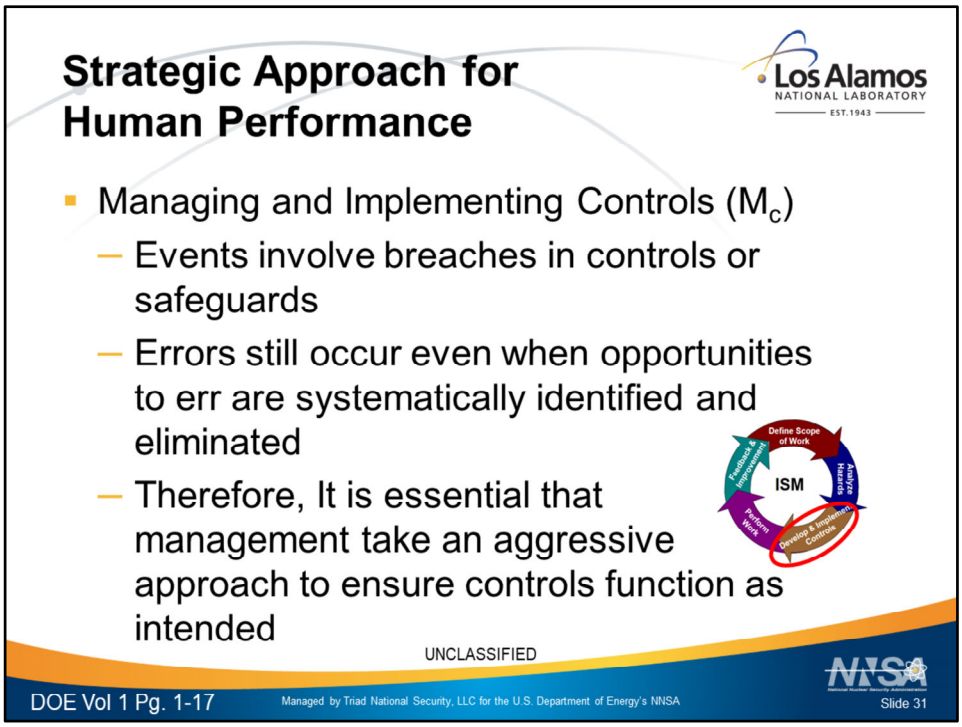
Work execution involves workers having direct contact with the facility, when they touch equipment and when knowledge workers touch the paper that influences the facility (procedures, instructions, drawings, specifications, etc.). During work execution, the human performance objective is to anticipate, prevent, or catch active errors, especially at critical steps, where error-free performance is absolutely necessary. While various work planning taxonomies may be used, opportunities for reducing error are particularly prevalent in what is herein expressed as preparation, performing and feedback.



• **Preparation** — *planning* – identifying the scope of work, associated hazards, and what is to be avoided, including critical steps; *job-site reviews* and *walkdowns* – identifying potential job-site challenges to error-free performance; *task assignment* – putting the right people on the job in light of the job's task demands; and *task previews* and *pre-job briefings* – identifying the scope of work including critical steps, associated hazards, and what has to be avoided by anticipating possible active errors and their consequences.

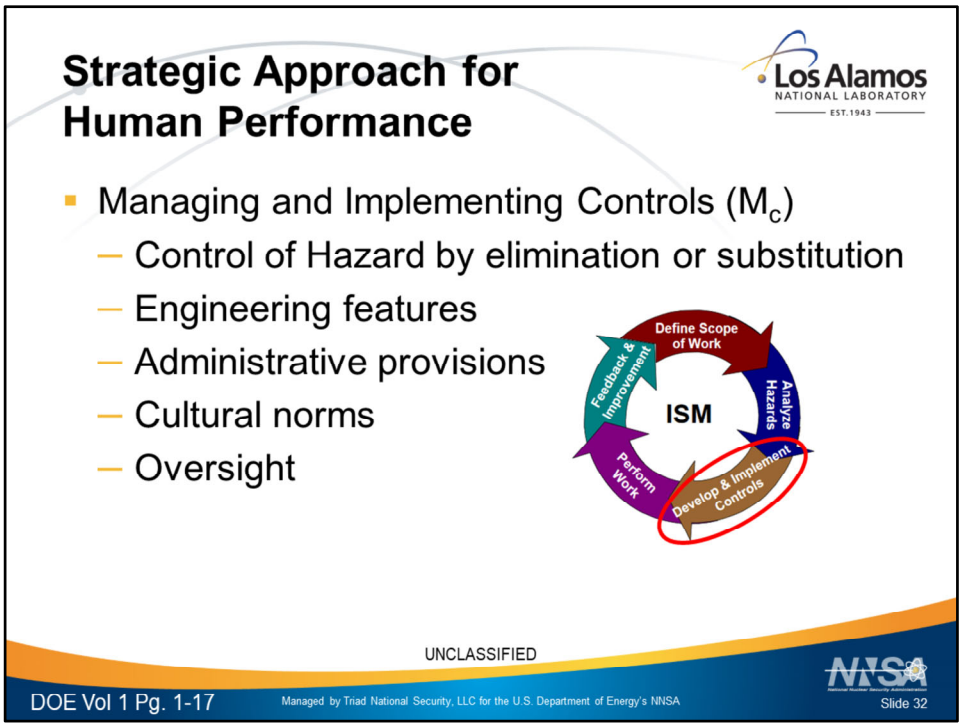
• **Performance** — performing work with a sense of *uneasiness;* maintaining *situational awareness; rigorous use of human performance tools* for important human actions, avoiding unsafe or at-risk work practices; supported with quality *supervision* and *teamwork.*

• **Feedback** — *reporting* – conveying information on the quality of work preparation, related resources, and work place conditions to supervision and management; *behavior observations* – workers receiving coaching and reinforcement on their performance in the field through observations by managers and supervisors.



Managing Controls

Events involve breaches in controls or safeguards. As mentioned earlier, errors still occur even when opportunities to err are systematically identified and eliminated. It is essential therefore that management take an aggressive approach to ensure controls function as intended. The top priority to ensure safety from human error is to identify, assess, and eliminate hazards in the workplace. These hazards are most often closely related to vulnerabilities with controls. They have to be found and corrected. The most important aspect of this strategy is an assertive and ongoing verification and validation of the health of controls. Ongoing self-assessments are employed to scrutinize controls, and then the vulnerabilities are mended using the corrective action program. A number of taxonomies of safety controls have been developed. For purposes of this discussion of the HPI strategic approach, four general types of controls are reviewed in brief.



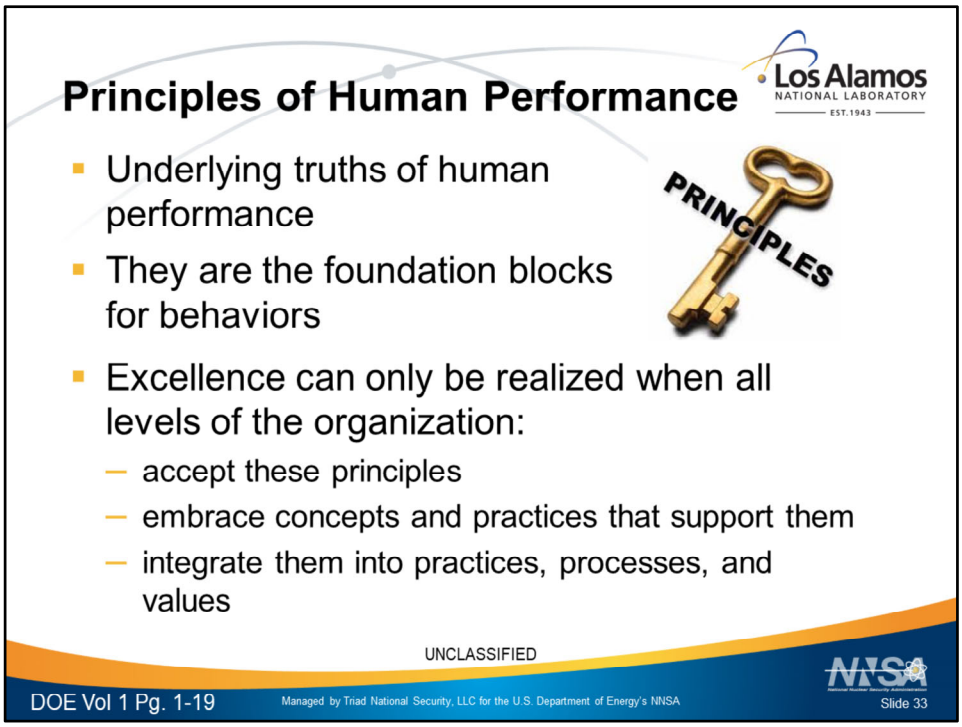
Control of Hazards by elimination or substitution – Organizations evaluate operations, procedures and facilities to identify workplace hazards. Management implements a hazard prevention and elimination process. When hazards are identified in the workplace they are prioritized and actions are taken based on risks to the workers. Management puts in place protective measures until such time as the hazard(s) can be eliminated. An assessment of the hazard control(s) is carried out to verify that the actions taken to eliminate the hazard are effective and enduring.

Engineered features— These provide the facility with the physical ability to protect from errors. To optimize this set of controls , equipment is reliable and is kept in a configuration that is resistant to simple human error and allows systems and components to perform their intended functions when required. Facilities with high equipment reliability, effective configuration control, and minimum human-machine vulnerabilities tend to experience fewer and less severe facility events than those that struggle with these issues. How carefully facility equipment is designed, operated, and maintained (using human-centered approaches) affects the level of integrity of this line of protection.

Administrative provisions— Policies, procedures, training, work practices processes, administrative controls and expectations direct people's activities so that they are predictable and safe and limit their exposure to hazards, especially for work performed in and on the facility. All together such controls help people anticipate and prepare for problems. Written instructions specify what, when, where, and how work is to be done and what personal protective equipment workers are to use. The rigor with which people follow and perform work activities according to correctly written procedures, expectations, and standards directly affects the integrity of this line of protection.

Cultural norms — These are the assumptions, values, beliefs, and attitudes and the related leadership practices that encourage either high standards of performance or mediocrity, open or closed communication, or high or low standards of performance. Personnel in highly reliable organizations practice error-prevention rigorously, regardless of their perception of a task's risk and simplicity, how routine it is, and how competent the performer. The integrity of this line of defense depends on people's appreciation of the human's role in safety, the respect they have for each other, and their pride in the organization and the facility.

Oversight — Accountability for personnel and facility safety, for security, and for ethical behavior in all facets of facility operations, maintenance, and support activities is achieved by a kind of "social contract" entered into willingly by workers and management where a "just culture" prevails. In a just culture, people who make honest errors and mistakes are not blamed while those who willfully violate standards and expectations are censured. Workers willingly accept responsibility for the consequences of their actions, including the rewards or sanctions (see "accountability" in the glossary). They feel empowered to report errors and near misses. This accountability helps verify margins, the integrity of controls and processes, as well as the quality of performance. Performance improvement activities facilitate the accountability of line managers through structured and ongoing assessments of human performance, trending, field observations, and use of the corrective action program, among others. The integrity of this line of defense depends on management's commitment to high levels of human performance and consistent follow-through to correct problems and vulnerabilities.



Five simple statements are referred to as the *principles* or underlying truths of human performance. Excellence in human performance can only be realized when individuals at all levels of the organization **accept these principles and embrace concepts and practices** that support them. These principles are the ***foundation blocks*** for the behaviors described and promoted in this handbook. **Integrating** these principles into management and leadership practices, worker practices, and the organization's processes and values will be instrumental in developing a working philosophy and implementing strategies for improving human performance within your organization.

<u>WARNING: Someone get injured in this video</u>

Error is universal. No one is immune regardless of age, experience, or educational level. The saying, "to err is human," is indeed a truism. It is human nature to be imprecise—to err. Consequently, error will happen. No amount of counseling, training, or motivation can alter a person's fallibility. Dr. James Reason, author of *Human Error* (1990) wrote: *It is crucial that personnel and particularly their managers become more aware of the human potential for errors, the task, workplace, and organizational factors that shape their likelihood and their consequences. Understanding how and why unsafe acts occur is the essential first step in effective error management.*

People are fallible, and even the best people make mistakes

Story and/or Video

When Good Pets Go Bad - Gator Bites Head An alligator trainer gets his head caught in a gator's mouth during his grand finale. **(0:59)**

<u>https://www.youtube.com/watch?v=cwemXuIHyVM&t=904s (10:50-14:25)</u>

https://www.youtube.com/watch?v=gmLNIecxe-g&t=5s

Message: There are dangers is your work location that you feel confident working with/around. Your experiences and knowledge are applied in a manner that makes you successful in the dangerous environment. You know the do's and don'ts. However, sometimes, a mistake happens and a consequence occurs.

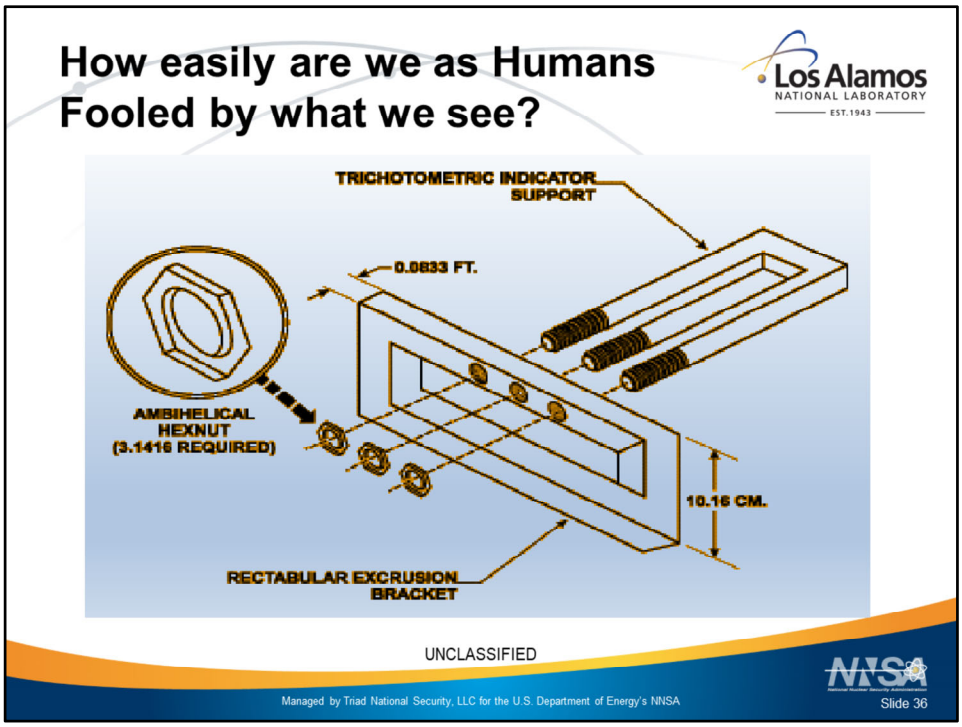
Other Options

Why We Make Mistakes and how we can avoid them (8:52, Good message from CBS

Sunday Morning) https://www.youtube.com/watch?v=oxc0u-C0XEY

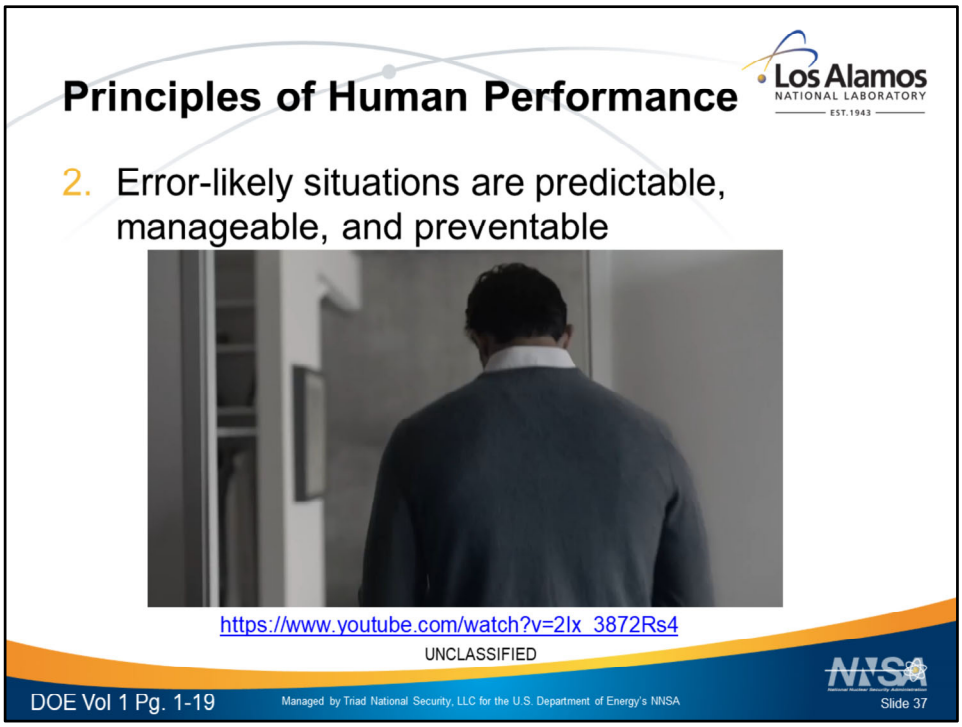
Why are we fallible?

- Pattern matchers
- Path of least resistance
- Group think (social loafing)



Have students looks for errors:

- Hex nut – optical illusion
- Plate – optical illusion
- Bolts – optical illusion
- Measurements – one is metric and the other is standard



Error-likely situations are predictable, manageable, and preventable

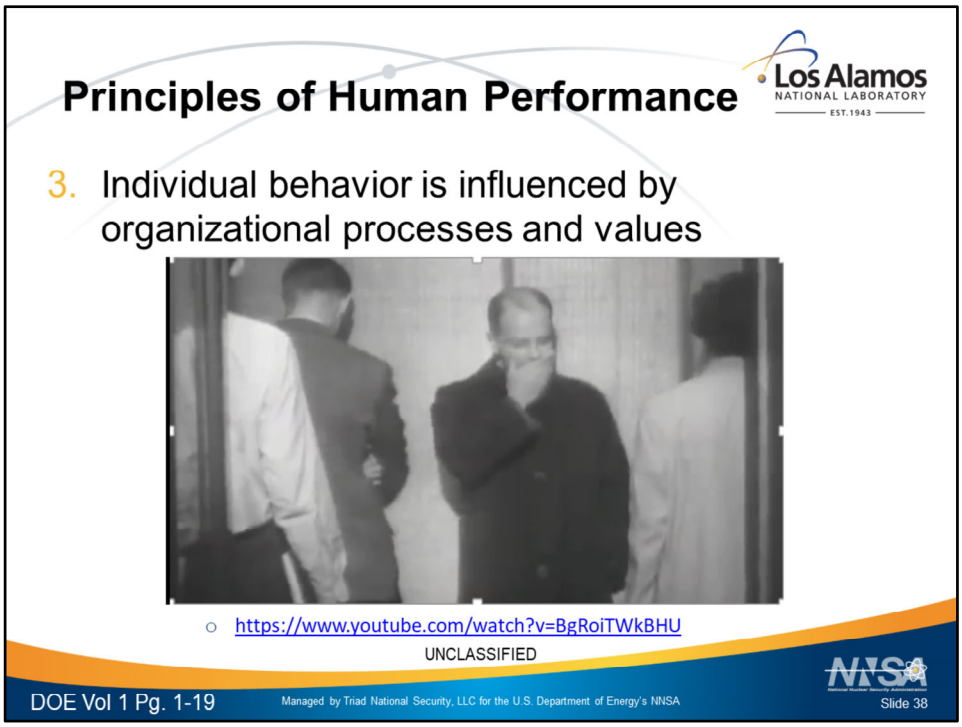
Despite the inevitability of human error in general, specific errors are preventable. Just as we can predict that a person writing a personal check at the beginning of a new year stands a good chance of writing the previous year on the check, a similar prediction can be made within the context of work at the job site. Recognizing error traps and actively communicating these hazards to others proactively manages situations and prevents the occurrence of error. By changing the work situation to prevent, remove, or minimize the presence of conditions that provoke error, task and individual factors at the job site can be managed to prevent, or at least minimize, the chance for error.

VIDEO: 2017 Lexus commercial
Nobody's perfect. That's why the Lexus RX comes with our most advanced safety features—standard. Experience it now, at your Lexus dealer.
https://www.youtube.com/watch?v=2Ix_3872Rs4

Other Options

The Exploding Whale – www.theexplodingwhale.com (2:26)

A Gator Bite to the Head is No Joke | Gator Boys (3:50, another alligator head chomp video) https://www.youtube.com/watch?v=0eiORAWH0bc



Organizations are goal-directed and, as such, their processes and values are developed to direct the behavior of the individuals in the organization. The organization mirrors the sum of the ways work is divided into distinct jobs and then coordinated to conduct work and generate deliverables safely and reliably. Management is in the business of directing workers' behaviors. Historically, management of human performance has focused on the "individual error-prone or apathetic workers." Work is achieved, however, within the context of the organizational processes, culture, and management planning and control systems. It is exactly these phenomena that contribute most of the causes of human performance problems and resulting facility events.

Individual behavior is influenced by organizational processes and values

Story and/or Video

Prudential: Everybody's Doing It (2:31, Elevator behavior experiment)

https://www.youtube.com/watch?v=BgRoiTWkBHU

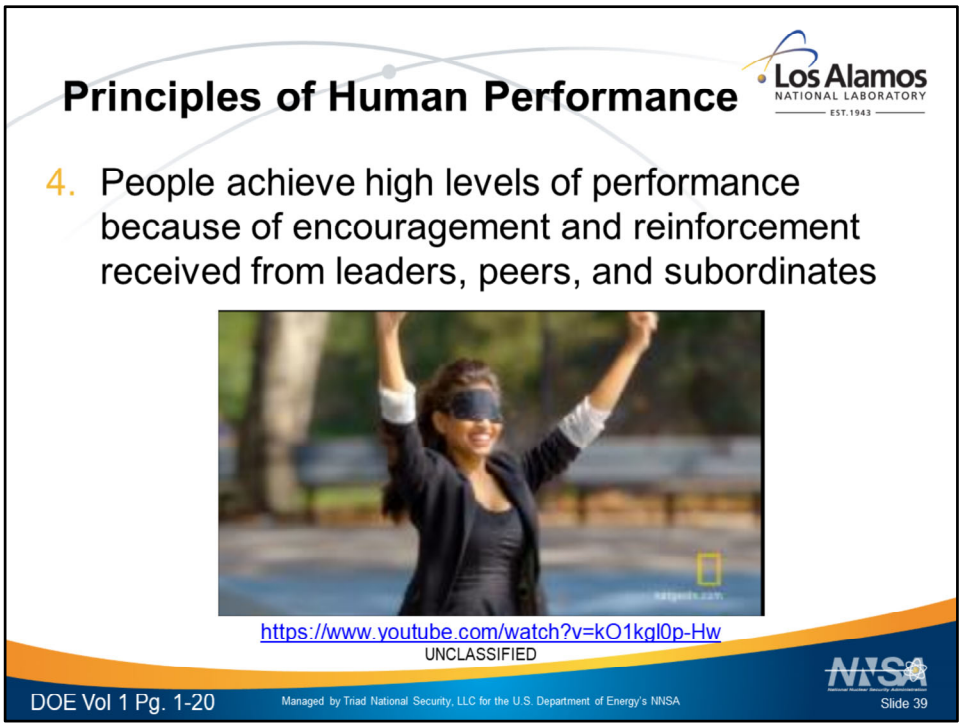
Candid Camera actors in an elevator cause unknowing participants to follow their lead. People will conform to the behaviors of those around them.

Other options:

Things That Influence Your Everyday Behavior (2:24, good examples of behavior being influenced)
https://www.youtube.com/watch?v=tbHRoHoZKxE

Top motivational speaker Jeff "Odie" Espenship on Leaders Influence behaviors of others (1:52, value of leadership influence)
https://www.youtube.com/watch?v=4S0uBqdMbTI

Peer Influence and Adolescent Behavior (4:04, inherent rewarding of peers changes behaviors – more risk taking)
https://www.youtube.com/watch?v=rt9MyNo65eI



The organization is perfectly tuned to get the performance it receives from the workforce. All human behavior, good and bad, is reinforced, whether by immediate consequences or by past experience. A behavior is reinforced by the consequences that an individual experiences when the behavior occurs. The level of safety and reliability of a facility is directly dependent on the behavior of people. Further, human performance is a function of behavior. Because behavior is influenced by the consequences workers experience, what happens to workers when they exhibit certain behaviors is an important factor in improving human performance. Positive and immediate reinforcement for expected behaviors is ideal.

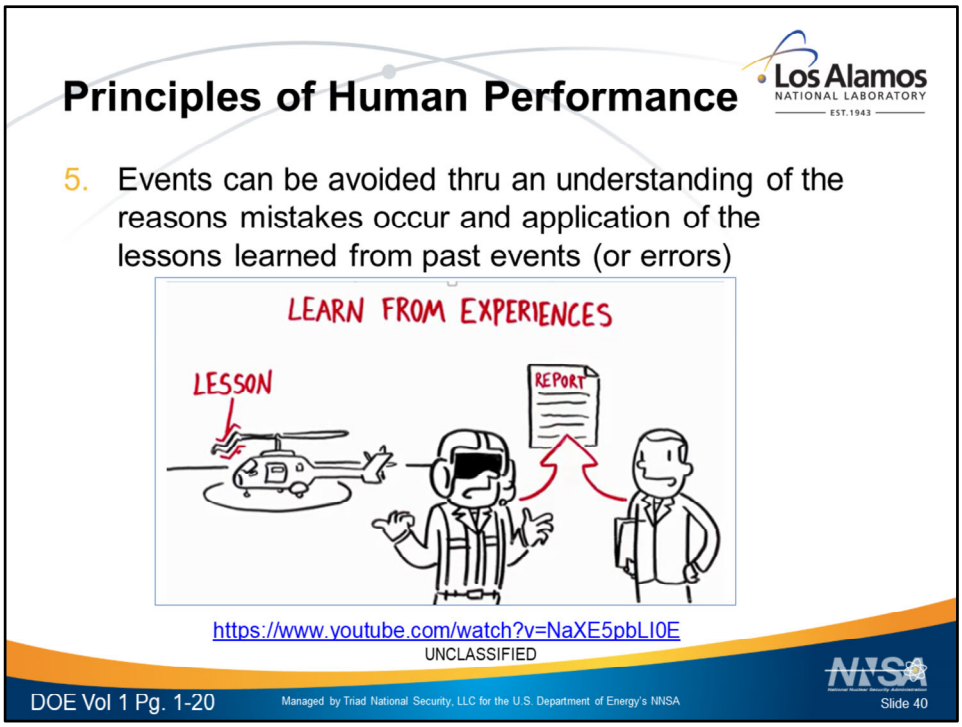
People achieve high levels of performance based largely on the encouragement and reinforcement received from leaders, peers, and subordinates

Story and/or Video

The Power of Positivity | Brain Games - See firsthand how positive and negative reinforcement can affect a player's game on the court.
https://www.youtube.com/watch?v=kO1kgl0p-Hw

ALTERNATE Video:

encouragement! (0:54, kid plays piano with concert pianist)
https://www.youtube.com/watch?v=zb8U3l9XHdY



Traditionally, improvement in human performance has resulted from corrective actions derived from an analysis of facility events and problem reports—a method that reacts to what happened in the past. Learning from our mistakes and the mistakes of others is reactive—after the fact—but important for continuous improvement. Human performance improvement today requires a combination of both proactive and reactive approaches. Anticipating how an event or error can be prevented is proactive and is a more cost-effective means of preventing events and problems from developing.

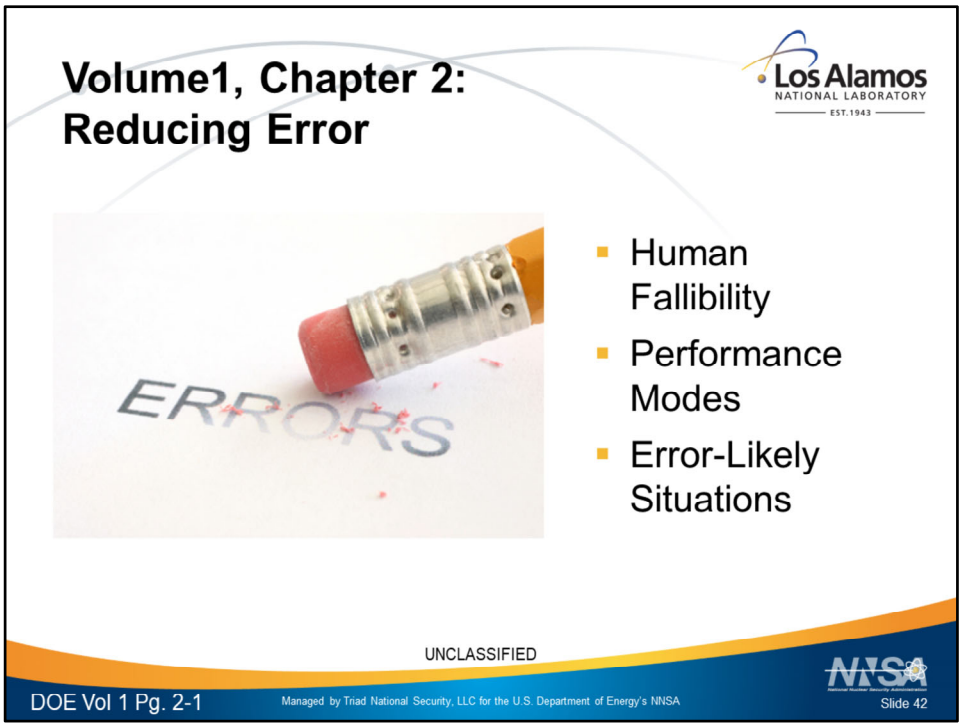
Events can be avoided through an understanding of the reasons mistakes occur and application of the lessons learned from past events (or errors)
Story and/or Video - Swiss Air video that explains principle #5

> 02 | How We Can Learn From Incidents (3:46, Swiss Air Force Investigations: why it made sense to that person, applying lessons learned, improving margin of safety) https://www.youtube.com/watch?v=NaXE5pbLI0E
> Other options: http://www.lanl.gov/safety/videos/humanbeings/human-beings2.shtml – LANL video "Human Beings 2, What happens before mistakes"

Principles of Human Performance

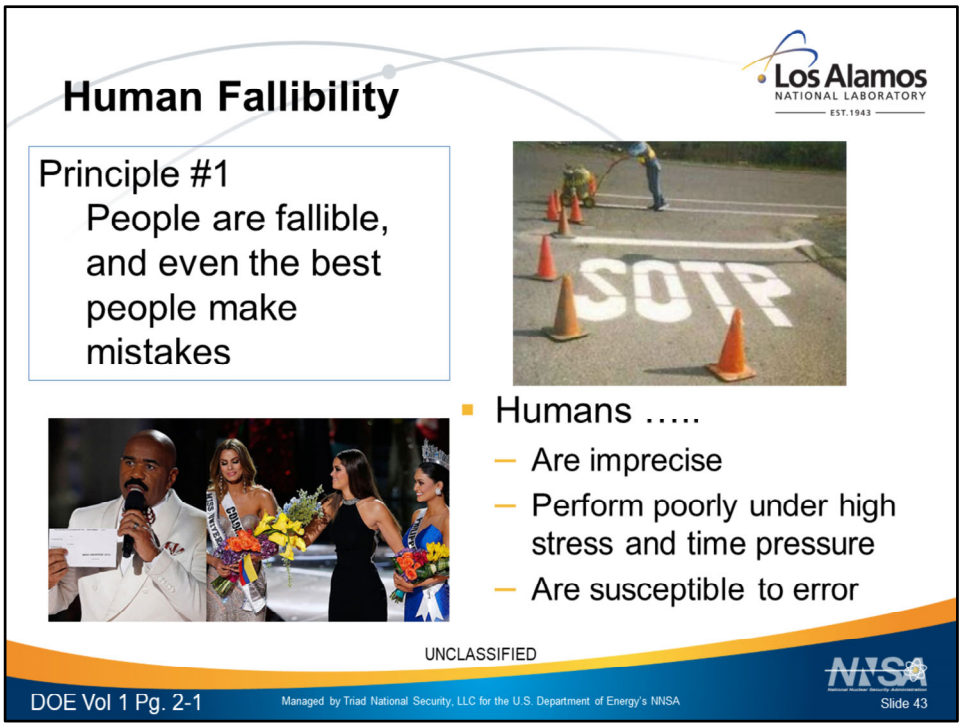
1. People are fallible, and even the best people make mistakes
2. Error-likely situations are predictable, manageable, and preventable
3. Individual behavior is influenced by organizational processes and values
4. People achieve high levels of performance because of encouragement and reinforcement received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

Review 5 principles together



INTRODUCTION slide for Chapter 2

As capable and ingenious as humans are, we do err and make mistakes. It is precisely this part of human nature that we want to explore in the first part of this chapter. This inquiry includes discussions of human characteristics, unsafe attitudes, and at-risk behaviors that make people vulnerable to errors. **A better understanding of what is behind the first principle of human performance, "people are fallible, even the best make mistakes," will help us better compensate for human error** through more rigorous use of error-reduction tools and by improving controls. Certain sections of this chapter are considered essential reading and will be flagged as such at the beginning of the section.



HUMAN FALLIBILITY (Essential Reading)

Human nature encompasses all the physical, biological, social, mental, and emotional characteristics that define human tendencies, abilities, and limitations. One of the innate characteristics of human nature is imprecision. Unlike a machine that is precise—each time, every time—people are imprecise, especially in certain situations. For instance, humans tend to perform poorly under high stress and time pressure. Because of "fallibility," human beings are vulnerable to external conditions that cause them to exceed the limitations of human nature. Vulnerability to such conditions makes people susceptible to error. Susceptibility to error is augmented when people work within complex systems (hardware or administrative) that have concealed weaknesses—latent conditions that either provoke error or weaken controls against the consequences of error.

PICTURES:

- (Lower Left) Steve Harvey announces wrong winner in Miss Universe 2015 pageant and admits his mistake.

Phrase Recall Exercise

Inform the students that they will see three familiar phrases.
They will be visible for 10 seconds and then disappear.
After which the instructor will ask students “what did you see?”

OPTIONAL:
Count out load to make “time pressure” more real.

BIRD
IN THE
THE HAND

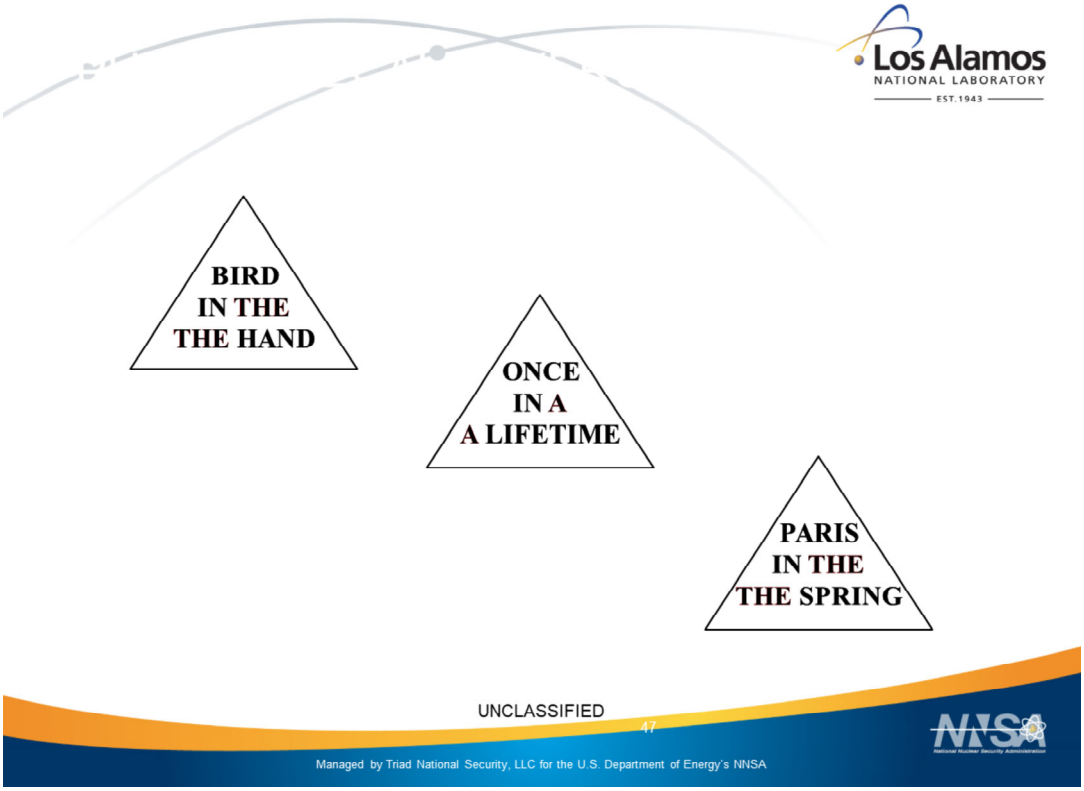
ONCE
IN A
A LIFETIME

PARIS
IN THE
THE SPRING

10

What did you See!

Have a discussion about what the students saw.
If someone identifies the double word, ask others if they saw it to.
If no-one identifies double word, ask if there was anything strange about the phrases.
If necessary, have a student READ the words out loud until they identify the double words



We see what we expect to see
Point out that each phrase has a duplicate word.
Demonstrate that 10 seconds is adequate time by going bac to timed slide and read EACH word at a normal pace.
Ask about induced (self-imposed) time pressure.

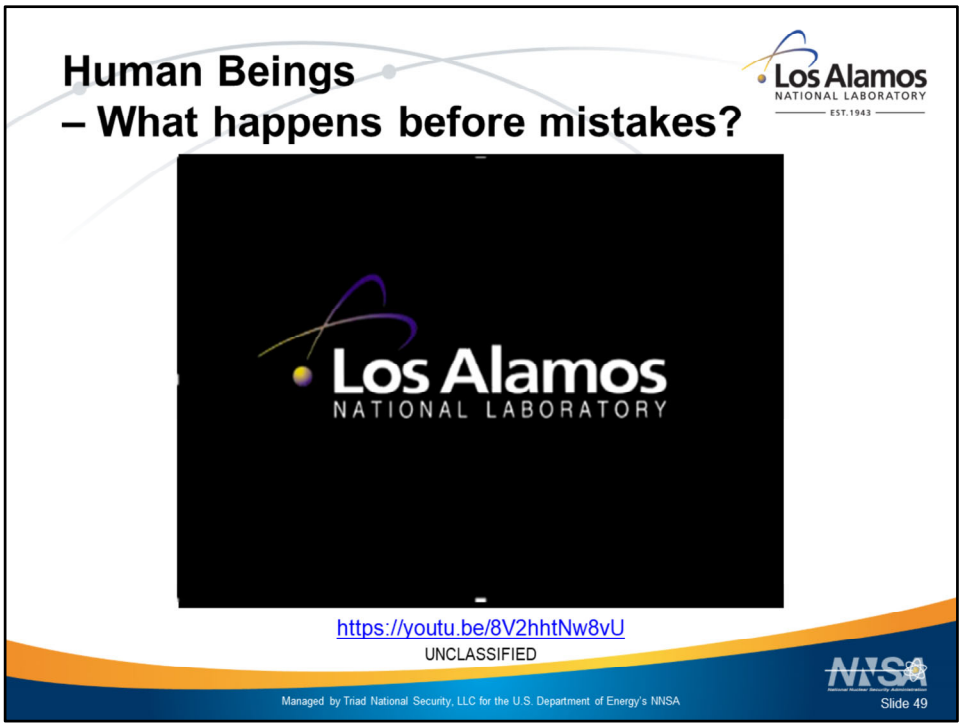
Stress. Stress in itself is not a bad thing. Some stress is normal and healthy. Stress may result in more focused attention, which in some situations could actually be beneficial to performance. The problem with stress is that it can accumulate and overpower a person, thus becoming detrimental to performance. Stress can be seen as the body's mental and physical response to a perceived threat(s) in the environment. The important word is perceived; the perception one has about his or her ability to cope with the threat. Stress increases as familiarity with a situation decreases. It can result in panic, inhibiting the ability to effectively sense, perceive, recall, think, or act. Anxiety and fear usually follow when an individual feels unable to respond successfully. Along with anxiety and fear, memory lapses are among the first symptoms to appear. The inability to think critically or to perform physical acts with accuracy soon follows.

Avoidance of Mental Strain. Humans are reluctant to engage in lengthy concentrated thinking, as it requires high levels of attention for extended periods. Thinking is a slow, laborious process that requires great effort. Consequently, people tend to look for familiar patterns and apply well-tried solutions to a problem. There is the temptation to settle for satisfactory solutions rather than continue seeking a better solution. The mental biases, or shortcuts, often used to reduce mental effort and expedite decision-making include:

- **Assumptions** – A condition taken for granted or accepted as true without verification of the facts.
- **Habit** – An unconscious pattern of behavior acquired through frequent repetition.
- **Confirmation bias** – The reluctance to abandon a current solution—to change one's mind— in

light of conflicting information due to the investment of time and effort in the current solution. This bias orients the mind to “see” evidence that supports the original supposition and to ignore or rationalize away conflicting data.

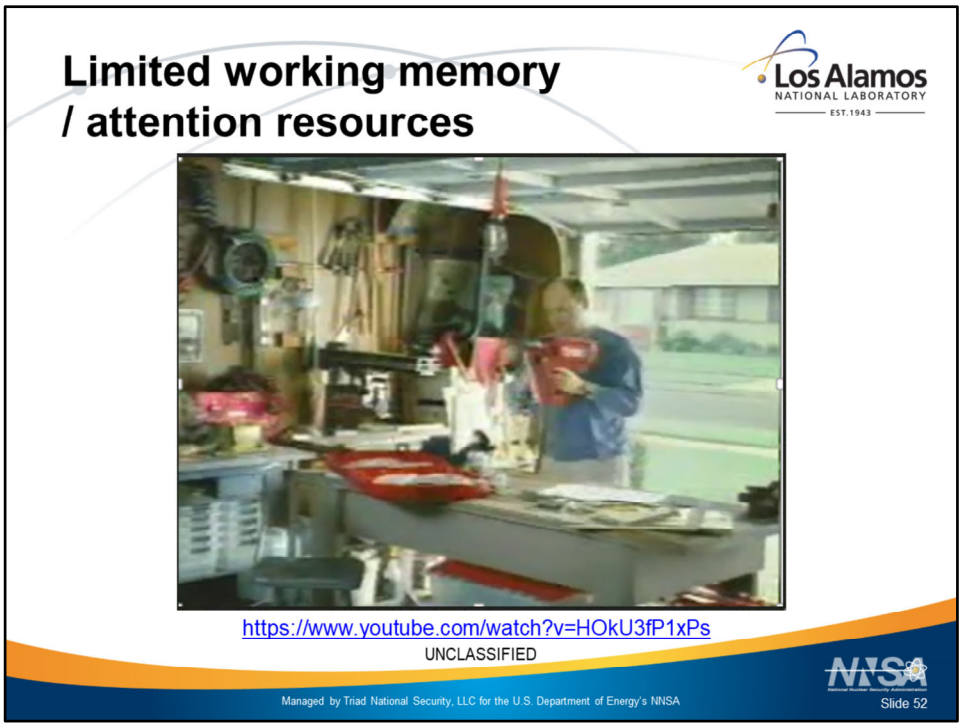
- **Similarity bias** – The tendency to recall solutions from situations that appear similar to those that have proved useful from past experience.
- **Frequency bias** – A gamble that a frequently used solution will work; giving greater weight to information that occurs more frequently or is more recent.
- **Availability bias** – The tendency to settle on solutions or courses of action that readily come to mind and appear satisfactory; more weight is placed on information that is available (even though it could be wrong). This is related to a tendency to assign a cause-effect relationship between two events because they occur almost at the same time.



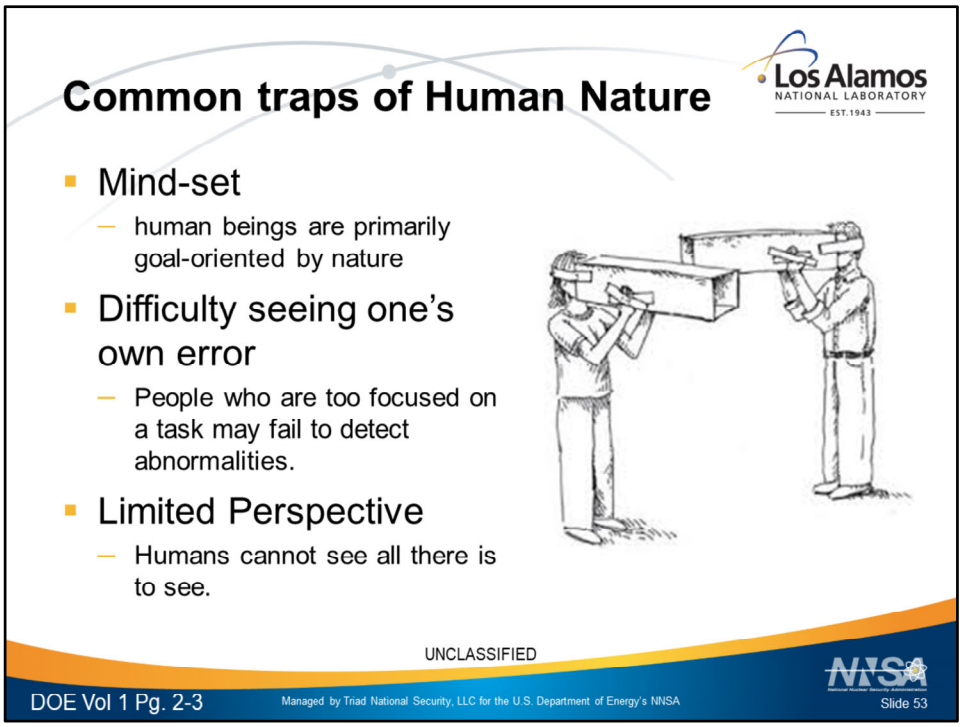
This video discusses stress and a possible solution
http://www.lanl.gov/safety/videos/humanbeings/human-beings2.shtml
https://youtu.be/8V2hhtNw8vU

Limited Working Memory. The mind's short-term memory is the “workbench” for problem-solving and decision-making. This temporary, attention-demanding storeroom is used to remember new information and is actively involved during learning, storing, and recalling information. Most people can reliably remember a limited number of items at a time often expressed as 7+1 or -2. The limitations of short-term memory are at the root of forgetfulness; forgetfulness leads to omissions when performing tasks. Applying place-keeping techniques while using complex procedures compensates for this human limitation.

Limited Attention Resources. The limited ability to concentrate on two or more activities challenges the ability to process information needed to solve problems. Studies have shown that the mind can concentrate on, at most, two or three things simultaneously. Attention is a limited commodity—if it is strongly drawn to one particular thing it is necessarily withdrawn from other competing concerns. Humans can only attend to a very small proportion of the available sensory data. Also, preoccupation with some demanding sensory input or distraction by some current thoughts or worries can capture attention. Attention focus (concentration) is hard to sustain for extended periods of time. The ability to concentrate depends very much upon the intrinsic interest of the current object of attention.8 Self-checking (Stop, Think, Act, Review) is an effective tool for helping individuals maintain attention.



VIDEO: Tools in October
This video shows the consequences of assembling nail gun while being distracted by watching the World Series.
https://www.youtube.com/watch?v=HOkU3fP1xPs



Mind-Set. People tend to focus more on what they want to accomplish (a goal) and less on what needs to be avoided **because human beings are primarily goal-oriented by nature**. As such, people tend to "see" only what the mind expects, or wants, to see.9 The human mind seeks order, and, once established, it ignores anything outside that mental model. Information that does not fit a mind-set may not be noticed; hence people tend to miss conditions and circumstances which are not expected. Likewise because they expect certain conditions and circumstances, they tend to see things that are not really present. A focus on goal tends to conceal hazards, leading to inaccurate perception of risks. Errors, hazards, and consequences usually result from either incomplete information or assumptions. Pre-job briefings, if done mindfully, help people recognize what needs to be avoided as well as what needs to be accomplished.

Difficulty Seeing One's Own Error. Individuals, especially when working alone, are particularly susceptible to missing errors. People who are too close to a task, or are preoccupied with other things, may fail to detect abnormalities. People are encouraged to "focus on the task at hand." However, this is a two-edged sword. Because of our tendency for mind-set and our limited perspective, something may be missed. Peer-checking, as well as concurrent and independent verification techniques, help detect errors that an individual can miss. Engineers and some knowledge workers, by the nature of their focus on producing detailed information, can be especially susceptible to not being appropriately self-critical.

Limited Perspective. Humans cannot see all there is to see. The inability of the human mind to perceive all facts pertinent to a decision challenges problem-solving. This is similar to attempting to see all the objects in a locked room through the door's keyhole. It is technically known as “bounded rationality.” Only parts of a problem receive one's attention while other parts remain hidden to the individual. This limitation causes an inaccurate mental picture, or model, of a problem and leads to underestimating the risk. A well-practiced problem-solving methodology is a key element to effective operating team performance during a facility abnormality and also for the management team during meetings to address the problems of operating and maintaining the facility.

Susceptibility To Emotional/Social Factors. Anger and embarrassment adversely influence team and individual performance. Problem-solving ability especially in a group may be weakened by these and other emotional obstacles. Pride, embarrassment, and the group may inhibit critical evaluation of proposed solutions, possibly resulting in team errors.

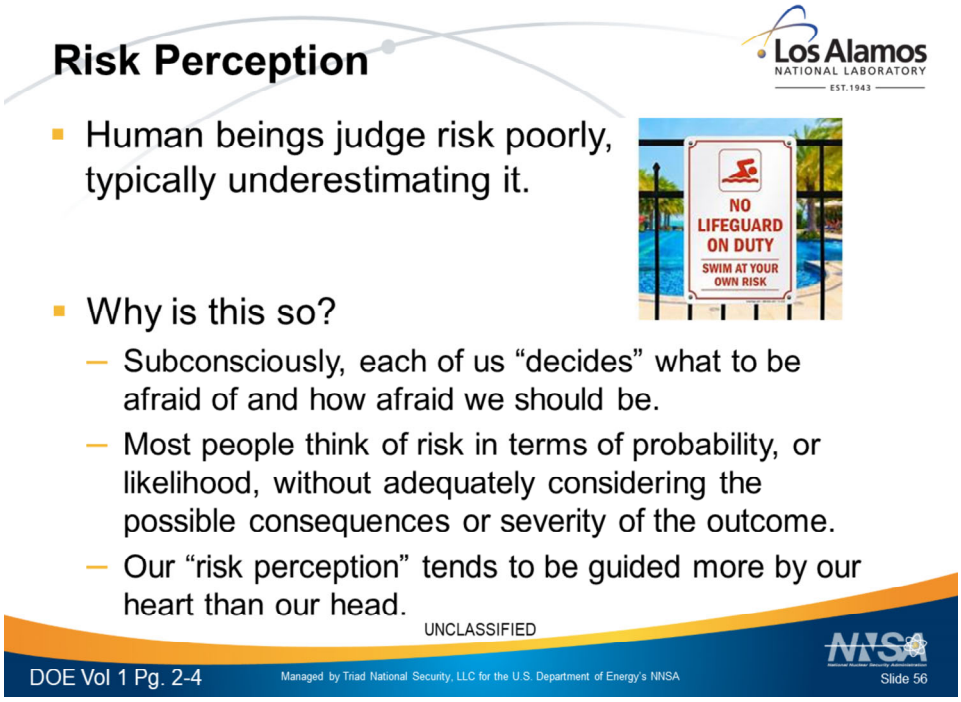
Fatigue. People get tired. In general, Americans are working longer hours now than a generation ago and are sleeping less. Physical, emotional, and mental fatigue can lead to error and poor judgment. Fatigue is affected by both on-the-job demands (production pressures, environment, and reduced staffing) and off-duty life style (diet and sleep habits). Fatigue leads to impaired reasoning and decision-making, impaired vigilance and attention, slowed mental functioning and reaction time, loss of situational awareness, and adoption of shortcuts. Acquiring adequate rest is an important factor in reducing individual error rate.

Presenteeism. Some employees will be present in the need to belong to the workplace despite a diminished capacity to perform their jobs due to illness or injury. The tendency of people to continue working with minor health problems can be exacerbated by lack of sick leave, a backlog of work, or poor access to medical care, and can lead to employees working with significant impairments. Extreme cases can include individuals who fail to seek care for chronic and disabling physical and mental health problems in order to keep working.

DOE Operating Experience Summary: Issue Number 2016-02, Article 1: **Situational Awareness: Focus Can Decrease Risk and Injuries**

Although the phrase "Situational Awareness" may sound highly technical, it simply means: Paying attention to what is happening around you. Workers at Department of Energy (DOE) facilities can benefit from honing their own situational awareness to reduce the likelihood of experiencing injuries on the job. Situational awareness is a skill that can prevent individuals from getting injured. This *Operating Experience Summary* focuses on the importance and benefits of situational awareness, keeping in mind that situational awareness is one piece of the large process of preventing events.

Situational awareness is the ability to scan the work environment and sense danger, challenges, and opportunities, while maintaining the ability to conduct normal activities. Failing to pay attention can be a contributing factor to injuries and accidents that range from mild sprains and strains resulting from slips, trips, and falls, to death. Often in public places, one can observe people with their heads down, looking at smartphones or reading books—some with headphones, others distracted or lost in thought. As potentially dangerous as such behavior can be, the dangers increase in the workplace, where it is essential to be alert and focused, using all senses to evaluate and appropriately respond to indications of impending danger.



Unsafe Attitudes and At-Risk Behaviors

An attitude is a state of mind, or feeling, toward an object or subject. Attitudes are influenced by many factors. They are formulated by one's experiences, by examples and guidance from others, through acquired beliefs and the like. Attitudes can develop as a result of educational experiences, and, in such cases, it can be said that attitudes may be chosen. Attitudes can also be acculturated—formulated by one's experiences and influences from beliefs and behaviors within one's peer group. For example, the Mohawk Indians, often referred to as "skywalkers," are renowned for their extraordinary ability to walk high steel beams with balance and grace, seemingly without any fear. It is commonly thought that this absence of fear of height was inborn among the woodland Indians. It seems more likely that the trait was learned.

Anyone can possess an unsafe attitude. Unsafe attitudes are derived from beliefs and assumptions about workplace hazards. Hazards are threats of harm. Harm includes physical damage to equipment, personal injury, and even simple human error. Unsafe attitudes blind people to the precursors to harm (exposure to danger). Notice that hazards are not confined to the industrial facility; they exist in the office facility as well. The unsafe attitudes that are described below are detrimental to excellent human performance and to the physical facility and are usually driven by one's perception of risk.

People in general are poor judges of risk and commonly underestimate it.

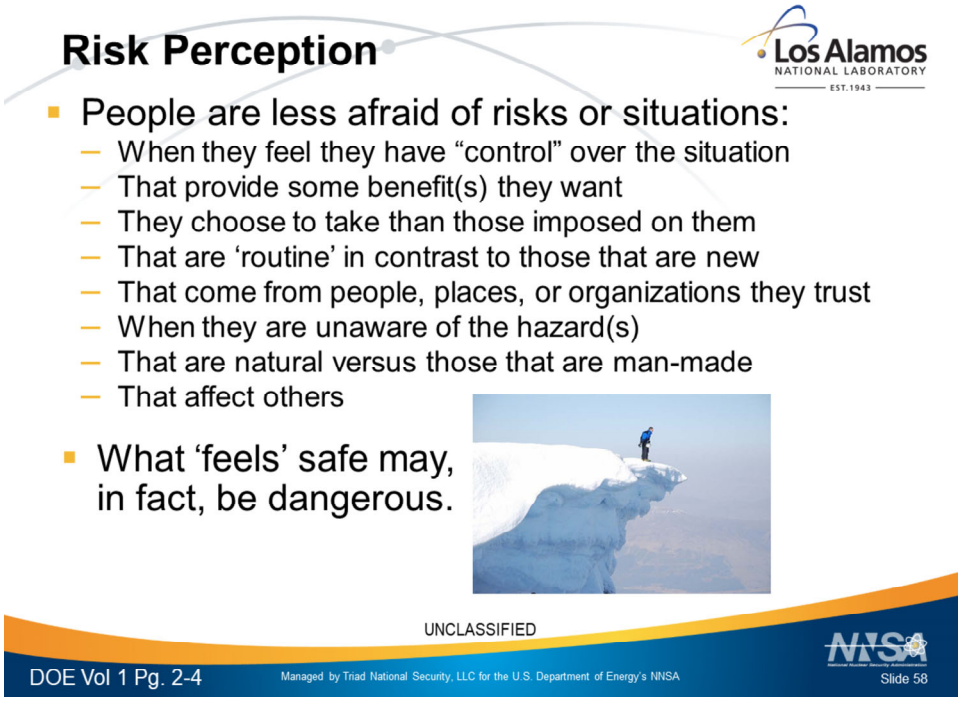
Examples of Risk Behaviors

Before the Park Service made it unlawful to feed the bears at Yellowstone National Park, in the summer time a long line of automobiles would be stopped at the side the road where the bears foraged for food in garbage cans. Tourists eagerly fed the animals through open windows—a very risky business. Every day of the year in our larger cities, television news cameras chronicle tragedies that have resulted from someone taking undue risks: trying to beat the train at a railroad crossing; playing with a loaded firearm; swimming in dangerous waters; binge drinking following the “big game”; and the like.

Misconceptions About Risk

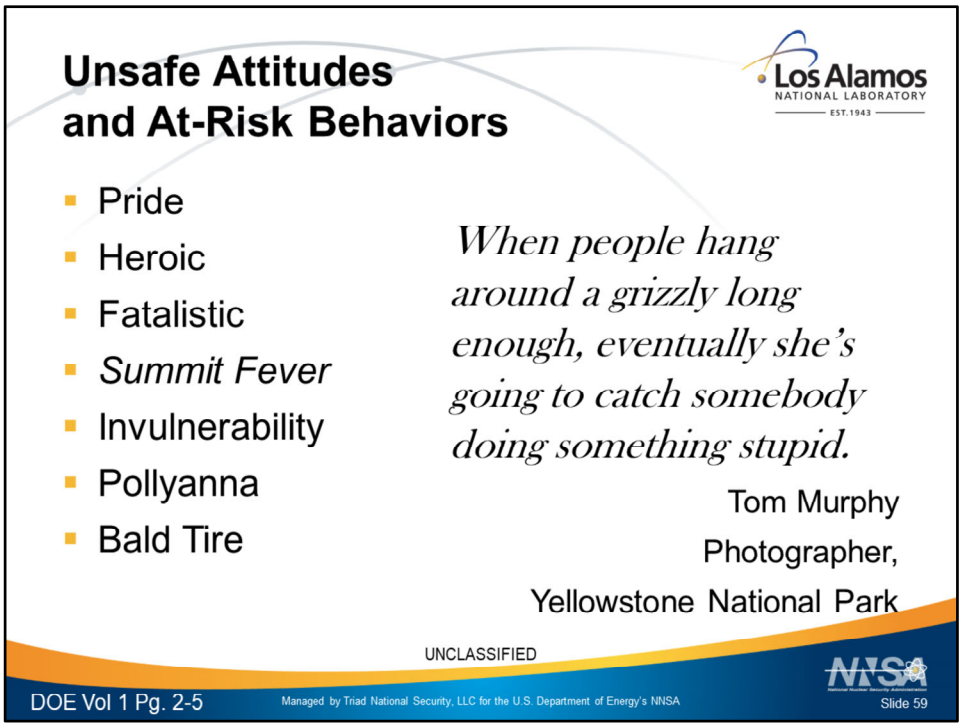
- Thinking that *someone else will know better* leads to decreased responsibility.
- Thinking that "*it is not in my role* description."
- Thinking that "*it is the Manager's* role to manage risks."
- Lack of *ability to comprehend* the real likelihood of events.
- Not accounting for differences in *personal risk tolerance levels*.

Some misconceptions and possible insights about risk.



Each individual "decides" what to be afraid of and how afraid he or she should be. People often think of risk in terms of probability, or likelihood, without adequately considering the possible consequences or severity of the outcome. For instance, a mountain climber presumes he will not slip or fall because most people don't slip and fall when they climb. The climber gives little thought to the consequences of a fall should one occur. (broken bones, immobility, unconsciousness, no quick emergency response) People take the following factors into consideration in varying degrees in assessing the risk of a situation. People are less afraid of risks or situations:

- that they feel they have "control" over;
- that provide some benefit(s) they want;
- the more they know about and "live" with the hazard
- that they choose to take rather than those imposed on them;
- that are "routine" in contrast to those that are new or novel;
- that come from people, places, or organizations they trust;
- when they are unaware of the hazard(s);
- that are natural versus those that are man-made; and
- that affect others.



It has been said that risk perception tends to be guided more by our heart than our head. What feels safe may, in fact, be dangerous. The following unsafe attitudes create danger in the work place. Awareness of these unsafe, detrimental attitudes among the workforce is a first step toward applying error-prevention methods.

Pride – An excessively high opinion of one's ability; arrogance. Being self-focused, pride tends to blind us to the value of what others can provide, hindering teamwork.
Heroic – The exaggerated sense of courage and boldness; the Admiral Farragut syndrome: "Damn the torpedoes, full speed ahead." Usually, reaction is impulsive, thinking something has to be done fast, or all is lost.
Fatalistic – A defeatist belief that all events are predetermined and inevitable, and nothing can be done to avert fate; "que será, será," (what will be will be) or "Let the chips fall as they may."
Summit Fever (Not in DOE HPI Handbook) – The seal to finish the closer one gets to the goal. Nearness to goal accomplishments can cause individuals to disregard or not see conditions or factors important to safety; for example, an automobile running a red light at a busy intersection.
Invulnerability – A sense of immunity to error, failure, or injury. Most people do not believe they will err in the next few moments; "that can't happen to me." Error is always a surprise when it happens.
Pollyanna – People tend to presume that all is normal and perfect in their immediate surroundings. Humans seek order in their environment, not disorder, to fill in gaps in perception and to see wholes instead of portions. Consequently, people unconsciously that everything will

go as planned. (routine activities)
Bald Tire – A belief that past performance is justified for not changing (improving) existing practices or conditions: “I’ve got 60,000 miles on this set of tires and haven’t had a flat yet.” A history of success can promote complacency.

WARNING: Someone get injured in this video

VIDEO: Bloody Ladder Fall
This video demonstrates an employee choosing to conduct At Risk practice and falls from ladder onto glass display case.
https://www.youtube.com/watch?v=MwCyVku1HvI
(1:50-2:22)

At-risk behaviors are actions that involve shortcuts, violations of error-prevention expectations, or simple actions intended to improve efficient performance of a task, usually at some expense of safety. **At-risk practices involve a move from safety toward danger**. These acts have a higher probability, or potential, of a bad outcome. This does not mean such actions are "dangerous," or that they should not ever be performed. However, the worker and management should be aware of at-risk practices that occur, under what circumstances, and on which systems. At-risk behavior usually involves taking the path of least effort and is rarely penalized with an event, a personal injury, or even correction from peers or a supervisor. Instead it is consistently reinforced with convenience, comfort, time savings, and, in rare cases, with fun.

Examples of at-risk behaviors on the job

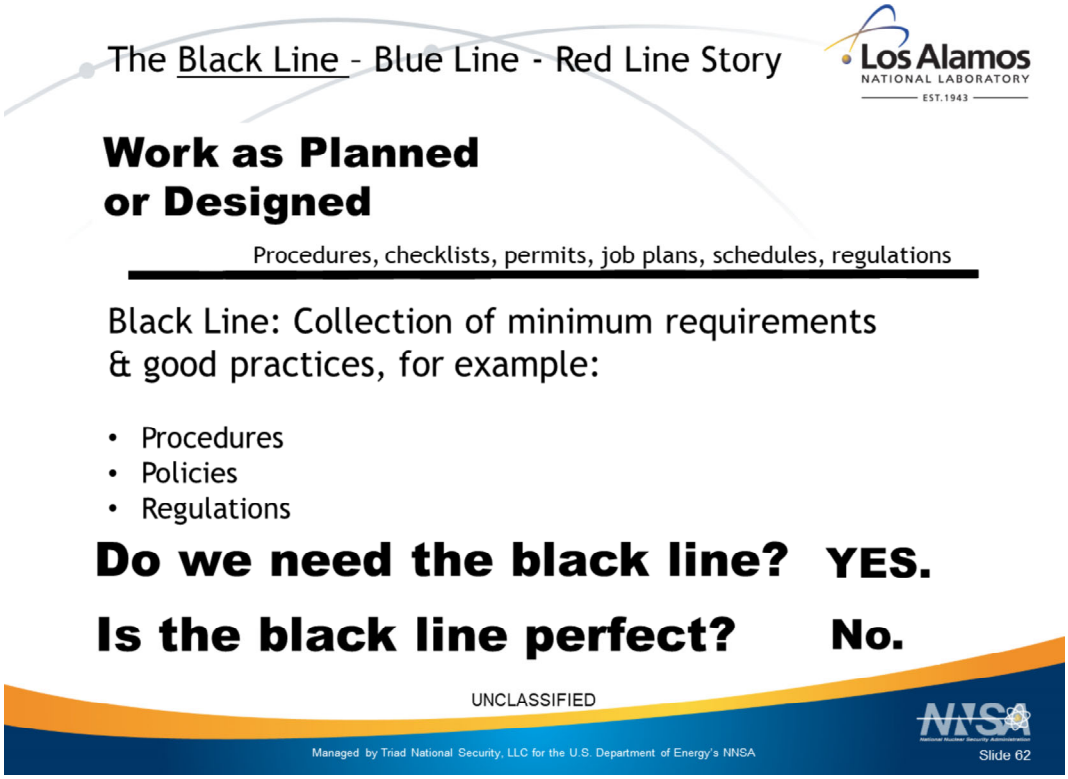
- hurrying through an activity;
- following procedures cookbook-style (blind or unthinking compliance);
- removing several danger tags quickly without annotating removal on the clearance sheet when removed;
- reading an unrelated document while controlling an unstable system in manual;
- having one person perform actions at critical steps without peer checking or performing concurrent verification;

- not following a procedure as required when a task is perceived to be “routine”;
- attempting to lift too much weight to reduce the number of trips;
- trying to listen to someone on the telephone and someone else standing nearby (multitasking);
- signing off several steps of a procedure before performing the actions; or
- working in an adverse physical environment without adequate protection (such as working on energized equipment near standing water—progress would be slowed to cleanup the water or to get a rubber floor mat).

Risky behaviors at DOE worksites have contributed to events, some causing injury and death, including:

- working on a hot electrical panel without wearing proper protective clothing;
- carrying heavy materials on an unstable surface while not using fall protection;
- failing to adhere to safety precautions when using a laser;
- operating a forklift in a reckless manner;
- opening a hazardous materials storage tank without knowing the contents; and
- failing to follow procedures for safeguarding sensitive technical information.

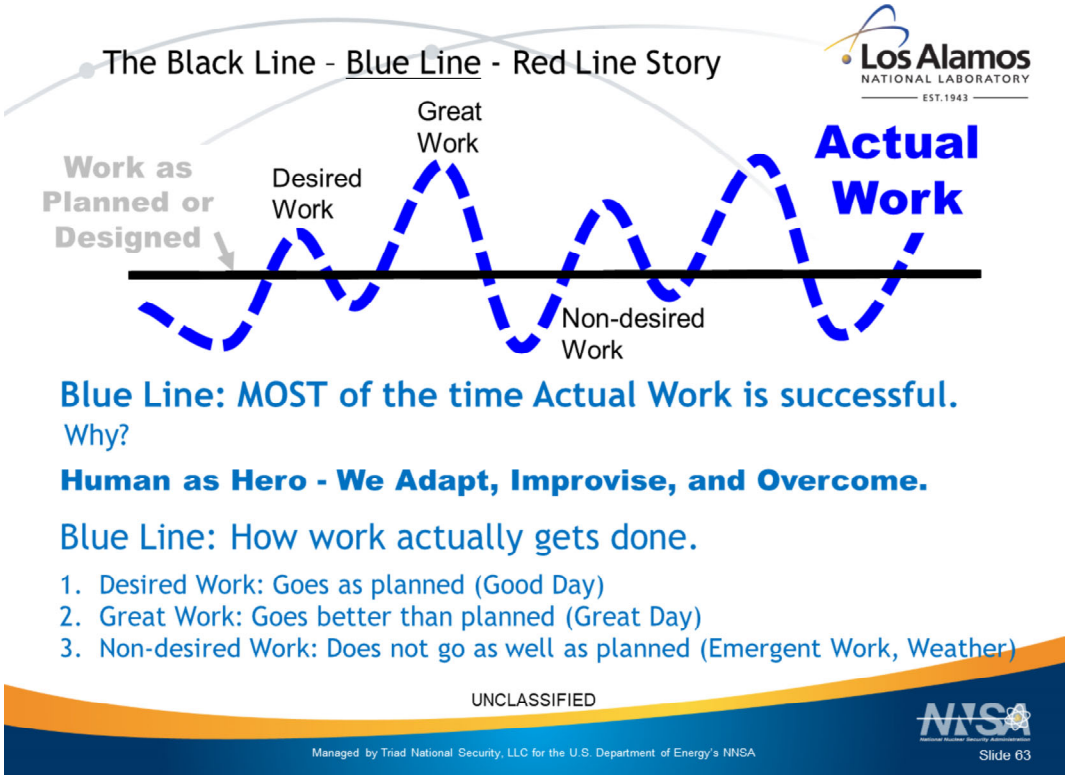
Persistent use of at-risk behaviors builds overconfidence and trust in personal skills and ability. This is a slippery slope, since people foolishly presume they will not err. Without correction, at risk behaviors can become automatic (skill-based), such as rolling through stop signs at residential intersections. Over the long-term, people will begin to underestimate the risk of hazards and the possibility of error and will consider danger (or error) as more remote. People will become so used to the practice that, under the right circumstances, an event occurs. Managers and supervisors must provide specific feedback when at-risk behavior is observed.



- The first line to discuss is the Black Line
- The Black Line represents Work as Planned or Designed. Its is a collection of our:
    - Procedures
    - Checklists
    - Permits
    - Plans
    - Schedules
    - Regulations
- *What do you notice about the Black Line?* Its straight, it doesn't deviate.
- Its work as we plan or desire it to be.
- Do we need the Black Line? Yes
- Because is represents the minimum standard that we believe is required to complete work effectively and lawfully.
- Is the black line perfect? No, it has gaps

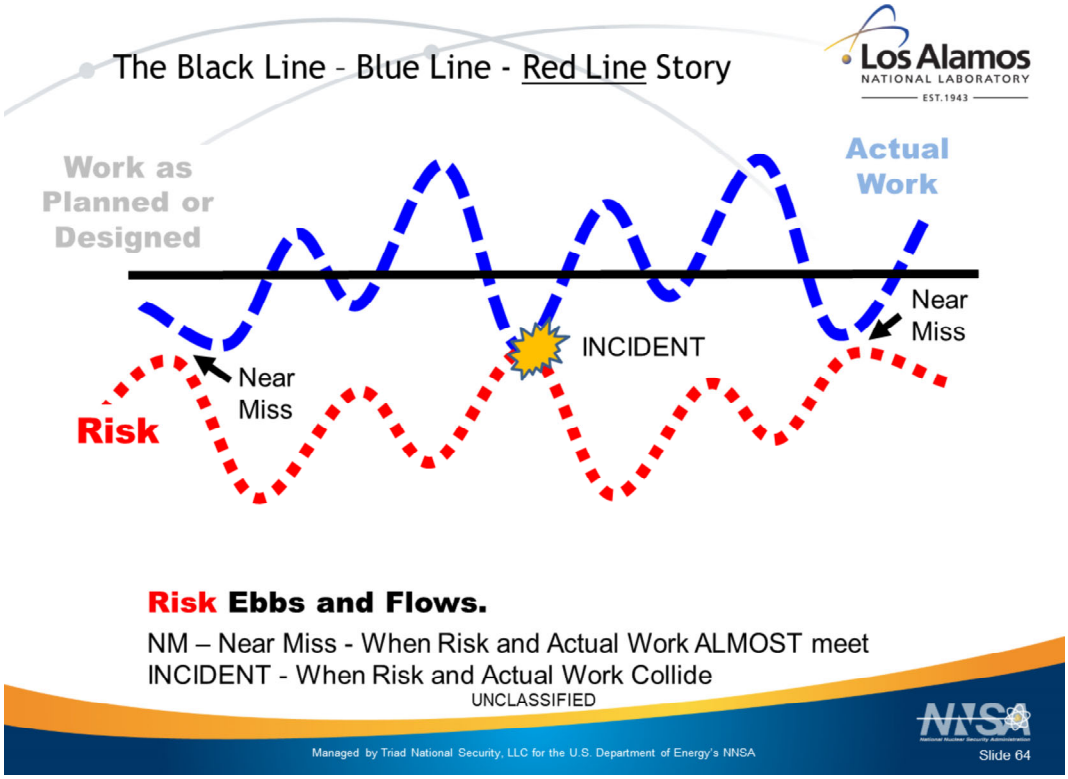
- Option: Draw the Black Line – Blue Line - Red Line slides.

- **BASIS:** IM-2018-45
  IAS 2016-459 HPI POFMR OFI-04: The HPI element is based in error management and could be further improved by broadening its philosophy and practices to include positive elements such as building adaptive capacity, "human as hero", and "people keep the system safe".



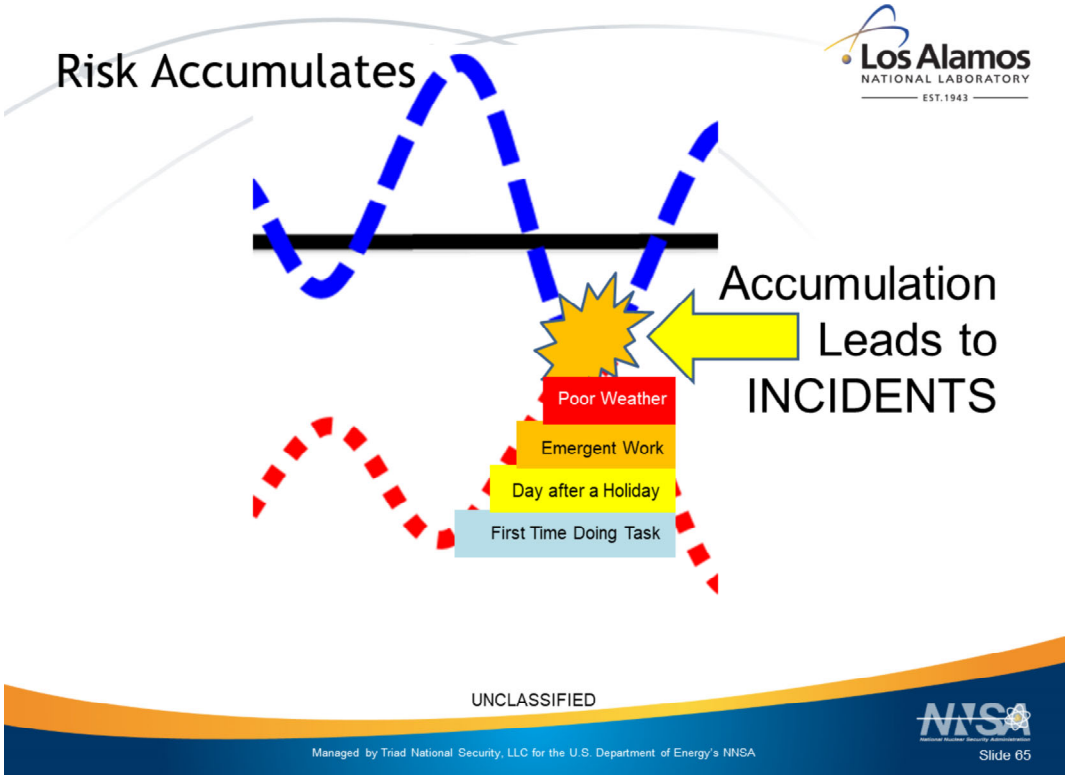
- The second line to discuss is the Blue Line
- The Blue Line represents Actual Work. The Blue Line is how work actually gets done.
- *What do you notice about the Blue Line?* Its not straight, its variable.
- The Blue line is a collection of work:
    - When we perform on the Black line = DESIRED WORK - Things go as planned (Good Day)
    - When we work above the Black Line = GREAT WORK – Things go better than planned (Great Day)
    - When we work below the Black Line = NON DESIRED WORK – Things do not go as well as planned (Emergent Work, Weather, Distraction)
- Almost every day Actual Work is successful. *Why?* Because our employees can adapt.
- Option: Solicit example from students on a task they perform.

- **BASIS:** IM-2018-45
  IAS 2016-459 HPI POFMR OFI-04: The HPI element is based in error management and could be further improved by broadening its philosophy and practices to include positive elements such as building adaptive capacity, “human as hero”, and “people keep the system safe”.



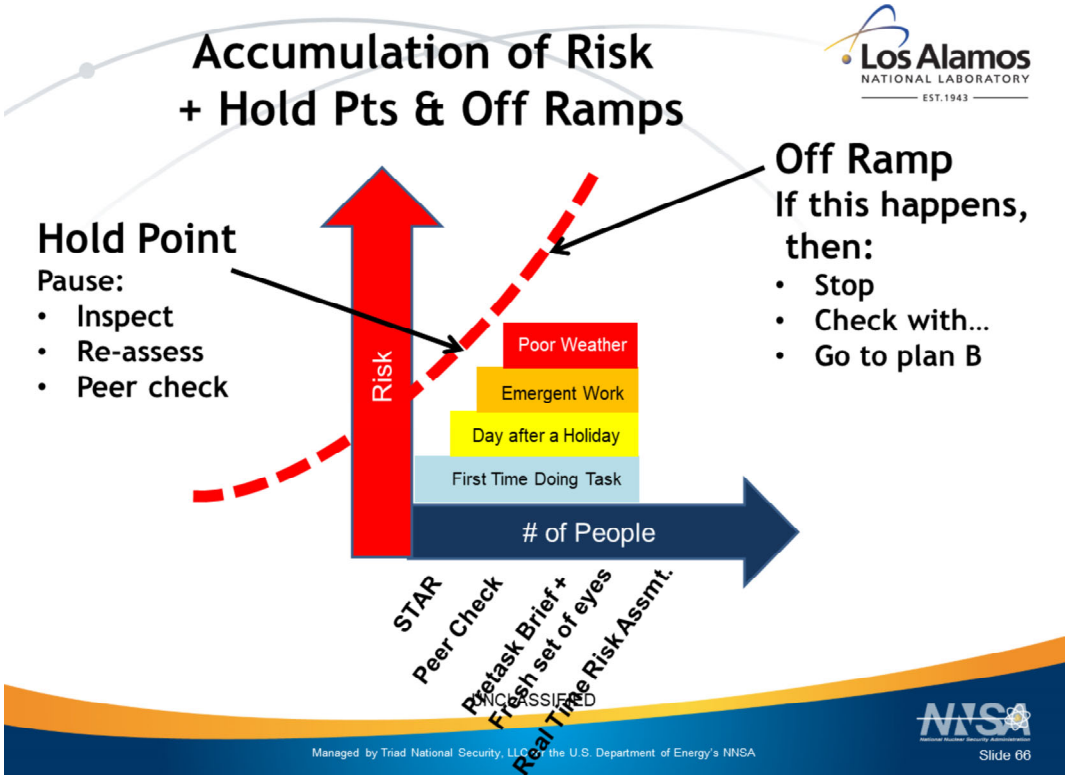
- The third line to discuss is the Red Line.
- The Red Line represents Risk.
- What do you notice about the Red Line?
    - It's not straight.
- Risk is always variable and it is always present. We can and should reduce or remove risk but:
    - Risk is always present
    - Risk is always changing
- What do we call it when the Red Line gets close to the Blue Line?
    - A Near Miss.
- What do we call it when the Red Line touches the Blue Line?
    - An Incident.

- **BASIS:** IM-2018-45
  IAS 2016-459 HPI POFMR OFI-04: The HPI element is based in error management and could be further improved by broadening its philosophy and practices to include positive elements such as building adaptive capacity, "human as hero", and "people keep the system safe".

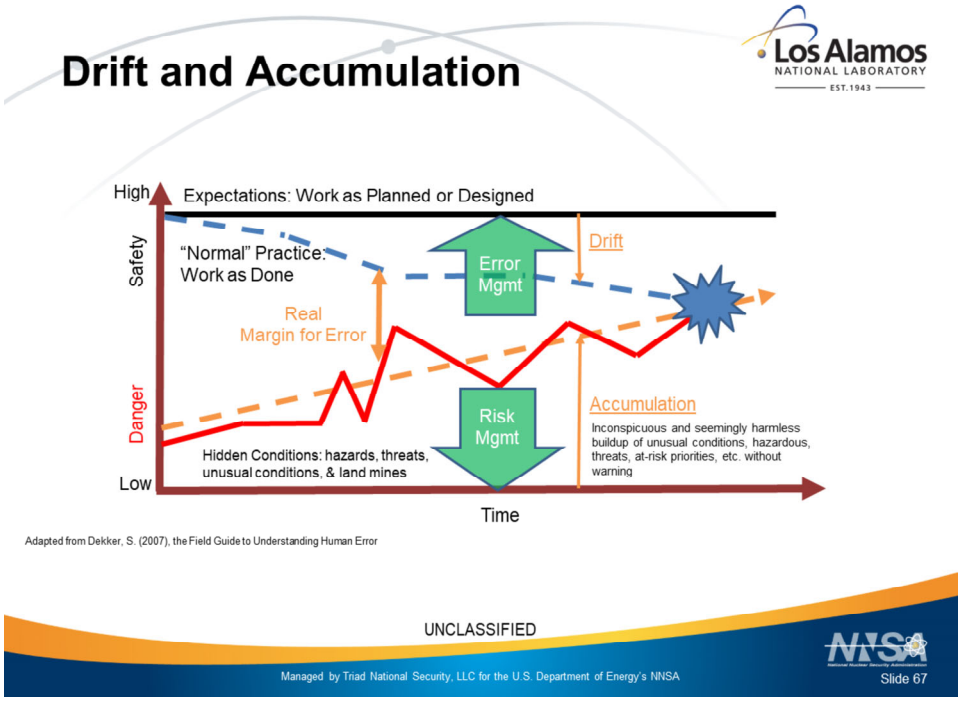


As error likely situations and risk factors stack-up, risk increases. 3 or more – watch-out! You are getting into really risky territory.

- **BASIS:** IM-2018-45
  IAS 2016-459 HPI POFMR OFI-04: The HPI element is based in error management and could be further improved by broadening its philosophy and practices to include positive elements such as building adaptive capacity, “human as hero”, and “people keep the system safe”.

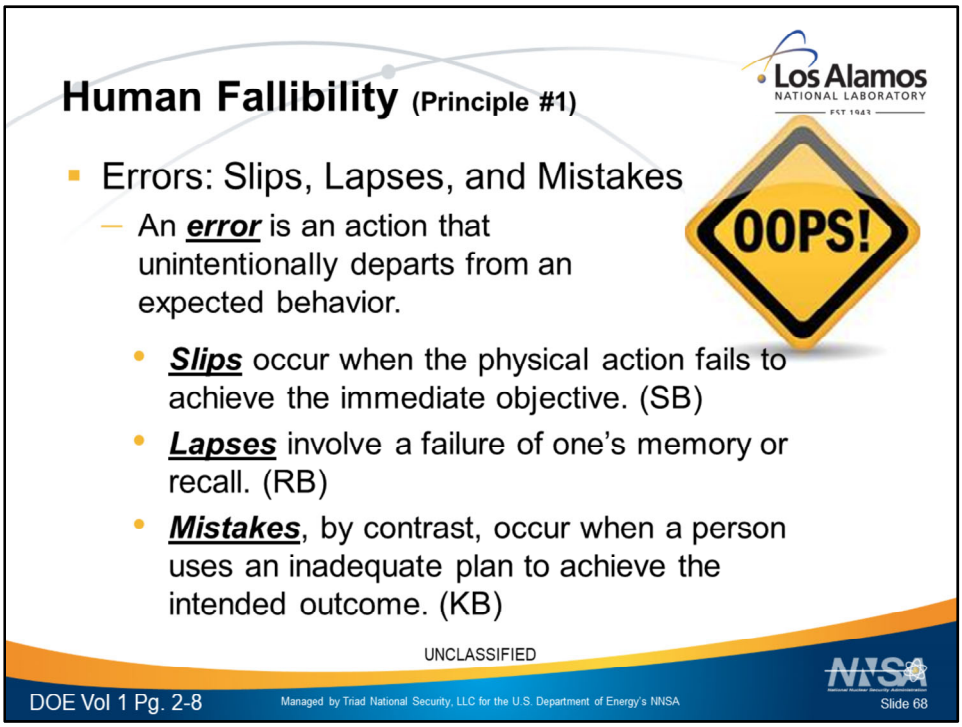


- Hold points
  - Build in "hold points" Stop here and we'll … inspect, do another pretask brief, get a peer check
  - Plan hold points:
    - Higher risk or uncertain conditions or situations
    - Irreversible or high risk steps
- Off ramps
  - Build in "off ramps" If this happens then we'll … stop, check with, go to plan B
  - Plan off ramps:
    - Ex. If outage runs into holiday, we'll stop work for 2 days.
    - If there is a stack-up of 3 or more risks, we'll add another person to help
    - If we find … we won't go forward.
- As risk, uncertainty, and / or complexity increases, involve more people in assessing risk and planning:
  - 1 person - STAR to slow yourself down long enough to get your bearings and to re-center. To snap out of automatic mode and increase attention.
  - 2 people - peer-check, get help from a co-worker in assessing risks, checking if you missed something, finding an error, checking your thinking, plan, or work.
  - 3 or more people - pre-task brief, Safe Work Permit, Job Safety Analysis for a more structured pause for discussion and assessment. Works better if you bring in a "fresh set of eyes" – someone who hasn't been involved in planning or work.
- 5 or more people – Real Time Risk Assessment- call your Regional Safety Manager. For high risk, new or novel work. A facilitator from the safety team brings together 5 – 10 people on a 1 hr. phone call to talk through the situation and assess risks. Typically includes someone from another plant, may include technical services or other subject matter experts.



People normally perform well/correctly – needs to be recognized.

Researchers have identified the process that "a drift toward failure" precedes major events as planned controls erode in the face of production pressures and change. This failure arises from systematic and predictable organizational factors at work, not simply erratic behaviors by individuals.



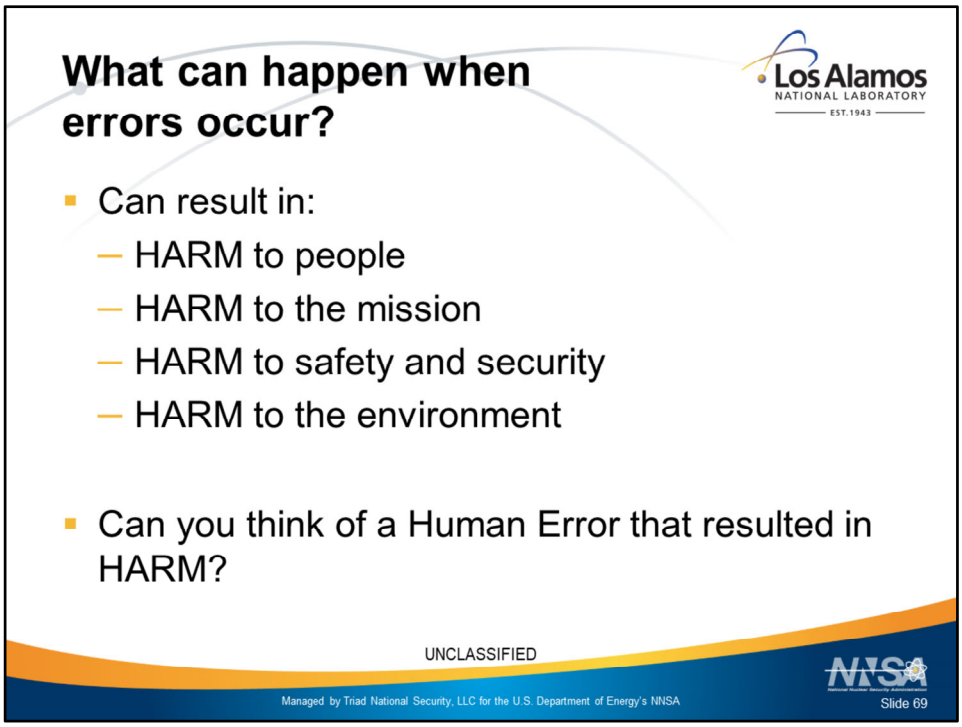
Error. People do not err intentionally. Error is a human action that unintentionally departs from an expected behavior. Error is behavior without malice or forethought; it is not a result. Human error is provoked by a mismatch between human limitations and environmental conditions at the job site, including inappropriate management and leadership practices and organizational weaknesses that set up the conditions for performance.

Slips occur when the physical action fails to achieve the immediate objective. - Skill based error
Lapses involve a failure of one's memory or recall. Rule based error
Slips and lapses can be classified by type of behavior when it occurs with respect to physical manipulation of facility equipment. The following categories describe how an incorrect or erroneous action can physically manifest itself or ways an action can go wrong:

- timing – too early, too late, omission;
- duration – too long, too short;
- sequence – reversal, repetition, intrusion;
- object – wrong action on correct object, correct action on wrong object;
- force – too little or too much force;
- direction – incorrect direction;
- speed – too fast or too slow; and
- distance – too far, too short.

Mistakes, by contrast, occur when a person uses an inadequate plan to achieve the intended outcome. Mistakes usually involve misinterpretations or lack of knowledge. *Knowledge based*

error



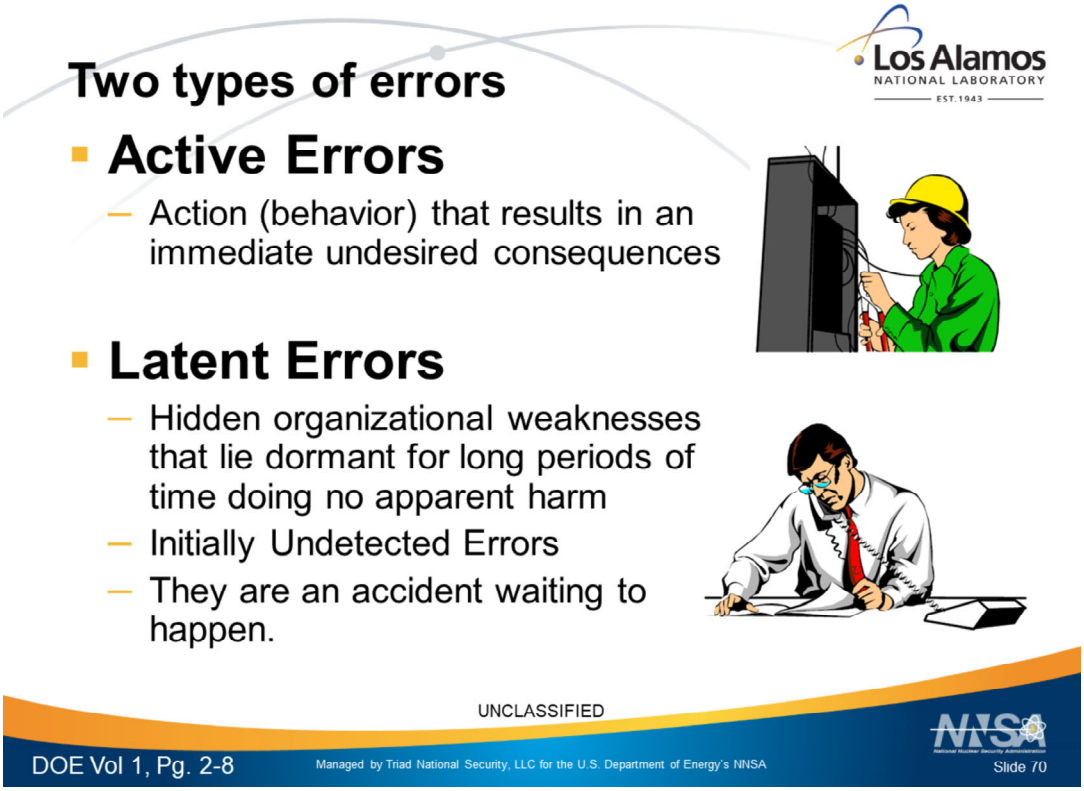
Critical Step (HPI)
Examples of intolerable harm:

- Personal
    - Death
    - Disabling injury
    - Overexposure to ionizing radiation
- Mission
    - Inability to achieve the mission
    - Asset damage/loss
    - Damage to LANL reputation
- Safety and Security
    - Loss of program/regulatory safety functions
    - Significant safeguards
        - physical security
        - information security and/or cyber security event
- Environmental
    - Harm to the environment
    - Non-Compliance regulatory violation

Discuss recent HPI events, such as:

- TA-53 Arc Flash event

- WIPP Waste drum “AN organic” event
- Plutonium Shipping event



Active Errors

Active errors are observable, physical actions that change equipment, system, or facility state, resulting in immediate undesired consequences. The key characteristic that makes the error active is the immediate unfavorable result to facility equipment and/or personnel. Front-line workers commit most of the active errors because they touch equipment. Most errors are trivial in nature, resulting in little or no consequence, and may go unnoticed or are easily recovered from. However, grievous errors may result in loss of life, major personal injury, or severe consequences to the physical facility, such as equipment damage. Active errors spawn immediate, unwanted consequences.

Latent Errors

Latent errors result in hidden organization-related weaknesses or equipment flaws that lie dormant.30 Such errors go unnoticed at the time they occur and have no immediate apparent outcome to the facility or to personnel. Latent conditions include actions, directives, and decisions that either create the preconditions for error or fail to prevent, catch, or mitigate the effects of error on the physical facility. Latent errors typically manifest themselves as degradations in defense mechanisms, such as weaknesses in processes, inefficiencies, and undesirable changes in values and practices. Latent conditions include design defects, manufacturing defects, maintenance failures, clumsy automation, defective tools, training shortcomings, and so on. Managers, supervisors, and

technical staff, as well as front-line workers, are capable of creating latent conditions. Inaccuracies become embedded in paper-based directives, such as procedures, policies, drawings, and design bases documentation. Workers unknowingly alter the integrity of physical facility equipment, such as the installation of an incorrect gasket, mis-positioning a valve, hanging a danger tag on the wrong component, or attaching an incorrect label.

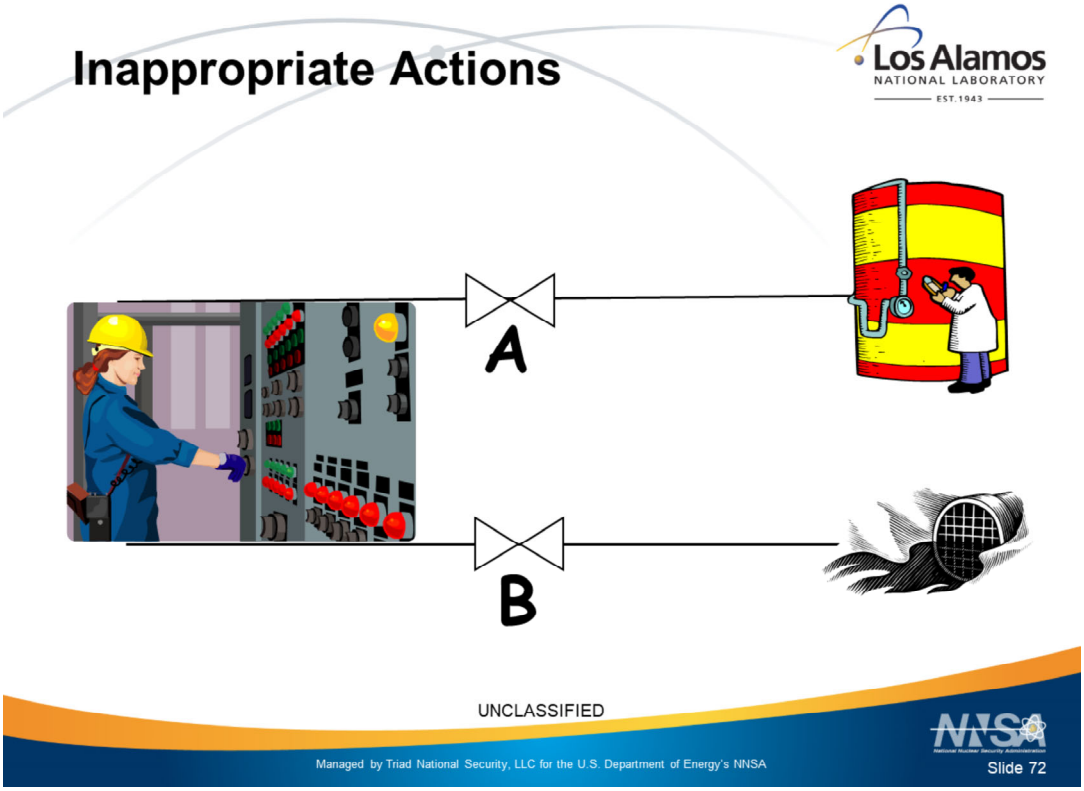
What is an inappropriate action?

- An action that results in an undesirable or unwanted condition
- An action that led the task or system outside its acceptable limits
- An action whose result was not desired by a set of rules or an external observer

NOTE: Inappropriate Action is NOT in the DOE HPI Handbook

If the wrong valve is operated, an inappropriate action occurred. The cause could be inadequate guidance, inappropriate orders, distractions, or any number of items. But the wrong component was manipulated.

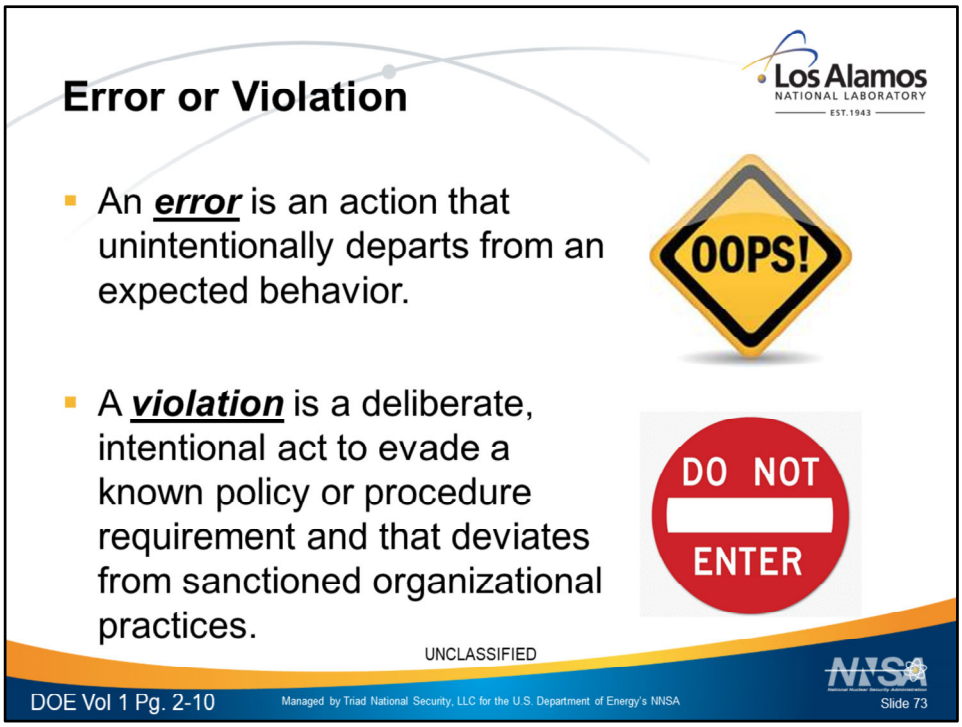
This slide does not discuss cause or significance of consequence. These often confuse people and are a cause of poor accountability system design.



NOTE: Inappropriate Action is NOT in the DOE HPI Handbook

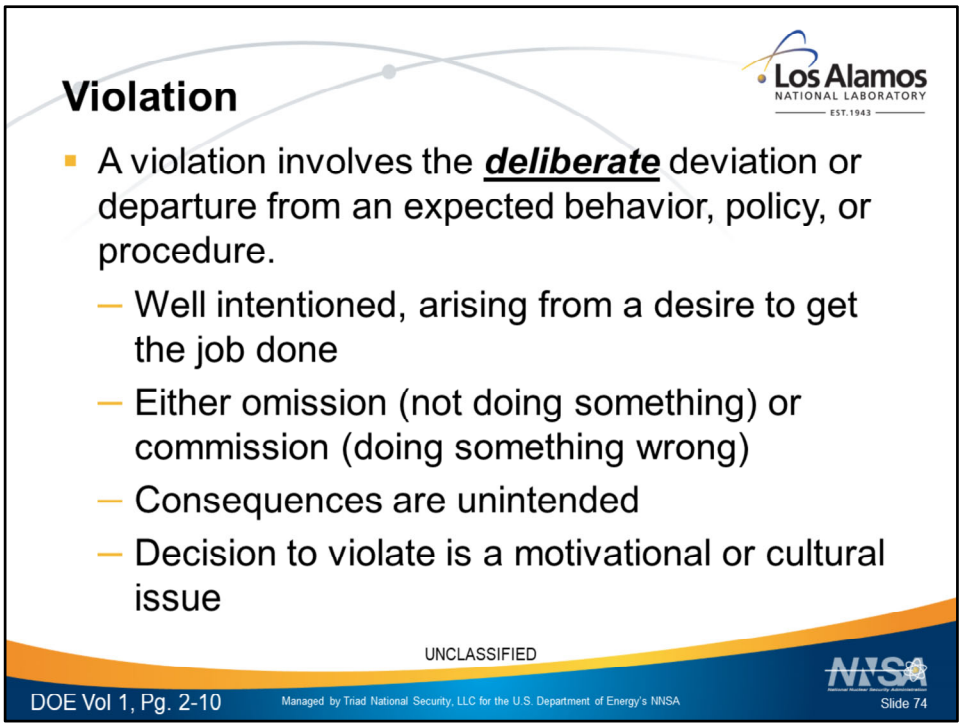
Separate cause from consequence.
It is not unusual for individuals to focus on why they think an error occurred, rather than the fact that an error occurred. For example, if you ask “Is it an inappropriate action if the wrong valve is operated?”, most people will answer “Yes”. IN this case the worker made an ACTIVE error.

But if you ask “Is it an inappropriate action if the wrong valve is operated because the procedure says to operate it?”, many people will answer “No, because we followed the procedure.” In this case it is a LATENT error



An *error* is an action that unintentionally departs from an expected behavior.
A *violation* is a deliberate, intentional act to evade a known policy or procedure requirement and that deviates from sanctioned organizational practices.

Active errors are those errors that have immediate, observable, undesirable outcomes and can be either acts of commission or omission. The majority of initiating actions are active errors. Therefore, a strategic approach to preventing events should include the anticipation and prevention of active errors.



Violations are characterized as the intentional (with forethought) circumvention of known rules or policy. A violation involves the *deliberate* deviation or departure from an expected behavior, policy, or procedure. Most violations are well intentioned, arising from a genuine desire to get a job done according to management's wishes. Such actions may be either acts of omission (not doing something that should be done) or commission (doing something wrong). Usually adverse consequences are unintended—violations are rarely acts of sabotage. The deliberate decision to violate a rule is a motivational or cultural issue. The willingness to violate known rules is generally a function of the accepted practices and values of the immediate work group and its leadership, the individual's character, or both. In some cases, the individual achieved the desired results wanted by the manager while knowingly violating expectations. Workers, supervisors, managers, engineers, and even executives can be guilty of violations.

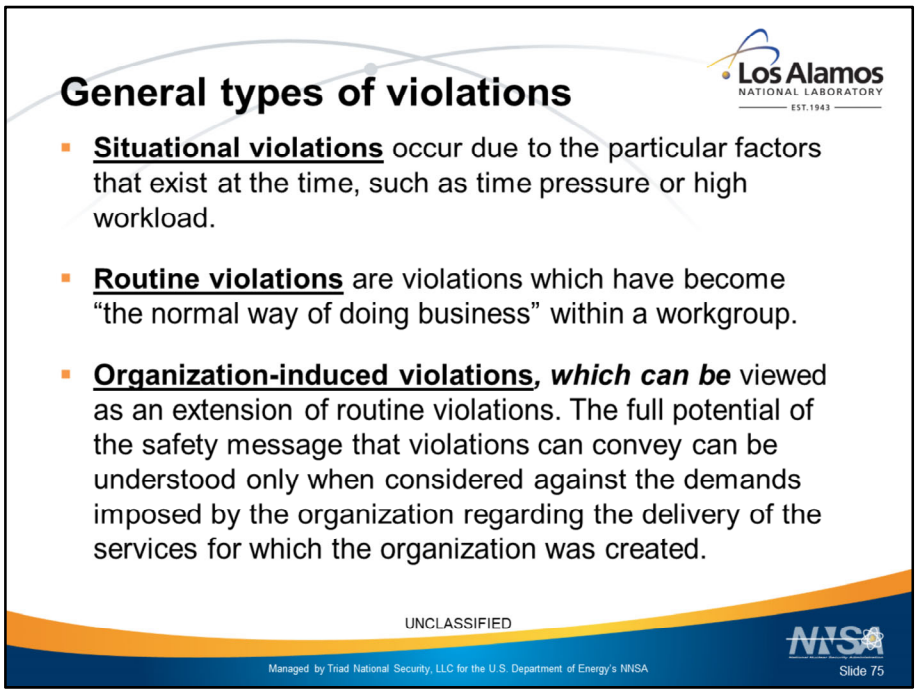
Violations are usually adopted for convenience, expedience, or comfort. Events become more likely when someone disregards a safety rule or expectation. A couple of strong situations that tempt a person to do something other than what is expected involve conflicts between goals or the outcome of a previous mistake. The individual typically underestimates the risk, unconsciously assuming he or she will not err, especially in the next few moments. People are generally overconfident about their ability to maintain control.

Examples: When People Commit Violations
Research has found that the following circumstances, in order of influence, prompt a person to

violate expectations.

- low potential for detection
- absence of authority in the immediate vicinity
- peer pressure by team or work group
- emulation of role models (according to the individual concerned)
- individual's perception that he or she possesses the authority to change the standard
- standard is unimportant to management
- unawareness of potential consequences; perceived low risk
- competition with other individuals or work groups
- interferences or obstacles to achieving the work goal
- conflicting demands or goals forcing the individual to make a choice
- precedent: "We've always done it this way" (tacitly acceptable to authority)

The discussion on violations intends to help clarify the differences between the willful, intentional decision to deviate associated with violations and the unintended deviation from expected behavior associated with error. This handbook focuses on managing human error.



A **routine violation** is one which is commonplace and committed by most members of the workplace. For example, in a particular office building it is against the rules for personnel to use the fire escape stairwell to move between floors, but it is common practice for people to do so anyway.

Example - Routine violation – BP Texas city refinery explosion, 2005
At BP's Texas city refinery, procedures were outdated and ineffective in managing operational problems frequently encountered during the raffinate unit start-up procedures. As a consequence, operators believed that procedures did not have to be followed or could be altered during startup. It was routine practice during ISOM unit start-up to fill the raffinate splitter tower above the range of the level transmitter, although procedures required the tower to be filled to a 50% reading. This is just one of many routine violations that occurred on the day of the explosion.

A **situational violation** occurs, as its name suggests, in response to situational factors, including excessive time pressure, workplace design, and inadequate or inappropriate equipment. When confronted with an unexpected or inappropriate situation, personnel may believe that the normal rule is no longer safe, or that it will

not achieve the desired outcome, and so they decide to violate that rule. Situational violations generally occur as a once-off, unless the situation triggering the violation is not corrected, in which case the violation may become routine over time.

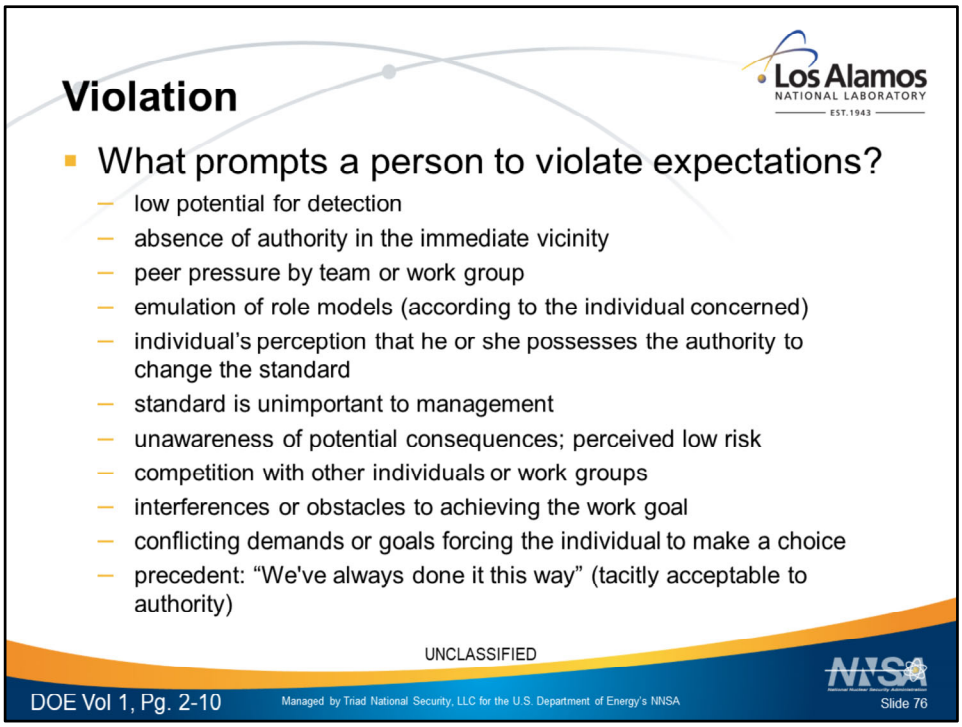
Example - Situational violation - BP Texas city refinery Explosion, 2005

On the day of the explosion, the day-shift supervisor left work at short notice to attend to a family emergency. BP procedures required the presence of an experienced supervisor during start-up activities. However, no-one was assigned to replace the day-shift supervisor, and work was not stopped until an appropriate replacement could be sourced. This example demonstrates how violations are also committed by decision-makers, not just by frontline personnel.

Note: Violations are classified as human error only when they fail to achieve the desired outcome. Where a violation does achieve the desired outcome, and does not cause any other undesired outcomes, this is not human error. These types of violations may include violation of a bad rule, such as a procedure that, if followed correctly, would trip the plant. In such cases, a review of the rules and procedures is advisable.

Example - Violating a bad rule - Piper Alpha muster

During the Piper Alpha disaster, personnel following the muster procedures found that they could not access the lifeboats from the accommodation block. Personnel who survived the disaster were those who chose to violate the muster rule and ‘step off’ the platform into the ocean. In this case a bad rule was violated and the desired outcome was achieved.



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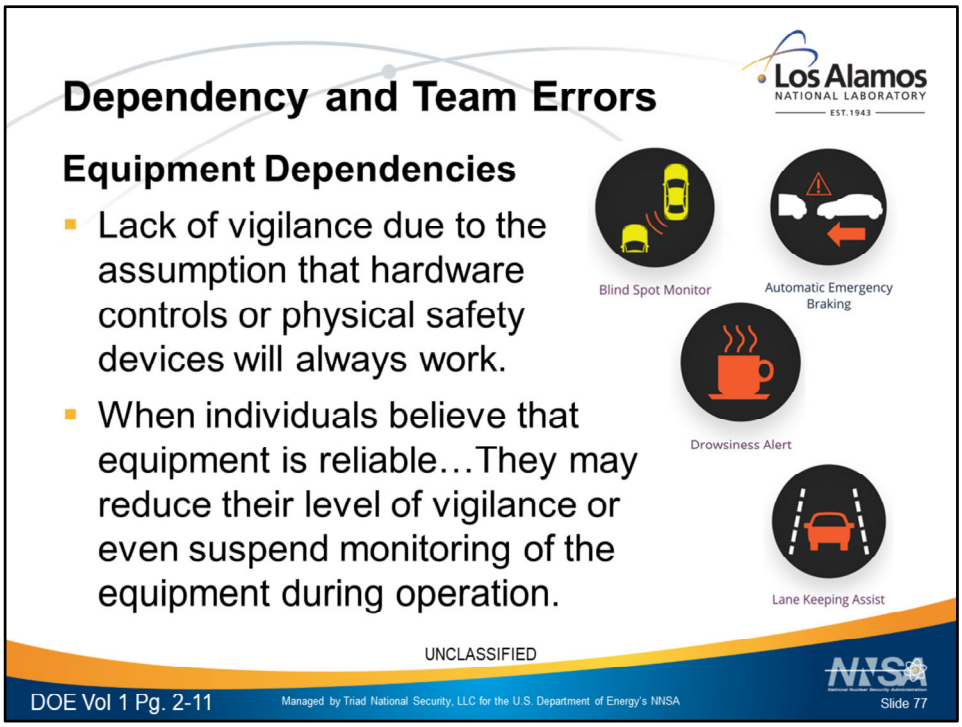
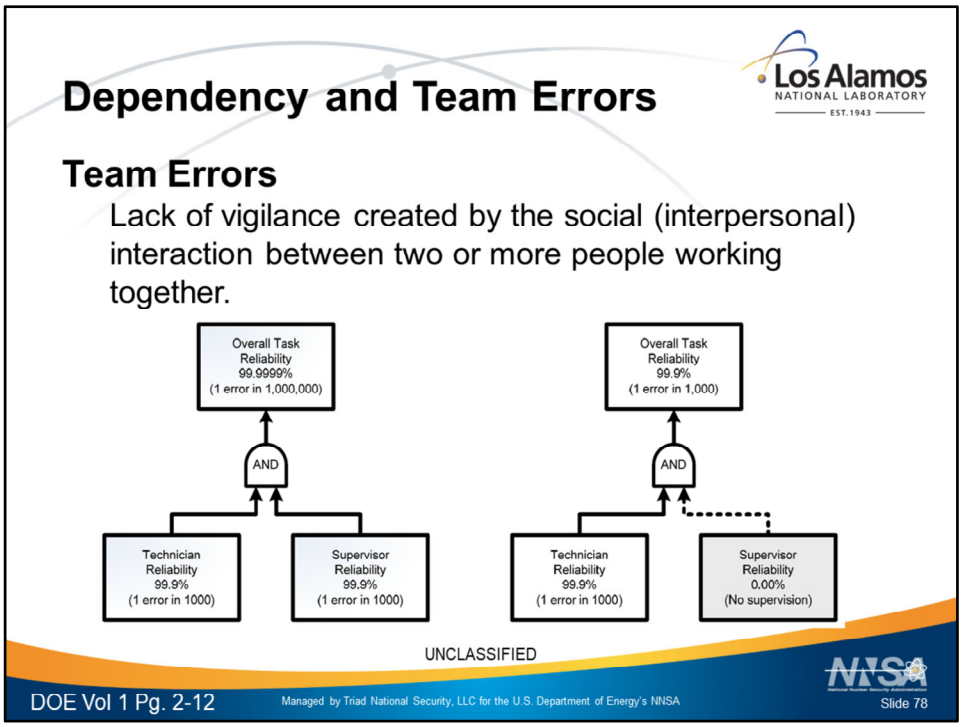


Equipment Dependencies

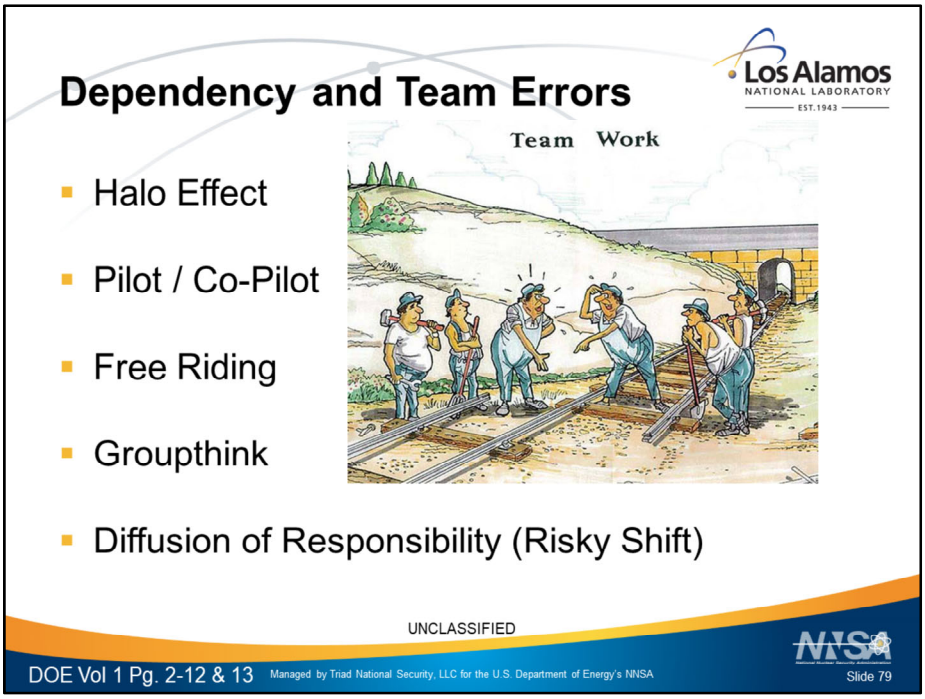
When individuals believe that equipment is reliable, they may reduce their level of vigilance or even suspend monitoring of the equipment during operation. Automation, such as level and pressure controls, has the potential to produce such a dependency. Boring tasks and highly repetitive monitoring of equipment over long periods can degrade vigilance or even tempt a person to violate inspection requirements, possibly leading to the falsification of logs or related records. Monitoring tasks completed by a computer can also lead to complacency. In some cases, the worker becomes a "common mode failure" for otherwise independent facility systems, making the same error or assumption about all redundant trains of equipment or components. Diminishing people's dependencies on equipment can be addressed by:

- applying forcing functions and interlocks;
- eliminating repetitive monitoring of equipment through design modifications;
- alerting personnel to the failure of warning systems;
- staggering work activities on redundant equipment at different times or assigning different persons to perform the same task;
- diversifying types of equipment or components, thereby forcing the use of different practices; for example, for turbine-driven and motor-driven pumps;
- training people on failure modes of automatic systems and how they are detected;
- informing people on equipment failure rates; and
- minimizing the complexity of procedures, tools, instrumentation, and controls.



Just because two or more people are performing a task does not ensure that it will be done correctly. Shortcomings in performance can be triggered by the social interaction between group members. In team situations, workers may not be fully attentive to the task or action because of the influence of coworkers. This condition may increase the likelihood of error in some situations. **A *team error* is a breakdown of one or more members of a work group that allows other individual members of the same group to err—due to either a mistaken perception of another's abilities or a lack of accountability within the individual's group.**

The logic diagram in the slide illustrates the mathematical impact of such a dependency, using the example of a supervisor (or peer) checking the performance of a maintenance technician. Assuming complete independence between the technician and the supervisor, the overall likelihood for error is one in a million; the overall task reliability is 99.9999 percent. **However, should the supervisor (or peer) assume the technician is competent for the task and does not closely check the technician's work, the overall likelihood for error increases to one in a thousand,** the same likelihood as that for the technician alone. Overall task reliability is now 99.9 percent. System reliability is only as good as the weakest link, especially when human beings become part of the system during work activities. The perception of another's capabilities influenced the supervisor's decision not to check the technician's performance—a team error.



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Several socially related factors influence the interpersonal dynamics among individuals on a team. Because individuals are usually not held personally responsible for a group's performance, some individuals in a group may not actively participate. Some people refrain from becoming. involved, believing that they can avoid answerability for their actions, or they "loaf" in group activities. Team errors are stimulated by, but are not limited to, one or more of the following social situations.

Halo Effect – Blind trust in the competence of specific individuals because of their experience or education. Consequently, other personnel drop their guard against error by the competent individual, and vigilance to check the respected person's actions weakens or ceases altogether. This dynamic is prevalent in hospital operating rooms, where members of the operating teams often fail to stay vigilant and check the procedures and actions in

progress because a renowned surgeon is leading the team and there are several other sets of eyes on the task at hand. Each year it is estimated that there are between 44,000 and about 90,000 deaths attributable to medical errors in hospitals, alone. Never mind the transfusions of mismatched blood plasma, amputations of the wrong limbs, administration of the wrong anesthesia, or issuance of the wrong prescriptions. It is the medical instruments, sponges, towels, and the like left in patients' bodies following surgery that are hard for laymen to understand.

Pilot/Co-Pilot – Reluctance of a subordinate person (co-pilot) to challenge the opinions, decisions, or actions of a senior person (pilot) because of the person's position in a group or an organization. Subordinates may express "excessive professional courtesy" when interacting with senior managers, unwittingly accepting something the boss says without critically thinking about it or challenging the person's actions or conclusions.
Example of Pilot/Co-Pilot Error:

> A classic example of this dynamic occurred between the pilot and co-pilot of Air Florida Flight 90 at Washington's National Airport in January 1982. The temperature was about 25 degrees. It had snowed hard for some time while the plane sat on the ground during airport closure because of weather. The aircraft had not properly been de-iced, and there was snow on the leading edges of the wings as the flight crew prepared for takeoff. During the after-start checklist procedure, the co-captain called out "engine anti-ice system." And the captain reported, "engine anti-ice system off," and then failed to turn it on. The system should have been on. Consequently, ice interfered with the engine pressure ratio (EPR) system, the primary indication of thrust being developed by the engines. The co-pilot called the captain's attention to the anomalous engine indications at least five times in the last moments before the plane rotated off the runway, but he did not oppose the captain's decision to continue takeoff. Given the engine indications, he should have insisted the takeoff be aborted. (All other engine parameters were later found to be well below limit values.) The pilot thought the EPR settings were at the indicated limits when he took off; in reality, the aircraft had only three-fourths of the necessary thrust in both engines. The plane failed to achieve adequate lift. It hit the 14th Street Bridge and plunged nose down into the freezing Potomac River, killing 74 of the 79 people on board.

Free Riding – The tendency to "tag along" without actively scrutinizing the intent and actions of the person(s) doing the work or taking the initiative. The other person takes initiative to perform the task, while the free-riding individual takes a passive role in the activity.
Example of Free Riding Error

> The water flushing of compound salts inside the transfer piping at the fertilizer and pesticide plant in Bhopal, central India, was a routine task. The flushing operation was normally carried out under the direction of a shift maintenance supervisor. On December 2, 1984, the maintenance supervisor was called to another assignment, and the flush was carried out under the direction of the operations supervisor. A new compound, methyisocyanate (MIC), was used
> to produce the pesticide Sevin at the plant. MIC is unstable and highly reactive to

water. The procedure to ensure isolation of water from a MIC tank during piping flushes was to close the valve to the tank, and then insert a slip blind (blank flange) into the piping to make sure that water did not leak through the valve and enter a MIC storage tank. During the investigation of the accident, an operator testified that he noticed the closed valve had not been sealed with a
slip blind (metal disc), but he said, "It was not my job to do anything about it."

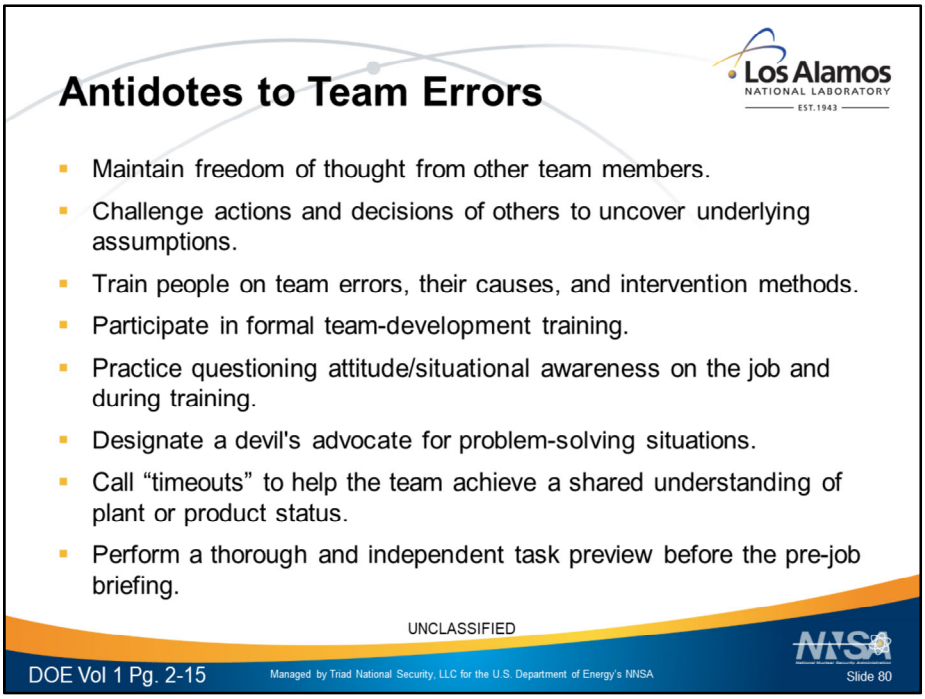
Groupthink – Cohesiveness, loyalty, consensus, and commitment to the team are all worthy attributes of a team. However, at times, these characteristics can work against the quality of team decisions. There can be a reluctance to share contradictory information about a problem for the sake of maintaining the harmony of the work group. This is detrimental to critical problem-solving. This dynamic can be made worse by one or more dominant team members exerting considerable influence on the group's thinking (pilot/co-pilot or halo effect). Consequently, critical information known within the group may remain hidden from other team members. Groupthink can also result from subordinates passing on only "good news" or "sugar-coating" bad news so as to not displease their bosses or higher level managers. The symptoms of groupthink are as follows:

- *Illusion of invulnerability – Creates excessive optimism and encourages extreme risk taking.*
- *Collective rationalization* – Discounts warnings that might lead to reconsidering assumptions before recommitting to past decisions.
- *Unquestioned morality* – Inclines members to ignore the ethical or moral consequences of decisions because of unquestioned belief in the group's inherent morality.
- *Stereotyped view* – Characterizes the opposition as too evil for genuine negotiation or too weak and stupid to effectively oppose the group's purposes.
- *Direct pressure* – Discourages dissent by any member who expresses strong arguments against any of the group's stereotypes, illusions, or commitments that this type of dissent is contrary to what is expected of loyal members.
- *Self-censorship* – Reduces deviations from the apparent group consensus reflecting each member's inclination to minimize to himself the importance of his doubts and counter arguments.
- *Illusion of unanimity* – Shared by members with respect to the majority view (partly resulting from self-censorship of deviations, augmented by a false assumption that silence means consent).
- *Self appointed mind-guards* – Emerge from the members to protect the membership from adverse information that might shatter their shared complacency about the effectiveness and morality of their decisions.

Diffusion of Responsibility often causes a "risky shift" in decision-making and problem resolution. It involves the tendency to gamble with decisions more as a group than if each group member was making the decision individually —responsibility is diffused in a group. As the saying goes, "there is safety in numbers." If two or more people agree together that they know a better way to do something, they will likely take the risk and disregard established procedure or policy. This has been referred to as a "herd mentality."

Example of Diffusion of Responsibility Error

At a DOE production facility in the late 1980s, a shift manager in the operating contractor organization, along with a small group of shift supervisors, planned and carried out the replacement of a faulty pump over a weekend. This undertaking was performed to support the startup of a system that had been shut down for an unusually long time. Operating within the work control system to get the job done had not been successful. Continued reliance on that system, the supervisory group reasoned, would not get a new pump in place, and the stream would continue to be unusable. Faced with pressures to meet a “startup” schedule, and frustrated with their inability to get work done through routine channels, the men took matters into their own hands and did the work themselves. In so doing, the team violated numerous procedures governing the work control system, in-process quality inspections, the worker certification program, and the union labor rules governing work assignments and responsibilities. No single salaried supervisor would have considered doing a union mechanic’s job on his/her own. In a group situation, given the urgency, it seemed to make good sense. The outcome for these men included days off without pay and a demotion for the shift manager.



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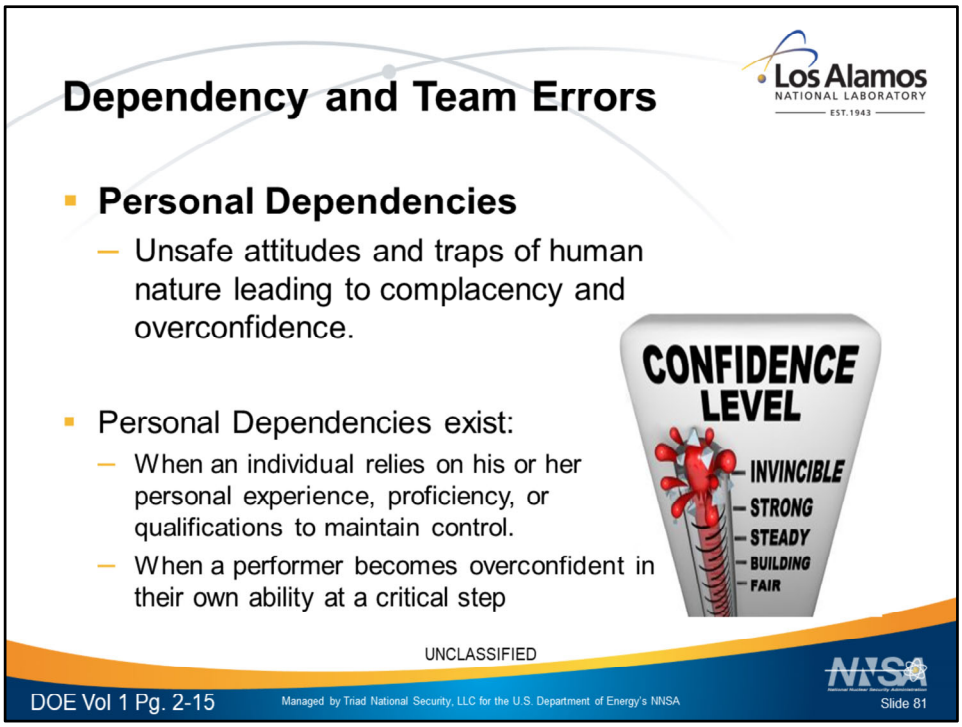


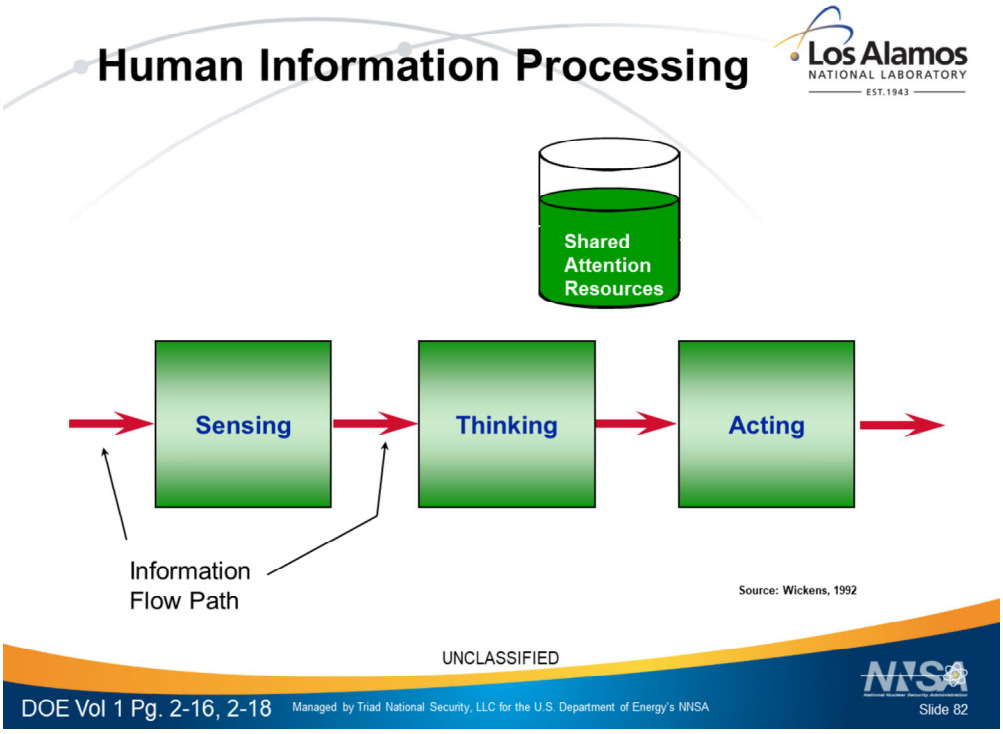
Personal Dependencies

An unsafe personal dependency exists when an individual relies on his or her personal experience, proficiency, or qualifications to maintain control. Because past practices have not led to a problem, the individual becomes indifferent toward the need for care and attention. Competence does not guarantee positive control. At the beginning of this chapter, “Traps of Human Nature” and “Unsafe Attitudes” were discussed regarding their impact on human fallibility. Such psychological and physiological factors can create unsafe personal dependencies and lead to error. Of particular concern is overconfidence in one’s own ability at a critical step, inhibiting the rigorous use of human performance tools.

Overcoming personal dependencies usually involves:

- Training that addresses the limitations of human nature;
- promoting a culture that supports situational awareness and a questioning attitude;
- reinforcing and coaching the proper application of human performance tools during in-field observations; and
- improving the knowledge of risk-important equipment and critical steps.

Training 1.0011

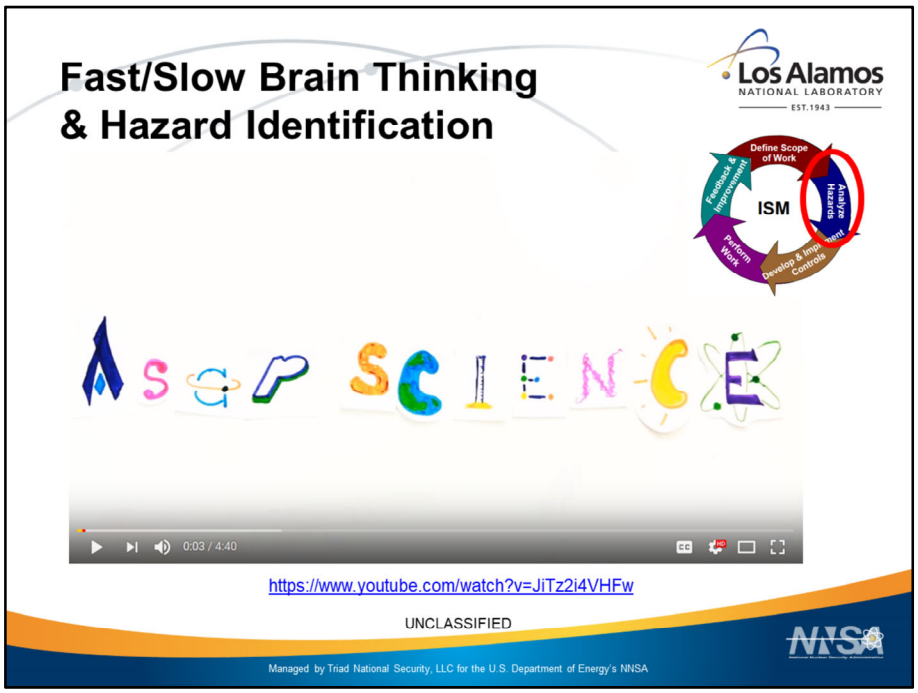


INPO 06-003, Human Performance Reference Manual, pages 34-33

- **Sensing** - visual, audible, and other senses engaged to detect and recognize available information in one's immediate proximity; displays, signals, or cues from immediate environment.
- **Decision** - mental activities to decide what to do with the information; interaction between one's working me and long-term memory (capabilities: knowledge, opinions, attitudes)
- **Acting** - physical response to change the state of the environment either by manipulation or verbal statement skills to apply appropriate force and timing to carry out action (e.g.., swinging a bat to hit a baseball); controls tools
- **Attention** - a pool of resources available for various mental activities to function effectively; defines workload; example: driving an automobile - one can do something in all four channels:
  visual - road, instrument cluster, vistas
  audible - radio, traffic, passenger
  mental - interpreting traffic flow and signals, home, family, work, radio
  physical - steering wheel, braking, accelerating, talking

However, some activities must cease to attend to other activities, such as stopping a conversation to look for a crit roadsign in high-speed traffic. Error is enhance if attempting to do more than one activity in each channel, e.g listening to radio and passenger simultaneously. Error likely to occur if workload exceeded. Limitation - can a to around two or three channels of information maximum to be effective. (Psychology Today)

- **Path of Least Mental Effort**; avoidance of mental strain; tendency to apply prepackaged solutions to recurring situations
- **Modes of information processing** (performance modes) characterized as skill-based (SB), rule-based (RB), or knowledge-based (KB). Various attentions requirements



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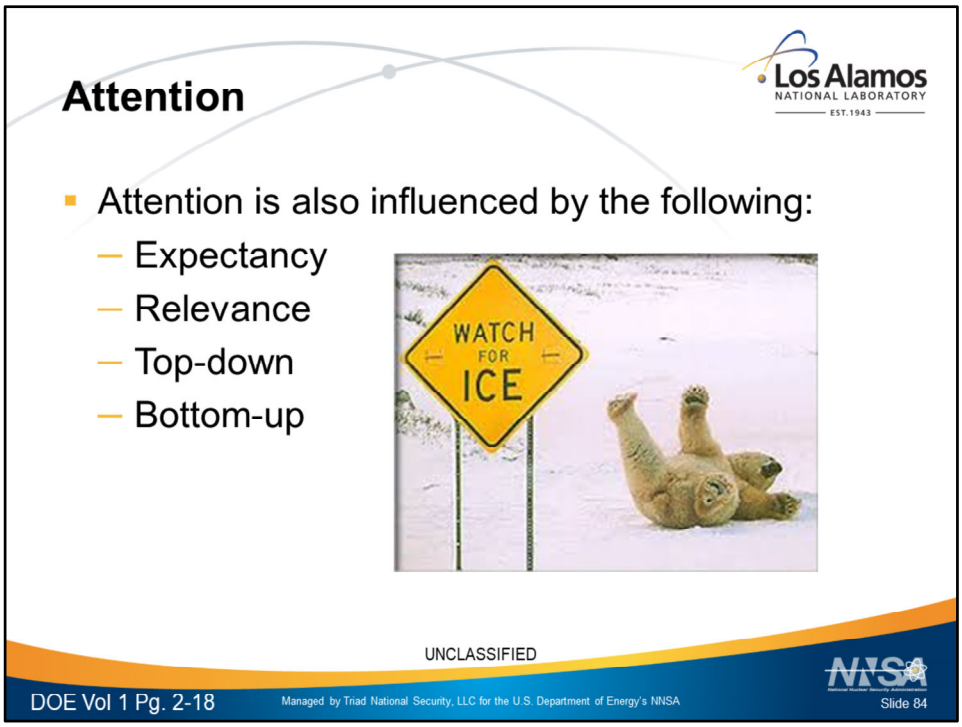


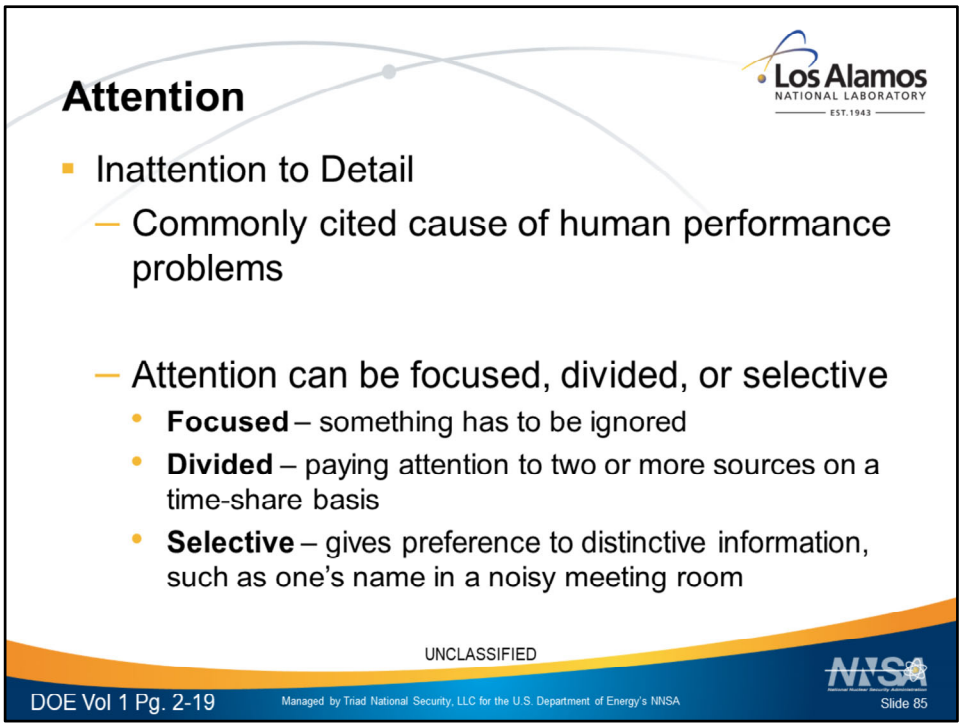
Attention is also influenced by the following:

Expectancy – We direct our sensory receptors—eyes, ears, nose, fingers to where we anticipate locating information within our environment. Surprise occurs when events differ from our expectations.

Relevance – We seek information/stimuli relevant to our immediate tasks and our goals. Our attention constantly shifts as a result of voluntary direction (internal) or automatically as a result of attention attracting stimuli (external) in the environment. Our focus of attention results from whether a stimulus activates top-down (internal) or bottom-up (external) processes.

Top-Down – Attention control is conscious direction, using information residing in memory stores. It is also termed concept-driven or effortful attention. Top-down attention is purposefully directed and is influenced by expectancy and relevance, as well as prior knowledge and experience. Examples are a search task, such as when looking for the face of a friend in the crowd, seeking a specific item on a control display, or conducting a parts inspection. Top-down attention is slower than bottom-up attention.

Bottom-Up – Attention is captured by external stimuli, usually unexpected events or salience. This is also termed data-driven or automatic attention. Examples are a bright flash of light, a loud sound, loss of balance due to slippery conditions, or impact by an object. Bottom-up attention is very rapid, reaching its maximum 100-200 milliseconds after stimulus perception.



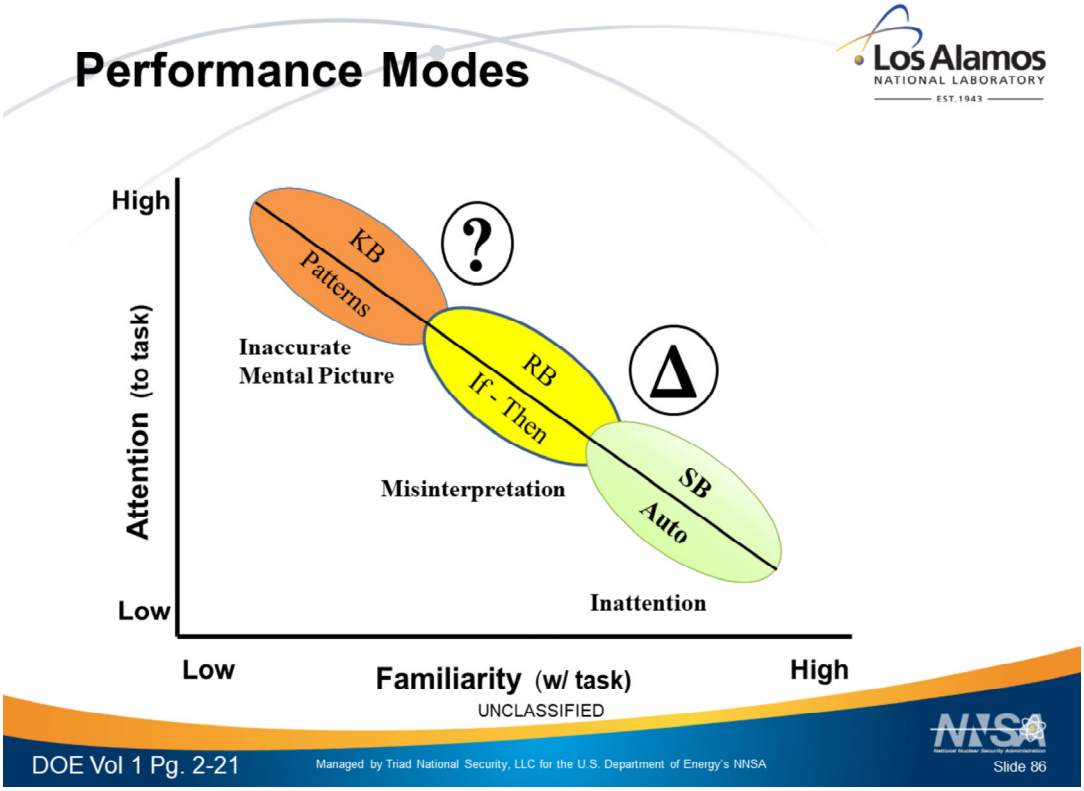
Inattention to detail is an often-cited cause of human performance problems. Avoiding error is not as simple as telling someone to "pay attention."

First of all, attention is a limited commodity; second, we can only attend to a very small proportion of the available sense data and; third, unrelated matters can capture our attention. There are three attention modes. Attention can be focused, divided, or selective.

If attention is **focused**, something has to be ignored. If attention is strongly drawn to one particular thing it is necessarily withdrawn from other competing concerns.

Divided attention involves paying attention to two or more sources of information on a time-share basis, similar to using a flashlight in a dark room trying to see two different items, moving the flashlight back and forth. Divided attention can be dangerous; for example, a driver's attention is significantly distracted while using a cell phone.

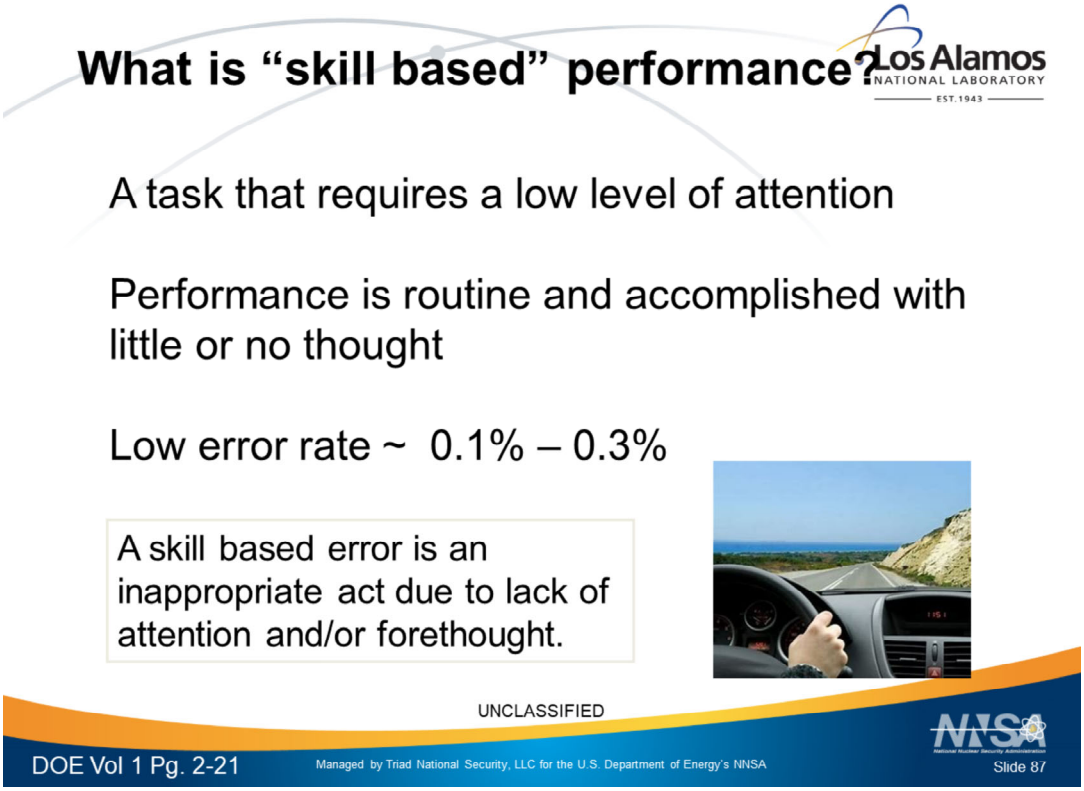
Selective attention means an individual gives preference to distinct information, such as one's name in a noisy meeting room. It is impossible for humans to pay attention to everything all the time. This can lead to the occasional error. The likelihood of error is enhanced when someone attempts to do more than one activity in one stage of information processing (sensing, thinking, acting), such as listening to the radio and a passenger simultaneously while driving an automobile. This is why it is so important to control the environment in which people work by minimizing interruptions and distractions or other stimuli that can negatively affect a performer's attention capabilities. Trained, experienced operators can consciously attend to a maximum of two or three channels of information (such as flow, temperature, pressure) and still be effective. Beyond that, error is likely due to limited attention resources of human nature.



The three performance levels can be readily applied to a familiar activity like driving an automobile. For an experienced driver, the control of speed and direction of the vehicle occur almost entirely at the **skill-based** level (an automatic mode of control). Things related to how the driver relates to other drivers on the road are covered by rules (speed limit, distance from other cars, right of way, etc.) of the kind if (situation X occurs) do—or don't do—(action Y). Here the driver is in a **rule-based** level of performance. While traveling at a good clip along a main highway, the driver hears on the radio that there is a traffic jam up ahead. To continue will result in long delays. So the driver has to use his/her knowledge of directions and road connections and accesses to find an alternative route. This problem-solving "mind-work"' occurs at the **knowledge-based** level (conscious mode) .

Another way to look at this is thru the eyes of a driver

- Student Driver is in knowledge base. They have attended drivers education class and passed their test. Now they are on a learners permit
- Inexperienced Driver – has their license, but is not very experienced. Follows the rules
- Experienced driver – skill based performance. Errors are slips and lapses.



<u>Skill-Based Performance</u>

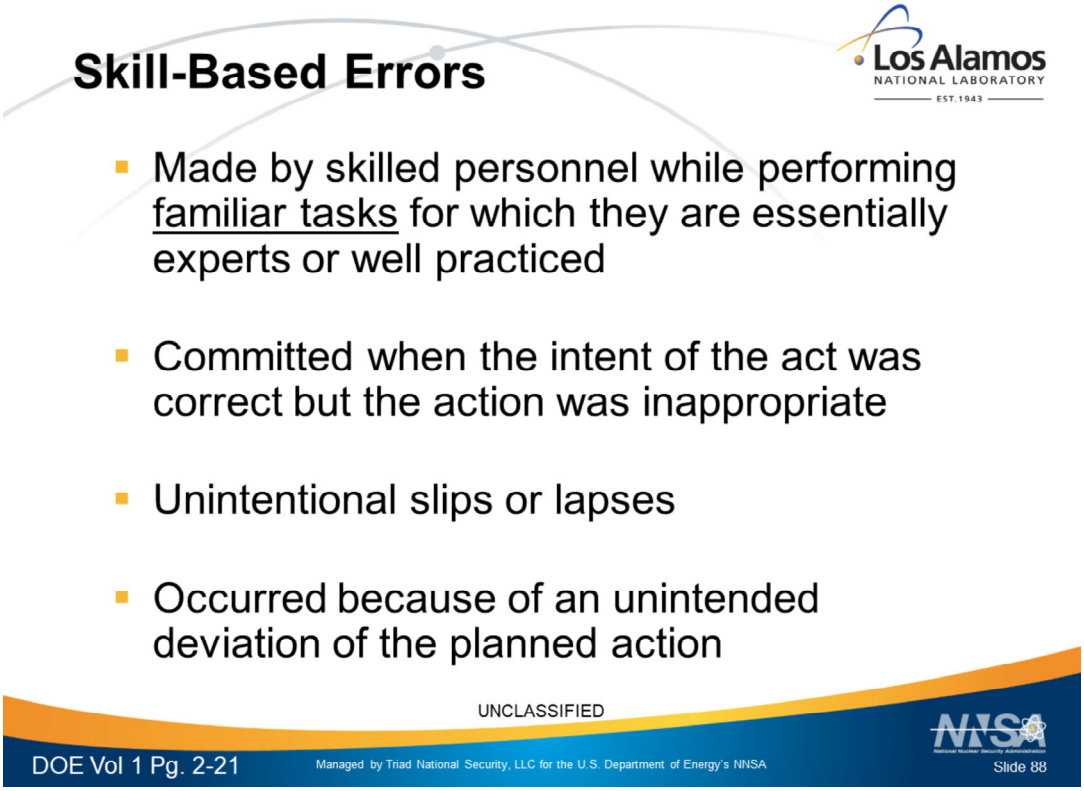
Skill-based performance involves highly practiced, largely physical actions in very familiar situations in which there is little conscious monitoring. Such actions are usually executed from memory without significant conscious thought or attention (see illustration). Behavior is governed by preprogrammed instructions developed by either training or experience and is less dependent upon external conditions. Information that can be processed with little or no allocation of attention resources is called automatic processing. When skills are learned to the point of being automatic, the load on working memory typically is reduced by 90 percent. This occurs after extensive practice of a task so that, literally, it can be performed "without thought." Many actions in a typical day are controlled unconsciously by human instinct, such as keyboarding, writing one's signature, taking a shower, driving a car. In the skill-based mode, the individual is able to function very effectively by using pre-programmed sequences of behavior that do not require much conscious control. It is only occasionally necessary to check on progress at particular points when operating in this mode.

Examples of skill-based activities for well-trained and practiced individuals include:

- mowing the lawn;
- using a hammer or other hand tool;
- controlling various processes manually (such as pressure and level),
- hanging a tag;
- analyzing chemical composition of a routine sample;
- performing repetitive calculations;
- using measure and test equipment;

- opening a valve;
- taking logs; and
- replacing parts during maintenance.

Error Modes are the prevalent ways, not the only ways, people err for the particular performance mode. Error modes are generalities that aid in anticipating and managing error-likely situations aggravated by inattention, misinterpretation, and inaccurate mental models.



Skill-Based Error Mode – Inattention

The error mode for skill-based performance is *inattention.* Skill-based errors are primarily execution errors, involving action slips and lapses in attention or concentration. Errors involve inadvertent slips and unintentional omissions triggered by simple human variability or by not recognizing changes (note the Δ symbol on the above chart) in task requirements, system response, or facility conditions related to the task. Some examples of errors committed while in the skill-based performance level follow.

- When addressing an envelope, he put his old address in the return box instead of his new (correct) address.
- She forgot to drop off shoes at the shoe shop to be repaired, and instead drove right past the shoe shop and straight to her home.
- An electrician had been asked to change a light bulb that indicated whether a hydraulic on/off switch was selected. The hydraulic system was being worked on, and the electrician was aware that it would be unsafe to activate the system. Nevertheless, after changing the bulb, and before he had realized what he was doing, he had followed his usual routine and pushed the switch to the ”on” position to test whether the light was now working.
- Intending to shut down lines A and B, the operator also pressed the “shut-off’“ control buttons for lines C and D.

Under ideal conditions, the chance for error is less than 1 in 10,000, according to a study in the nuclear power industry. People most often possess an accurate understanding of the task and have correct intentions. Roughly 90 percent of a person's daily activities are spent in the skill-based performance mode. However, only 25 percent of all errors are

attributable to skill-based errors in the nuclear power industry.68 Potentially, a person can be so focused on a skill-based task that important information in the work place is not detected. Another concern for skill-based tasks is that people *are* familiar with the task. The greater the familiarity, the less likely perceived risk will match actual risk. People become comfortable with risk and eventually grow insensitive to hazards. Several tools in the HPI Handbook volume 2 are designed to help anticipate, prevent or catch skill-based errors (task preview, job-site review, questioning attitude, stop when unsure, self-checking, pre-job briefing, place-keeping, peer check and concurrent verification).

VIDEO: Teeth anyone
This video demonstrates skill based error when husband and wife get wear each other's dentures
https://www.youtube.com/watch?v=rg4GiKXkSys

Examples of "Skill Based" Errors

Bill Dance – Fishing expert

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Slide 90

VIDEO: Bill Dance
This video demonstrates Multiple Skill based errors by fishing show host Bill Dance

billdancefishing
https://www.youtube.com/user/billdancefishing
https://www.youtube.com/user/billdancefishing/search?query=bloopers

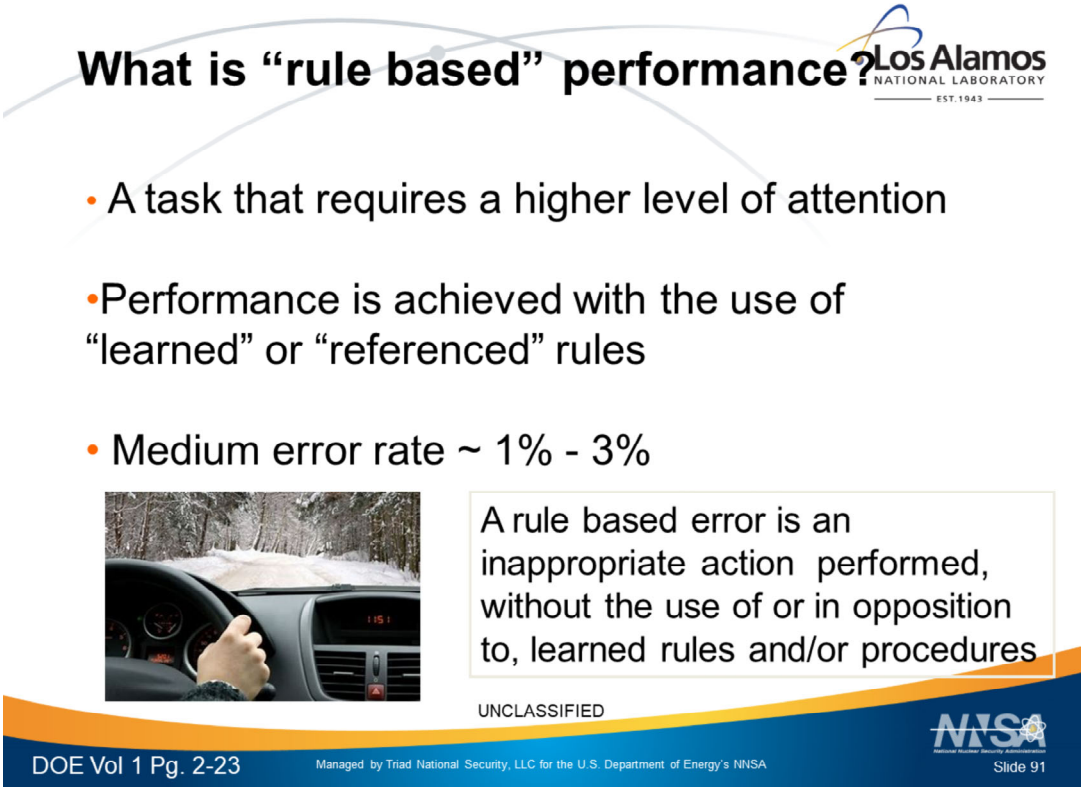
BDO13 Bloopers Volume 1
https://www.youtube.com/watch?v=iK_h-2kot6s&t=24s

BDO13 Bloopers Volume 2
https://www.youtube.com/watch?v=hoQIIjOKwpo

BDO13 Bloopers Volume 3
https://www.youtube.com/watch?v=InpVTPK6o9Q&t=30s

BDO13 Bloopers Volume 4
https://www.youtube.com/watch?v=VSazi4GwRqI

BDO13 Bloopers Volume 5
https://www.youtube.com/watch?v=zQSDI-GIPBc



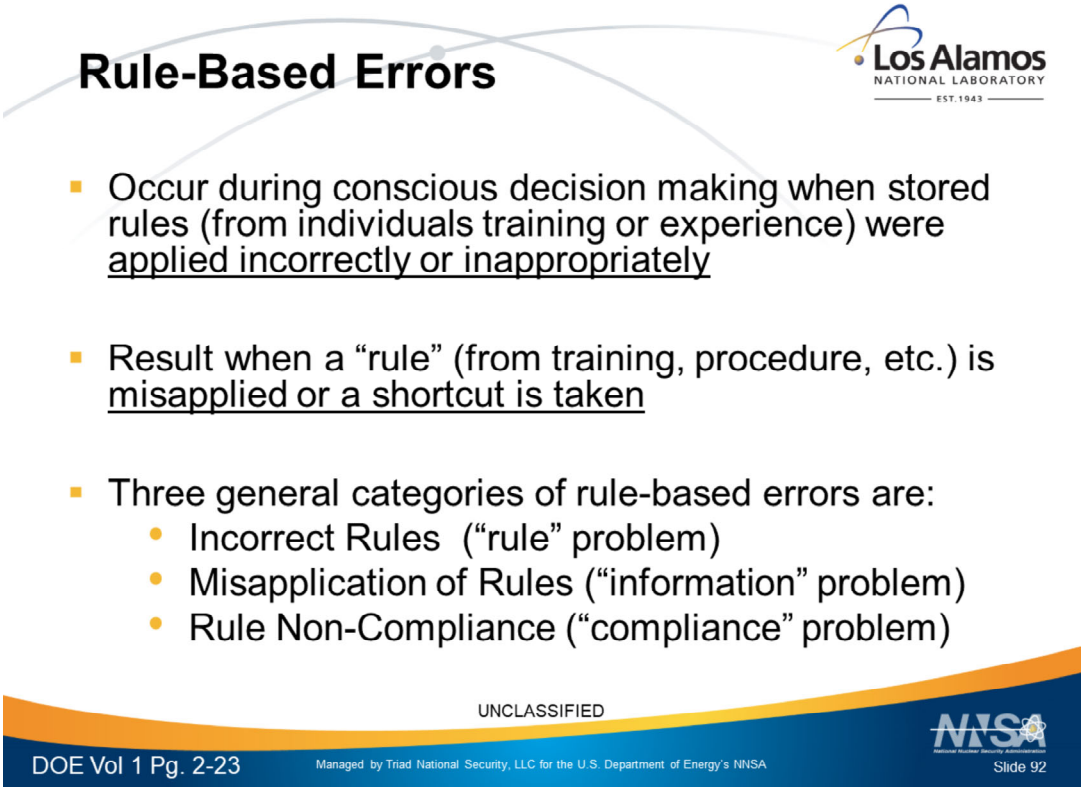
<u>Rule-Based Performance</u>

People switch to the rule-based performance level when they notice a need to modify their largely pre-programmed behavior because they have to take account of some change in the situation. The work situation has changed such that the previous activity (skill) no longer applies. This problem is likely to be one that they have encountered before, or have been trained to deal with, or which is covered by the procedures. It is called the rule-based level because people apply memorized or written rules. These rules may have been learned as a result of interaction with the facility, through formal training, or by working with experienced workers. The level of conscious control is between that of the knowledge- and skill-based modes. The rule-based level follows an *IF* (symptom X), *THEN* (situation Y) logic. In applying these rules, we operate by automatically matching the signs and symptoms of the problem to some stored knowledge structure. So, typically, when the appropriate rule is applied, the worker exhibits prepackaged units of behavior. He/she may then use conscious thinking to verify whether or not this solution is appropriate.

The goal in rule-based performance is to improve one's interpretation of the work situation so that the appropriate response is selected and used. This is why procedures are prepared for situations that can be anticipated. Procedures are pre-determined solutions to possible work situations that require specific responses. Rules are necessary for those less familiar, less practiced work activities for which a particular person or group is not highly skilled. Not all activities guided by a procedure are necessarily rule-based performance. In normal work situations, such activities are commonly skill-based for the experienced user.

Examples of rule-based activities include:

- deciding whether to replace a ball bearing inspected during preventive maintenance;
- responding to a control board alarm;
- estimating the change in tank level based on a temperature change (thumb rules);
- feeling equipment for excessive vibration or temperature on operator rounds;
- performing radiological surveys;
- using emergency operating procedures; and
- developing work packages and procedures.



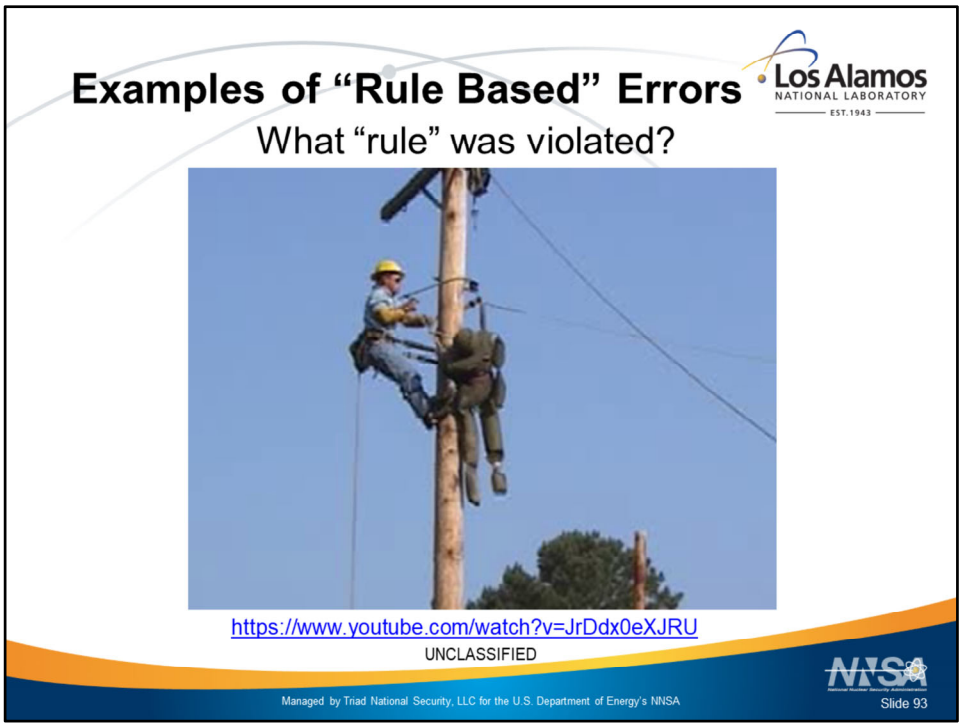
Rule-Based Error Mode

Since rule-based activities require interpretation using an if-then logic, the prevalent error mode is *misinterpretation.* People may not fully understand or detect the equipment or facility conditions calling for a particular response. Errors involve deviating from an approved procedure, applying the wrong response to a work situation, or applying the correct procedure to the wrong situation. Examples of errors committed when working in the rule based performance level include the following.

- A driver was about to pull out into the traffic flow following a stop at the side of the road. He checked the side-view mirror and saw a small green car approaching. He briefly checked his rear-view mirror (which generally gives a more realistic impression of distance) and noted a small green car some distance away. He then pulled out from the shoulder of the road and was nearly hit by a small green car. There were two of them, one behind the other. The driver assumed they were one and the same car. The first car had been positioned so that it was only visible in the side-view mirror.
- The technician knew that normal tire pressures in automobile tires is 32-35 psi. So, when he was required for the first time to air up a smaller, temporary-use automobile tire, he filled the tire to the customary 35 lbs. In actuality, small-diameter, temporary-use tires are aired up to 55-60 psi.
- A northbound commuter train in London in 1988 ran into the back of a stationary train after having passed a green signal. Thirty-five people died and 500 were injured. The signal light had given the wrong signal because the old signal wires had come into contact with nearby equipment for the new signal system that caused a wrong-side signal failure. The light should have shown red, for stop. The electrician who had wired the signal on the new system just the day before the accident had never been

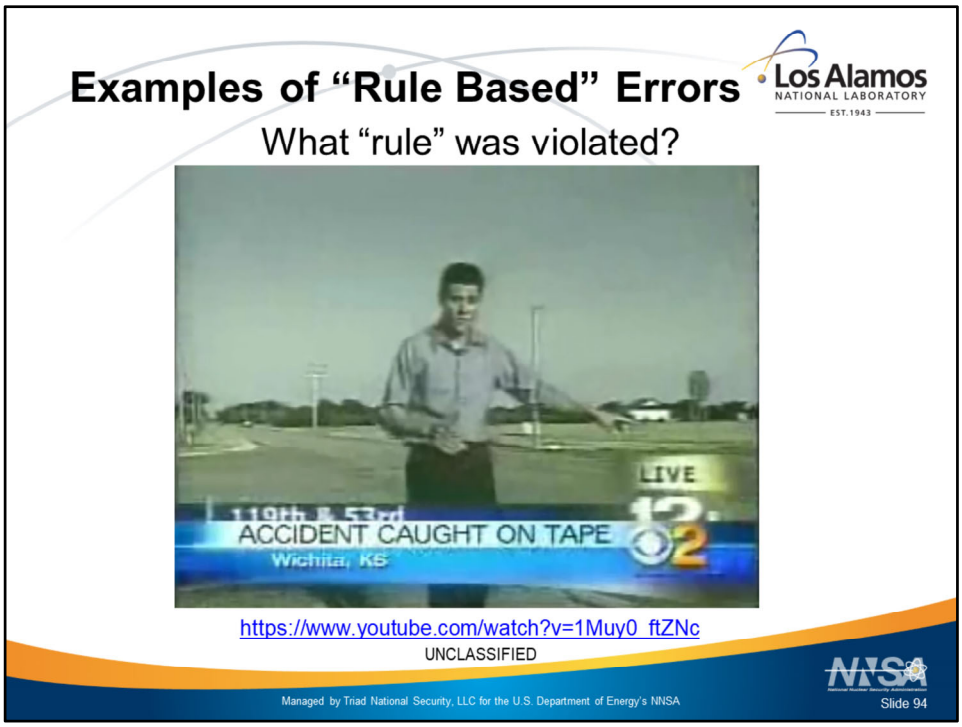
properly trained. He failed to cut off or tie back, and then insulate, old wires as he wired in the new signal system. He merely bent old wires back out of the way. The untrained technician had learned bad habits on his own that became his “strong but wrong rules.” His application of a bad rule went uncorrected.

The chance for error increases when people make choices or decisions, especially in the field. Rule-based and knowledge-based performance modes involve making choices. With less familiarity for the activity, the chance for error increases to roughly 1 in 1,000. In terms of reliability, this is still very good (99.9 percent). In the nuclear power industry, studies have shown that roughly 60 percent of all errors are rule-based. HPI Handbook volume 2 includes tools to help anticipate, prevent or catch rule-based errors. They include for example: task preview, procedure adherence, pre-job briefing, questioning attitude, peer-checking and concurrent verification among others.



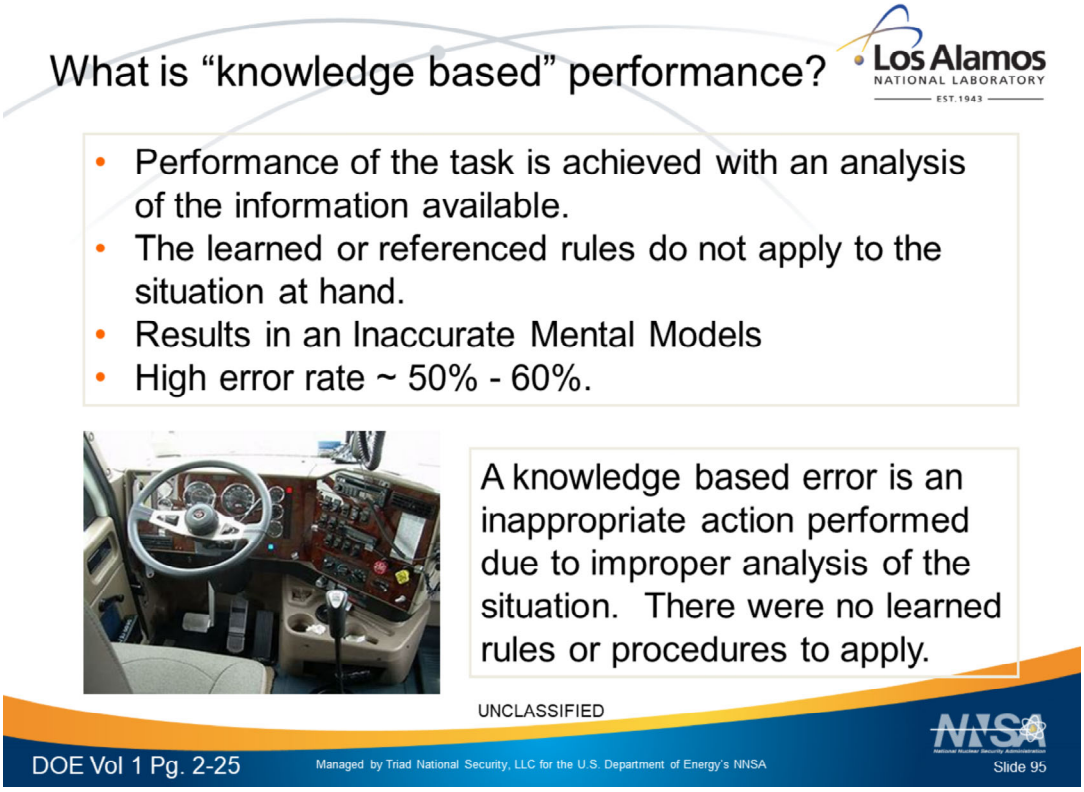
<u>WARNING: Someone get injured in this video</u>

VIDEO: Pole Climbing FAIL
This video demonstrates the consequences of a rule based error when the lineman deviates from the rule and "cuts" the rope.
During a Pole climbing training session some noob forgets to grab the rope to the dummy he is trying to rescue.
https://www.youtube.com/watch?v=JrDdx0eXJRU



<u>WARNING: Someone get injured in this video</u>

VIDEO: Accident Caught on Tape
This video records a "Crash at intersection caught on camera" where one of the drivers does not follow the rule (yield the right of way) prior to entering the intersection. Distractions and truck blocking view contribute to the event.
https://www.youtube.com/watch?v=1Muy0_ftZNc



Knowledge-Based Performance

Warning; the terminology of knowledge-based performance can be confusing! It is tempting to think that much of the engineering design work and the scientific investigations and research at DOE laboratories falls in the knowledge based category – simply because such work is performed by highly knowledgeable people. We must however at all costs avoid the temptation to shrug off the essential nuances and simply argue that since we do research or one of a kind work, and our people are highly educated and skilled, then our work is knowledge based. The truth is quite the opposite. The situation described as “knowledge based mode” might better be called “lack of knowledge” mode.

Knowledge based work, as defined by Rasmussen, generally means that we don’t really understand what we are doing. Clearly, that is not the case with most DOE work. Even in the most cutting edge science, the ability to develop and conduct controlled experiments depends on control; keeping the uncontrolled variables as few as possible so that we may observe the results of the experiment in order to hypothesize, test theories and ultimately develop new knowledge. It in fact might be argued that the accomplished researcher has highly refined abilities to work in skill and rule modes in order to be able to work in knowledge mode, since working in knowledge mode is so difficult.

Not all hazards, dangers, and possible scenarios can be anticipated in order to develop appropriate procedures. Even training is unable to anticipate all possible situations that can be encountered. There are some situations in which no procedure guidance exists and no skill applies. Dr. James Reason concludes that the knowledge-based level of

performance is something we come to very reluctantly. Humans only resort to the slow and effortful business of thinking things through on the spot after they have repeatedly failed to find some pre-existing solution.

Hence, knowledge-based behavior is *a response to a totally unfamiliar situation* (no skill or rule is recognizable to the individual The person must rely on his or her prior understanding and knowledge, their perceptions of present circumstances, similarities of the present situation and similarities to circumstances encountered before , and the scientific principles and fundamental theory related to the perceived situation at hand. People enter a knowledge-based situation when they realize they are uncertain (see the **?** symbol on previous chart) about what to do. If uncertainty is high, then the need for information becomes paramount. To effectively gain information about what we are doing or about to do, our attention *must* become more focused.

Knowledge-based situations are puzzling and unusual to the individual. Often our understanding of the problem is patchy, inaccurate, or both. In many cases, information sources contain conflicting data, too much data, or not enough data, amplifying the difficulty of problem-solving. Additionally, consciousness is very limited in its capacity to hold information, storing no more than two or three distinct items at a time. Consciousness tends to behave like a leaky sieve, allowing things to be lost as we turn our attention from one aspect of the problem to another. Because uncertainty is high, knowledge-based tasks are usually stressful situations.

Examples of Knowledge-Based Activities

Knowledge-based activities involve problem-solving. Such situations require the use of fundamental knowledge of processes, systems, and so on—"thinking on your feet." Examples of common problem-solving situations include the following:

- troubleshooting;
- performing an engineering evaluation of a new design;
- reviewing a procedure for 'intent of change;'
- resolving conflicting control board indications;
- holding meetings to address problems;
- conducting scientific experiments;
- resolving human performance problems;
- planning business strategies, goals, and objectives;
- performing root cause analysis of events;
- conducting trend analyses;
- designing equipment modifications
- making budget allocation decisions
- allocating resources;
- changing policies and expectations; and
- performing an engineering calculation.

Knowledge-Based Errors

- error occurred during conscious decision making but explicit "rules" do not exist for the individual or the individual is not aware of them
- analytical or logical thought processing was needed (when the error occurred) since the individual did not possess a specific rule to follow
- the individual had to draw on fundamental principles and utilize his/her overall technical understanding to make the decision associated with the error

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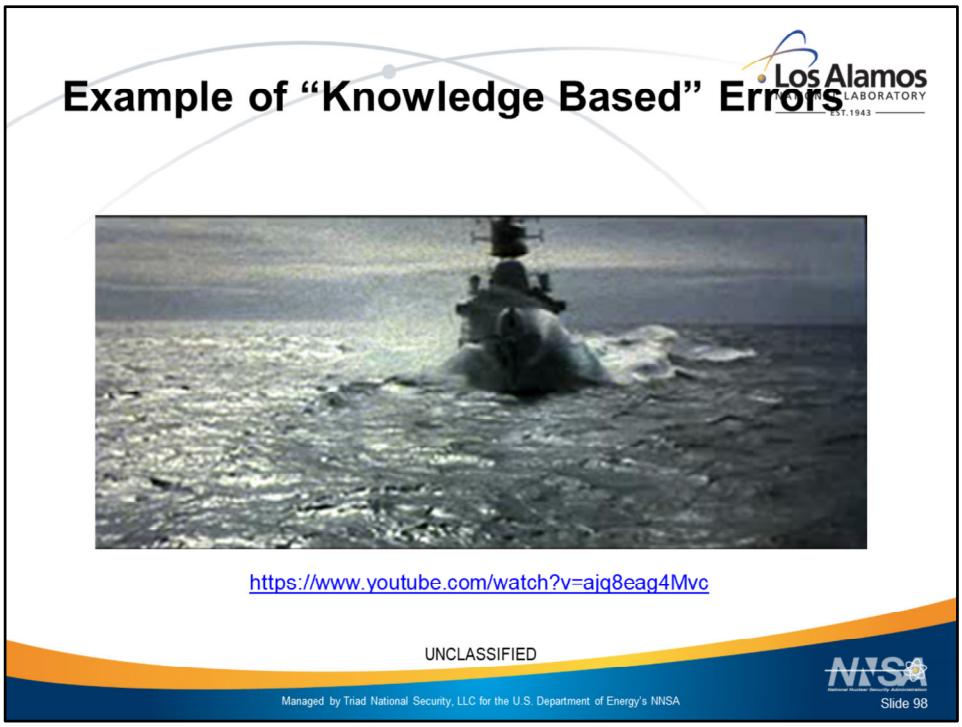
DOE Vol 1 Pg. 2-25 Managed by Triad National Security, LLC for the U.S. Department of Energy's NNSA Slide 96

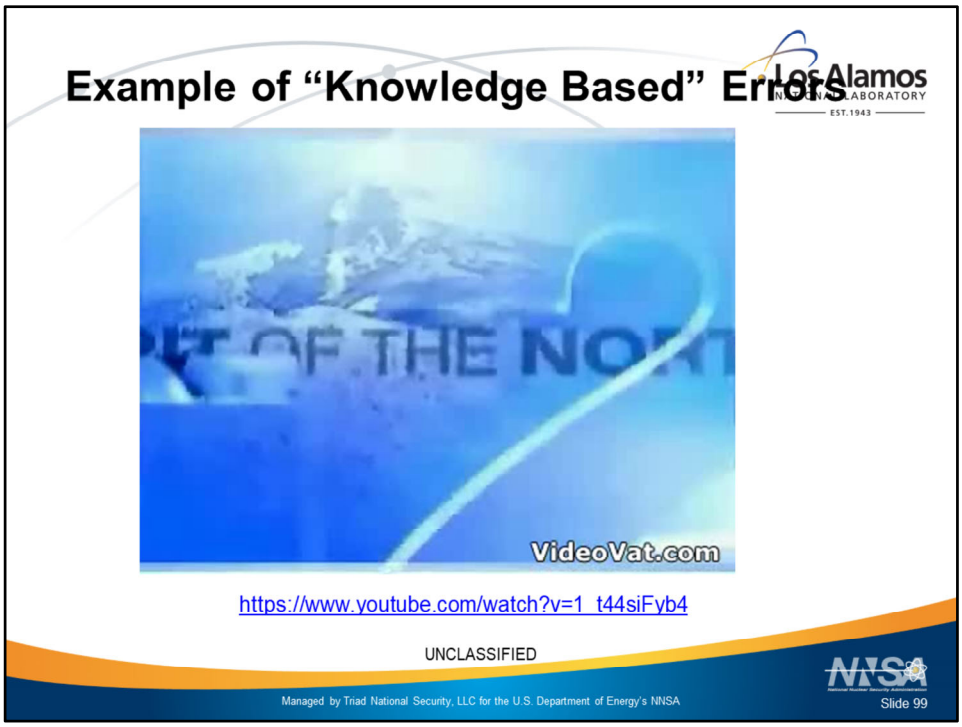
Knowledge-Based Error Mode

Knowledge-based activities require diagnosis and problem-solving. There are considerable demands on the information-processing capabilities of the individual that are necessary when a situation has to be evaluated from first principles. It is not surprising that humans do not perform very well in high stress, unfamiliar situations where they are required to 'think on their feet' in the absence of rules, routines, and procedures to handle the situation. People tend to use only information that is readily available to evaluate the situation. Also, problem solvers often become over-confident in the correctness of their knowledge; an "I know I'm right" effect. They also become enmeshed in one aspect of the problem to the exclusion of all other considerations. Decision-making is erroneous if problem-solving is based on inaccurate information. Often, decisions are made with limited information and faulty assumptions. Consequently, the prevalent error mode is an *inaccurate mental model* of the system, process, or facility status. Under such circumstances, the chance for error is particularly high, approximately one in two (50 percent) to one in ten. In the nuclear power industry, studies indicate that roughly 15 percent of all errors are knowledge-based. HPI Handbook volume 2 provides several tools to help anticipate, prevent, or catch knowledge-based errors. They include, for example, technical task pre-job briefing; project planning; problem-solving; decision-making; and peer review.

VIDEO: Funniest double speak ever
https://www.youtube.com/watch?v=QaxqUDd4fiw
This video demonstrates the various levels of things you know used to make decisions.
NOTE: The fourth bullet is not in the film, but obtained thru several presentations and student feedback.



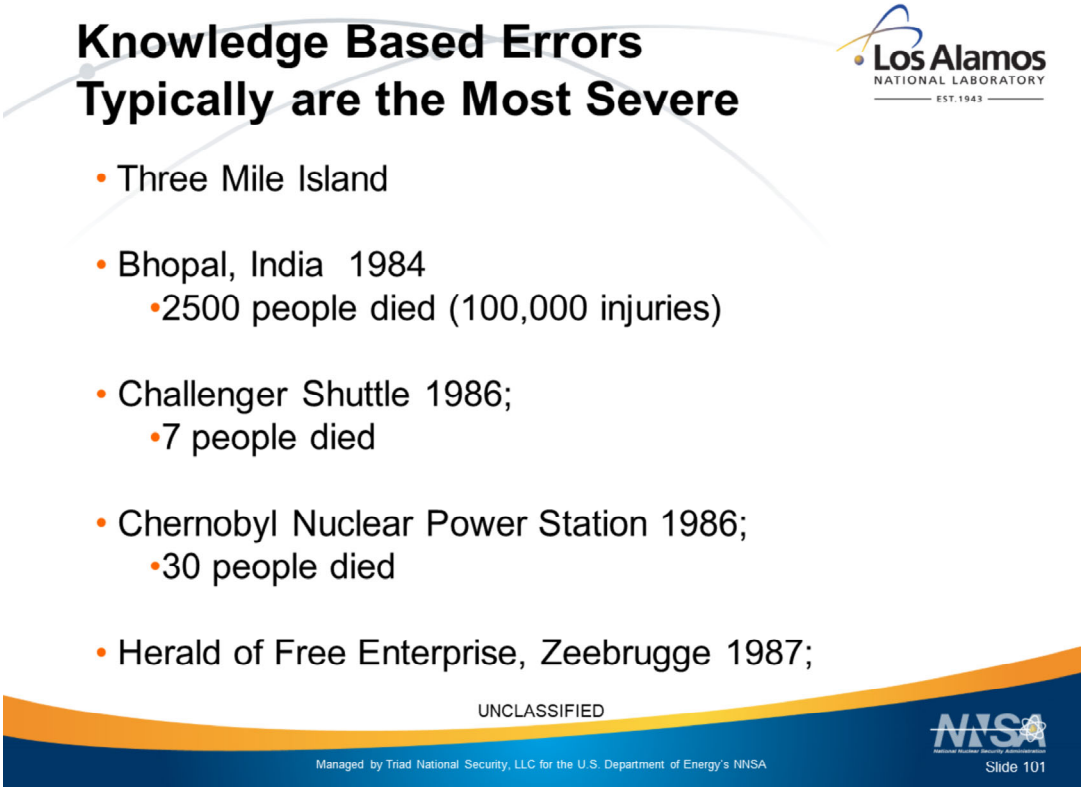
VIDEO: Know your limitations navy_captain
This video demonstrated knowledge based error when a navy crew sees an object on the radar that it thinks is another ship…but turns out to be a lighthouse.
https://www.youtube.com/watch?v=ajq8eag4Mvc



VIDEO: The Exploding Whale (www.theexplodingwhale.com)
https://www.youtube.com/watch?v=1_t44siFyb4
This video demonstrates an explosives expert applying his trade to a dead whale on the beach.

“Knowledge Based” Errors

- International Symbol for Knowledge Based Error Mode



The **Three Mile Island accident** was a partial nuclear meltdown that occurred on March 28, 1979, in reactor number 2 of Three Mile Island Nuclear Generating Station (TMI-2) in Dauphin County, Pennsylvania, United States. It was the worst accident in U.S. commercial nuclear power plant history.[2] The incident was rated a five on the seven-point International Nuclear Event Scale: Accident With Wider Consequences.[3][4]
The accident began with failures in the non-nuclear secondary system, followed by a stuck-open pilot-operated relief valve in the primary system, which allowed large amounts of nuclear reactor coolant to escape. The mechanical failures were compounded by the initial failure of plant operators to recognize the situation as a loss-of-coolant accident due to inadequate training and human factors, such as human-computer interaction design oversights relating to ambiguous control room indicators in the power plant's user interface. In particular, a hidden indicator light led to an operator manually overriding the automatic emergency cooling system of the reactor because the operator mistakenly believed that there was too much coolant water present in the reactor and causing the steam pressure release.

The **Bhopal disaster**, also referred to as the **Bhopal gas tragedy**, was a gas leak incident in India, considered the world's worst industrial disaster.[1]
It occurred on the night of 2–3 December 1984 at the Union Carbide India Limited (UCIL) pesticide plant in Bhopal, Madhya Pradesh. Over 500,000 people were exposed to methyl isocyanate (MIC) gas and other chemicals. The toxic substance made its way into and around the shanty towns located near the plant.[2]
Estimates vary on the death toll. The official immediate death toll was 2,259. The government of Madhya Pradesh confirmed a total of 3,787 deaths related to the gas

release.[3] A government affidavit in 2006 stated that the leak caused 558,125 injuries, including 38,478 temporary partial injuries and approximately 3,900 severely and permanently disabling injuries.[4] Others estimate that 8,000 died within two weeks, and another 8,000 or more have since died from gas-related diseases.[5]

The cause of the disaster remains under debate. The Indian government and local activists argue that slack management and deferred maintenance created a situation where routine pipe maintenance caused a backflow of water into a MIC tank triggering the disaster. Union Carbide Corporation (UCC) contends water entered the tank through an act of sabotage. The owner of the factory, UCIL, was majority owned by UCC, with Indian Government-controlled banks and the Indian public holding a 49.1 percent stake. In 1989, UCC paid $470m ($907m in 2014 dollars) to settle litigation stemming from the disaster. In 1994, UCC sold its stake in UCIL to Eveready Industries India Limited (EIIL), which subsequently merged with McLeod Russel (India) Ltd. Eveready ended clean-up on the site in 1998, when it terminated its 99-year lease and turned over control of the site to the state government of Madhya Pradesh. Dow Chemical Company purchased UCC in 2001, seventeen years after the disaster.

Civil and criminal cases were filed in the District Court of Bhopal, India, involving UCC and Warren Anderson, UCC CEO at the time of the disaster.[6][7] In June 2010, seven ex-employees, including the former UCIL chairman, were convicted in Bhopal of causing death by negligence and sentenced to two years imprisonment and a fine of about $2,000 each, the maximum punishment allowed by Indian law. An eighth former employee was also convicted, but died before the judgement was passed.[1] Anderson died on September 29, 2014.

The **Space Shuttle *Challenger* disaster** occurred on January 28, 1986, when the NASA Space Shuttle orbiter *Challenger* (OV-099) (mission STS-51-L) broke apart 73 seconds into its flight, leading to the deaths of its seven crew members, which included five NASA astronauts and two Payload Specialists. The spacecraft disintegrated over the Atlantic Ocean, off the coast of Cape Canaveral, Florida, at 11:39 EST (16:39 UTC). Disintegration of the vehicle began after an O-ring seal in its right solid rocket booster (SRB) failed at liftoff. The O-ring was not designed to fly under unusually cold conditions as in this launch. Its failure caused a breach in the SRB joint it sealed, allowing pressurized burning gas from within the solid rocket motor to reach the outside and impinge upon the adjacent SRB aft field joint attachment hardware and external fuel tank. This led to the separation of the right-hand SRB's aft field joint attachment and the structural failure of the external tank. Aerodynamic forces broke up the orbiter.

The crew compartment and many other vehicle fragments were eventually recovered from the ocean floor after a lengthy search and recovery operation. The exact timing of the death of the crew is unknown; several crew members are known to have survived the initial breakup of the spacecraft. The shuttle had no escape system,[1] and the impact of the crew compartment with the ocean surface was too violent to be survivable.

The disaster resulted in a 32-month hiatus in the shuttle program and the formation of the Rogers Commission, a special commission appointed by United States President Ronald Reagan to investigate the accident. The Rogers Commission found NASA's organizational

culture and decision-making processes had been key contributing factors to the accident,[2] with the agency violating its own safety rules. NASA managers had known since 1977 that contractor Morton Thiokol's design of the SRBs contained a potentially catastrophic flaw in the O-rings, but they had failed to address this problem properly. They also disregarded warnings (an example of "go fever") from engineers about the dangers of launching posed by the low temperatures of that morning, and failed to adequately report these technical concerns to their superiors.
As a result of the disaster, the Air Force decided to cancel its plans to use the Shuttle for classified military satellite launches from Vandenberg Air Force Base in California, deciding to use the Titan IV instead.
Approximately 17 percent of Americans witnessed the launch live because of the presence of Payload Specialist Christa McAuliffe, who would have been the first teacher in space. Media coverage of the accident was extensive: one study reported that 85 percent of Americans surveyed had heard the news within an hour of the accident.[3] The *Challenger* disaster has been used as a case study in many discussions of engineering safety and workplace ethics.

The **Chernobyl disaster** (also referred to as the **Chernobyl accident** or simply **Chernobyl**) was a catastrophic nuclear accident that occurred on 26 April 1986 at the Chernobyl Nuclear Power Plant in the city of Pripyat, then located in the Ukrainian Soviet Socialist Republic of the Soviet Union (USSR). An explosion and fire released large quantities of radioactive particles into the atmosphere, which spread over much of the western USSR and Europe.
The Chernobyl disaster was the worst nuclear power plant accident in history in terms of cost and casualties.[1] It is one of only two classified as a level 7 event (the maximum classification) on the International Nuclear Event Scale, the other being the Fukushima Daiichi nuclear disaster in Japan in 2011.[2] The struggle to contain the contamination and avert a greater catastrophe ultimately involved over 500,000 workers and cost an estimated 18 billion rubles.[3] During the accident itself, 31 people died, and long-term effects such as cancers are still being investigated.[4]
The disaster began during a systems test on 26 April 1986 at reactor number four of the Chernobyl plant, which is near the city of Pripyat and in proximity to the administrative border with Belarus and the Dnieper River. There was a sudden and unexpected power surge, and when an emergency shutdown was attempted, a much larger spike in power output occurred, which led to a reactor vessel rupture and a series of steam explosions. These events exposed the graphite moderator of the reactor to air, causing it to ignite.[5] The resulting fire sent a plume of highly radioactive fallout into the atmosphere over an extensive geographical area, including Pripyat. The plume drifted over large parts of the western Soviet Union and Europe. From 1986 to 2000, 350,400 people were evacuated and resettled from the most severely contaminated areas of Belarus, Russia, and Ukraine.[6][7] According to official post-Soviet data,[8][9] about 60% of the fallout landed in Belarus.

The ***Herald of Free Enterprise* disaster** occurred on 6 March 1987 after the Townsend Thoresen car ferry MS *Herald of Free Enterprise* left her berth at Zeebrugge, Belgium, with her bow doors open, capsizing soon after leaving the harbour.
On the day the ferry capsized, the *Herald of Free Enterprise* was working the route between

Dover and the port of Zeebrugge. This was not its normal route and the linkspan at Zeebrugge had not been designed specifically for the Spirit class vessels: it used a single deck, preventing the simultaneous loading of both vehicle decks, decks E and G, and the ramp could not be raised high enough to reach E deck.[1][2] To compensate for this, the vessel's bow ballast tanks were filled.[1] However, the ship's natural trim was not restored after loading.[1] Had the *Herald* survived, she would have been modified to obviate this procedure.[2]

Before dropping moorings, it was normal practice for the assistant boatswain to close the doors. However, the assistant boatswain, Mark Stanley, had returned to his cabin for a short break after cleaning the car deck upon arrival, and was still asleep when the harbour-stations call sounded and the ship dropped her moorings.[3] The first officer, Leslie Sabel, was required to stay on deck to make sure the doors were closed.[4] Sabel said he thought he saw Stanley approaching. He was seriously injured in the disaster and the court concluded that his evidence was inaccurate.[4] It is believed that under pressure to get to his harbour station on the bridge, he had left G deck with the bow doors open in the expectation that Stanley would arrive shortly.[4] The court also described the attitude of boatswain Terence Ayling, believed to have been the last person on G deck, as 'most unfortunate'.[4] Asked why he did not close the doors given there was no one else there to do it, he said it was not his duty.[4] However the court praised his work in the rescue.[4]

Captain David Lewry assumed that the doors had been closed since he could not see them from the wheelhouse owing to the ship's design, and had no indicator lights in the wheelhouse.[5]

The ship left its berth in Zeebrugge inner harbour at 18:05 (GMT) with a crew of 80 and carrying 459 passengers, 81 cars, 3 buses and 47 trucks. She passed the outer mole at 18:24 and capsized about four minutes later.[6]

When the ferry reached 18.9 knots (35.0 km/h; 21.7 mph) 90 seconds after leaving the harbour, water began to enter the car deck in large quantities. The resulting free surface effect destroyed her stability.

In a matter of seconds, the ship began to list 30 degrees to port. The ship briefly righted herself before listing to port once more, this time capsizing. The entire event took place within 90 seconds.[7] The water quickly reached the ship's electrical systems, destroying both main and emergency power and leaving the ship in darkness.

The ship ended on its side half-submerged in shallow water 1 kilometre (0.5 nmi; 0.6 mi) from the shore. Only a fortuitous turn to starboard in her last moments, and then capsizing on to a sandbar, prevented the ship from sinking entirely in much deeper water.

Crew aboard a nearby dredger noticed the *Herald*'s lights disappear, and notified the port authorities. The alarm was raised at 18:26 British time (or 19:26 Belgian time). A rescue helicopter arrived within half an hour, shortly followed by assistance from the Belgian Navy, who were undertaking an exercise within the area.[*citation needed*] Wolfgang Schröder, a German Captain, was commended by Prime Minister Margaret Thatcher and received a medal from King Baudouin of Belgium for his heroic efforts in rescuing passengers.[8]

The disaster resulted in the deaths of 193 people. Many of those on board had taken advantage of a promotion in *The Sun* newspaper offering cheap trips to the continent. Most of the victims were trapped inside the ship and succumbed to hypothermia because of the

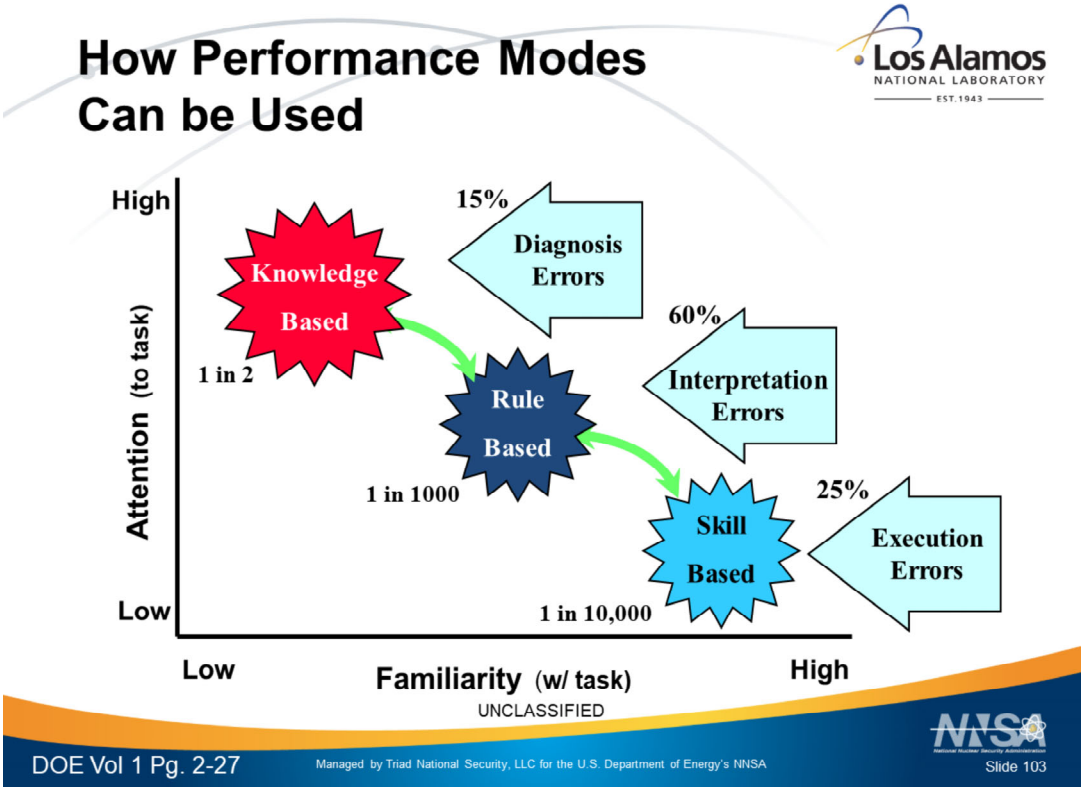
frigid (3 °C) water. The rescue efforts of the Belgian Navy limited the death toll. Recoverable bodies were removed in the days following the accident. During the rescue the tide started to rise and the rescue team was forced to stop all efforts until morning. The last of the people left on board died of hypothermia.

GEMS Exercise

Skill Rule Knowledge

- Throwing a baseball
- Using a Caulk gun
- Preparing Roast Duck
- Ordering a meal at a restaurant
- Driving on a Traffic Circle (Rotary)
- Water Skiing

NOTES: make sure to discuss that different people will be in different “modes” and that people transition between modes as they complete a task

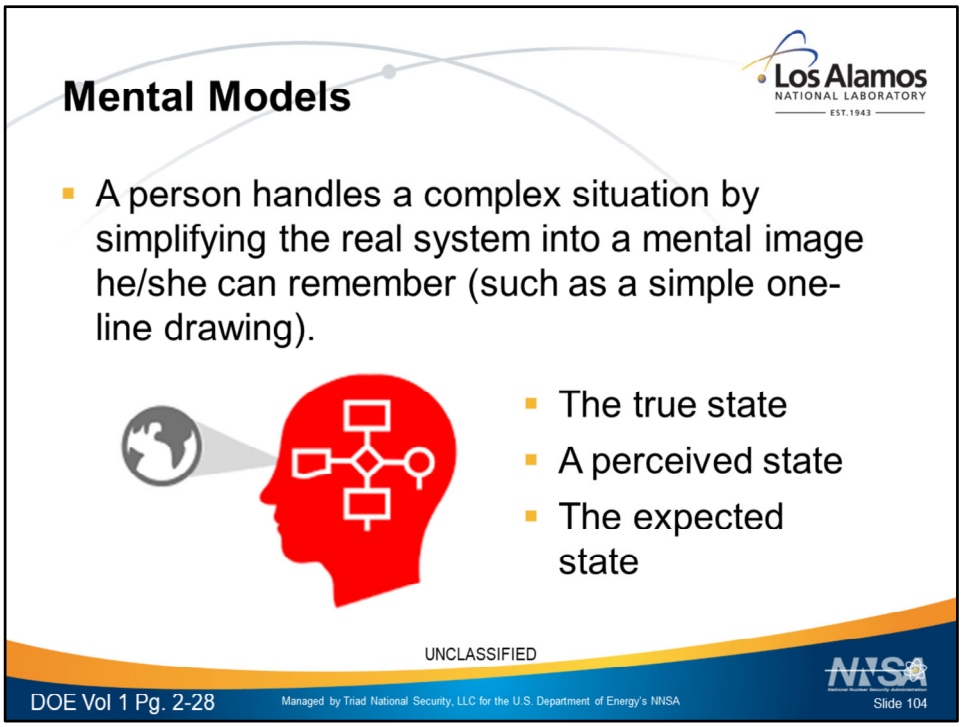


How Performance Modes Can be Used

A better contextual understanding of individuals' conscious and automatic behaviors as described in the skill, rule, and knowledge performance modes, and knowing the kinds of errors individuals tend to make while working in those various modes, can be extremely useful. Managers responsible for establishing and maintaining effective controls can make good use of this information. Workers need accurate, complete, and unambiguous procedures and guides for reference when doing rule-based work. They may also need access to a subject matter expert when making choices about the rules to select and for correct application of those rules.

Workers performing skill-based work need adequate tools to minimize action slips, and they need to be free from interruptions and distractions that aggravate concentration, divide their attention, and contribute to lapses in memory that cause error. When working in skill-based performance mode, workers may benefit from simple job aids and reminders.

On the other hand, for individuals working in the knowledge-based mode, where their understanding of the problem is often patchy, or inaccurate, or both, and where the slow and effortful business of thinking things through is needed, collaboration with a small team of thoughtful, committed, and experienced individuals is needed to help in problem-solving and decision-making.



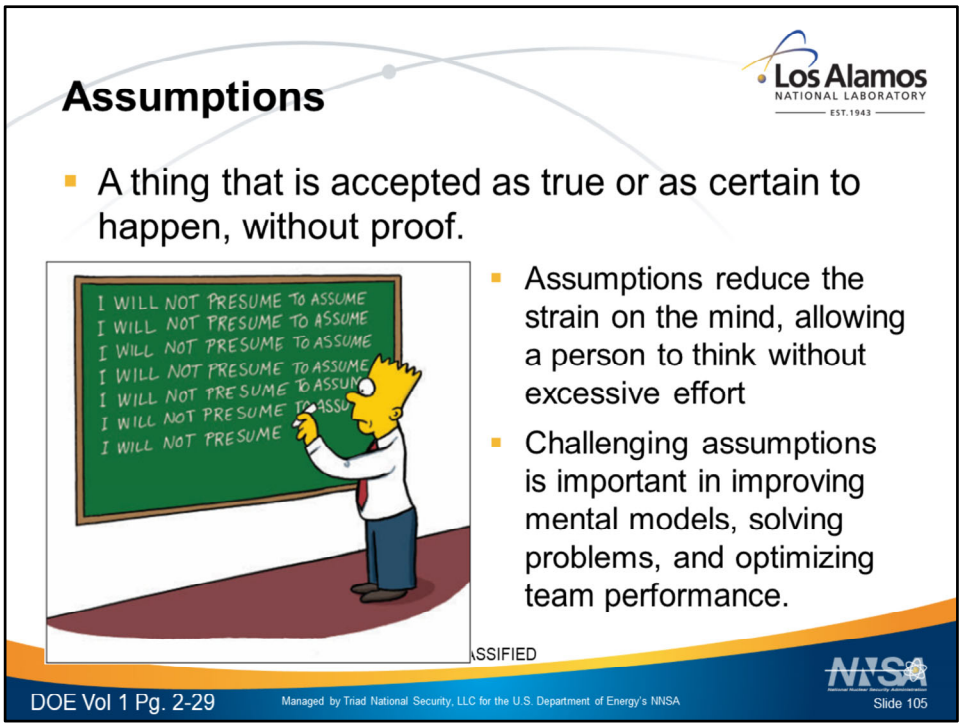
Mental Models

A person handles a complex situation by simplifying the real system into a mental image he/she can remember (such as a simple one-line drawing). A mental model is the structured understanding of knowledge (facts or assumptions) a person has in his or her mind about how something works or operates (for example, facility systems). Mental models are used in all performance modes. In fact, mental models give humans the ability to detect skill-based slips and lapses. They aid in detecting deviations between desired and undesired system states, such as manually controlling tank water level. A mental model organizes knowledge about the following.

- what a system contains
- how components work as a system
- why it works that way
- current state of a system
- fundamental laws of nature

An individual's mental model may reflect (1) the true state of the system, (2) a perceived state of the system, or (3) the expected state of the system that is developed through training and experience with the system and recent interactions with the system. Note that all mental models are inaccurate to some extent because of the limitations of human nature. It is important to remember that knowledge-based performance involves problem-solving, and mental models should be considered explicitly when a team works on a problem. Team members should agree with the model they intend to use to diagnose and solve a problem. Otherwise,

misunderstandings and assumptions may occur. Frequent time-outs can help teams keep mental models up to date.



Assumptions

Knowledge-based situations can be stressful, anxious situations. Assumptions reduce the strain on the mind, allowing a person to think without excessive effort. Assumptions are necessary at times to help constrain a problem. Consequently, assumptions tend to occur more often when people experience uncertainty, leading to trial-and-error and cause-and-effect problem-solving approaches. Assumptions also occur as an outgrowth of unsafe attitudes and inaccurate mental models. Statements such as “I think ...,” “We've always …,” or “I believe ...” are hints that an assumption has been or is being made. These phrases are known as “danger words.” Inaccurate mental models, in turn, can promote erroneous assumptions that may lead to errors.

Often, assumptions are treated as fact. Challenging assumptions is important in improving mental models, solving problems, and optimizing team performance. Assigning a devil’s advocate in a critical problem-solving situation may be worthwhile to achieve a better solution. Also, challenging assumptions helps detect unsafe attitudes and inaccurate mental models. A devil’s advocate can challenge assumptions using the following process.

- Identify *conclusion*(s) being made by another person or yourself.
- Ask for or identify the *data* that leads to the conclusion(s). “How did you get that data?” “What is the source of your concern?”
- Ask for the *reasoning* (mental model) that connects the data with the conclusion. “Do you mean…?” “Why do you feel that way?”
- Infer possible beliefs or *assumptions*.

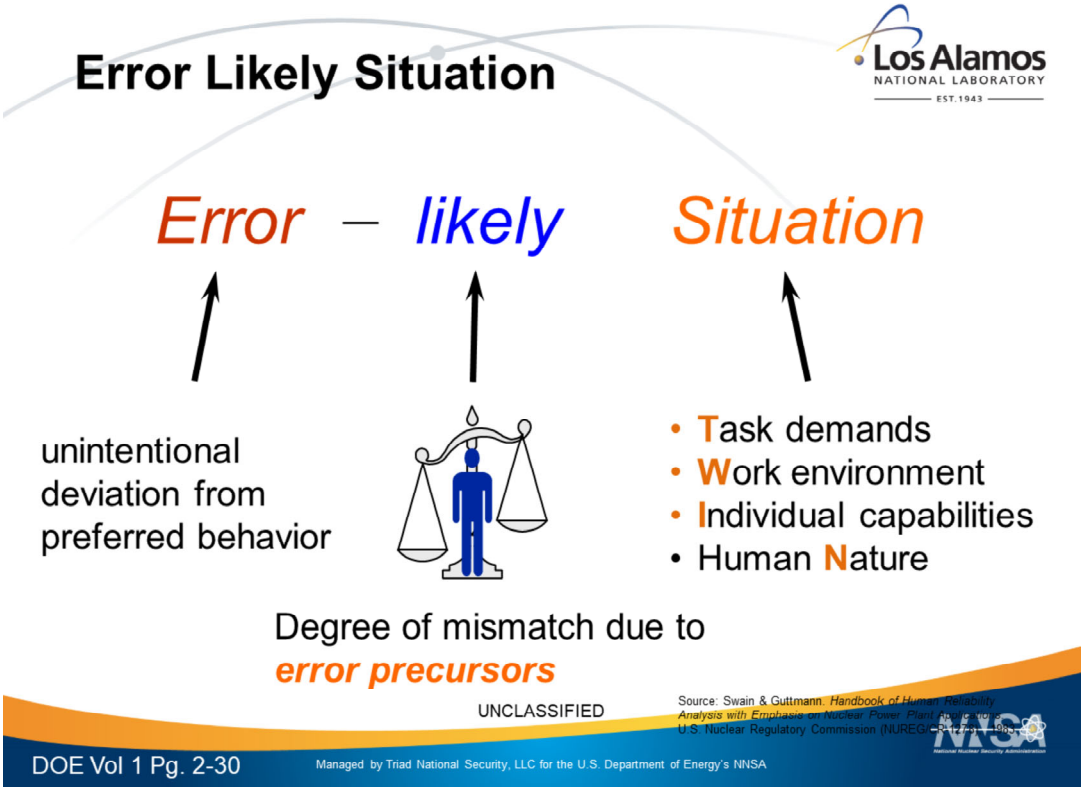
- Test the assumption with the other person. “What I hear you saying is…”

Mental Biases – Shortcuts (pg. 2-29)
- This section was covered in Volume 1, Chapter 1, “Avoiding Mental Strain”

Conservative Decisions (pg. 2-30)
- This section will be covered in HPI Tools for Management

Error-Likely Situations

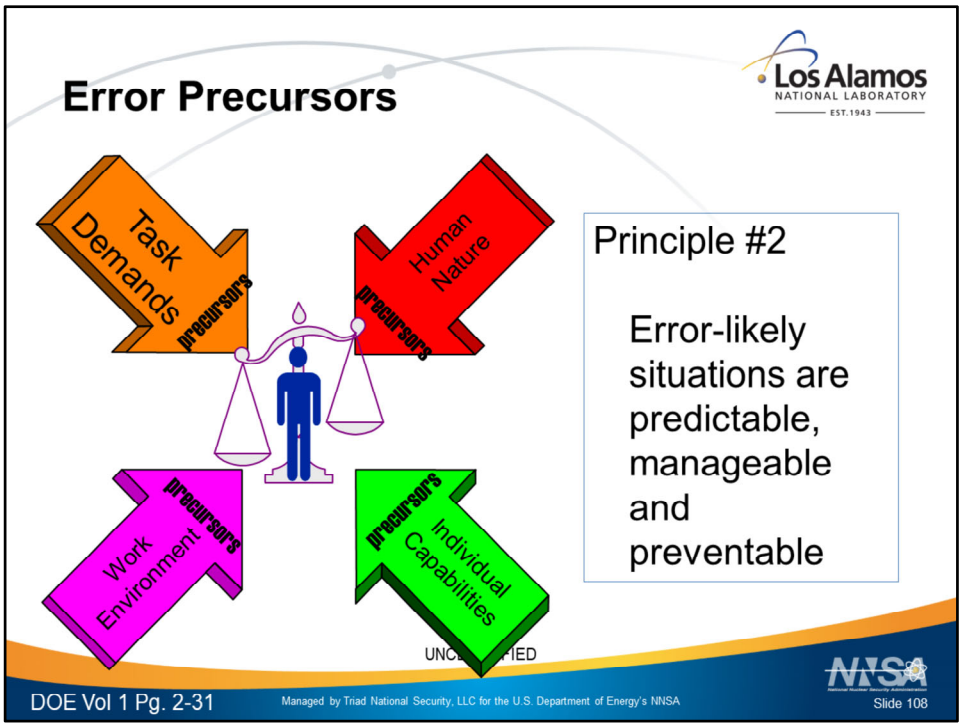
- Errors and mistakes are NOT predictable
- But the environment in which errors and mistakes may happen is predictable



Error-likely situation: A work situation in which there is a greater chance for error when performing a specific action or task in the presence of error precursors
Error-likely situation – an error about to happen – typically exists when the task-related factors exceed the capabilities of the individual (a mismatch) at the point of “touching” either the physical or paper plant.

Examples:

- A person cannot fall off of a bicycle unless they are riding the bicycle
- Darkness is not a factor for performance until the technician attempts to read the label on an instrument.



Error Precursors – unfavorable conditions embedded in the job site that create mismatches between a task and the individual. Error precursors interfere with successful performance and increase the probability of error. Error-precursors are, by definition, prerequisite conditions for error and, therefore, exist *before* the error occurs. IF discovered, job-site conditions can be changed to minimize the chance for error.

Task Demands – *Specific* mental, physical, and team requirements to perform an activity that may either exceed the capabilities or challenge the limitations of human nature of the individual assigned the task; for example, excessive workload, hurrying, concurrent actions, unclear roles and responsibilities, and vague standards.

Individual Capabilities – *Unique* mental, physical, and emotional characteristics of a particular person that fail to match the demands of the specific task; for example, unfamiliarity with the task, unsafe attitudes, level of education, lack of knowledge, unpracticed skills (proficiency), personality, inexperience, health and fitness, poor communication practices, and low self-esteem.

Work Environment – *General* influences of the workplace, organizational, and cultural conditions that affect individual behavior; for example, distractions, awkward equipment layout, complex tagout procedures, at-risk norms and values, work group attitudes toward various hazards, and work control processes.

Human Nature – *Generic* traits, dispositions, and limitations that may incline individuals to err under unfavorable conditions; for example, habit sort-term memory, fatigue, stress, complacency, and mental shortcuts.

Creating an Error-Likely Situation

- **Technical Area**: 03
  Location : TA-3-261 Restroom

  Description: A tenant of the Otowi building fell while walking in the women's restroom. The custodian had just mopped the floor and was looking for a wet floor sign when the accident occurred. No other information is available at this time.

- What could have been done differently?

Answers include obtaining the wet floor sign prior to mopping the floor.

Common Error Precursors

Task Demands	Individual Capabilities
• Time pressure (in a hurry)	• Unfamiliarity with task / First time
• High Workload (large memory requirements)	• Lack of knowledge (faulty mental model)
• Simultaneous, multiple tasks	• New technique not used before
• Repetitive actions / monotony	• Imprecise communication habits
• Irreversible actions	• Lack of proficiency / Inexperience
• Interpretation requirements	• Indistinct problem-solving skills
• Unclear goals, roles, or responsibilities	• Unsafe attitude
• Lack of or unclear standards	• Illness or Fatigue; general poor health or injury
Work Environment	**Human Nature**
• Distractions / Interruptions	• Stress
• Changes / Departures from routine	• Habit patterns
• Confusing displays or controls	• Assumptions
• Workarounds / Out of Service instruments	• Complacency / Overconfidence
• Hidden system / equipment response	• Mindset (intention)
• Unexpected equipment conditions	• Inaccurate risk perception
• Lack of alternative indication	• Mental shortcuts or biases
• Personality conflicts	• Limited short-term memory

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DOE Vol 1, Chapter 2, Attachments A & B

DOE Vol 1 Pg. 2-32

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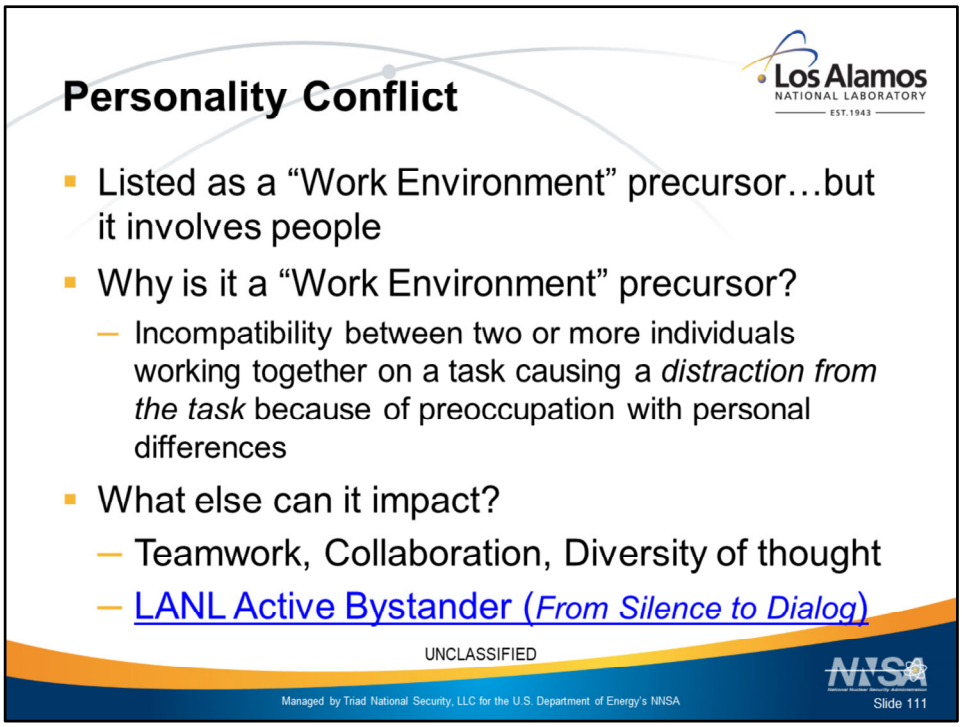
Slide 110

USE Attachments A and B of DOE HU Handbook, volume 1, Chapter 2, attachments A & B to facilitate a discussion on each error precursor.

Error precursors are not mysterious or obscure. To the contrary, they are *noticeable,* even obvious, if people look for them. The error precursors listed below (in order of impact) were compiled from a study of INPO's event database and from human performance, ergonomics, and human factors sources. These are the more common conditions associated with events triggered by human error. Some organizations distribute a plastic-coated error precursor card to their front line workers to carry with them on the job. Workers refer to these cards during pre-job briefings to help identify precursors related to the upcoming task.

Irreversible actions are not necessarily precursors to error, but are often overlooked, leading to preventable events. It is included in this list because of its importance.
Inaccurate Risk Perception = Pollyanna



Personality conflict:
Incompatibility between two or more individuals working together on a task causing a distraction from the task because of preoccupation with personal differences.

INSUTRUCTOR NOTES: Take the time to make a connection between the error precursor, personality conflicts, and the LANL "Active Bystander" initiative:
http://int.lanl.gov/employees/health-wellness/bystander-intervention/index.shtml

How can we create a healthy culture at the Lab?

- This initiative seeks to create a healthy culture at the Lab by transforming silence to dialogue around incivility, disrespect, and micro-aggressions through awareness and empowerment to speak up as an active bystander.
- *We hold shared values at LANL — let's make this a great place to work through safety, security, diversity, inclusiveness, respect, civility, dignity, trust, support.*

Why do we need this initiative?

- People need to feel that they are treated with dignity and respect.
- There is significant data that shows people who experience consistent and repeated micro-aggressions express greater levels of loneliness, anger, depression, and anxiety. They feel less psychological wellbeing as well as poorer physical health.
- In alignment with LANL values, when there is trust, respect, and diversity in a workplace, teamwork and creativity thrive. See the Laboratory's Code of Conduct.

Top 10 Error Traps

✓ First Time Evolution	✓ Individual Capabilities
✓ Unclear Communications	✓ Individual Capabilities
✓ Vague or Incorrect Guidance	✓ Task Demand
✓ Time Pressure	✓ Task Demand
✓ Distractions	✓ Work Environment
✓ Over-Confidence	✓ Human Nature
✓ Stress	✓ Human Nature
✓ High Workload	✓ Task Demands
✓ First Day Back	✓ Work Environment (change in routine)
✓ 30 minutes after Wake-up or Meal	✓ Individual Capabilities (fatigue)

Ask the students what they think each one means:
Ask them what they do in that situation to become successful

Help facilitate the discussion as necessary
Reveal the TWIN Connection after each item is discussed
****

Have students look at DOE Human Performance Handbook, Volume 1, Attachment B – Common Error Precursor Descriptions
HINT: Use personal experiences or examples as each is discussed. For example: use traveling to a new destination for vacation.

Tenerife – "Top 10 Error Trap" Case Study

- The Tenerife collision took place on March 27, 1977, at 17:06:56 local time, when two Boeing 747 airliners collided at Los Rodeos (TCI) on the island of Tenerife, Canary Islands, Spain, killing 583 people.

- The accident has the highest number of fatalities (excluding ground fatalities) of any single accident in aviation history.
- It occurred as a result of an unfortunate synchronicity of a chain of events, any one of which having not transpired would have prevented the accident

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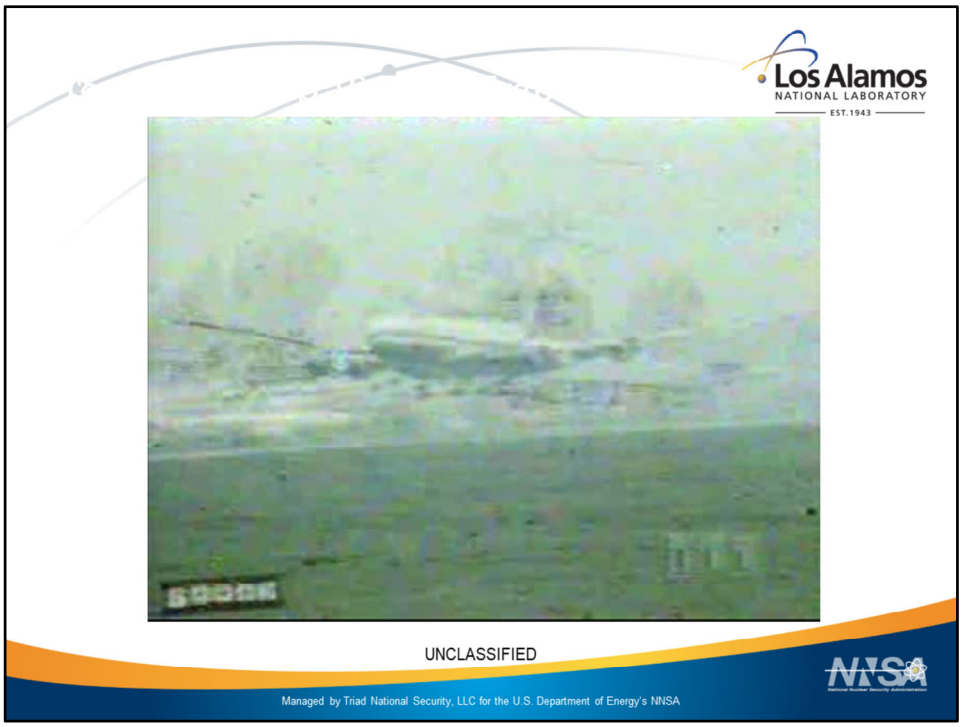
Slide 113

Have students use a piece of paper to write down error precursors (Traps)
OPTION: Tables or groups will report out on what they saw

SHOW Tenerife VIDEO

Group Discussion on 10 error traps

Tell story about airplane accident out of England.
Explain that back then the Pilot was God, co-pilot was someone sitting there.
These two had a conversation. Pilot did not want union, co-pilot wanted union. Atmosphere in cockpit was not good. They didn't talk to each other.
Show 28,000ft, stair step flight plan from control tower communications.
Plane is in autopilot, co-pilot told pilot you're going to kill us, the pilot had died 30 minutes ago.



Additional information:
https://en.wikipedia.org/wiki/Tenerife_airport_disaster
https://www.youtube.com/watch?v=4MferspAuv4
https://www.youtube.com/watch?v=VhVo32AjTZc (19 minutes – good detail)
https://www.youtube.com/watch?v=kjLrZ2SDDaU (5 minutes – highlights major points)

Review Tenerife video

Notes:
Air Tower has to speak "English." = Canary Islands speaks Portuguese.

Pan Am Pilot did not see turnoff for taxiway 4, Captain of KLM flight is eager to takeoff.

The cause of the event: Overconfidence on the part of Captain VanZane. Not willing to follow procedure.
Restart Tenerife Video to show conclusion.

Two lessons:
1. People don't see things about themselves. Maybe I am the driver of some of these events
2. Are we looking at other groups as equals? Organizational culture????

Relate this back to being a supervisor.

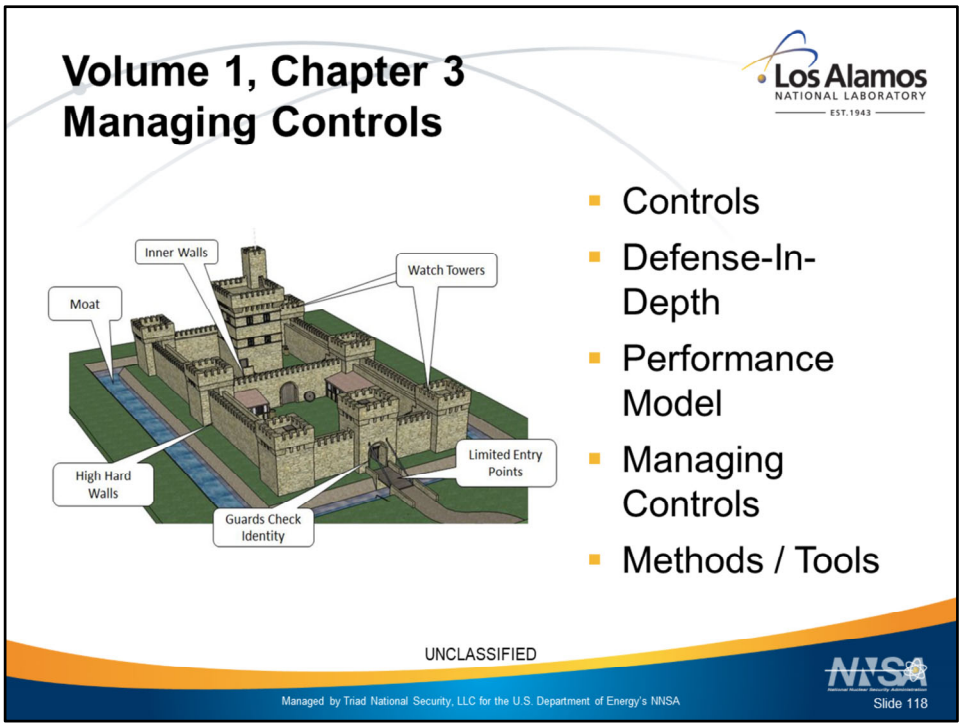
Organizational culture => safety culture => bob's culture
National Culture
Professional Culture (one driver => You) influenced by Training & Oversight (Supervisors and managers)
Changing the climate will have a small change on safety culture, Climate change is bring in new people (leadership) will have a big change on bob's culture.

- ☐ First Time Evolution
- ☐ Unclear Communications
- ☐ Vague or Incorrect Guidance
- ☐ Time Pressure
- ☐ Distractions
- ☐ Over-Confidence
- ☐ Stress
- ☐ High Workload
- ☐ First Day Back
- ☐ 30 minutes after Wake-up or Meal

- **PRINT Slide for Student Handout**
- **HIDE slide for presentation**

How can you better identify Error Likely Situations

- Changes / Departures from routine:
  - You may ask: Any changes to our work?
  - You may hear: No, same as yesterday.
- Consider asking:
  - What is different today?
    - Joe is out sick today and Sue is filling in…
  - What's different at the jobsite today?
    - Electricians want to……



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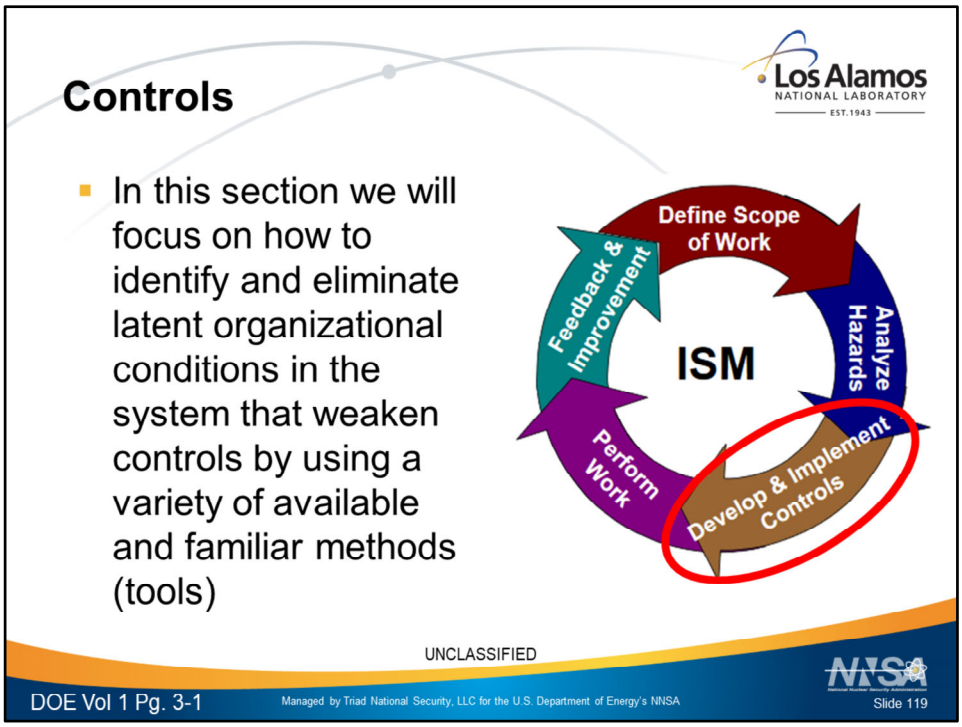
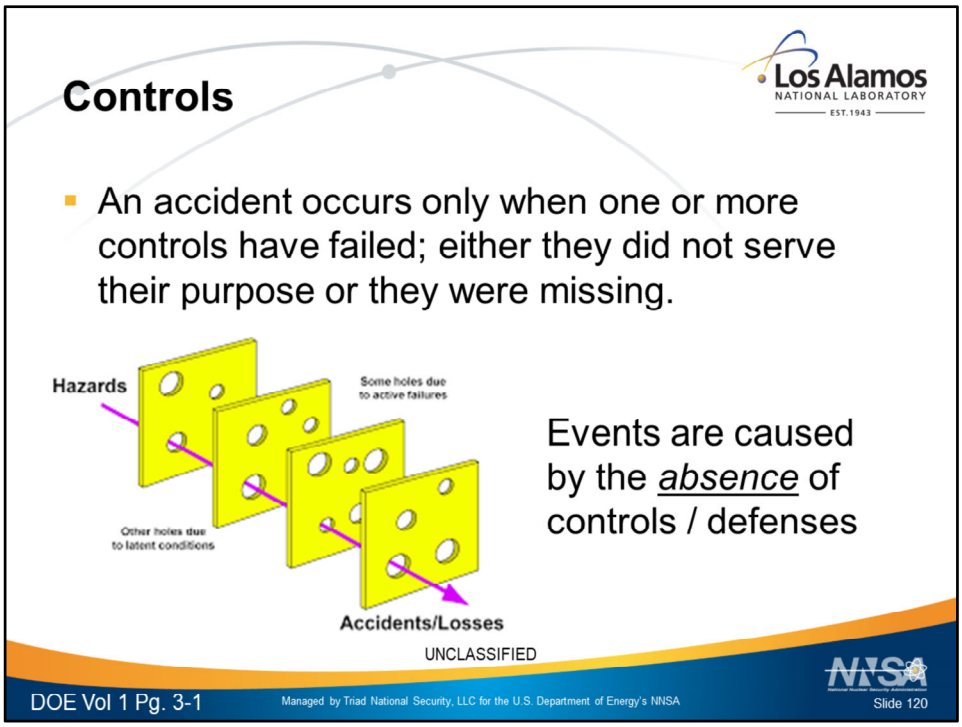


Controls

In this chapter, the reader will become familiar with controls as they relate to DOE facilities. From that introduction, the reader will gain an appreciation of the importance of controls in preventing events. The various categories of controls used and their relative dependability will be addressed. Most importantly, the emphasis will be placed on how to identify and eliminate latent organizational conditions in the system that weaken controls by using a variety of available and familiar methods (tools) introduced herein.

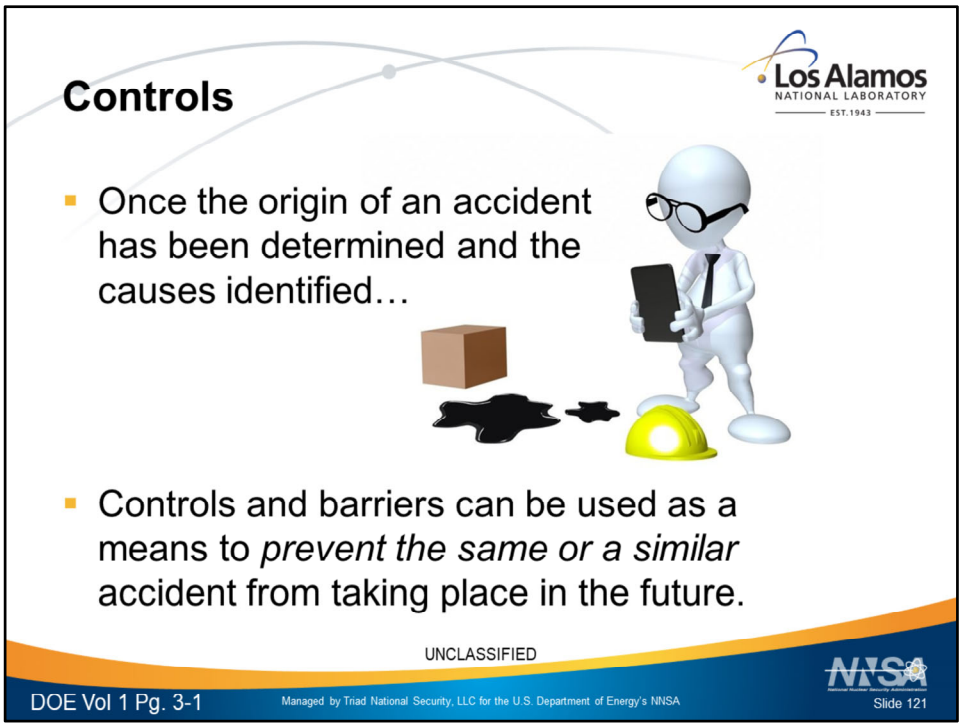
For readers who have taken DOE sponsored Human Performance Improvement training or who are familiar with some of the key HPI literature such as the research of Dr. James Reason, the term “defenses” is often used. Depending on the linguistic traditions of various hazardous technological domains, the terms “defenses, barriers, controls”, or similar terms may be used. In general, they all connote technological or organizational features specifically designed to protect against hazards. To emphasize the role of HPI in supporting the DOE’s Integrated Safety Management systems, the term “controls” is used in this Handbook in preference to the word “defenses” or other similar terms.. The meaning of the terms is essentially the same. ISM uses the term “controls” so this is the term used throughout this Handbook to promote consistency of usage and consistency of understanding.



Controls are extremely important in DOE facilities; successful controls prevent or mitigate the severity of events. Proper understanding and use of controls are important to understanding and preventing accidents.

- An **accident occurs only when one or more controls have failed**; either they did not serve their purpose or they were missing.
- Once the origin of an accident has been determined and the causes identified, controls and barriers can be used as a means to prevent the same or a similar accident from taking place in the future.

Controls comprise any human, technical, or organizational features that protect the facility and personnel against hazards. In addition to human error, other hazards include radiation, industrial safety hazards, hazardous chemicals, and various forms of energy, such as electricity and rotating equipment. Controls can protect against a hazard, mitigate consequences, or warn. Controls take the form of containments; physical interlocks; redundant equipment, power sources, and annunciators; personal protective equipment; procedure use; caution tags; and self-checking, among others



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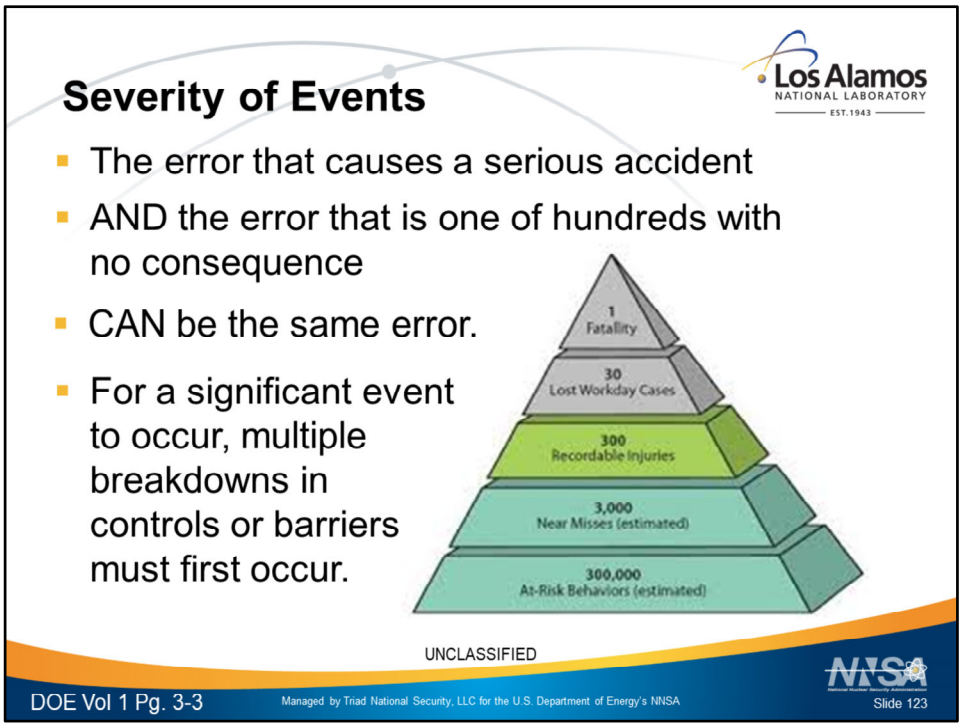
Examples of Controls in Every-day Life

Controls are built into our everyday lives. We will consider two examples—fire protection and driving a car. Take the controls against a fire in your home. There are fire-resistant building materials (*exterior:* brick, stucco, or cement-based siding, metal or tile roofs, steel doors, and so on.; *interior:* metal studs, sheetrock walls and ceilings, ceramic tile flooring, and so on).

Ground-fault interrupter (GFI) circuit breakers automatically cut off electricity when they sense shorts in the circuit. The above controls guard against a fire starting or they slow its spread in the event of a fire. Smoke detectors and alarms warn of danger should a fire start. Fire extinguishers, fire hydrants and hoses, and the local firemen are controls that contain and put out a fire if it should break out.

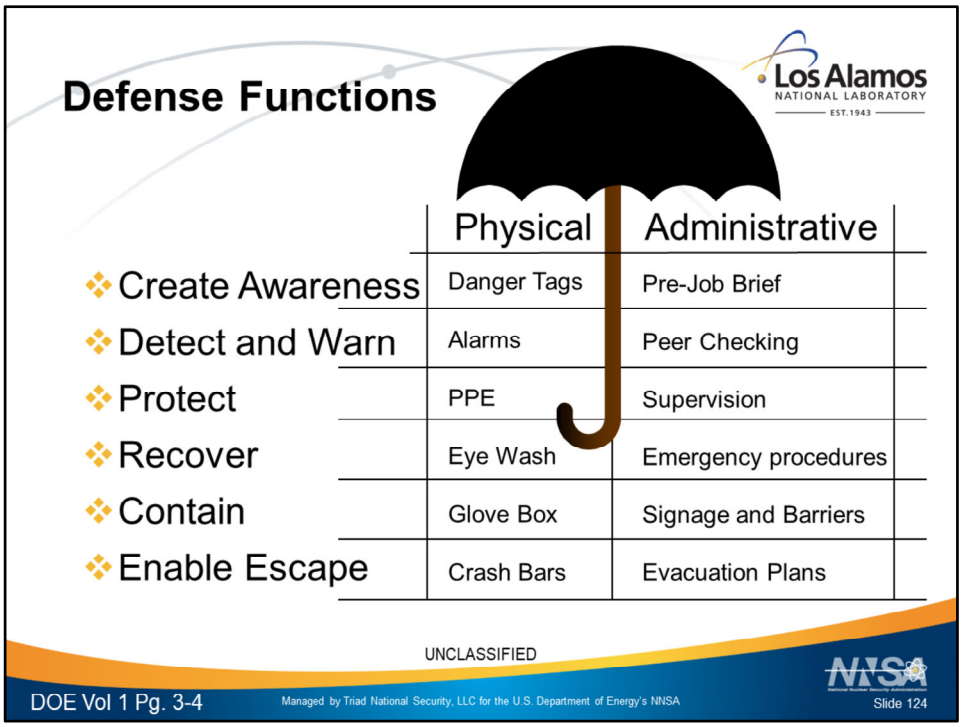
There are many controls associated with driving an automobile. Traffic lights signal drivers to proceed or stop at an intersection. Speedometers help drivers control vehicle speed. Drivers' licenses provide proof that people are qualified to operate an automobile. Seatbelts and air bags mitigate the effects of collisions. Ripples built into the edges of asphalt highways alert drivers with a rumbling noise when the vehicle is riding on the edge of the road. Likewise, controls in the facility take the form of procedures; physical interlocks; redundant equipment, power sources, and annunciators; as well as those that rely on people, such as self-checking, peer-checking, three-way communication, reviews and approvals, and supervisory oversight.



Severity of Events

The significance, or severity, of a particular event lies in the *consequences* suffered by the physical plant or personnel, not the error that initiated the event. The error that causes a serious accident and the error that is one of hundreds with no consequence can be the same error that has historically been overlooked or uncorrected. For a significant event to occur, multiple breakdowns in controls or barriers must first occur. Whereas human error typically triggers an event, it is the number of controls and the weaknesses of those controls that dictate the severity of the event.

The existence of many flawed controls is directly attributable to weaknesses in the organization or management control systems. Individual error-prevention practices are important and need to be implemented and maintained. However, to focus only on error reduction to prevent events is a bad strategy for this reason. Error reduction can only reduce the time between events. The greater successes in minimizing the occurrence of severe events are realized by focusing on defense-in-depth. Improving controls will minimize severity. Therefore, one of management's top priorities must be verifying the integrity of controls.



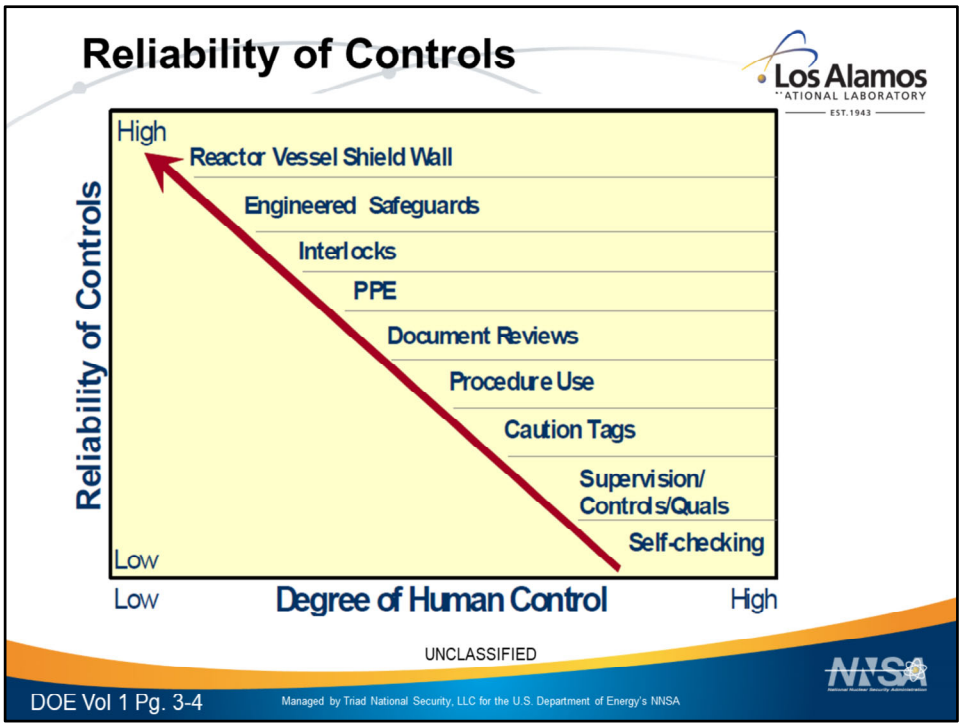
Defense Functions

Controls serve various functions, including the following.

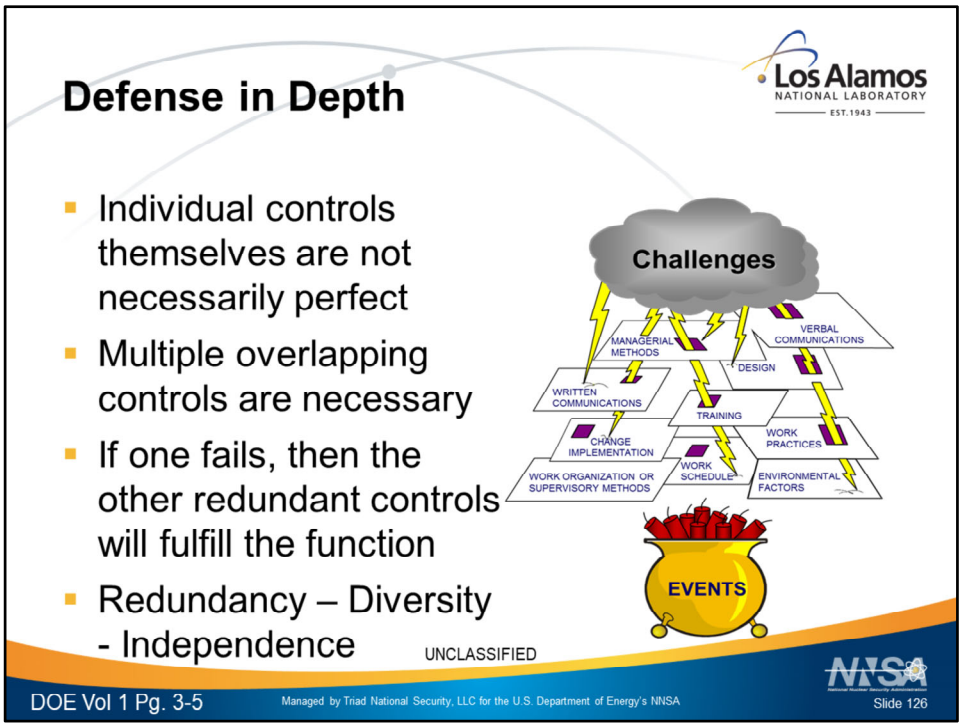
- **Create Awareness** – understanding the risks and hazards and recognizing the presence of hazards. Examples include pre-job briefings, post-job reviews, risk assessments, procedures, component labeling, color-coding, self-checking, computer screen layout, logs, meetings, communication practices, danger tags, and radiological postings.
- **Detect and Warn –** alerted to the presence of off-normal conditions or imminent dangers. Examples include alarms and annunciators, equipment operator rounds, concurrent verification, peer-checking, supervision, confined-space entry requirements, self-checking, and problem-solving methodology.
- **Protect** – guarding people, equipment, and the environment from error or harm. Examples include personal protective equipment, supervision, equipment lockout, interlocks, shielding, and ventilation.
- **Recover** – restoration from off-normal conditions and restoring the system to a safe state. Examples include independent verification, emergency procedures, eye wash stations, pre-established response procedures, continuity of operations plans, re-entry teams, and decontamination.
- **Contain** – restricting or limiting the accidental release of harmful energy or substances. Examples include double-shell storage tanks, glove boxes, remote manipulations, tank

berms, piping and valves, and containment.

- **Enable Escape** – providing the means to flee from uncontrolled hazard. Examples include emergency plans, crash bars on doors, emergency lighting, and network installation management (NIM)



As might be expected, some controls are more reliable than others. Controls, barriers, or safeguards tend to be more reliable when they are not dependent on people to carry out their protective functions. In general, physical controls tend to perform their intended functions despite human action or inaction. Engineered controls, such as physical interlocks and equipment design, are more reliable than administrative controls, such as procedures, human performance tools, and training programs, as shown in the graphic above. When the effectiveness of a defense mechanism relies on the) routes. performance of people—as do procedures, training, self-checking, and verifications—then it is less reliable. When plant safety and reliability are dependent on people during risk-important activities, the physical plant is more vulnerable to their errors. Reliability is related to the dependability of the defense or barrier to perform its intended function when needed. If it is imperative to prevent error, then physical, engineered controls are more appropriate.



Controls themselves are not necessarily perfect. Multiple, overlapping controls are needed to compensate for this reality. The Defense-in-depth concept is achieved by imbedding controls in an overlapping fashion into the organization, its culture, and the physical facility. Thus, if one controls fails or is ineffective, other systematically placed redundant controls will fulfill the same defensive function. Controls include various devices, methods, or practices that make an activity or process go safely and predictably to protect key assets from human error. Four types of lines of controls—engineered, administrative, cultural, and oversight controls—work together to anticipate, prevent, or catch active errors from causing a significant event. An explanation of each of these four types of control, as well as examples and common flaws associated with each follow.

An explanation of each control may be found in DOE-HDBK-1028-2009, volume 1, page 3-5

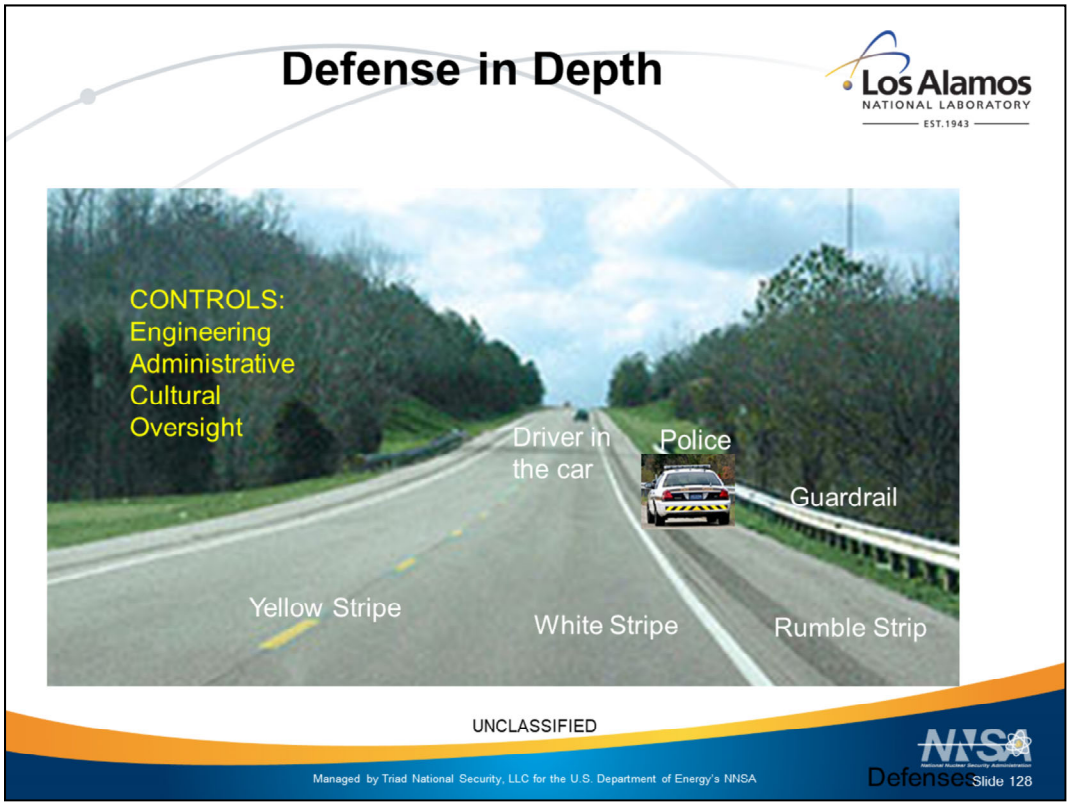
Vol 1, pg. 3-5: Engineered Controls
Engineered design controls are all those hardware, software, and equipment items in the physical environment that affect people's behavior, choices, and attitudes, and are a result of engineering design. Engineered controls act either actively or passively. *Active controls include equipment such as pumps or valves that perform a specific safety-related function. Passive controls include pipes, vessels, and berms that provide containment and generally do not have moving parts.* The most reliable defense mechanisms are passive because they require no operational or maintenance support to remain effective, eliminating dependence on human involvement.

Vol 1, pg. 3-6: Administrative Controls
Administrative controls, such as procedures, inform people about what to do, when to do it, where it is to be done, and how well to do it, and are usually documented in various written policies, programs, and plans. Administrative controls rely on human judgment, training, and personal initiative to follow the direction contained in documents. Consequently, administrative controls are not as reliable as engineered controls.

Vol 1, pg. 3-8: Cultural Controls – Values, Beliefs, Attitudes
An effective safety culture engenders the belief that when production and safety conflict, safety will prevail. Cultural controls include those leadership practices that teach (consciously or unconsciously) people how to perceive, think, feel, and behave toward challenges to safety. Culture is defined by people's behavior, and safe

behavior is value-driven. What an organization says its values are may not be reflected in its behavior. The true values of an organization are reflected in the observed acts of its people, especially its managers. For instance, when procedures are vague or incomplete, people tend to default to what they think is important for success as they define it.
Organizational culture comprises a set of *shared* assumptions, values, and beliefs that characterize the choices and behaviors of the members in an organization. Culture is to the group what character and personality are to the individual. Because of the special nature of hazards present at DOE facilities, organizations that work in these facilities need a *strong* safety culture. "Strong" implying the extent to which the organization's members adopt or internalize such values and behaviors. More will be said about culture in Chapter 5.

Vol 1, pg. 3-10: Oversight Controls
Vulnerabilities with controls can be found and corrected when management decides it is important enough to devote resources to the effort. The very nature of latent conditions is such that they will not self-reveal, they must be discovered. The fundamental aim of oversight is to improve facility resilience to significant events triggered by active errors in the workplace—that
is, to minimize the severity of events. Oversight controls provide opportunities to see what is actually going on in the facility, to identify specific vulnerabilities or performance gaps, to take action to address those vulnerabilities and performance gaps, and to verify that they have been resolved.



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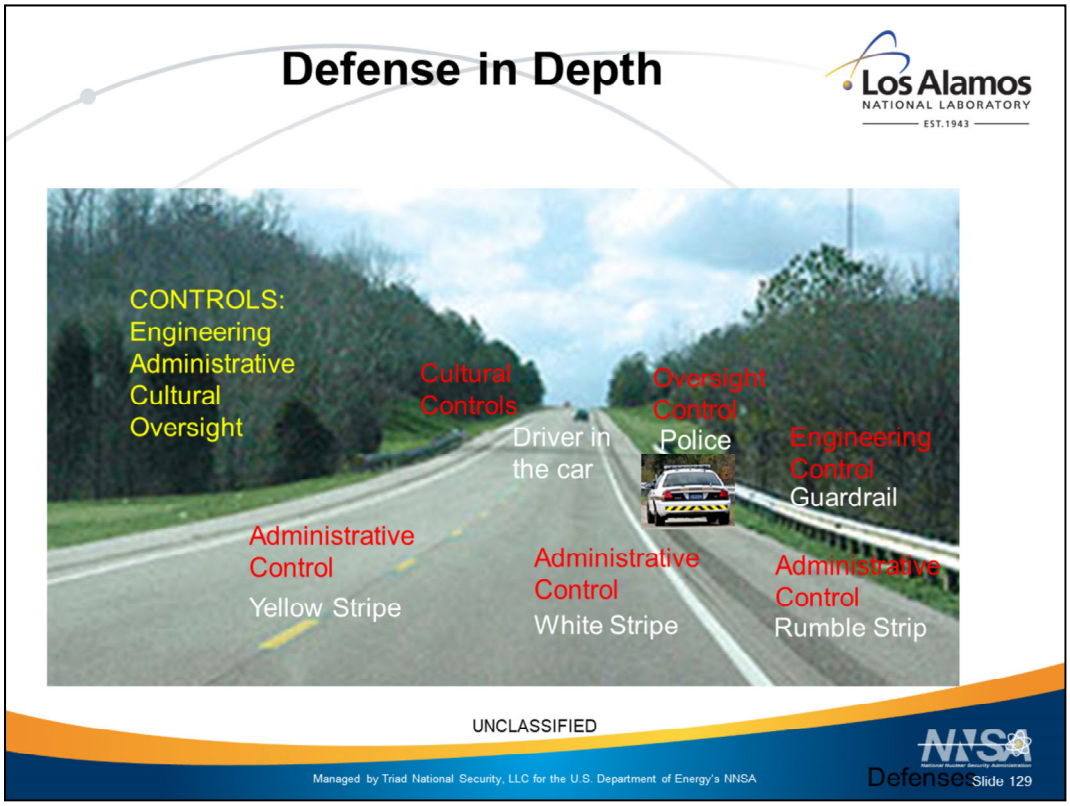

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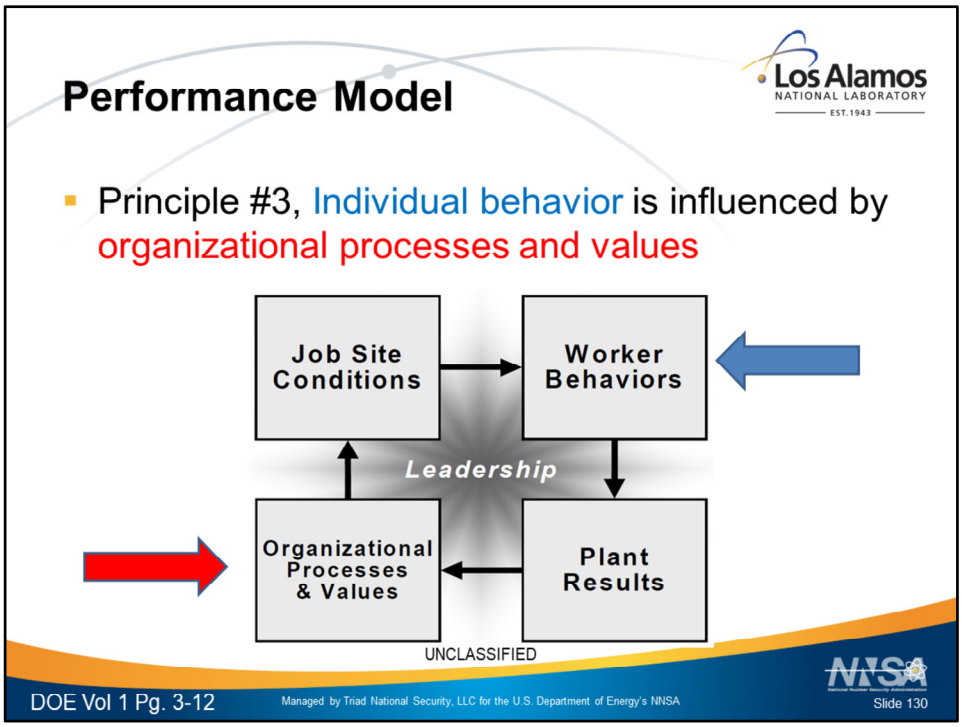
- Defense in depth is a strategy that enables us to "fail safely". It involves having multiple independent and redundant layers of protection and response to eliminate or reduce harm.
- The idea is that no single layer, no matter how robust, is exclusively relied upon.
- A hard control provides a physical barrier between the person and the hazard. Hard controls include machine guards, restraint equipment, fencing/barricading.
- A soft control does not provide a physical barrier between the person and the hazard. Soft controls include signage, procedures, permits, verbal instructions etc.
- Defenses serve various functions, including the following -
    - Create Awareness – component labeling, color-coding
    - Detect and Warn – alarms and annunciators, danger tape/tags
    - Protect – PPE, equipment lockout, interlocks, shielding, handrails
    - Recover – emergency procedures, eye wash stations, response plans
    - Contain – double-shell storage tanks, tank berms, containment, PSM/RMP
    - Enable Escape – emergency plans, crash bars on doors, emergency lighting



Human Performance – A system is a network of elements that function together to produce an outcome. A facility contains numerous systems, among them, the electrical system, the water circulation system, the work process system, the telephone system, the fire suppression system, and the heating, ventilation, and air conditioning (HVAC) system. There are also numerous intangible systems that function in the facility environment. For instance, the social system, the organizational system, incentives and disincentives systems, and belief systems are examples that typically function behind the scenes. *Human performance can also be considered a system.*

Understanding organizational systems and the impact of facility processes and values and leadership dynamics on performance is important to improving human performance. Systems-thinking involves pondering the multiple causes and effects, the variables that come to bear on the worker at the point of touching equipment in the facility.

An organization is defined as a group of individuals, including managers, supervisors, and workers, with a shared purpose or mission and means (processes) to efficiently apply resources toward the safe and reliable (values) design, construction, operation, and maintenance of the physical facility. Recall that the third principle of human performance states: *individual behavior is influenced by organizational processes and values.* Thus, human performance does not take place in a vacuum. Rather, performance occurs within the confines of the organization. No matter how well work is organized, how good procedures are, how well equipment is designed, or how well teamwork is achieved, people will never perform better than what the organization will support.

Workers make decisions, perform tasks and carry out activities in the workforce according to prescribed protocols Procedures, policies, programs, training, and even culture influence worker behavior. The organization affects all of these. As illustrated in the *Anatomy of an Event* (Chapter 1), organization and the associated management control systems are the prevalent origins of events. Events are not so much the result of error-prone workers as they are the outcome of error-prone tasks and error-prone work environments, which are controlled by the organization.

There is a direct cause-and-effect relationship between the organization and the individual performer. It is the organization that determines the division of labor and the coordination of effort—what people do, when they do it, under what conditions it is accomplished, and how well it is to be done. Roles and responsibilities have to be clearly determined.

The *Performance Model* shown in the boxes above is a simple, cause-and-effect model of these interdependencies that shows the organizational nature of human performance. The individual boxes in the model represent either conditions or action, and arrows indicate influence or causality.

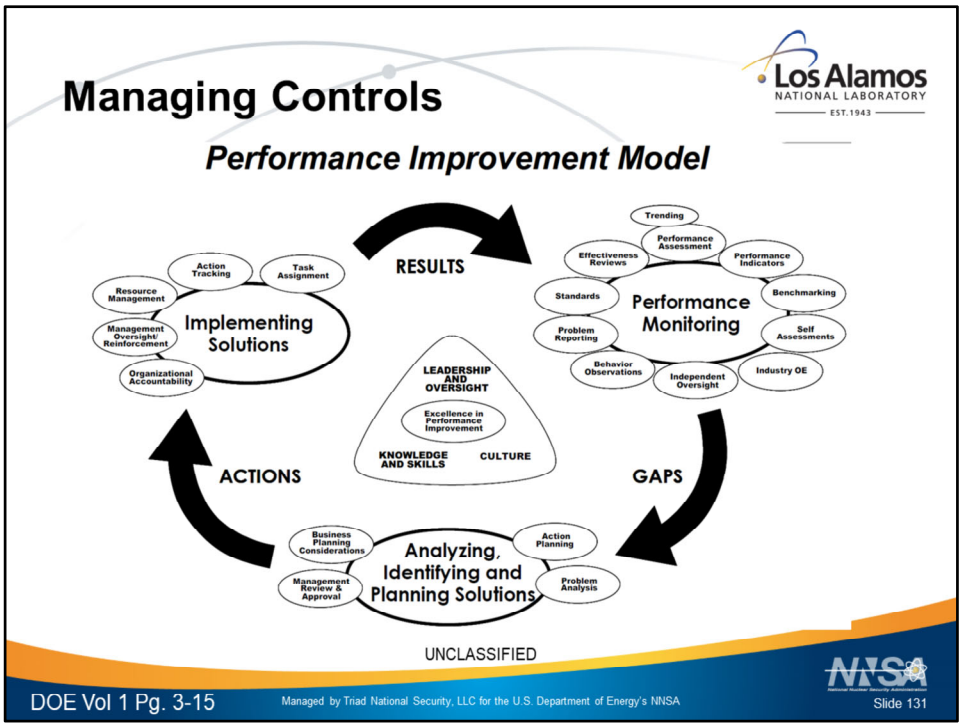
Organizational Factors
Organizational factors have a strong influence on human performance. Organizational factors encompass all the ways management uses to direct and coordinate the work of the facility, which together shape the behavior of the people performing their jobs. Collectively, they are the hub of all that goes on at the facility. Organizational factors reveal themselves in engineered controls, administrative controls, cultural controls, and oversight controls (corporate and independent).

Job-Site Conditions
These factors define the unique set of conditions for a particular worker about to perform a specific task or action. The job site is that location or place where behavior occurs during task performance and can be characterized by either environmental or individual factors. Environmental factors (overarching both from the organization and the work environment) include conditions external to the individual and often beyond his or her direct control, such as procedure quality, component labeling, human-machine interface, heat, and humidity. Individual factors include conditions that are a function of the person assigned the task, some of which are also beyond his or her direct control, such as knowledge, skills, experience, family problems, and color blindness.

Worker Behaviors
Worker behaviors include all the actions (or inactions) by an individual at the job site. Examples are component manipulations, use of human performance tools and other work practices, calculations, tool use, verbal exchanges, and procedure use. The effect of individual behavior is a change in the state of facility structures, systems, and/or components—plant results—for good or bad.

Plant Results

This element of the performance model represents the outcomes to the physical plant—good or bad. Examples of facility results include productivity, rejections, non-conformances, forced shutdowns, equipment reliability, safety-system availability, and outage effectiveness, as well as injuries, overexposures, spills, and damage. The quality of facility performance depends on the presence, integrity, and effectiveness of both processes and controls.



MANAGING CONTROLS – Performance Improvement Model

It is a commonly held belief that people are always able to distinguish right from wrong and that people lack proper motivation when they act carelessly or without clear judgment. This is a faulty assumption. Error-prone tasks and work environments are usually created by latent organizational weaknesses. These are undetected deficiencies in organizational processes or values or equipment flaws that create workplace conditions that provoke error (error precursors) or degrade the integrity of controls (flawed controls). Undetected organizational deficiencies plague human performance.

Latent errors or conditions are difficult to prevent. Once they are created they do not fade away, but rather they accumulate in the system. Because of their hidden characteristic, it is management's primary challenge to *limit the time these vulnerabilities exist*. Managers should aggressively identify and correct vulnerabilities with controls at the earliest opportunity. A more significant contribution to safety can be expected from efforts to decrease the duration of latent errors than from measures to decrease their basic frequency.

"Managing" is the ongoing act of planning, directing, or controlling activities and resources toward accomplishing or achieving a purpose. Because significant events are few in number, less information is available about the presence of flawed controls and controls. This means that performance information has to be gathered from other sources. Luckily, these sources are preexisting and are known to managers, supervisors, and staff. Typically, reliance is placed on field

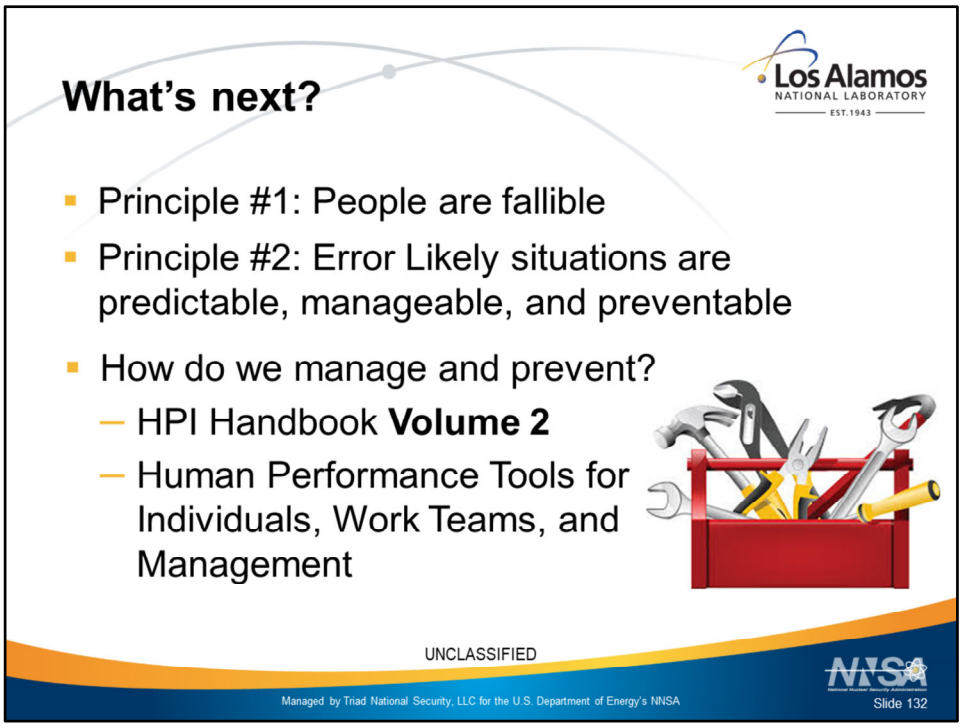
observations, self-assessments, benchmarking, apparent cause evaluations, and trending to provide management with information needed to improve performance and to eliminate vulnerabilities to facility events. See Appendix A for a list of factors known to defeat controls.

Performance improvement involves three primary activities.

- ***Performance monitoring*** *– activities that assess current performance, identifying gaps between current and desired levels of performance or results.*
- ***Analyzing, identifying, and planning solutions*** *– activities that determine actions needed to close the gaps.*
- ***Implementing solutions*** *– the collective activities that result in applying the chosen solutions and verifying their effectiveness to close the gaps.*

METHODS (Tools) FOR FINDING LATENT ORGANIZATIONAL CONDITIONS
NOTE: These will be discussed during the Volume 2, HPI Tools for Management section
• self-assessments
• trending
• performance indicators
• operating experience
• behavior observations
• problem (causal) analysis
• surveys and questionnaires
• corrective action program *(Issues Management at LANL)*
• benchmarking
• independent oversight
• problem reporting
• management oversight, involvement, and reinforcement
• event investigation

Many of the methods for finding latent organizational conditions described below are addressed in more detail in HPI Handbook, Volume 2, section 3 "Management Tools." The information in this section and in section 3 of Volume 2 is targeted to managers and supervisors.



Introduction slide for Volume 2 discussion
Have students go to Volume 2 in the HPI Handbook.
Volume 1 and 2 are separated by a sheet of cardstock paper

The first two sections of this "Good Practice Handbook" describe several human performance tools that define a set of discrete behaviors to help individuals and work teams anticipate, prevent, or catch errors before they cause harm to people, the facility, or the environment. Section 3 of the DOE Human Performance Handbook is for use by managers and supervisors in identifying latent errors that lie dormant in the organization, weakening defenses and provoking error. For the human performance tools to provide value in improving safety, workers first must possess a solid foundation in the technical fundamentals of the equipment, systems, and operational processes they work with. Facility equipment, work processes, the organization and its culture, and its oversight processes all contain hidden flaws or latent conditions that could cause harm if work is undertaken without thinking. Safety is not obtained by mindlessly applying human performance tools but rather by people conscientiously applying their knowledge, skills, experience and insights, as well as the tools to accomplish their work goals.

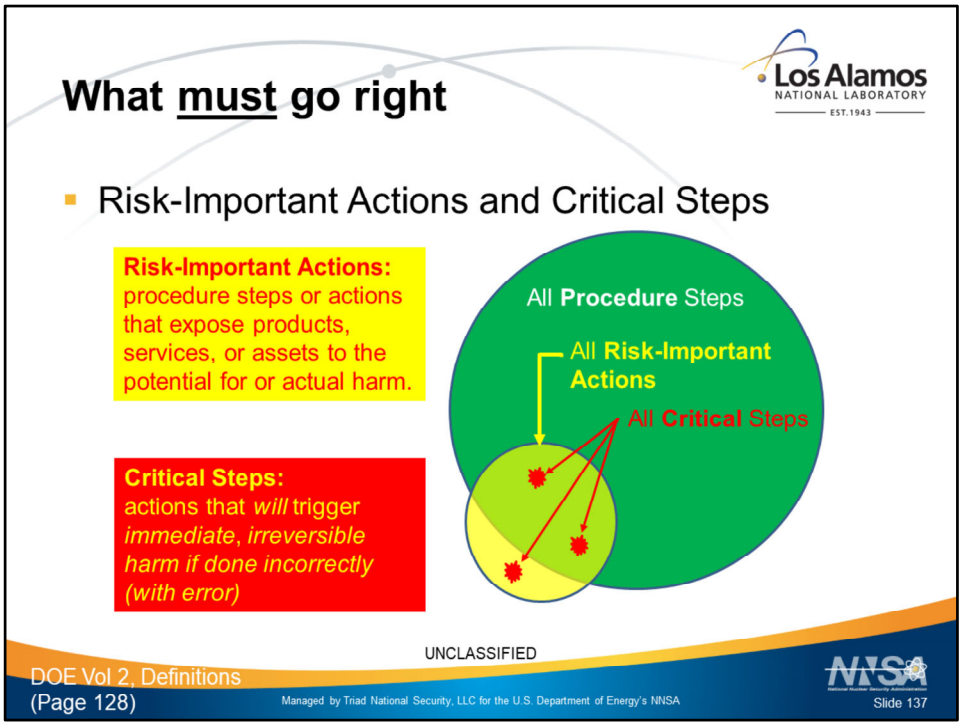
The first two sections of this "Good Practice Handbook" describe several human performance tools that define a set of discrete behaviors to help individuals and work teams anticipate, prevent, or catch errors before they cause harm to people, the facility, or the environment. Section 3 of the DOE Human Performance Handbook is for use by managers and supervisors in identifying latent errors that lie dormant in the organization, weakening defenses and provoking error. For the human performance tools to provide value in improving safety, workers first must possess a solid foundation in the technical fundamentals of the equipment, systems, and operational processes they work with. Facility equipment, work processes, the organization and its culture, and its oversight processes all contain hidden flaws or latent conditions that could cause harm if work is undertaken without thinking. Safety is not obtained by mindlessly applying human performance tools but rather by people conscientiously applying their knowledge, skills, experience and insights, as well as the tools to accomplish their work goals.

What will these tools do for us?

- The tools are not designed to teach people how to do their job, just how to think about it!
  - Methodically focuses us on the task at hand.
  - Teaches us how to ask the right questions.
  - Provides guidance on planning work.
  - Demonstrates “thinking compliance” instead of blindly proceeding.
  - Makes it okay to STOP if unsure.

DOE HPI Tools

- ***Overview*** – practical information about the tool's purpose and potential limitations;
- ***Use the Tool*** – cues as to circumstances when the tool could be used
- ***Recommended Practices*** – the steps, routines, or procedures generally used in the industry to properly apply the tool; and
- ***At-Risk Practices*** – a set of behaviors, beliefs, assumptions, or conditions that tend to diminish the effectiveness of the tool.



Definitions: Volume 2 Page 128
Every process has steps necessary to accomplish a task. *Some* of these steps are classified as Risk-Important Steps/Actions. Risk-Important Steps/Actions are procedure steps or actions that expose products, services, or assets to the potential for, or actual harm, *but are recoverable*. A smaller sub-set are known as a Critical Steps. From a Human Performance Improvement (HPI) perspective, Critical Steps are actions that ***will*** trigger *immediate*, *irreversible* harm ***if*** done incorrectly (with error).
When performing a task, one must know *what absolutely has to go right* (i.e., Critical Steps). Once the Critical Step(s) is identified, then selecting an appropriate Human Performance defense (such as mandatory peer check, or supervisor hold point) adds resiliency against human error to ensure that execution of that step goes as planned. It makes the performer *think* about the actions they are going to take.

Risk-Important Actions:

procedure steps or actions that expose products, services, or assets to the potential for or actual harm.

Critical step -

HPI Definition: Actions that will trigger immediate, irreversible harm if done incorrectly (with error)

****

Risk Factors:
Harm (consequence) is *intolerable*
Harm is *irreversible*
Action (or inaction) depends solely on the *individual(s)*
Harm is *immediate*

What is harm?
Merriam-Webster defines *harm* as: physical or mental damage or injury: something that causes someone or something to be hurt, broken, made less valuable or successful, etc.
Examples of intolerable harm:
Personal
- Death
- Disabling injury
- Overexposure to ionizing radiation

Mission
- Inability to achieve the mission
- Asset damage/loss
- Damage to LANL reputation

Safety and Security
- Loss of program/regulatory safety functions
- Significant safeguards, physical security, information security and/or cyber security event

Environmental
- Harm to the environment
- Non-Compliance regulatory violation

What is *irreversible*?
Merriam-Webster defines *irreversible* as: impossible to change back to a previous condition or state.
An action is considered irreversible if it would be impossible to reverse the results of the action. It may be possible to reverse the action, but **not** the results.
Some actions/steps may be irreversible only during certain plant conditions. Examples would include on-line, outage (including various modes), transients, and steady-state conditions.

***Immediacy* of the harm**
Critical Steps *may* involve *immediate* consequences upon occurrence of the initiating action, whether in error or violation. In these cases, there is no delay between action and outcome; there is **not** enough time between the error and its consequences for people to intervene. Selection of a Human Performance tool to prevent the error (e.g., Concurrent Verification) is imperative.

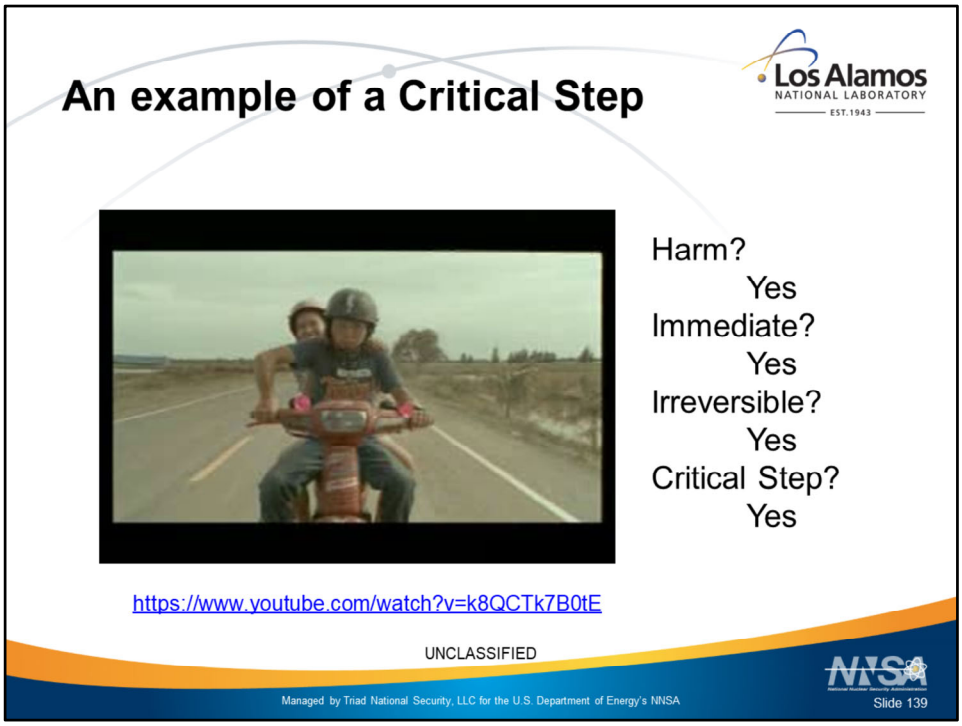
***Risk-Important actions may result in future* harm**

In some cases, such as during maintenance activities or an engineering modification, the consequence of an error would **not** occur until after a future initiating action makes it irrecoverable (such as restoration of the equipment to an operational status). Selection of a Human Performance tool to prevent the consequence (e.g. supervisor hold point, independent verification, peer check, etc.) is necessary to recover from the error before the consequence occurs. In this case it is the combination of actions and steps that may result in the immediate, irreversible harm.

NOTE: There are variations of Critical Step HPI definitions found in DOE references of LANL procedures/policies and industry accepted practices:
DOE-HDBK-1028-2009, Human Performance Improvement Handbook, volume 1 Concepts and Principles: A procedural step, series of steps, or action that, **if** performed improperly, **will** cause irreversible harm to equipment, people, or the environment.
DOE-HDBK-1028-2009, Human Performance Improvement Handbook, volume 2 Human Performance Tools: A procedural step or series of steps or an action that, **if** performed improperly, **will** cause irreversible harm to plant, equipment, or people, or that will significantly affect facility operation. An action that, if performed improperly, has an immediate negative consequence that cannot be reversed or undone.
P315, Conduct of Operations Manual, Attachment 16: Those procedure steps that directly impact, either positively or negatively, some safety, environmental, equipment, or operational limit or commitment. Examples include but are not limited to steps that support a Technical Safety Requirement (TSR); an environmental permit; an equipment technical limit; a location entry requirement; and a procedure "hold point."
Institute of Nuclear Power Operations (INPO) 06-002, Human Performance Tools for Workers: A procedure step, series of steps, or action that, **if** performed improperly, **will** cause irreversible harm to plant equipment or people or significantly impact plant operation.
Muschara Error Management Consulting, LLC: A human action that **will** trigger immediate, irreversible, and intolerable harm to an asset **if** that action or preceding action is performed improperly.

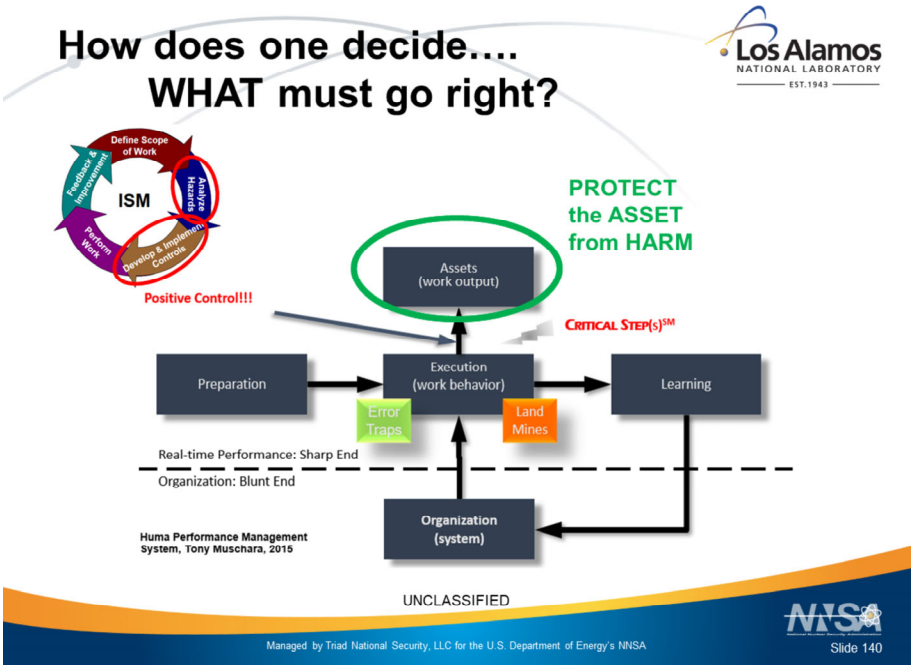
What is HARM?

- To Personal
  - Death, disabling injury, overexposure to ionizing radiation
- To the Mission
  - Inability to achieve the mission, Asset damage/loss, Damage to LANL reputation
- To Safety and Security
  - Loss of program/regulatory safety functions, significant safeguards, physical security, information security and/or cyber security event
- To the Environment
  - Harm to the environment, Non-Compliance regulatory violation



<u>WARNING: Someone get injured in this video</u>

VIDEO: No time to think
https://www.youtube.com/watch?v=k8QCTk7B0tE
This video pauses a scenario where a motorcycle drive has made a decision (critical step) to pass a truck, for which that action becomes irreversible and consequential.



Procedure Solutions: http://proceduresolutionsmgmt.com/critical-step-misconception/

This industry guidance has been around for a number of years in the commercial nuclear industry and it has been fairly successful. However, as the workforce changes, a word of caution is needed.

It is important for personnel, and most notably supervisory personnel, to understand that the identification of a critical step using the guidance provided above **may only help to identify where the failure is going to occur versus preventing irreversible harm**.

Personnel and supervisors must be aware that every action step consists of three main parts: "Who, What, and How."

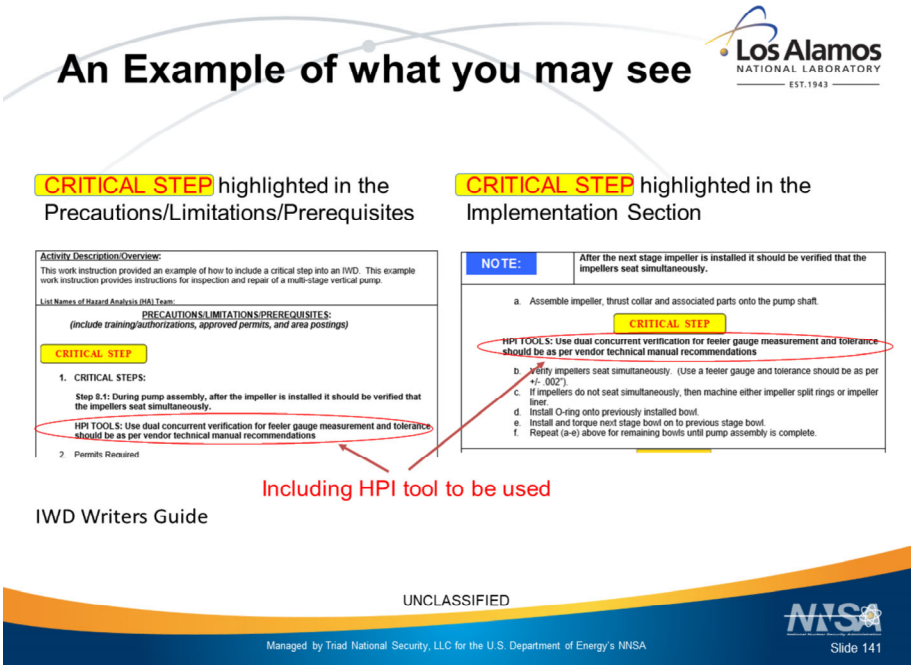
I think we would all agree that during critical step identification the "who" is the person designated to perform the step; consequently ownership is clearly identified.

Where the misconception most commonly occurs is ensuring the critical step clearly communicates the correct level of detail to ensure the successful completion of the step; or simply stated: the balance between an instruction step that directs "what-to-do" or "how-to-do."

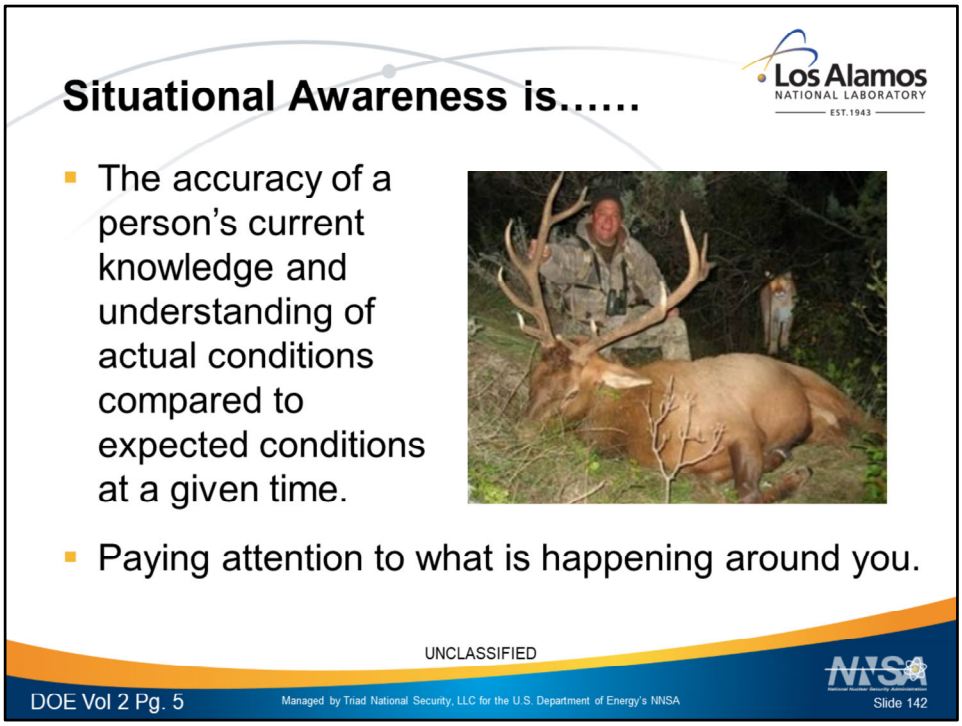
At every step, the performer must clearly understand "how" to perform the task. When the step is identified as critical, it must be understood without question. No in-field decisions. No assumptions. So, despite having an understanding of the expected results, it is more imperative that the performer understands "how" the step is to be performed especially if

the instruction is written at only the “what-to-do” level for detail.

To conclude, the misconception is this: despite industry efforts to proactively identify the location of critical steps, it is even more important that the critical step provides the correct level of detail that aligns with the needs of the performer. Supervisors need to ensure that not only is the expected result clearly understood, but also that the performer clearly understands “how” to perform the task and has the tools to be successful.



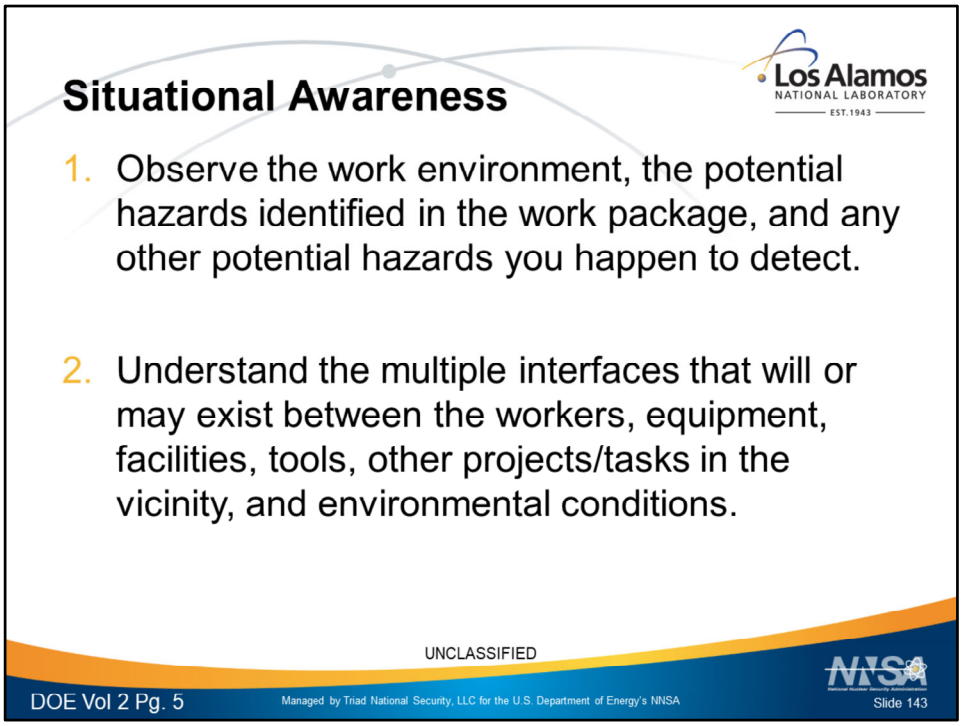
Example of a **Risk Important Action** (action is reversible and harm is not immediate)



DOE Operating Experience Summary: Issue Number 2016-02, Article 1: **Situational Awareness: Focus Can Decrease Risk and Injuries**

Although the phrase "Situational Awareness" may sound highly technical, it simply means: Paying attention to what is happening around you. Workers at Department of Energy (DOE) facilities can benefit from honing their own situational awareness to reduce the likelihood of experiencing injuries on the job. Situational awareness is a skill that can prevent individuals from getting injured. This *Operating Experience Summary* focuses on the importance and benefits of situational awareness, keeping in mind that situational awareness is one piece of the large process of preventing events.

Situational awareness is the ability to scan the work environment and sense danger, challenges, and opportunities, while maintaining the ability to conduct normal activities. Failing to pay attention can be a contributing factor to injuries and accidents that range from mild sprains and strains resulting from slips, trips, and falls, to death. Often in public places, one can observe people with their heads down, looking at smartphones or reading books—some with headphones, others distracted or lost in thought. As potentially dangerous as such behavior can be, the dangers increase in the workplace, where it is essential to be alert and focused, using all senses to evaluate and appropriately respond to indications of impending danger.



DOE Operating Experience Summary: Issue Number 2016-02, Article 1: **Situational Awareness: Focus Can Decrease Risk and Injuries**

Situational awareness is a skill, and as such, can be developed over time with practice. When beginning drivers are undergoing instruction, they develop the critical skill to recognize potential hazards that they are approaching in their vehicle. For example, the new driver may be alerted to the presence of a leashed dog on the side of the road walking with its owner, and instructed to anticipate that the dog could dart into the road. Over time, with repeated actions of noticing such a hazard and anticipating its effect on the driver's environment, a person becomes experienced and is able to notice and anticipate it with minimal mental effort. Likewise, practicing situational awareness in the daily work environment can hone hazard recognition and the ability to use it in critical or new situations. By practicing "turning on" attention again and again in a variety of situations, awareness of potential hazards or threats can become second nature.

Situational Awareness

3. Predict the likelihood of these interfaces producing an undesired result and the impacts of that undesired result.
4. Prevent the undesired event from happening by monitoring the interfaces in and close to your work zone.
   - Be aware of equipment status, where you are relative to equipment (both mobile and stationary), and other work activities around you.
   - When practical, cordon off your work zone to prevent others from entering.

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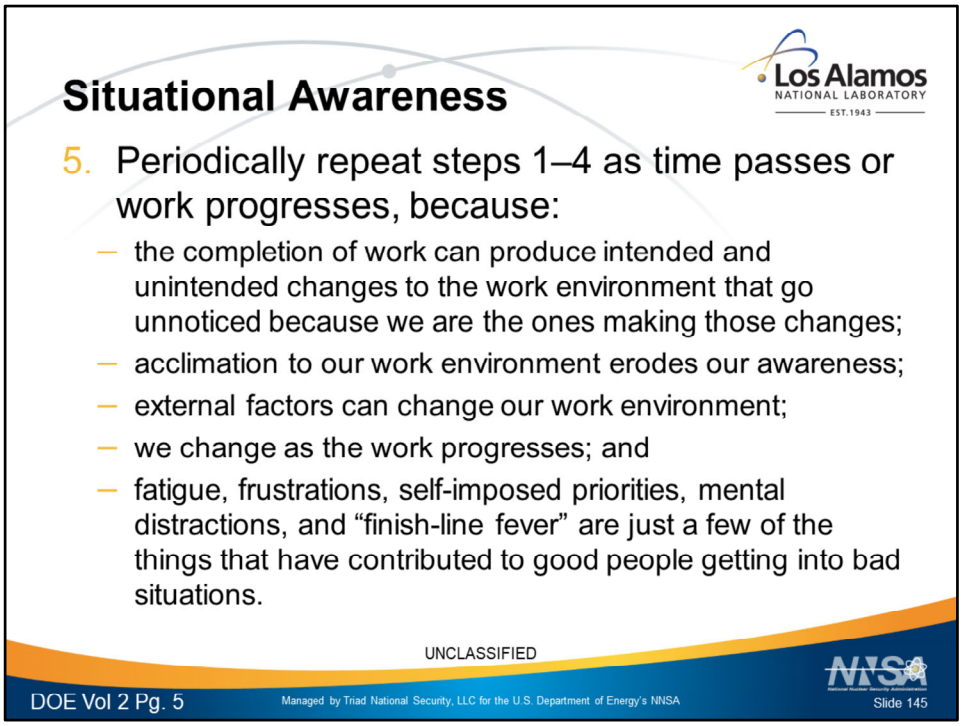
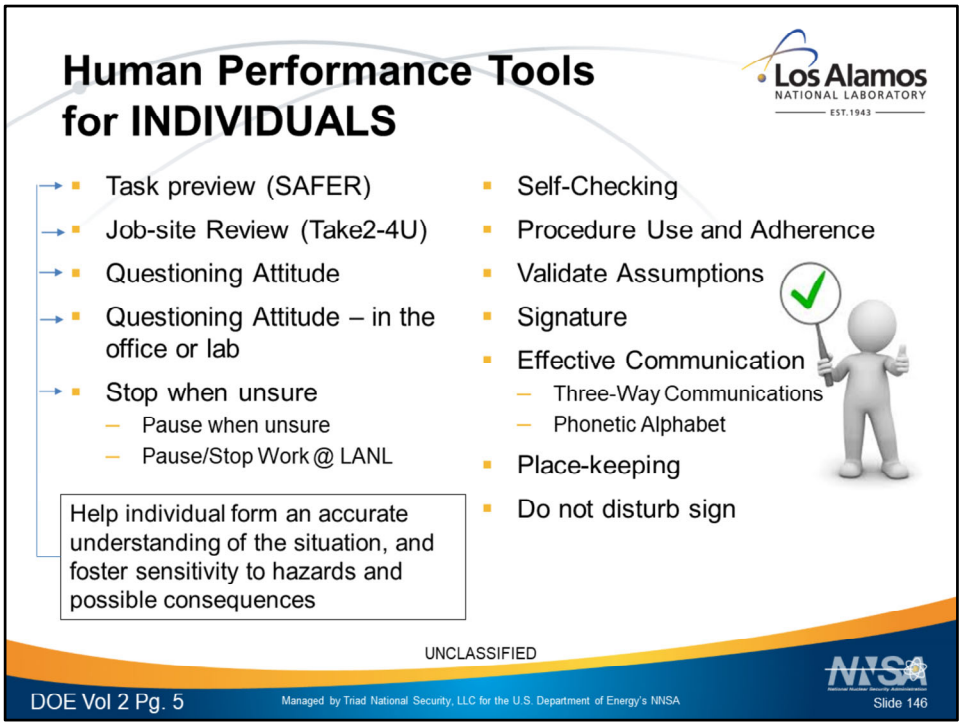
DOE Operating Experience Summary: Issue Number 2016-02, Article 1: **Situational Awareness: Focus Can Decrease Risk and Injuries**



DOE Operating Experience Summary: Issue Number 2016-02, Article 1: **Situational Awareness: Focus Can Decrease Risk and Injuries**

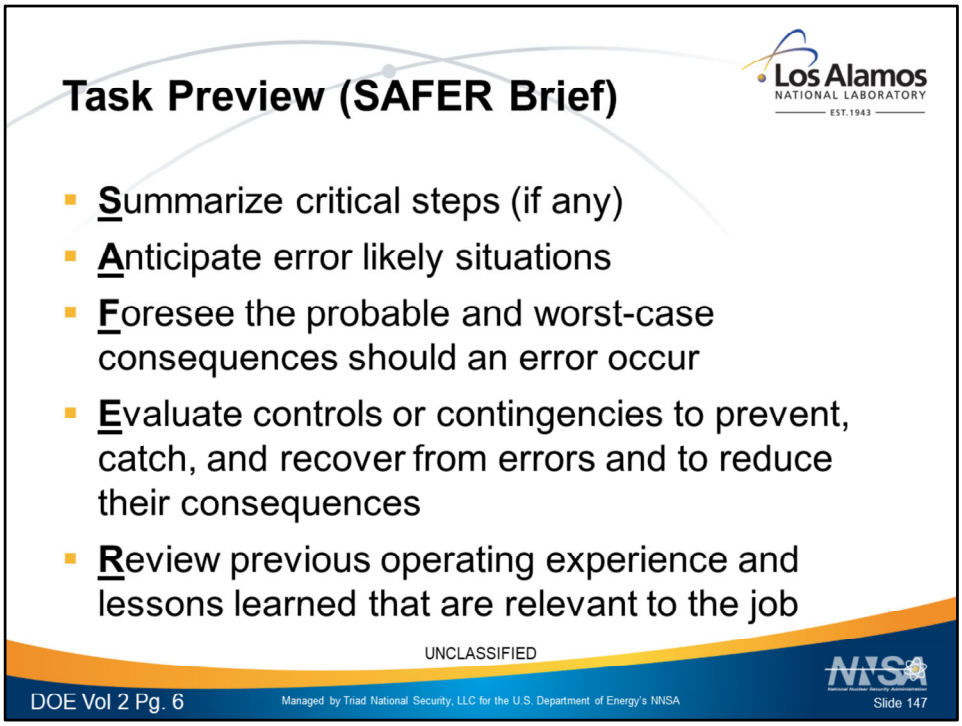


The Individual Human Performance Tools described in Section 1 can be used routinely and consistently by single individuals for any work activity, regardless of the hazard or complexity of the task and without prompting or supervisory involvement.

The basic purpose of these tools is to help the individual performer maintain ***positive control*** of a work situation**.** Positive control means that what is intended to happen is what happens, and that is all that happens. Before taking an action, a conscientious individual understands the significance of the action and its intended result. Such thinking takes time. All human performance tools deliberately slow things down to ultimately speed things up by avoiding delays that accompany events triggered by active errors. When used conscientiously, these tools give the individual more time to think about the task at hand—about what is happening, what will happen, and what to do if things do not go as expected. The performer's primary goal is to retain positive control at critical steps when error-free performance is essential for safety. Using these human performance tools does not guarantee perfect performance, but individuals can greatly reduce their chances of erring by using the tools thoughtfully and rigorously.

Many of the tools in this "Individual" section might be categorized as "situational awareness" tools. Two of the Individual tools, Procedure Use and Adherence and Validate

Assumptions have particular value when performing Rule base work. Situational awareness is defined as the accuracy of a person’s current knowledge and understanding of actual conditions compared to expected conditions at a given time. The tools listed in the left-.hand column above help the individual form an accurate understanding of the work and equipment situation, and foster an attitude sensitive to the presence of hazards and the possible consequences of a mistake. Situational awareness refers to the accuracy of a person's current knowledge and understanding of the task at hand and related working conditions compared to actual conditions at a given time. A performer needs an accurate knowledge and understanding of relevant information from the work environment to guide his or her decisions and actions. Situation awareness means the individual clearly understands the job requirements, the equipment condition, and work environment before acting. The situation awareness tools, described below, improve an individual’s insightfulness and ability to detect unsafe conditions he or she may not see otherwise. They are particularly helpful in the performance of skill mode work.



Before starting work, individuals should conduct a task preview. The review can include reviewing procedures and other related documents to familiarize themselves with the scope of work, task sequences and critical steps; a conversation with those who performed the job in the past; and a walkdown of the job site.

The task preview helps the individuals performing a task consider how their actions affect safety and production. The preview also provides a structured, risk-based review of the work activities from a human performance perspective and enhances the individual's situational awareness while in the field. During the task preview the individual:

- Identifies the critical steps (see definition).
- Considers the possible errors associated with each critical step, and the likely consequences.
- Ponders the “worst that could happen.”
- Considers the appropriate human performance tool(s) to use.
- Discusses other controls, contingencies, and relevant operating experience.

Note: Operating experience should include lessons learned from in-house events, equipment work history, and personal experience, as well as relevant industry experience.

Use This Tool

- Before attending a pre-job briefing
- Before starting a job
- Just before performing a critical step
- After interruptions or extended delays in an activity

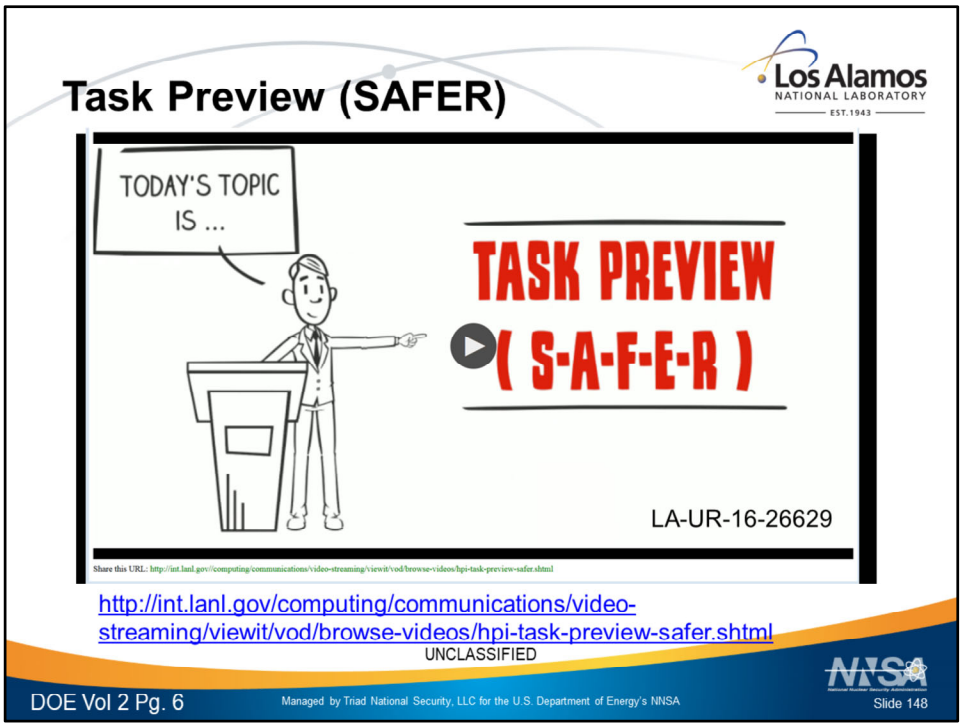
(S-A-F-E-R):

- **Summarize** the critical steps.
- **Anticipate** errors for each critical step and relevant error precursors.
- **Foresee** probable and worst-case consequences should an error occur during each critical step.
- **Evaluate** controls or contingencies at each critical step to prevent, catch, and recover from errors and to reduce their consequences.
- **Review** previous experience and lessons learned relevant to the specific task and critical steps.

The SAFER process outlined above helps the individual to methodically recognize and address the risk of human error to safety and reliability.

Avoid These At-Risk Practices:

- Not taking the time to review procedures/work documents
- Individuals not prepared for the task
- Omitting a discussion of specific controls for each critical step
- Individuals failing to express concerns they may have
- Not using lessons learned from previous activities for the task



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Overview

The purpose of a job-site review is to improve a person's situational awareness when first arriving at the job site. People should take the time to develop an accurate understanding of critical indicators, system/equipment condition, work environment, hazards, and even team members. Taking the time necessary to get acquainted with the immediate work area helps individuals to establish a healthy sense of uneasiness. It also boosts their questioning attitude and enhances the accuracy of their situation awareness.

Use This Tool

- Upon arriving at the physical work location
- Before interaction with risk-important equipment
- During a walk-down of a work package
- When a potential safety hazard is present
- After extended breaks or interruptions

Recommended Practices When Using This Tool

1. Explore the job site for a few minutes by walking around and looking at the work area and adjacent surroundings to identify the following.

- Industrial safety, radiological, and environmental hazards
- Trip-sensitive equipment to avoid jarring or disturbing
- Right system, right equipment, right component

• Critical parameters or indicators important for task success
• Error precursors (at critical steps)
• Conditions consistent with the procedure and pre-job briefing.

BACK OF TAKE2-4U card

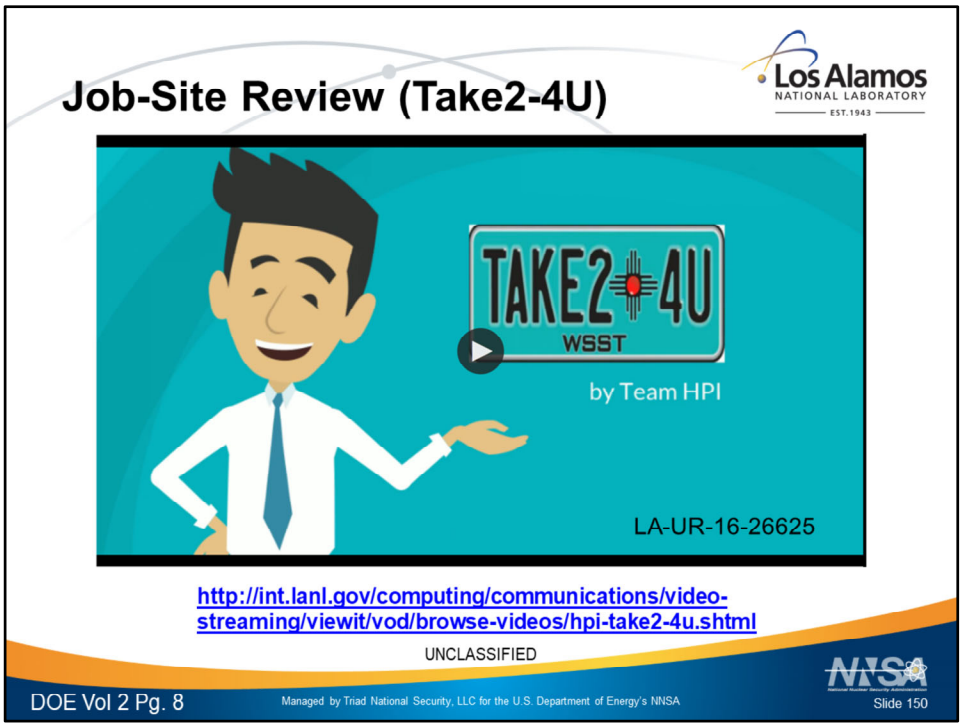
After the paperwork, after the pre-job, before you begin the work, take 2 minutes for you.

WHAT COULD GO WRONG?
WHAT DIDN'T I THINK OF?
IS ANYTHING MISSING?
DO I HAVE THE RIGHT TOOLS?
DO I HAVE THE REQUIRED TRAINING?
NOW DO THE JOB!

2. Talk with coworkers or the supervisor about unexpected hazards or conditions and the precautions to take.
3. Eliminate hazards, install appropriate defenses, or develop contingencies before proceeding with the task.

Avoid the Following At-Risk Practices

- Hurrying, not taking the time to look around the job site
- Thinking that repetitive work is "routine" or "simple", meaning "no risk"
- Not talking about hazards or precautions with co-workers
- Not talking about "gut feelings"
- Failing to eliminate hazards or installing appropriate defenses



http://int.lanl.gov/computing/communications/video-streaming/viewit/vod/browse-videos/hpi-take2-4u.shtml
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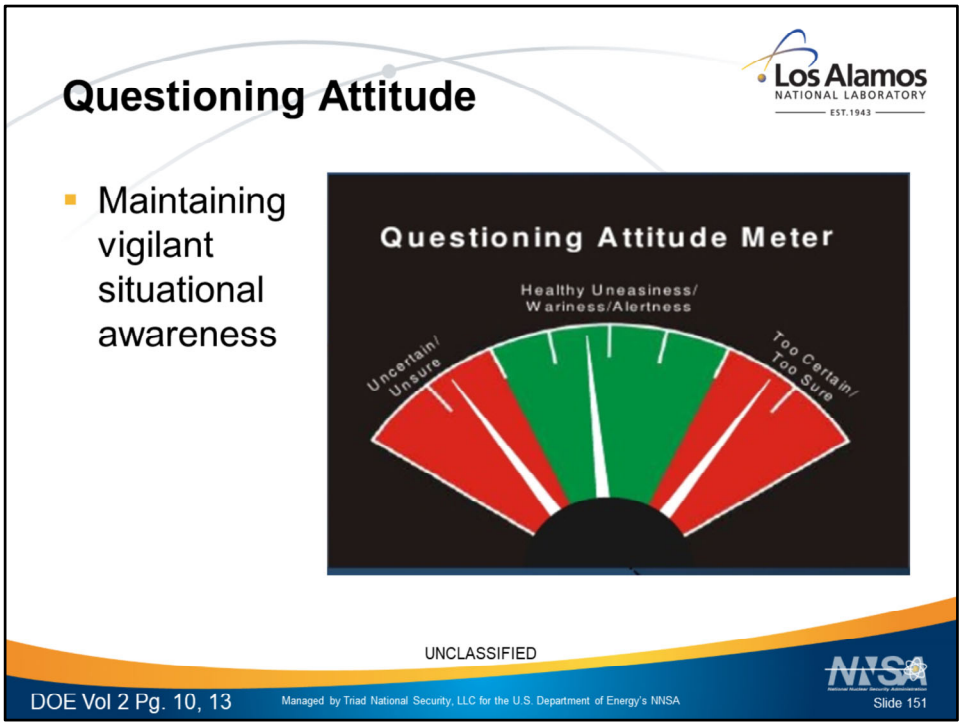
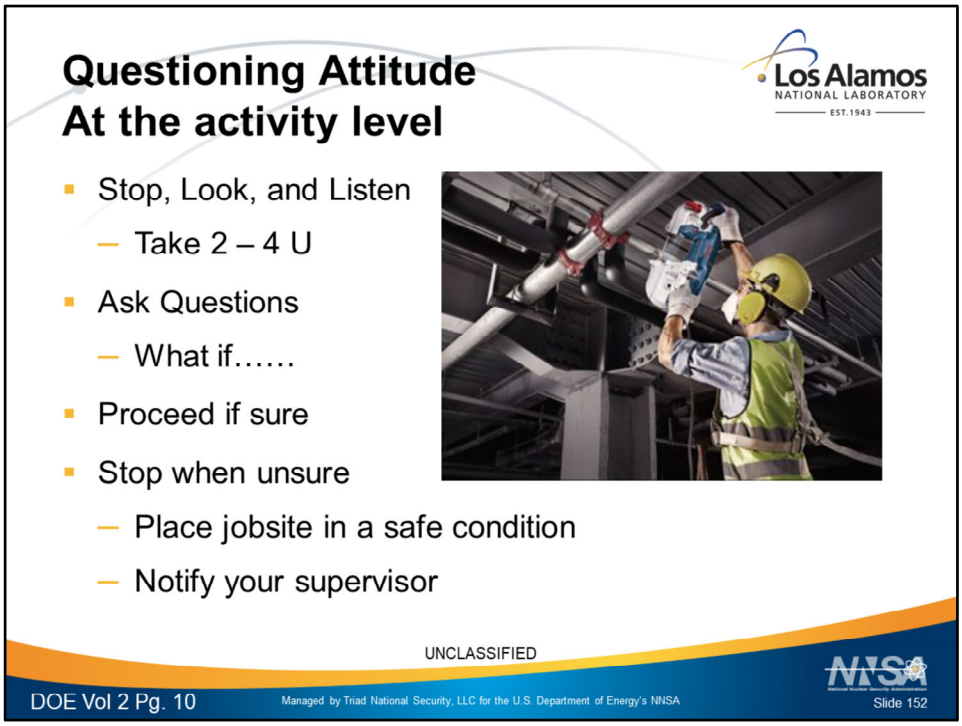


Questioning attitude – maintaining vigilant situational awareness toward surrounding working conditions to detect error-likely situations, unsafe or hazardous working conditions, or otherwise unusual conditions; not proceeding in the face of uncertainty and basing decisions on facts



Overview

A questioning attitude fosters thought about safety before action is taken and helps individuals maintain an accurate understanding of work conditions at any given time. This tool alerts people to potential hazards, warning signs, critical activities (steps), error-likely situations, and other uncertainties in the work environment or the work plan. It also encourages the user to stop and resolve those hazards, warnings, error-likely situations, or uncertainties before proceeding with the job. It promotes follow-up when doubt arises with the discovery of facts, not assumptions, to reveal more knowledge about the situation and eliminate the doubt. People, in general, are reluctant to fear the worst, and a healthy questioning attitude will overcome the temptation to rationalize away "gut feelings" that something is not right.

A questioning attitude promotes a preference for facts over assumptions and opinion. Questions such as "What if . . .?" or "Why is this acceptable?" help improve recognition of improper assumptions and possible mistakes. The structured approach described below promotes the discovery of facts. Facts depend on the reliability of the information source and the accuracy of that information. Without sufficient facts, the performer should stop the activity to address an unpredictable work situation that could lead to a serious mistake or significant event.

Use This Tool

- During self-checking ("Think" step of STAR)
- Before performing an important step or phase of an activity

- When making a decision about an important activity
- When experiencing uncertainty, confusion, or doubt
- When experiencing a “gut feeling” that something is not right
- When encountering unanticipated changes in conditions
- When conflicts or inconsistencies exist between plans, procedures, and actual conditions
- After encountering unexpected results
- After discovering missing information or resources
- Upon hearing the danger words: “I assume,” “probably,” “I think, “maybe,” “should be,” “not sure,” “might,” “we've always...” and so forth

Recommended Practices When Using This Tool

1. Stop, Look, and Listen – Proactively search for work situations that flag uncertainty (see When to Use the Tool).

• Periodically pause-timeout-to check the work situation.
• Pause when a flag is recognized.
• Identify inconsistencies, confusion, uncertainties, and doubts.
• State or verbalize the uneasiness or question in clear terms.

2. Ask questions – Gather relevant information.

• What are the “knowns” and “unknowns”?
• Use independent, accurate, and reliable information sources, especially other knowledgeable persons.
• Compare the current situation (knowns) with independent sources of information.
• Consider “what if...?” and/or use a “devil's advocate” approach in a spirit of helpfulness.
• Identify persistent inconsistencies, confusion, uncertainties and doubts.

3. Proceed if sure – Continue the activity if the uncertainty has been resolved with facts. Otherwise, **do not proceed in the face of uncertainty!**

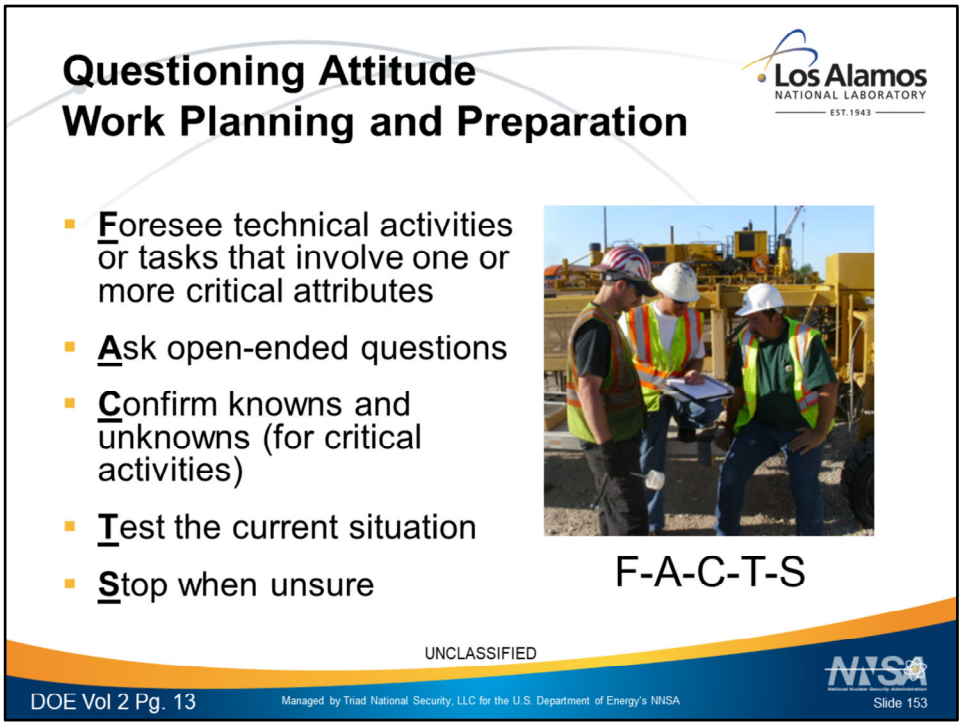
4. Stop when unsure – If inconsistencies, confusion, uncertainties, or doubts still exist, do the following.

• Stop the activity
• Place equipment and the job site in a safe condition
• Notify *your* immediate supervisor

Avoid These At-Risk Practices

- Not pausing periodically (timeout) to refresh *your* understanding of the work situation
- Proceeding with a task when questions exist
- Being unaware of critical parameters or margins
- Believing nothing can go wrong
- Believing that repetitive means “routine” or “simple” and carries “no risk”
- Trying to make reality conform to *your* expectations (mental model) rather than seeing what is really around you
- Rationalizing doubts, uncertainties, contradictory information, subtle differences, or anomalies
- Not asking questions when subtle cues suggest disorientation is occurring
- Accepting the first thing that comes to mind, initial impression or assessments, as factual

- Ignoring subtle differences or apparently minor inconsistencies
- Not understanding the basis of the procedure step
- Allowing emotions rather than reason to guide decisions
- Accepting supporting evidence without questioning its validity



Overview

Proper planning of and preparation for work play a major role in prevention of error and avoidance of consequences. The NNSA document **Activity Level Work Planning and Control Processes:** Attributes, Best Practices, and Guidance for Effective Incorporation of Integrated Safety Management and Quality Assurance" provides effective practices to enhance both work planning and preparation. A questioning attitude fosters awareness of uncertainty, assumptions, risk factors, and the significance of a decision or action before proceeding. It helps a person make sure that planning, judgment, and decision-making are appropriate for the product in development. Questions, such as "If… then?" "What if …?" and "Why is this okay?" help improve recognition of actual or possible mistakes. A healthy questioning attitude will overcome the temptation to rationalize away a gut feeling that something is not right. To avoid dependence on unsubstantiated assumptions or subjective opinions, a structured approach promotes the discovery of facts.

A good pre-job briefing enhances a person's questioning attitude. From information discussed during the briefing, individuals will *know* the potential hazards, critical activities (steps), risk-important parameters, and error-likely situations and their potential consequences before starting the work activity. The pre-job briefing sensitizes personnel to what should and should not be. "Cook-booking" of procedures (mindless compliance) and over-reliance on rules of thumb tend to promote an unthinking response to perceived simple problems and will eventually lead to rule-based errors. A questioning attitude will help prevent such at-risk practices.

The questioning attitude practices are intended to enhance guidance contained in the NNSA

document and other DOE Conduct of Operations guidance.

Use This Tool

- When uncertain – a gut feeling that something is not right
- When using previously approved evaluations, solutions, designs, or other approved guidance to address a current issue
- When unexpected results are obtained or unfamiliar situations are encountered
- When making a decision about an activity for which a mistake could have adverse consequences
- During the initial phase of the performance of a critical activity, regardless of how often it occurs
- When encountering unexpected information or instructions that conflict with other guidance or procedures
- During experiments or trials
- During engineering evaluations
- During product review meetings
- When preparing and reviewing calculations
- When revising drawings, design criteria, or system descriptions
- When reviewing procurement documents
- When uncertain that the product is in compliance with expectations, procedures, codes, or regulations
- When the definition of success is uncertain
- When approving an engineering product
- During root cause analysis, apparent cause evaluations, and troubleshooting

Recommended Practices When Using This Tool (F-A-C-T-S)

1. Foresee technical activities or tasks that involve one or more critical attributes.

• Ask open-ended questions.
• Inputs
• Method(s)
• Outputs
• Priorities
• Awareness of situations that "don't seem right"

2. Confirm knowns and unknowns (for critical activities).

• Identify and verify critical facts (their source and validity) with current conditions.
• Identify inconsistencies and unverified assumptions.
• Summarize critical parameters.
• Recognize work-related error precursors (risk factors).

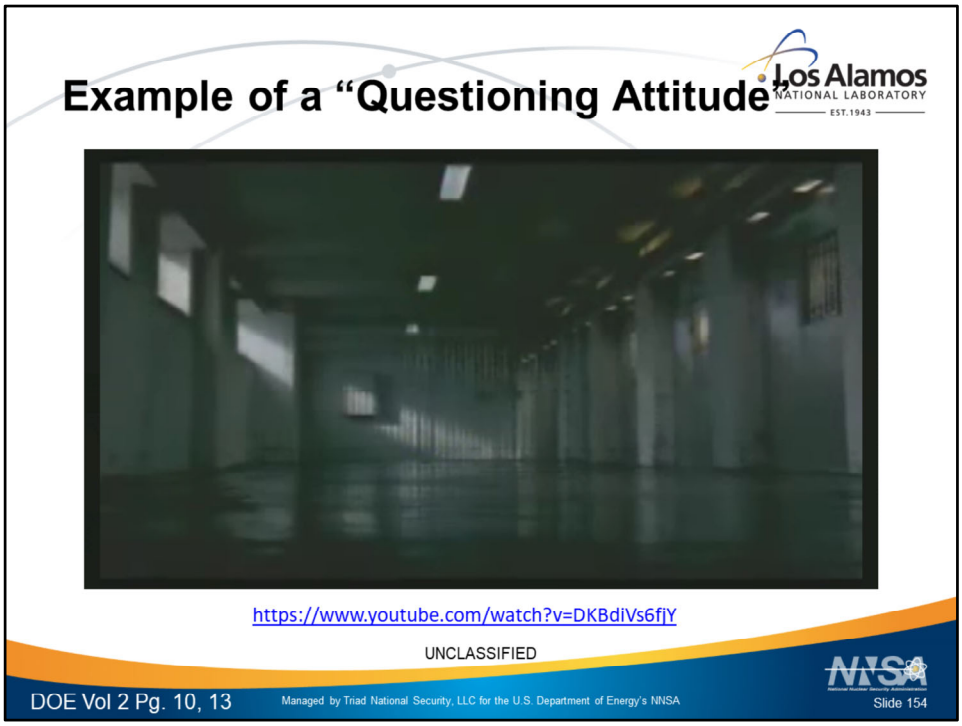
3. Test the current situation.

• Anticipate possible consequences with the current situation.
• Be receptive to the questions of others; use a devil's advocate approach.
• Ask another qualified individual to check and verify the information (peer review).
• Compare the current situation with relevant facility documentation or engineering standards and codes.

• Consider testing, alternate analysis, and calculation.
• Stop when unsure.
• Do not proceed in the face of uncertainty.
• Inform the responsible supervisor.

Avoid These At-Risk Practices

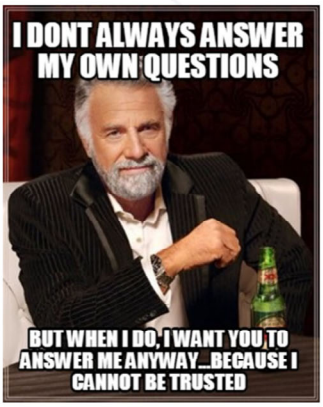
- Dismissing contrary points of view
- Making assumptions
- Using unsuitable rules of thumb
- Believing the source of information is absolutely reliable
- Following a procedure without critical thinking (cook-booking)
- Rationalizing an anomaly away
- Thinking the task is routine or simple
- Believing nothing bad can happen
- Ignoring subtle differences or weak signals
- Not asking for help
- Being unaware of critical attributes of the project or task
- Not questioning adverse impacts that could occur at later stages of the project, beyond the individual's scope or responsibility



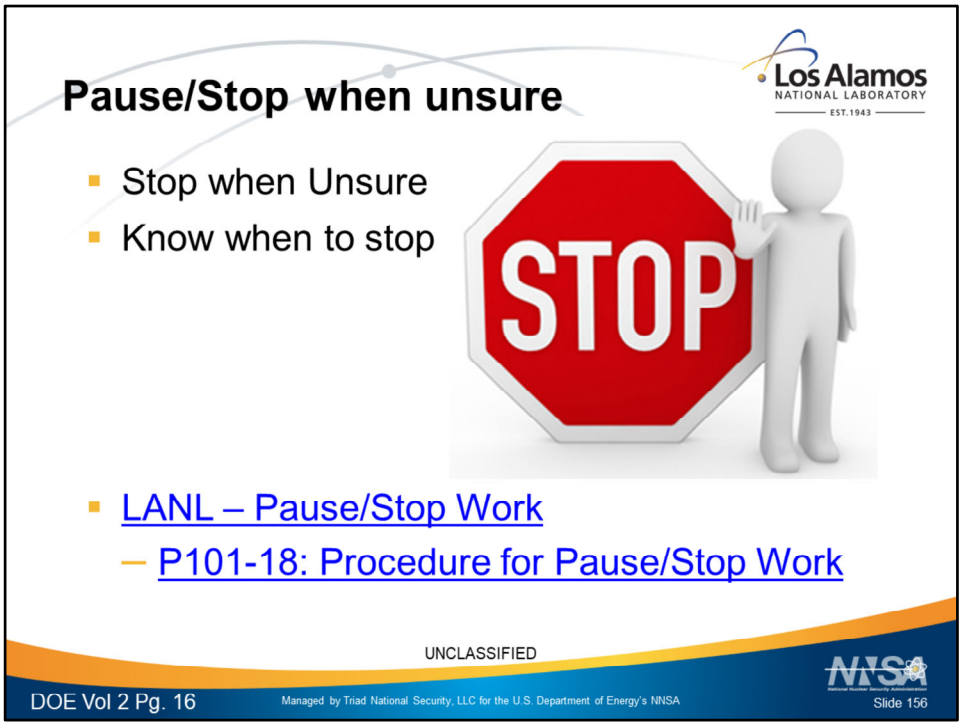
VIDEO: Prison Break - New Guy in prison life insurance commercial
https://www.youtube.com/watch?v=DKBdiVs6fjY
This video demonstrates an new inmate having a questioning attitude about a draft in his cell block

One other thing….

- Don't answer *your own* question!
  - Validate by referring to the IWD, drawing, reference material, etc.
  - Ask a peer, the SME, the PIC, etc.



You may be in Knowledge Based performance mode.
If you have an incorrect mental model, your answer may be wrong!



When confronted with confusion or uncertainty, a person is in unfamiliar territory without a defined path forward (knowledge-based performance mode). Given that the chances for error are particularly high in such situations (a 10 percent to 50 percent probability), the best course of action, when unsure, is to **stop**. Whenever a question arises and what to do remains uncertain—stop and ask! Every person has the responsibility and authority to stop work when uncertainty persists (a graded approach of "pause" or "time-out" is also used by some organizations).

DOE facilities have formalized Stop Work processes. These are intended for use by activity level workers when they believe conditions may be unsafe. They are also intended to be used by the organization in circumstances where work may need to be postponed for re-analysis and subsequent safety improvements prior to resuming work.

The Pause When Unsure tool is intended to supplement the existing formalized practices and emphasis that workers approach work deliberatively and mindfully. And if they encounter unexpected conditions or need additional clarification or support, then pausing is a recommended and conservative approach.

Even if it seems simple and straightforward, notify your supervisor, and get help from other people. The "Pause When Unsure" technique prompts performers to gain more accurate information about the work situation from other knowledgeable persons before proceeding with the activity. It involves a stoppage of work long enough to allow individuals, their supervisors, or

other knowledgeable persons with expertise to discuss and resolve the issue before resuming
the task.

Use This Tool

- When uncertainty, doubt, confusion, or questions persist
- If outside of conditions assumed by a technical procedure
- When encountering conditions inconsistent with the procedure
- When outside the bounds of key parameters
- If beyond the scope of the plan or process
- When unexpected results or unfamiliar situations are encountered
- When something expected does not happen
- When uncertain regarding compliance with expectations or procedures
- When inexperienced or lacking knowledge with a task
- When someone else expresses doubt or concern

Recommended Practices When Using This Tool

1. **Pause** (pause or time-out) the activity.
2. **Place** the equipment and the job site in a safe condition.
3. **Notify** your immediate supervisor.
4. **Get help** from more knowledgeable persons

LANL Pause/Stop Work

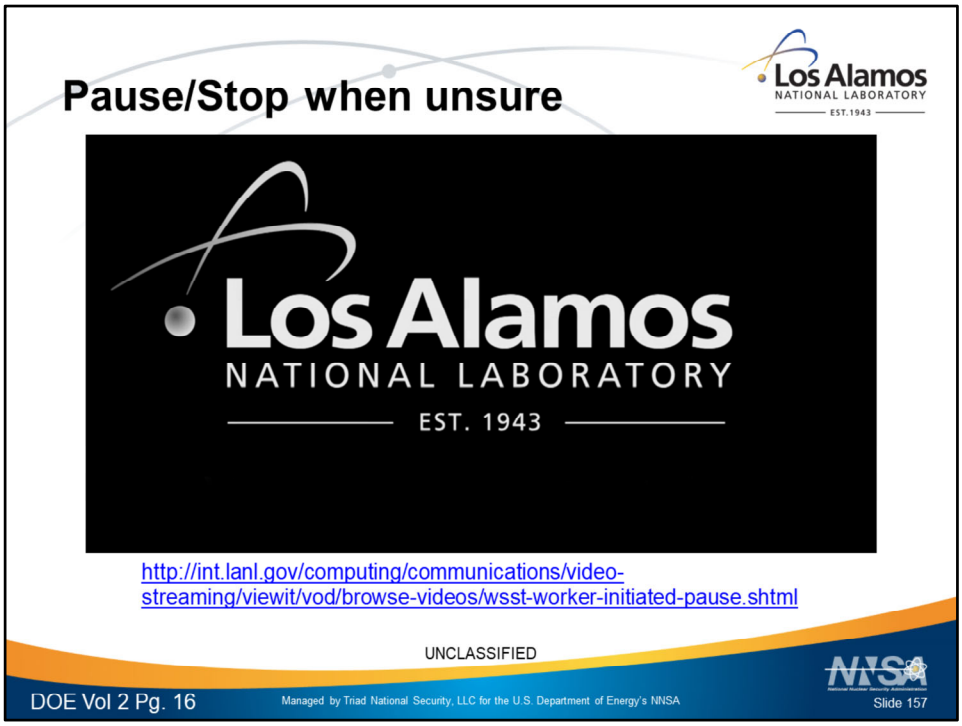
P101-18: Procedure for Pause/Stop Work

Ability to pause or stop work is critical worker right

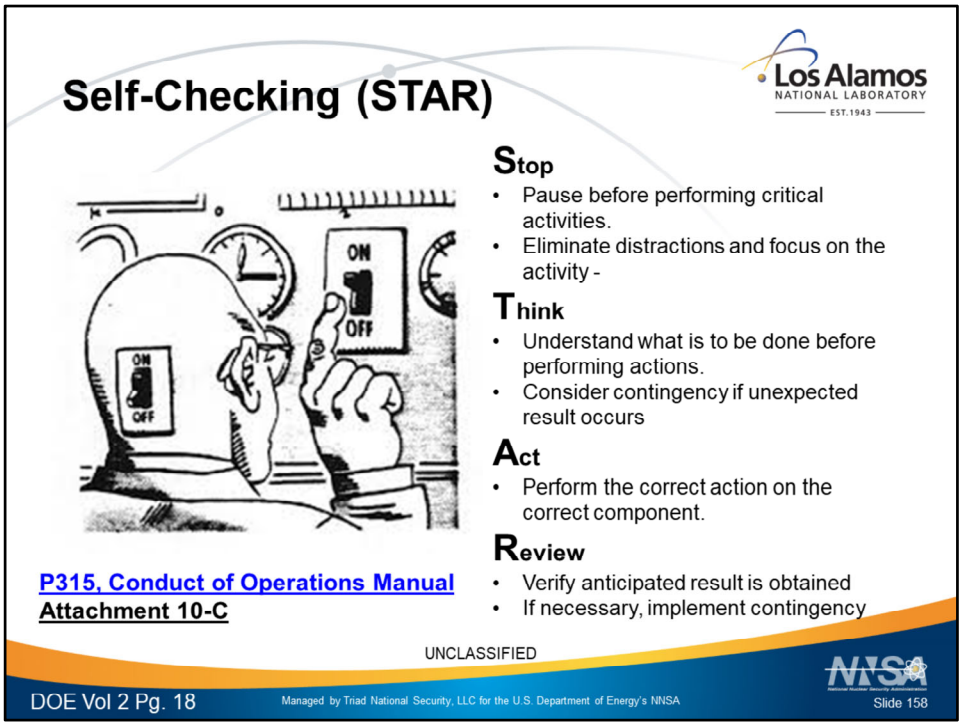
The Laboratory's pause/stop work procedure contains requirements for all workers who perform any and all work tasks at the Laboratory, including managers and supervisors who are responsible for worker safety.

The right of workers at the Laboratory to pause or to stop work implements a critical worker right under 10 CFR 851, *Worker Safety and Health Program*, Section .20(b)(8) and (9).

The Industrial Hygiene and Safety Division provides direct support to those with questions or concerns associated with how and when to implement pause/stop.



LANL Video on demand – Human Performance Improvement Videos
http://int.lanl.gov/computing/communications/video-streaming/viewit/vod/browse-videos/wsst-worker-initiated-pause.shtml



Self-checking helps a performing individual focus attention on the appropriate component or activity; think about the intended action; understand the expected outcome before acting; and verify the results after the action. When used rigorously, self-checking boosts attention and thinking just before a physical action is performed. The performer pauses to take a moment to reflect on the intended action, the component, and its expected outcome; think about whether the proposed action is the right action for the situation; and resolve any questions or concerns before proceeding. When prepared, the performer takes the action, followed by a review of the results of the action to decide if the right result was obtained.

Self-checking is particularly effective for skill-based, repetitive tasks, which people usually perform without a lot of conscious thought. But, attention must peak when the risk is greatest—when altering a component's status. This technique also helps prevent errors when noting, recording, or entering data; performing calculations; and the like.

Use This Tool

- When manipulating or altering equipment or controls
- During physical activities or interfaces with plant equipment (tests, walk-downs, inspections, etc.)
- When entering facility data into a computer or recording it on a form
- When performing a calculation
- When performing an experiment
- When reading a computer readout or other indicator related to any critical attribute

- When revising drawings or procedures using cut-and-paste on a computer or by making handwritten annotations
- Before and during an impending change in equipment status
- When performing critical tasks identified during pre-job briefings
- When assembling components that contain similar parts that potentially could be interchanged

Recommended Practices When Using This Tool

STAR is an acronym people use to help them remember to slow down and concentrate on an important action or task. STAR stands for **S**top, **T**hink, **A**ct, **R**eview.

1. Stop – Pause.

• Pause before performing critical activities.
• Eliminate distractions and focus on the activity.

2. Think – Understand what is to be done before performing actions.

• Understand what will happen when correct action is taken on the correct component.
• Verify that conditions match those discussed during the pre-job briefing.
• Verify that the action is appropriate, given the equipment status.
• Identify expected outputs/results of the action.
• Compare conditions to the controlling document.
• Consider a contingency if an unexpected result occurs.
• If uncertain, use the questioning-attitude (FACTS) tool.

3. Act – Perform the correct action on the correct component.

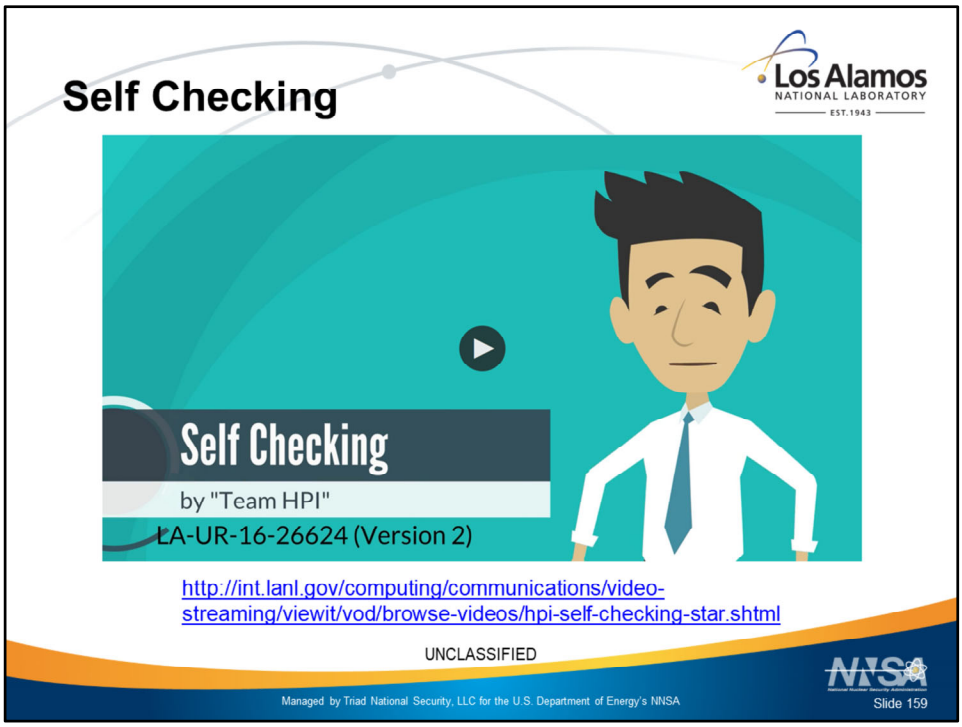
• Follow relevant guidance (procedure, policy, and other guidance).
• Without losing eye contact with the component, read and touch the component label.
• Compare the component label with the guiding document.
• Perform planned actions for the specific activity.

4. Review – Verify anticipated result is obtained.

• Verify that outputs or results match the expected outputs/results.
• Perform the contingency, if the expected result does not occur.
• Notify supervisor, as needed.

P315, Conduct of Operations Manual;

Self-checking techniques (Appendix 10-C) provide a list of expectations related to individuals performing actions and independently verifying those actions. These expectations should be clearly understood by all personnel involved in the IV program and included in IV training.



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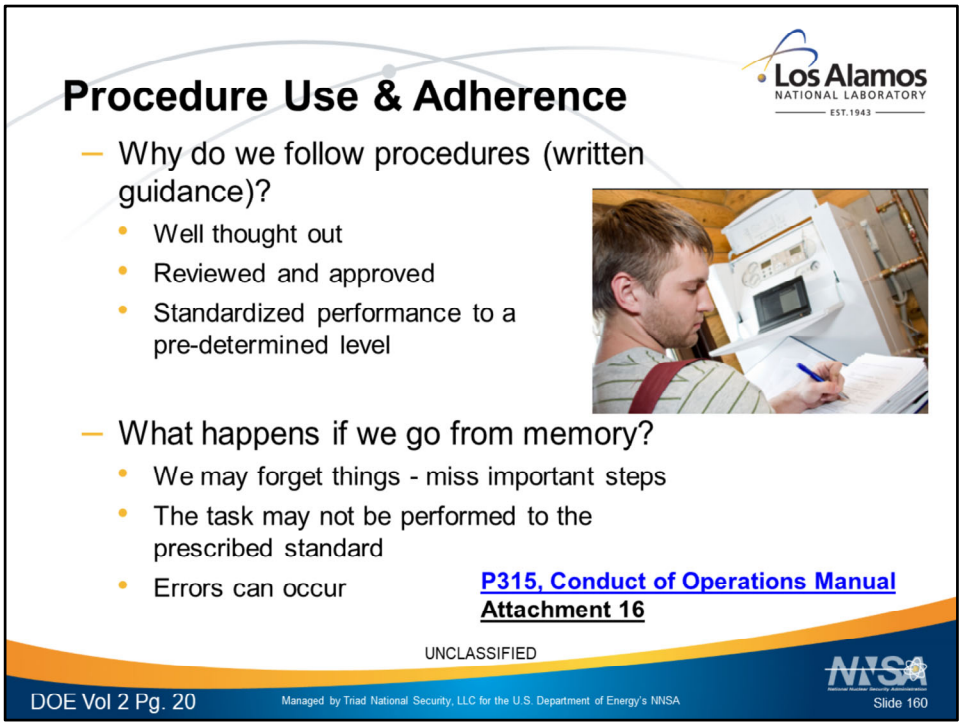
LA-UR-16-26624 (Version2)



Procedure adherence means understanding the procedure's intent and purpose, and following its direction. The user performs all actions as written in the sequence specified by the document. However, if it cannot be used safely and correctly as written, then the activity is stopped, and the procedure is revised before continuing. Consistent and rigorous use of this HPI tool at DOE facilities will improve productivity and safety and reduce unwanted events and occurrence reports.

Procedure quality is paramount to safety and reliability. Following the procedure without question does not guarantee safety because procedures sometimes contain hidden flaws. The completeness, accuracy, and internal consistency of the instructions and their usability (ease of understanding and compliance) all impact the user. Procedures are usually complete and accurate; however, the performer cannot follow them blindly. Experience has shown that procedures do not always contain sufficient information. With this in mind, users should follow procedures mindful of the impact their actions could have on facility equipment before taking the actions.

Use This Tool

- When manipulating, altering, monitoring, or analyzing equipment
- When a procedure exists for a work activity
- When no procedure exists, but there should be (STOP and get help)
- When required by technical specifications or other technical documents

Recommended Practices When Using This Tool

1. **Compare** the working copy to the controlled copy to verify it is the most recent revision.
2. **Review** all prerequisites, limits and precautions, initial conditions, and instructions before starting work; confirm understanding of the procedure's overall purpose and verify it is appropriate for the system or equipment condition.
3. **Use** the procedure according to its designated level of use (continuous, reference, or information) or as directed by management.
4. **Follow** the procedure as written, aware of the potential impact the action can have on equipment.
5. **STOP** the task, place the equipment or system in a safe condition, and contact a supervisor if any of the following situations exist.
    - The step cannot be performed as written.
    - Injury or damage to equipment will occur if used as is.
    - Use of the procedure will result in incorrect or unsafe equipment configuration.
    - The procedure is technically incorrect.
    - Unexpected results are achieved after performing the step.
    - The procedure conflicts with another procedure.
    - The procedure is otherwise unsafe.
6. **Report** procedure problems when they are found and ensure that important deficiencies are corrected before re-using the procedure.

<u>P315, Conduct of Operations Manual</u>

Attachment 16

16.4.1 Usage Levels

The management expectations, called "usage expectations," for using procedures, sections, or attachments vary depending upon a variety of characteristics, including complexity of the work activity, frequency of execution, and potential for negative impact of improper execution. To determine the appropriate usage level, "determination criteria" has been established.

Use Every Time (UET):

If one or more of the following determination criterion are true, then the correct usage level for the procedure, section, or attachment is UET:

▪ has potential high consequence of error
▪ is complex
▪ is infrequently performed
▪ has stringent quality or regulatory documentation requirements
▪ is used to capture data
▪ is used as a record
▪ requires placekeeping or sign-off (see Section 5.13, *Placekeeping and Sign-off Steps*, of FSD-315-16-001, *Technical Procedure Writer's Manual*)

The following are the usage expectations for UET procedures, sections, or attachments. All are to be applied.

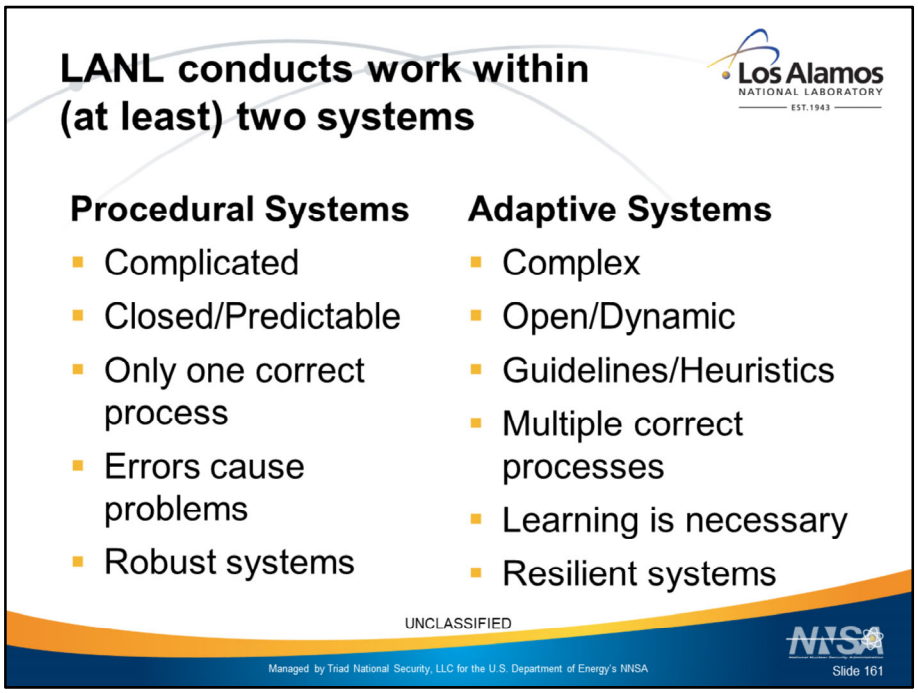
▪ The procedure revision, including IPCs, must be confirmed to be the latest approved version

prior to execution of the procedure.
▪ The procedure must be at the jobsite and open to the page containing the step being performed.
▪ The procedure must be executed as written and in the sequence written, unless the procedure allows otherwise (see Section 5.3, *Non-sequence Steps*, of FSD-315-16-001).
▪ The completed procedure must be reviewed by the worker to confirm that all steps were executed and appropriately documented.

Reference:
If none of the determination criterion for the UET usage level is true, then the correct usage level for the procedure, section, or attachment is Reference.
All of the following usage expectations for Reference procedures, sections, or attachments must be applied.
▪ The procedure revision, including IPCs, must be confirmed to be the latest approved version prior to execution of the procedure.

Note: For purposes of this attachment, "readily available" means a copy can be obtained within 15 minutes.
▪ The procedure must be readily available to workers at the jobsite.
▪ The procedure must be executed as written and in the sequence written, unless the procedure allows otherwise (see Section 5.3, *Non-sequence Steps*, of FSD-315-16-001).
▪ The individual step may be executed from memory, but frequent confirmation is recommended.
▪ The completed procedure must be reviewed by the worker to confirm that all steps were executed and appropriately documented.

Mixed Usage Levels:
For some procedures it may be appropriate to have "mixed" usage levels." For example, the procedure instructions could be one usage level while the attachment used to collect data or submit as a record is a higher usage level. The "determination criteria" must be used when determining the usage level to apply to a procedure section and/or attachment.



An example is relocating a US Navy ship from the Suez canal to the Panama canal
Some if procedural: Operating the power plant, sonar equipment,
Some is adaptive: Navigation

Complicated:
1. consisting of many interconnecting parts or elements; intricate.
2. difficult to analyze, understand, or explain

Complex:
1. hard to separate, analyze, or **solve**

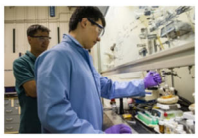
LANL works in both systems

Procedural Systems

- Operations
- Maintenance
- High Hazard Activities

Adaptive Systems

- Troubleshooting
- Research

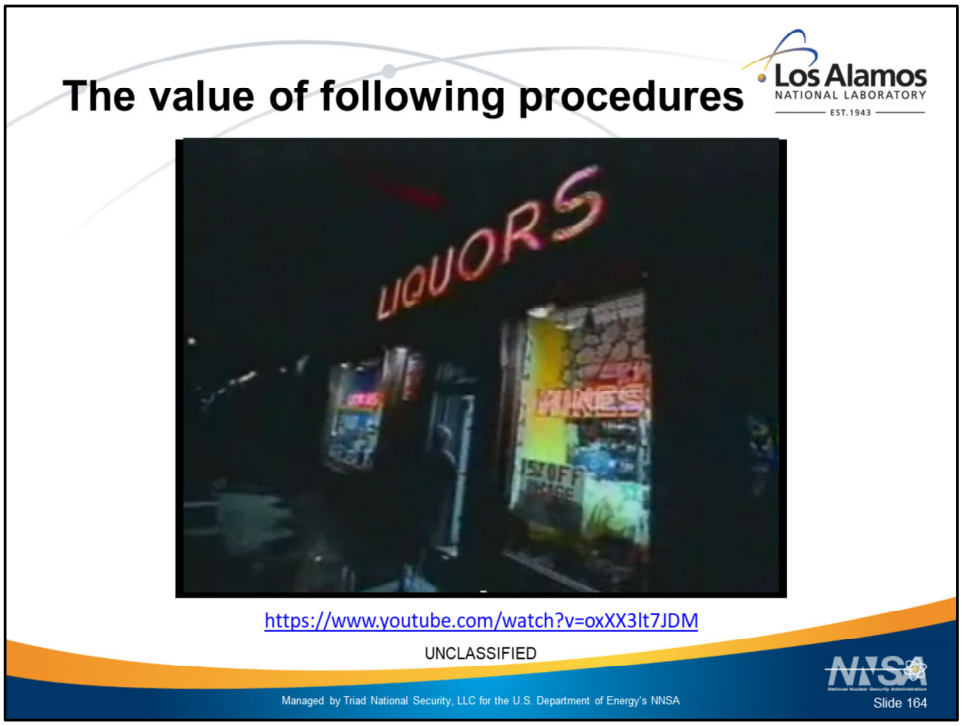


What system do you operate in?

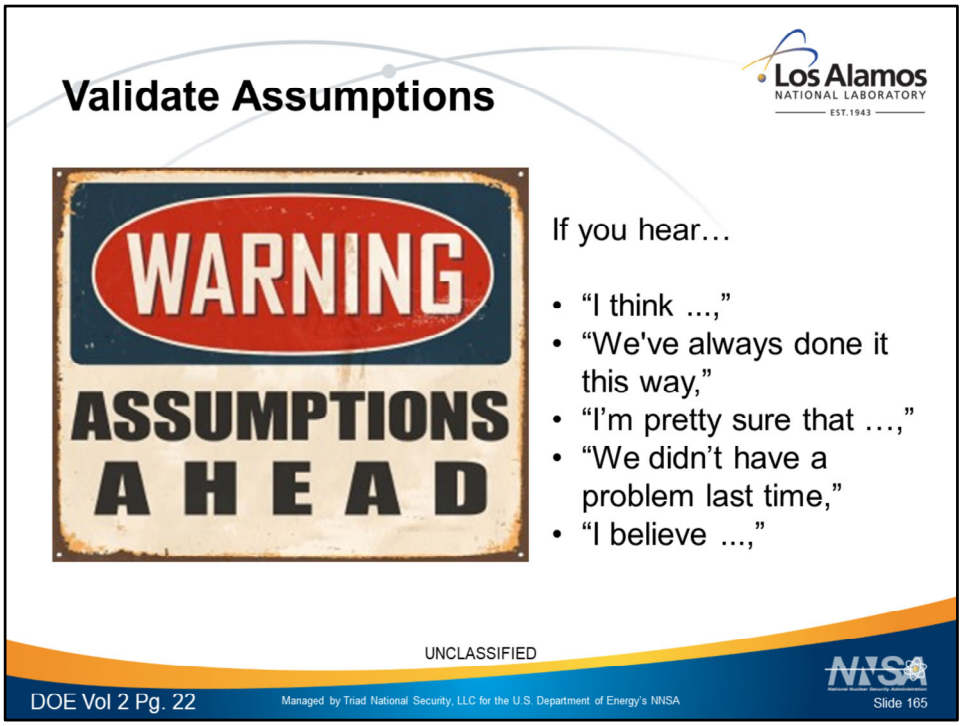
UNCLASSIFIED

WARNING: Someone get injured in this video

VIDEO: *Officer* Asks Lady To Step To Roadside Seconds Before Crash
This video demonstrates an officer requesting a driver to follow the protocol of getting out of the car because her car may get hit…and it does.
https://www.youtube.com/watch?v=McZHJ9-jYi8



VIDEO: How to outsmart robbers
https://www.youtube.com/watch?v=oxXX3lt7JDM
This video demonstrates a person robbing a liquor store. The attendant is thoughtful enough to ask for ID…per the sign (e.g., following the procedure).



Assumptions are a necessary part of scientific and engineering work so that a problem can be bounded while more information or knowledge is being developed or acquired. For these situations, scientists and engineers devote additional effort to justify why the assumption is conservative and provide detailed evidence that supports it. Knowledge workers must resist inadvertently treating an assumption as fact or forgetting that they made the assumption. Assumptions can occur during knowledge-based work situations because they ease mental effort by reducing the detail involved. The lack of requisite knowledge also tends to promote erroneous assumptions that may lead to errors and defects. In these cases, an assumption is a special mental shortcut, which becomes particularly tempting during stressful, anxious situations when time may be scarce. Until the additional information is available, engineers and scientists are tempted to make assumptions to improve efficiency or to simply make progress with the task. Qualifying statements, such as "I think ...," "We've always done it this way," "I'm pretty sure that …," "We didn't have a problem last time," or "I believe ...," are hints that an assumption has been made. When assumptions can not be verified, subject matter experts should be called in to bring additional technical expertise to help substantiate inputs, resolve assumptions, and solve the problem.

Use This Tool

- During the conceptual phase of the design or experiment
- In product review meetings
- Before delivery of the product to the customer

- During verification of output document
- During calculations
- During procurement
- Before using preliminary or invalidated vendor data
- When answering technical questions in support of operations

Recommended Practices When Using This Tool

1. Documentation – Write down the assumption, citing the following:

- applicability to the engineering issue;
- critical attributes affected by the assumption;
- reasoning and logic;
- extent of condition and worst-case outcomes; and
- level of certainty, consistency, and conservatism.

2. Evidence – Is there *objective* evidence to support/justify the assumption?

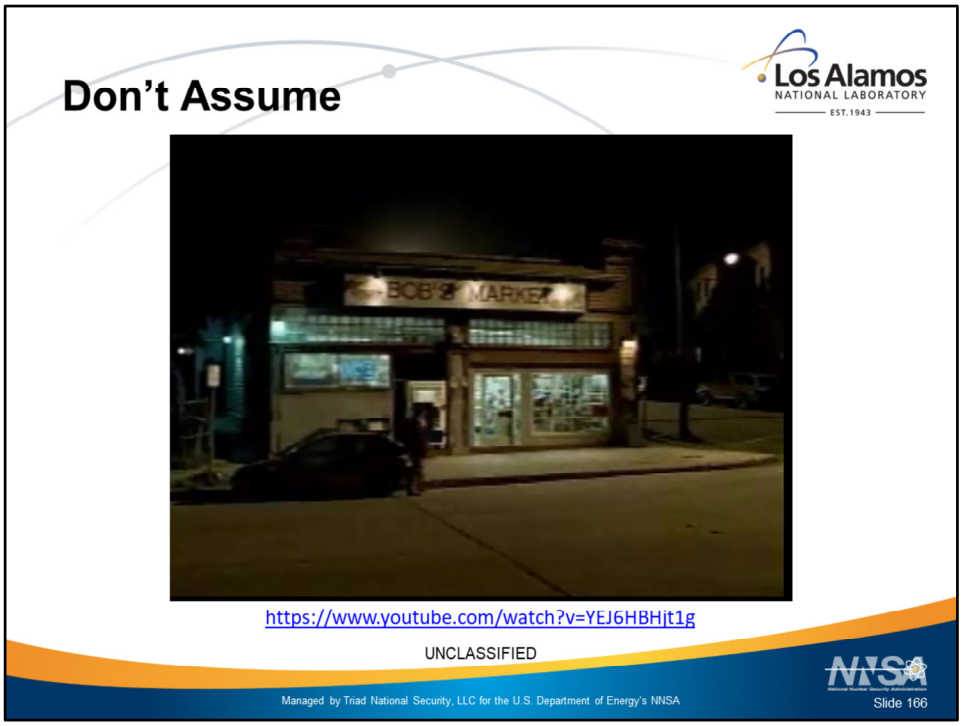
- Past success(es)
- Operating experience
- Expert opinion
- Reference documents (such as prints, drawings, procedures)
- Alternative techniques or computer simulations
- Technical rational for accuracy of assumption

3. Field Walk-down – Were in-field factors considered? Perform a hands-on/eyes-on review of the physical environment.

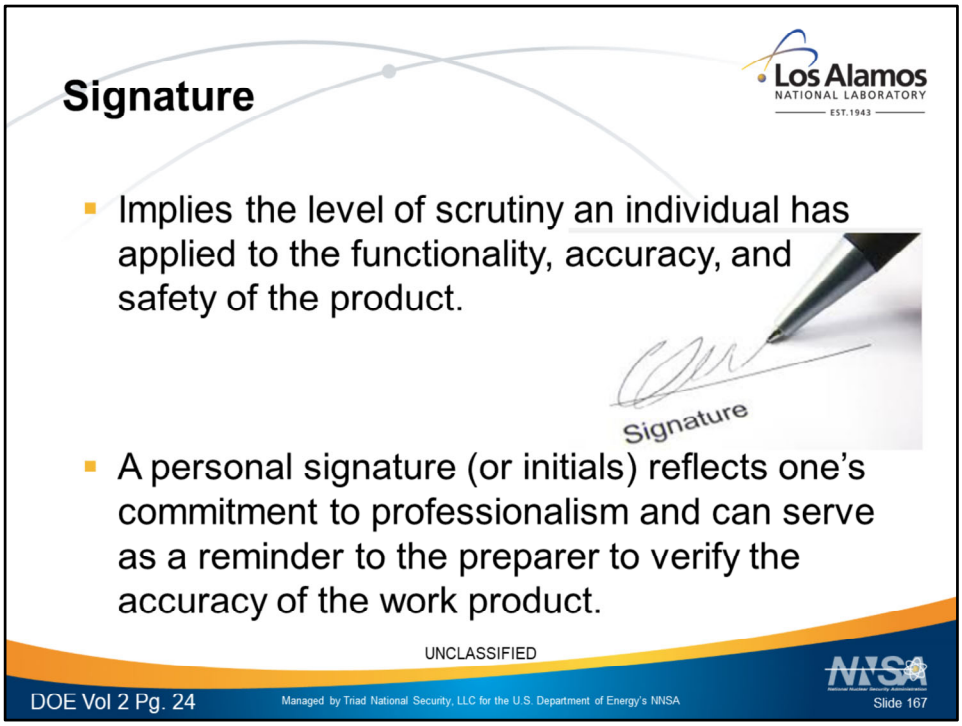
4. Track and Close Out – Close out all unverified assumptions as valid or otherwise before delivering the product to the facility customer.

Avoid These At-Risk Practices

- Not documenting an assumption
- Not verifying assumptions because of the perceived competence of the preparer/source
- Relying on assumptions as factual
- Not formally tracking closure of unverified assumptions
- Not recognizing that an assumption has been made
- Not recognizing conflicting input data in two or more design documents
- Not verifying assumptions before delivering an engineering product to a customer
- Not documenting the basis of engineering judgment
- Not reconciling contradictory or disconfirming sources of information
- Relying too heavily on past successes to justify current assumptions



VIDEO: "You're being robbed"
https://www.youtube.com/watch?v=YEJ6HBHjt1g
This video demonstrates how a store clerk hears one side of the conversation when a Man is talking on a hands-free cell phone. The conversation is about paying too much for a service. The clerk assumes the customer intends to rob the store.



Overview

Documentation of engineering, scientific, and other technical products provides a record of the technical rigor applied to the product at its present stage of development. In engineering, for example, it is the documentation of the design of structures, systems, and components in the plant or facility. These products typically make up the quality assurance record of the facility design bases. Before engineering products are released to the next step in an engineering work process, the individual concludes the work by signing or affixing a seal to the document to signify that he or she performed the task completely and accurately in accordance with all standards, procedures, and code requirements.

The purpose of this tool is to remind the user of what a signature or seal means on a technical document. It helps others recognize the significance of the product development process. The signature implies the level of scrutiny an individual has applied to the functionality, accuracy, and safety of the product. A personal signature (or initials) reflects one's commitment to professionalism and can serve as a reminder to the preparer to verify the accuracy of the work product.

Use This Tool

- When preparing, checking, reviewing, verifying, and approving products and services important to safety and reliability
- Before releasing the product to the next step in the related work process
- During engineering evaluations in support of emergent issues
- When approving purchase orders for new equipment
- When procuring safety-related components

Recommended Practices When Using This Tool

The individual affirmatively acknowledges all of the following statements before releasing the product to the next step in the engineering process.

1. Knowledge – The individual possesses the knowledge, expertise, qualifications, understanding, and authority to perform the task that has been completed or for the area the signature encompasses. He or she knows the role or function being signed for, such as author, peer reviewer, reviewer, or supervisor.

2. Involvement – The individual prepared, reviewed, or supervised (as indicated) the product he or she is signing.

3. Independent – The individual possesses the required level of "freedom of thought" from those earlier in the work process. **4. Quality** – The product satisfies the following criteria.

• to accepted standards and codes (where applicable)

• Possesses appropriate factors of safety and design margin.

• Satisfies all design basis requirements for the intended application; product resolves the problem.

• conforms is complete and correct in all respects

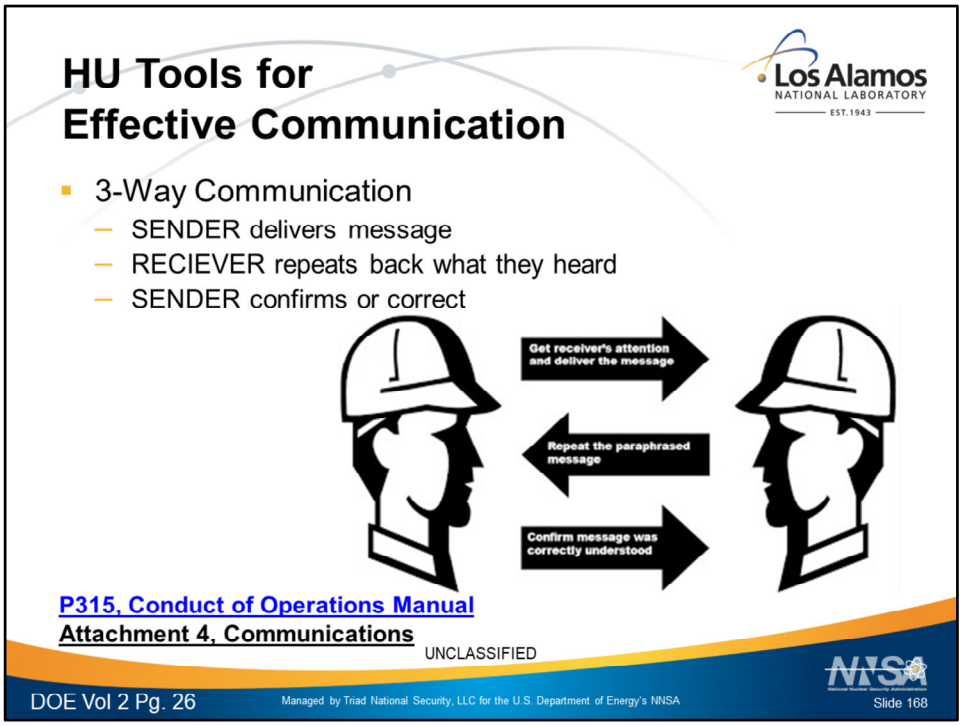
5. Right and Proper – The individual believes the product is the right thing to do.

6. No Doubt – The individual has no doubts or uncertainties with the product, as is, at this stage in its development. He or she is willing to take ownership and accountability of its technical accuracy and completeness. Otherwise, the individual stops and asks for help,

Avoid These At-Risk Practices

- Signing a document for work the individual did not perform, oversee, or manage
- Signing a document for an area outside the area of expertise or qualifications
- Deferring to what management wants without critical thinking
- Defining an excessive number of approvers

- Failing to define the meaning and scope of the signature
- Relaxing design standards for expediency
- Relying on one’s memory of codes or requirements without looking them up
- Accepting everything as fact
- Not verifying assumptions or justifying the basis for engineering judgment
- Being in a hurry



Three-way or the "repeat back" method is used to communicate changes to physical facility equipment during work activities via face-to-face, telephone, or radio requires three verbal exchanges between a sender and a receiver to promote a reliable transfer of information and understanding. The person originating the communication is the sender and is responsible for verifying that the receiver understands the message as intended. The receiver makes sure he or she understands what the sender is saying.

1. First, the sender gets the attention of the receiver and clearly states the message.
2. Second, the receiver repeats back the message in a paraphrased form, which helps the sender know if the receiver understands the message. During this exchange, the receiver restates equipment-related information exactly as spoken by the sender. If the receiver does not understand the message, he or she should ask for clarification, confirmation, or repetition of the message.
3. Third, the sender informs the receiver whether the message is properly understood, or corrects the receiver and restates the message.

Consider using three-way communication in verbal conversations involving the following.

- Operation or alteration of facility equipment
- Condition of facility equipment or the value of an important parameter
- Performance of steps or actions using an approved procedure
- Task assignments that impact equipment or activities, the safety of personnel, the environment, or the facility

Recommended Practices When Using This Tool

1. Sender states the message.
    - When practical, the sender and receiver should be face to face.
    - The sender ensures that he/she has the receiver's attention—normally calling the receiver by name or position.
    - Sender states the message clearly and concisely.
2. Receiver acknowledges the sender.
    - The receiver paraphrases back the message in his or her own words.
    - Equipment designators and nomenclature are repeated word for word.
    - The receiver may ask questions to verify his or her understanding of the message.
3. Sender acknowledges the receiver's reply.
    - If the receiver understands the message, then the sender responds with "That is correct."
    - If the receiver does not understand the message, the sender responds with "That is wrong" (or words to that effect) and restates the original message.
4. If corrected —
    - Receiver acknowledges the corrected message, again paraphrasing the message in his or her own words.

P315, Conduct of Operations Manual
Attachment 4, Communications

Example of effective communication

https://www.youtube.com/watch?v=sKGtb1t9iVw

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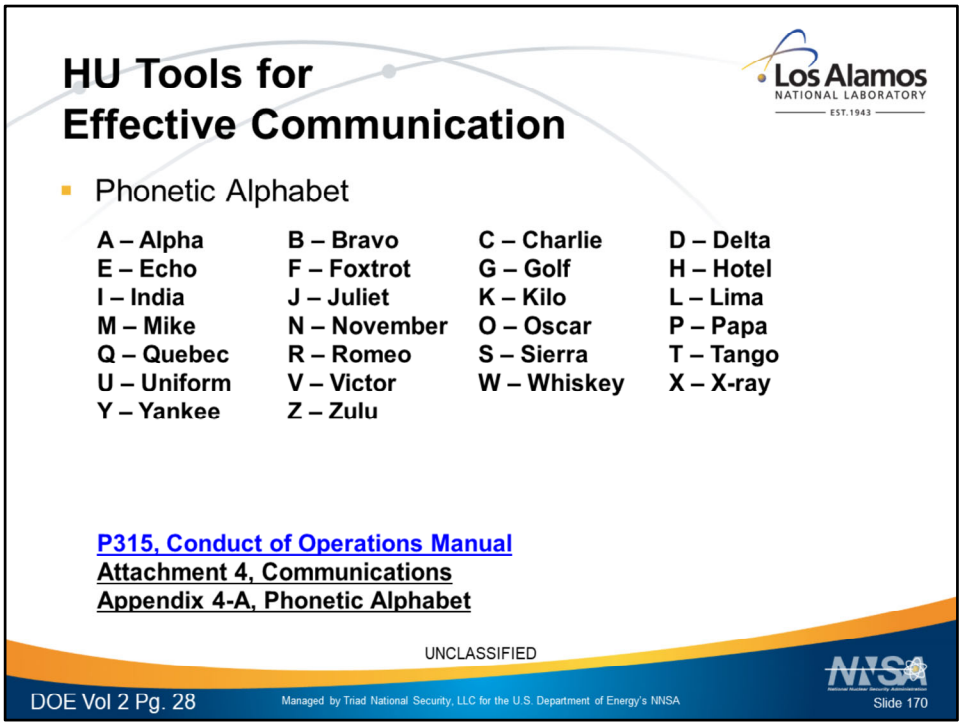
VIDEO: Copper Clappers
https://www.youtube.com/watch?v=sKGtb1t9iVw
“Copper Clappers” is a Johnny Carson skit that demonstrates three-way communication technique.



Several letters in the English language sound alike and can be confused in stressful or noisy situations. For example, some letters sound alike when spoken and can easily be confused such as “D” and “B.” The phonetic alphabet specifies a common word for each letter of the English alphabet. By using a word for each letter there is less chance that the person listening will confuse the letters. Using the phonetic alphabet, “Delta” and “Bravo” are more easily differentiated. The effects of noise, weak telephone or radio signals, and an individual's accent are reduced through the use of the phonetic alphabet.

People use the phonetic alphabet and unit designators when describing unique identifiers for specific components. When the only distinguishing difference between two component labels is a single letter, then the **phonetic alphabet** form of the letter should be substituted for the distinguishing character. For example, 2UL-18L and 2UL-18F would be stated “two Uniform Lima dash Lima eighteen LIMA” and “two Uniform Lima dash eighteen FOXTROT.”

This Tool is Used

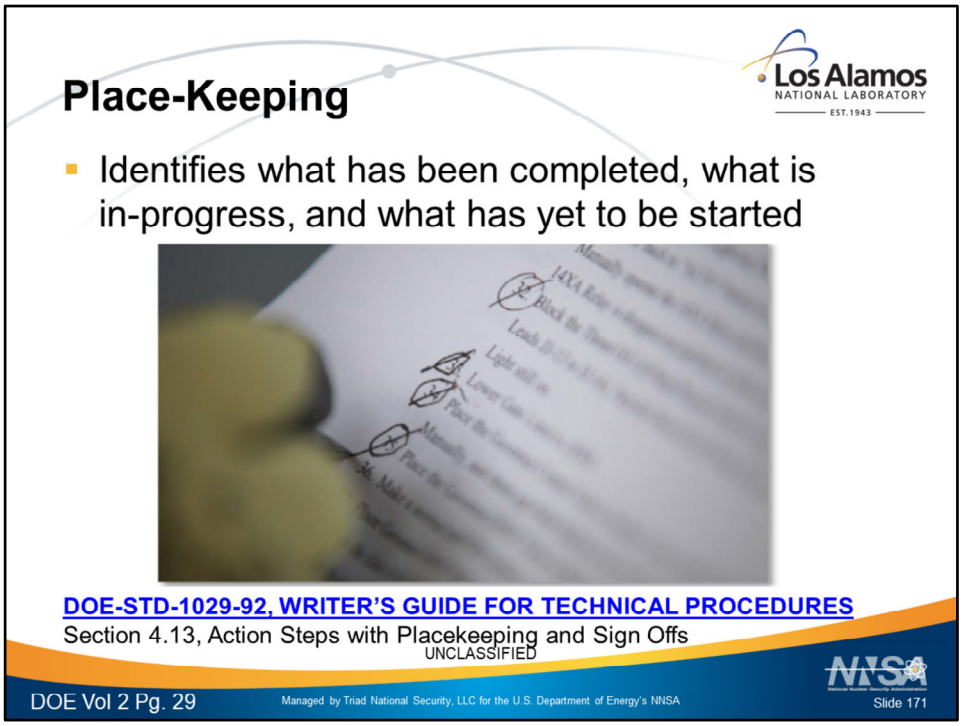
- When communicating alphanumeric information related to facility equipment noun names
- When the sender or receiver might misunderstand, such as sound-alike systems, high noise areas, poor reception during radio or telephone communications

Avoid the Following At-Risk Practices

- Using phonetic words other than those designated
- Using slang terms instead of specific or standard terms

P315, Conduct of Operations Manual, Attachment 4, Communications, Appendix 4-A, Phonetic

Alphabet



Place-keeping involves physically marking steps in a procedure that have been completed. Effective place-keeping prevents omitting or duplicating steps. Managing a procedure, especially a detailed technical procedure with frequent branching and multiple decision points, can place the facility, equipment, or process in jeopardy if the user inadvertently omits a step or performs a series of steps in an incorrect sequence. When using a procedure, an individual's attention constantly shifts from the procedure to the controls, to indicators, to physical equipment, to other people, and so on. Place-keeping has proven to be an important error prevention technique.

Place-keeping is particularly important for facility status and configuration control, as well as during the reassembly of equipment after maintenance or for any situation when the consequences of skipping, repeating, or partially completing a step could result in adverse consequences. The place-keeping method should help the individual maintain a positive record of steps completed and those not yet performed. If the user is interrupted or delayed, this technique will help him or her return to the last step performed.

Use This Tool

- When performing a continuous-use procedure (Use-Every-Time UET @ LANL)
- When performing a reference-use procedure on risk-important equipment

Recommended Practices When Using This Tool

Examples of good practice techniques include one or more the following.

1. Blacking-out procedure steps that are “not applicable” or highlighting procedure steps that are “applicable.”
2. Marking critical steps in an eye-catching manner before starting work.
3. Signing or initialing a sign-off blank for each step *or* each action.
4. Checking a check box for each step or each action in a step.
5. Circling the step number, denoting it “in progress,” and slashing through the circle to indicate completion of the step.
6. Checking or slashing a step number when completed.
7. Initialing step numbers completed to denote the last step completed when blanks are not provided.
8. Annotating completion of a page in the margin of the procedure.

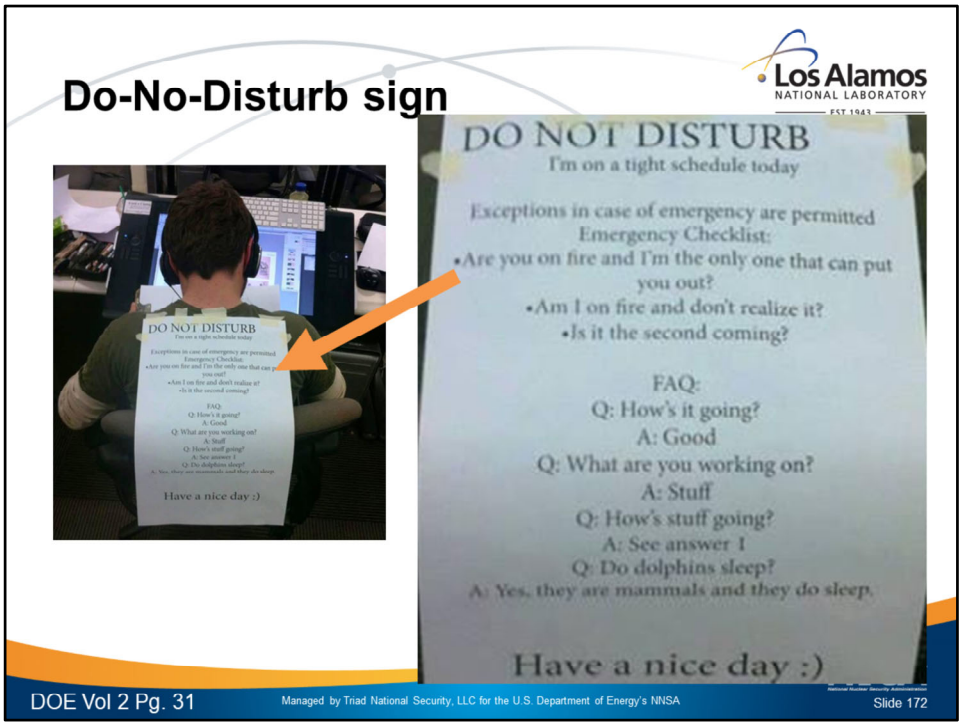
Avoid These At-Risk Practices

- Writing one set of initials followed with a vertical line through remaining signoff blanks for following steps.
- Skipping steps or segments of a familiar procedure because those steps have been unnecessary in the past.
- Following a procedure casually because of past success with the task.
- Signing or checking off a step as completed before it is completed.
- Signing or checking off several steps completed at the same time.
- Using ditto marks (“).
- Not applying some form of place keeping for continuous-use procedures.
- Not verifying completion of the last step checked off, if job was interrupted.

Section 5.13, *Placekeeping and Sign-off Steps*, of FSD-315-16-001, *Technical Procedure Writer’s Manual*

DOE-STD-1029-92, WRITER’S GUIDE FOR TECHNICAL PROCEDURES

Section 4.13, Action Steps with Placekeeping and Sign Offs



When scientists, engineers, procedure writers, and work planners, and so on perform risk-important or safety-critical work, it is essential that they maintain their concentration and attention on the task at hand, especially if that task involves a review or a verification of the work product. Managers of such personnel assigned these tasks must control access to these people to prevent them from being distracted from their primary tasks. The "Do Not Disturb" sign provides a means to control this access. The intent of the sign is to limit access and interruption of the responsible individual performing the work or review. The need to sequester or isolate the individual depends on the significance and complexity of the product. Otherwise, the activity can occur at the normal work location. It is important that all workers understand and respect the purpose of the sign.

Use This Tool

- During risk-important work or a review or verification of an technical product.
- When a short turnaround time is requested/demanded for a complex or critical review.
- For any task, especially a repetitive task, for which interruptions could lead to more errors.
- Whenever the preparer requests it to maintain focus on the task.

Recommended Practices when Using This Tool

1. **Develop a Sign** that includes the following information**.**

- A review of a critical task is in progress.
- An individual is not to be interrupted.

- Name and telephone number of the individual's supervisor or alternate point of contact.

2. **Post the Sign** – P

Avoid These At-Risk Practices

- Not using the "Do Not Disturb" sign for risk-important activities
- Posting the sign in an inconspicuous location (not noticeable)
- Ignoring the sign (by others)
- Not indicating the person's supervisor/alternate and contact information on the sign
- Not obtaining supervisor concurrence before using the signlace an eye-catching sign at a conspicuous place at the entrance of the individual's work space.

HPI Tools for INDIVIDUALS

	In the Field Ops, Maint., Field Support			In the Office Engineering, Science, Research		
HPI Tool	**Prior to start**	**Perform Work**	**Complete Work**	**Prior to start**	**Problem Solving**	**Complete Work**
Task Preview (SAFER)	X					
Job-Site Review (Take2-4U)	X					
Questioning Attitude	X	X	X	X	X	X
Stop When Unsure (Pause Work)	X	X	X	X	X	X
Self Checking (STAR)	X	X	X	X	X	X
Procedure Use & Adherence	X	X	X	X	X	X

HPI Tools for INDIVIDUALS

	In the Field Ops, Maint., Field Support			In the Office Engineering, Science, Research		
HPI Tool	**Prior to start**	**Perform Work**	**Complete Work**	**Prior to start**	**Problem Solving**	**Complete Work**
Validate Assumptions				X	X	X
Signature						X
Three-way communication		X	X			
Phonetic Alphabet		X	X			
Place-Keeping		X	X			X
Do-Not-Disturb Sign					X	X

Pick the HPI tool for the condition

Condition	HPI Tool (s)
Prior to restarting a job that has been interrupted and delayed for approximately two hours.	• Task Preview (SAFER Brief) • Take 2-4 You (Job Site Review)
The task has experienced a conflict between plans, procedures or actual conditions	• Questioning Attitude • Pause/Stop Work (Pause when unsure)
When manipulating equipment When entering data When performing an experiment	• Self-Checking • Procedure Use and Adherence • Place-keeping • Validating Assumptions
When working on risk-important work Reviewing a technical product A need to maintain focus on the task	• Do not disturb sign

Present condition, solicit responses from students, then reveal possible HPI Tools

The *Work Team Human Performance Tools* described in this section provide people with error prevention methods that depend on the work situation, the needs of the task or job, the risks involved; and support from within the organization and the participation of two or more individuals.

The use of work team human performance tools depends on the task's hazards complexity, and frequency of performance; the duration of an activity (requiring multiple shifts or work groups); and management's need for feedback on work completed. The tools in this category require the coordination and/or participation of two or more individuals, supervisory involvement, and management support.

Pre-Job Briefing

Level of detail

Complexity or Frequency	Job's Hazard	
	Low Hazard	High Hazard
Simple or Frequent Activity	Task Preview (low risk only)	Tailored Pre-Job Brief
Complex or Infrequent Activity	Standard Pre-Job Brief	Infrequent Plant Activity (IPA) Brief

- P300, Integrated Work Management
  - For Moderate-Hazard and High-Hazard/Complex activities, the PIC must perform a Pre-Job Brief with the workers immediately before beginning work or when resuming work where conditions or process parameters have or may have changed.
- P300.1 Integrated Work management for R&D

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DOE Vol 2 Pg. 34 Managed by Triad National Security, LLC for the U.S. Department of Energy's NNSA Slide 177

DOE HPI Handbook Volume 2, page 34:

The level of detail for a pre-job briefing depends on the job's hazards and complexity and on the proficiency of the individuals assigned. Simple briefings can be conducted for uncomplicated, or repetitive, low-hazard tasks. More detailed briefings are appropriate for complex, or infrequently performed and high-hazard tasks.

Low-Hazard* and *Simple or Repetitive activities usually involve the assigned individual(s) mentally walking through a *task preview* before starting the job. There are no critical steps. Regardless of the hazards, complexity, or frequency of a job, the participant(s) always reviews the personal safety hazards and personal protective equipment (PPE) requirements. Holding a face-to-face meeting with the performer(s) depends on the supervisor's judgment and knowledge of their experience and proficiency with the job.

Low-Hazard* and *Complex or Infrequent work activities need only a standard but thorough brief specific to the job. There may be critical steps; however, the potential harm is limited. But, because of its complexity, the job could hide developing hazards or unsafe conditions from the participants. A complex task can involve any of the following situations.

- Multiple interactions with equipment controls
- Simultaneous activities or use of multiple procedures
- Multiple interpersonal interactions needing significant coordination Major changes in equipment or system condition
- Unusual system or equipment configurations

- Limitations of tools and resources, or difficult physical constraints

The supervisor or the lead on the work team can use a standard pre-job briefing checklist to guide the dialogue for these types of activities. For first-time activities, the work lead should consider tailoring the briefing as described below for high-risk and simple/repetitive work.

High-Hazard* and *Simple or Repetitive may characterize much of the work performed in the facility. One or more critical steps likely exist, and the potential for harm or damage is significant. Most events occur during so-called "routine" activities. People may erroneously think that "simple" or "routine" means "no hazards." Prepare for a pre-job briefing for recurring high-hazard jobs, such as safety system surveillance tests, by using a standard checklist that incorporates task-specific information. The content of these forms should be tailored to the particular job, paying close attention to critical steps and hazards.

High-Hazard* and *Complex or Infrequent evolutions fall into a special category of tasks or evolutions. One or more critical steps likely exist, and the potential for injury or damage is high. Activities that place equipment in unusual configurations, require complex coordination with several work groups, or involve complex sequencing, highly hazardous materials, and/or major

changes to components are examples of complex or high-risk activities. Reduced safety margins typically challenge these types of work activities. Extra effort is required to provide training and the work in place.

****

P300, Integrated Work Management

3.1.4.b Pre-Job Briefings

For Moderate-Hazard and High-Hazard/Complex activities, the PIC must perform a Pre-Job Brief with the workers immediately before beginning work or when resuming work where conditions or process parameters have or may have changed. At a minimum, the questions listed on Part 3 of the IWD must be covered. The PIC is encouraged to perform a pre-job briefing for low hazard work. The PIC must then formally release the work by performing the following steps:

▪ verify the RLM and FOD or FOD representative have signed the WCD;
▪ conduct a validation walk down;
▪ confirm that the required controls are in place and functioning and that initial conditions are as expected;
▪ confirm that each assigned worker has the required competencies and authorization to perform the activity;
▪ ensure coordination with any Operations Manager or other FOD-designated interface point-of-contact when required by the FOD; and
▪ sign the WCD work release section.

If permits are required for the work activity, applicable portions of each permit must be included in the Pre-Job Brief. In some cases, RWPs and some sections of the Pre-Job Brief may be conducted by the respective SME.

Depending on the scope of the planned activity, the nature of the hazards, the associated work controls, and/or the population of workers, the Pre-Job Brief may be conducted for

different phases of work to ensure clear instruction to affected workers. If this approach is taken as determined by the PIC, it is important to capture the date and signature of the workers for each Pre-Job Brief in Part 3 of the IWD or in the equivalent WCD, which validates worker agreement and confirms worker authorization, qualifications, and fitness to perform the work. Additional guidance for conducting a Pre-Job Brief is included in Attachment C, *Error Precursor Card and Task Preview Work Aids*, and also in the IWM Toolbox. A Pre-Job Briefing and Post-Job Review video is available on the IWM Toolbox. For Maintenance, Pre-Job Briefings are covered in AP-WORK-004, *Work Performance*.

P300.1, Integrated Work management for R&D

3.3.12.c Pre-Job Brief

The PIC performs a Pre-Job Brief for all workers engaged in the work activity. A Pre-Job Brief is required for each worker before beginning work.

The Pre-Job Brief will include a review of the hazards and controls, critical steps in the process and any identified contingency actions, and a review of potential human error precursors that may affect the safe and secure conduct of the work. Suggested content for Pre-Job Briefs is included in Form 2103, *IWD Part 3, Validation and Work Release*. Additional guidance for the Pre-Job Brief is included in the Task Preview (see Attachment D, *Error Precursor Card and Task Preview Work Aids*). Where appropriate the Pre-Job Brief should be responsive to known differences among individual workers regarding the error precursors shown in Attachment D, such as knowledge and familiarity with tasks within the activity.

Pre-Job Briefs should be conducted as frequently as necessary. At a minimum, they must be conducted before beginning work, whenever the work scope is changed, when new Lessons Learned are available, when unanticipated hazards or conditions have been identified, or before critical steps are to be initiated.

The PICs and all workers who will be working under the IWD must sign Part 3 of the IWD. The worker signatures indicate that they agree to

▪ follow the work steps and implement the controls as written, and

▪ pause/stop work when conditions or hazards change, when they encounter unexpected conditions during the execution of work, when work cannot be performed as written, or when instructions become unclear during execution. Workers also confirm that they are authorized, qualified (if formal qualification is required), and fit to perform the work.

The PIC's signature indicates that he or she has

▪ verified authorization of the work by ensuring approval signatures of the RLM and FOD on Parts 1 and 2 of the IWD;

▪ jointly conducted a validation walk down with workers and SMEs, as required, to confirm the IWD can be performed as written, and required initial conditions and other prerequisites are in-place and adequate;

▪ conducted the Pre-Job Brief, and ensured that all workers have been briefed;

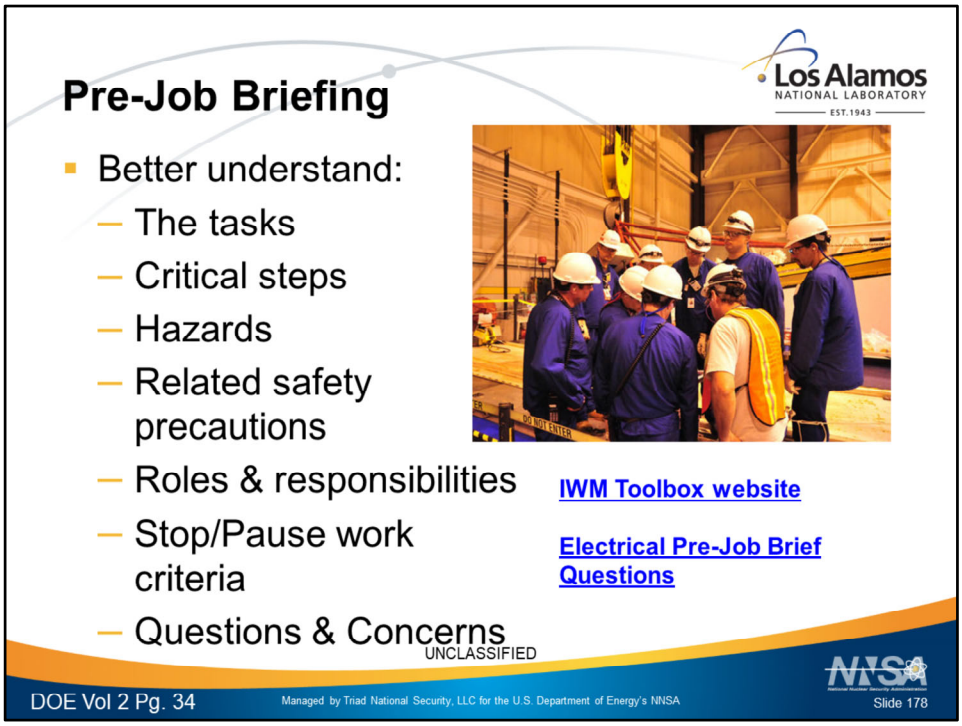
▪ ensured coordination with any required FOD work-area representatives (e.g., area work coordinators); and

▪ ensured that assigned workers are authorized to perform the work in a safe, secure, and environmentally responsible manner.

P300, *Integrated Work Management*, requires that the RLM responsible for the work activity

ensures that personnel are trained; competent; and qualified, where required, on the activity to be performed, as well as being knowledgeable of facility access requirements. This determination may be delegated to the PIC and must be achieved before workers begin work, e.g., at the Pre-Job Brief.

To support these responsibilities and to support the PIC's signature on Part 3 of the IWD, the PIC is expected to verify (through confirmation with the worker's RLM, e.g., by e-mail or Form 3024, *Integrated Work Management Responsible Line Manager Delegation Form*) that the all assigned workers (internal or deployed) are authorized and qualified to perform the work. The PIC is expected to obtain this confirmation before signing Part 3 of the IWD or including new workers. Both initially and when new workers are added to an IWD, the PIC should communicate to the RLM responsible for the work activity that workers have been signed on to Part 3 of the IWD.



A pre-job briefing is a meeting of individual performers and supervisors conducted before performing a job to discuss the tasks, critical steps, hazards, and related safety precautions. This meeting helps individuals to better understand the task(s) to be accomplished and the associated hazards. Participants clarify the task's objectives, roles and responsibilities, and resources. Knowing clearly what you are trying to do improves error recognition. Similarly, precautions, limitations, hazards, critical steps, controls, contingencies, and relevant operating experience are discussed.

The effectiveness of a pre-job briefing depends largely on the preparation of the participants and supervisors. Individuals should come to the pre-job briefing having completed the task review (individual tool #1). This promotes a quality dialogue that helps participants understand what they are to go do and what to avoid. A good pre-job briefing raises everyone's awareness of critical activities and gives participants time to mentally rehearse performance of critical steps. Pre-job briefings help participants avoid surprises in the field and reinforce the idea that there are no “routine” activities.

Use This Tool

• Before work activities involving facility equipment
• Once per shift, if the activity exceeds one shift in duration
• After extended delays in an activity

Recommended agenda for a detailed pre-job briefing:

1. Task purpose, scope, and nature of work

2. Review of procedures, work package documents, drawings, turnover information,

prerequisites, and so on. that will be used to complete the task

3. Task assignments, identifying and understanding roles and responsibilities, qualifications, personal limitations, handoffs, and the controlling authority

• Safety hazards and mitigating methods, identification of the following.
• Safety hazards
• Work procedures involved
• Special precautions
• Radiation, confined space, etc. work permit requirements
• Control of energy sources, including permits and clearances
• Personal protective equipment (PPE)
• ALARA requirements

4. Human performance, addressing human performance tools for each critical step relevant to risks with nuclear, industrial, radiological, and environmental safety, as well as risks to operations/production (see Task Preview)

• Special requirements or unusual conditions (as applicable)
• Resources, tools, and material
• Technical specifications
• Structure, system, component, and environmental conditions
• Use of partial procedures (steps or sections of procedure marked "Not Applicable")
• Foreign material exclusion (FME) and housekeeping interfaces with other organizations
• Interaction with other activities planned or in progress
• Communication methods and potential obstacles to their effectiveness

5. Operating experience, specifying how similar errors, events, or the causes of similar events will be avoided

6. Stop-work or Pause Work criteria, reviewing contingencies, changes in task conditions or its scope, and person(s) responsible for making critical decisions

7. Oversight, defining the degree of management and supervisory involvement

8. Questions and concerns individual performers may have with the job

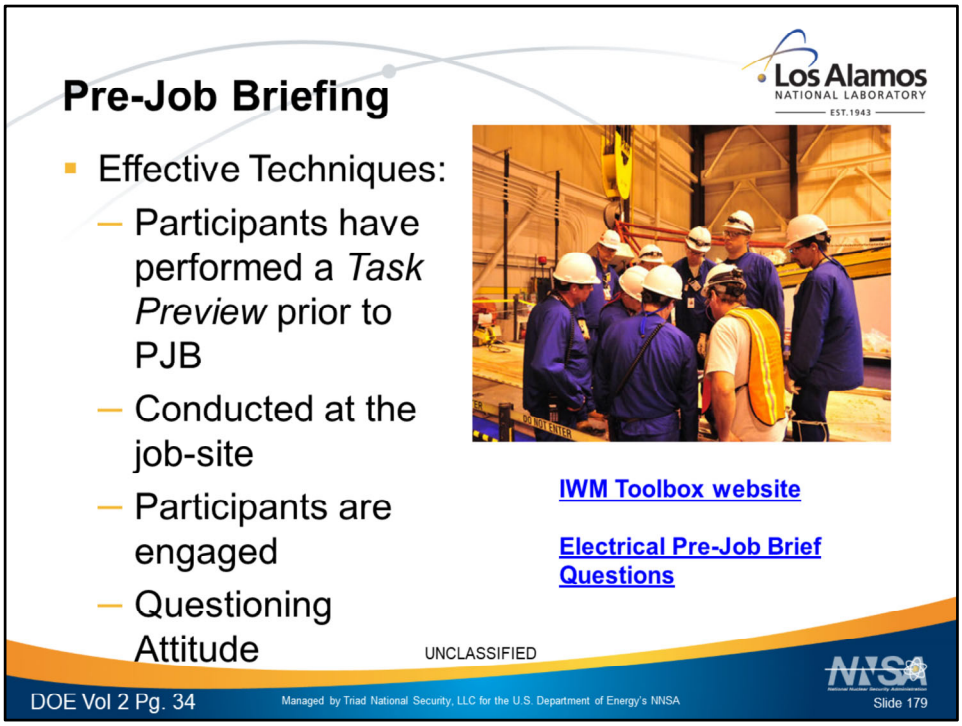
Avoid These At-Risk Practices

- Not planning for the conduct of the pre-job briefing
- Not allowing time for individuals to prepare
- Discussing generalities rather than specifics
- Conducting the meeting as a monologue, without active participation by the assigned individuals
- Individuals failing to express their concerns or ask questions
- Using a "cookbook" approach to the briefing, covering every item on the pre-job briefing checklist in the same manner regardless of its applicability
- Being insensitive to how mind-sets or expectations may disguise problems and warning signals
- Not assigning individual-specific responsibilities for contingencies and abort decisions
- Omitting discussion of error-likely situations, risk factors, possible consequences, and defenses for critical activities
- Conducting the meeting in a noisy or distracting environment
- Holding long briefings which could promote inattention and lack of interest

- Not considering equipment work history or the individuals' personal experience as relevant sources of operating experience
- Not considering the participants' proficiency with the task to determine if the task is considered infrequent
- Covering operating experience irrelevant to the task

LANL Pre-job Brief Guide
IWM Toolbox website -
http://int.lanl.gov/safety/integrated_work_management/toolbox/_assets/docs/pre-job-guide.pdf

Electrical Pre-Job Brief Questions
http://int.lanl.gov/safety/industrial_hygiene_and_safety/electrical-safety/_assets/docs/electrical_pre_job_brief_checklist.pdf



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• Special requirements or unusual conditions (as applicable)
• Resources, tools, and material
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• Structure, system, component, and environmental conditions
• Use of partial procedures (steps or sections of procedure marked "Not Applicable")
• Foreign material exclusion (FME) and housekeeping interfaces with other organizations
• Interaction with other activities planned or in progress
• Communication methods and potential obstacles to their effectiveness

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- Being insensitive to how mind-sets or expectations may disguise problems and warning signals
- Not assigning individual-specific responsibilities for contingencies and abort decisions
- Omitting discussion of error-likely situations, risk factors, possible consequences, and defenses for critical activities
- Conducting the meeting in a noisy or distracting environment
- Holding long briefings which could promote inattention and lack of interest

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- Covering operating experience irrelevant to the task

LANL Pre-job Brief Guide
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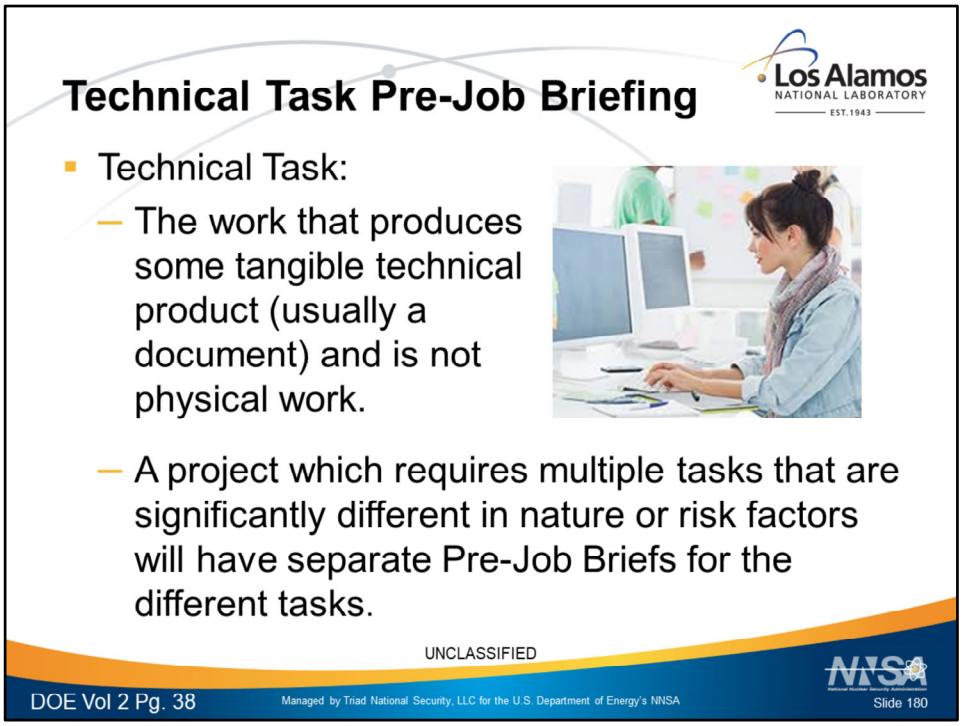
http://int.lanl.gov/safety/integrated_work_management/toolbox/_assets/docs/pre-job-guide.pdf

Electrical Pre-Job Brief Questions
http://int.lanl.gov/safety/industrial_hygiene_and_safety/electrical-safety/_assets/docs/electrical_pre_job_brief_checklist.pdf



The technical task pre-job briefing is fundamentally different than a briefing for a maintenance or operations activity or experiment because technical tasks usually do not require hands-on performance on facility equipment. They are used to assign personnel specific tasks; to clarify roles, responsibilities, methods, resources, and deliverables; and to identify risk factors, critical parameters, and compensating actions. The discussion takes place between the supervisor and the individual(s) performing the activity.

The primary purpose of the technical task pre-job briefing is to identify and compensate for error-likely situations that could lead to the product jeopardizing the plant or person. The pre-job briefing includes a discussion of human error and its possible consequences for critical attributes of the project, as well as the identification of additional controls or barriers needed. Such thinking increases alertness to risk factors (task-related error precursors) and improves the effectiveness of error-prevention tools during critical segments of technical activities.

The supervisor uses this tool to create a work environment that increases the chances of a defect-free product being produced. To enhance the effectiveness of a pre-job briefing, the individual(s) is given time to preview the task before participating in the briefing, to identify critical attributes, potential error traps, possible consequences, and practical defenses and contingencies against error when performing critical activities. “Reverse” briefings, in which the assigned individual leads the dialogue, help the supervisor ascertain the individual understands the details of the project. In addition, review of previous experience and past mistakes relevant to the task is part of the pre-job briefing dialogue. A dialogue on these topics is particularly important for risk-important activities and promotes understanding between the supervisor and

the performer regarding the task deliverables and expectations.

Use This Tool

1. For a new task assignment
2. Before a peer review or verification
3. During turnover
4. Before physical activities or interfaces with plant equipment (walk-downs, inspections, and so forth)
5. After extended breaks (several days) in the activity
6. During vendor activities

Recommended Practices When Using This Tool

1. **Assign a qualified reviewer** to the technical task(s), considering the following.

• Risks, demands, and complexities of the task
• Relevant skills, qualifications, proficiency, experience, fitness, and attitude of the assigned individual
• Opportunity for assigned individuals to review task-related processes and procedures before the pre-job briefing

2. **Summarize the task accomplishments and risks, using the following.**

• Scope of problem, the technical task(s) being addressed
• Personnel roles and responsibilities
• Critical attributes pertinent to this activity
• Critical parameters, interfaces, and operating conditions
• Proposed methods and tools to be used
• Applicable procedures, codes, and standards
• Input data sources and how up-to-date they are
• Key interfaces (with other individuals and/or organizations)

3**. Anticipate challenges to human performance for critical activities using S-A-F-E-R**

• **Summarize** activities/tasks related to critical attributes.
• **Anticipate** specific errors or mistakes for each critical activity or phase, in light of task-specific risk factors (especially from previous experience with this activity).
• **Foresee** credible as well as worst-case consequences on the facility, on personnel, and on the environment if error goes undetected.
• **Evaluate** methods to prevent and catch errors and related compensatory actions to mitigate identified risk factors, as well as contingencies to prevent/mitigate adverse consequences.
• **Review** previous experience (lessons learned) relevant to the specific technical task(s).

4. **Ask the assigned individual(s) to summarize, in his or her own words, the following:**

• Task requirements and proposed methods
• Critical attributes/functions related to the product
• Credible consequences of an error or defective product
• Stop work or abort criteria
• Concerns he or she may have with the task, as planned and scheduled – renegotiate deadlines, if necessary
• Individual preparedness to deliver a defect-free product

Avoid These At-Risk Practices (In addition of those in the Pre-job Briefing section)

- Not using lessons learned acquired from previous activities to support the task
- Displaying or expressing a lack of interest (ownership) in the task
- Assigning an individual who lacks experience with required processes
- Not acknowledging the learning curve of the assigned engineer

Technical Task Pre-Job Briefing

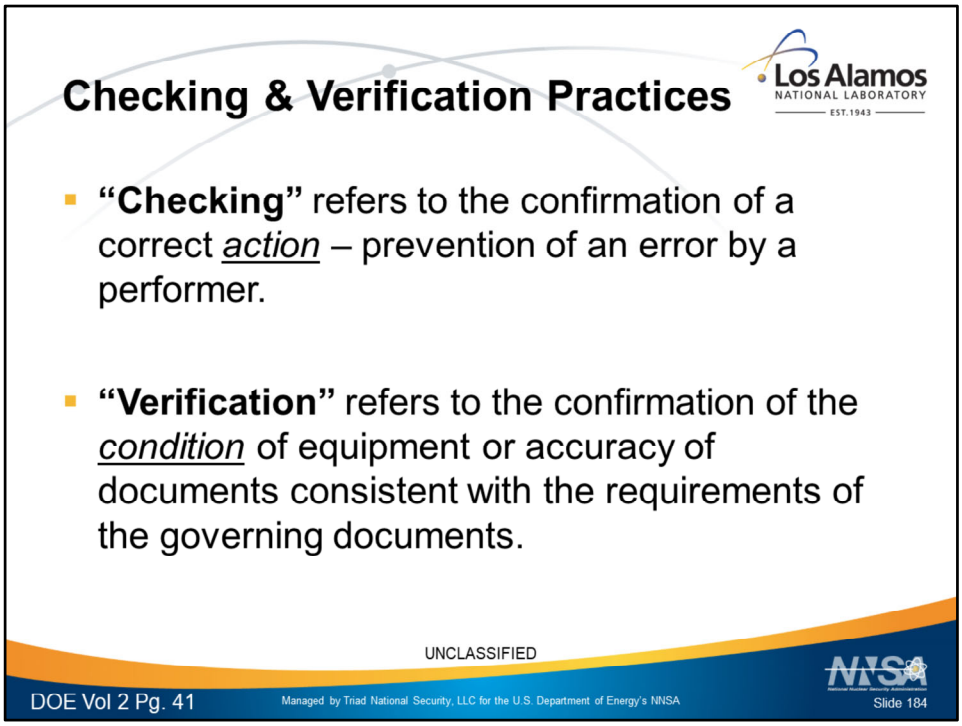
- An assessment and communication regarding a technical task, with the following objectives:
  - Uses a graded approach;
    - a simple brief for less complex lower risk tasks,
    - and a more detailed brief for more complex higher risk tasks.
  - Communicate the specific scope of the technical task, resources, and processes to be used for the task.
    - The discussion is conducted between the supervisor and the individual(s) performing the task.

Technical Task Pre-Job Briefing

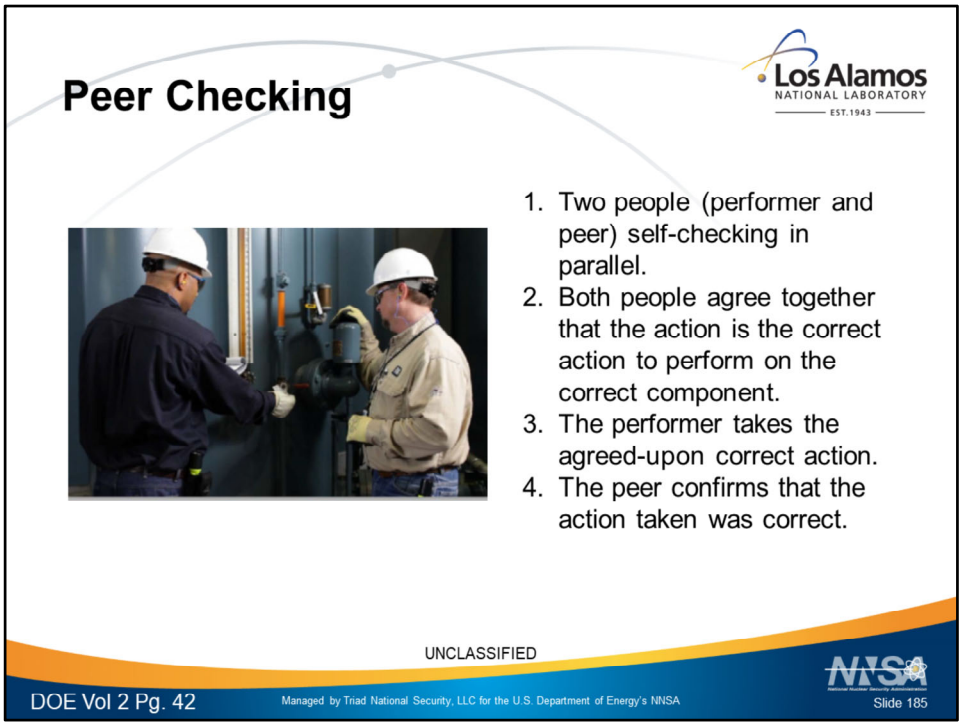
- An assessment and communication regarding a technical task, with the following objectives:
  - Assess the potential challenges to producing an error-free technical product.
    - Consequence (low, medium, high)
    - Process Error Precursors (few or many)
    - Individual Error Precursors (few or many)
  - Determine and initiate specific actions to be taken as compensatory actions to mitigate identified risk factors.

Technical Task Pre-Job Briefing

- An assessment and communication regarding a technical task, with the following objectives:
  - Determine appropriate level of augmented review for the technical product.
  - The challenges of producing an error-free technical product are fundamentally different than those for error-free manipulation of equipment



Verification practices refer broadly to four tools: peer-checking; concurrent verification; independent verification; and peer review. These tools involve a second (or more) person to confirm the actions and results achieved by a performer. While peer-checking (PC) focuses on preventing a mistake by the performer, independent verification (IV) and concurrent verification (CV) focus more on confirming the correct configuration or status of equipment or documents. Peer-review is a defense to detect errors and defects before the completion of documents by reading and checking the quality of another's work product (design, calculation, procedure, work package, etc.)



Peer checking (PC) is a series of actions by two individuals working together at the same time and place, before and during a specific action. PC augments self-checking by the performer—it does not replace it. The purpose of PC is to *prevent* an error by the performer. PC focuses on performing the correct act. PC is the least rigorous of the checking and verification tools.
PC involves:

1. Two people (performer and peer) self-checking in parallel.
2. Both people agree together that the action is the correct action to perform on the correct component.
3. The performer takes the agreed-upon correct action.
4. The peer confirms that the action taken was correct.

This technique takes advantage of a fresh set of eyes. The peer, an individual familiar with the activity, may see hazards the performer does not see. PC is intended to be informal; people can apply peer-checks at any time to any work situation to help them avoid mistakes. Peer-checks can be requested by anyone and performed by anyone familiar with the task and trained in the PC technique. In some cases, management establishes specific actions or classes of actions that require mandatory PC.

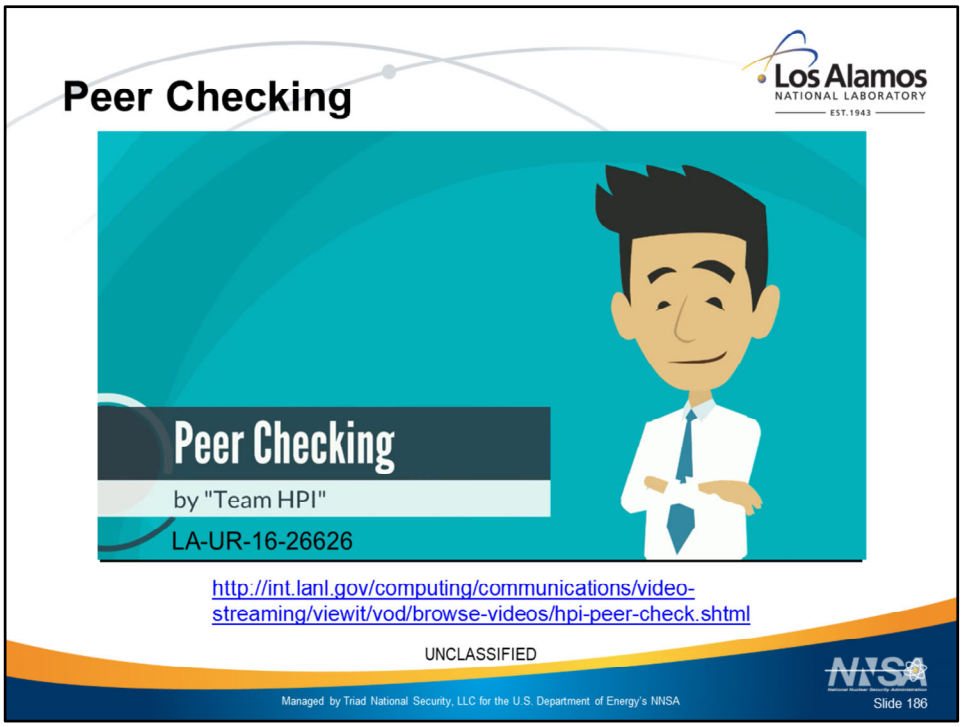
Work activities involving tasks or situations such as the following could benefit from the use of PC.

- Critical steps
- Irreversible or otherwise unwanted actions

• Comparisons of test data with acceptance criteria
• Start or stop of major components
• Return to or removal from service
• Identification of correct parts or correct component before maintenance
• During installation of similar components or parts that could be interchanged or installed incorrectly

Recommended Practices When Using This Tool

1. The **performer** self-checks the correct component.
2. The **peer** self-checks the correct component.
3. The **performer** and the **peer** agree on the action to take and on which component.
4. The **peer** observes the **performer**, before and during execution, to confirm that the **performer** takes the correct action on the correct component.
5. The **performer** executes the intended action on the correct component.
6. If the **performer's** action is inconsistent with the intended action, the **peer** stops the **performer.**
7. If the **performer's** action is consistent with the intended action, the **peer** informs the **performer** that the action taken is correct.



http://int.lanl.gov/computing/communications/video-streaming/viewit/vod/browse-videos/hpi-peer-check.shtml
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Concurrent verification (CV) is a series of actions by two individuals working together at the same time and place to separately confirm the condition of a component before, during, and after an action when the consequences of an incorrect condition would subsequently lead to undesired harm to the facility or personnel. CV is similar to PC, but addresses conditions vice actions. PC and CV can be used together.

The process of CV helps users maintain positive control of alterations of risk-important equipment. CV supports the confirmation and documentation of the equipment condition consistent with the procedure. Because it is important to establish the correct equipment condition, the procedure serves as a record of the verification, as indicated by each person's signature or initials, and signifies that the equipment is in the condition specified in the procedure step.

CV is usually reserved for key components, where an error with the action could result in possibly irreversible harm. The primary intent of verification is to confirm the final condition of the equipment. When used conscientiously, CV provides a means to identify an error in the act of establishing the new equipment or component condition.

The performer and verifier attempt to create *freedom of thought* between them. Freedom of thought requires the verifier, to the extent possible, to be mentally objective, without relying on the other person as to what has or has not been done. Because CV requires both individuals to work together, side by side, true independence cannot be achieved. But, each person attempts to be as objective and unbiased as possible during each step of the CV process.

Consider using CV for actions that could lead to irreversible consequences such as the following.

- Nuclear safety: fissile material loss or damage, loss of a safety function, loss of criticality safety control
- Industrial and radiological safety: death, injury, overexposure to ionizing radiation
- Environmental safety: uncontrolled discharge or emission of harmful substances
- Facility safety (including productivity): safety system impairment, equipment damage, and/or property loss

Recommended Practices when Using This Tool

1. Before execution, the **performer and verifier** mutually agree on the action to take, referencing the guiding document separately, and the equipment condition to achieve.
2. The **performer** self-checks the correct component.
3. The **verifier** separately self-checks the correct component.
4. The **performer and the verifier** agree on the final condition of the component.
5. The **verifier** observes the **performer** before and during execution.

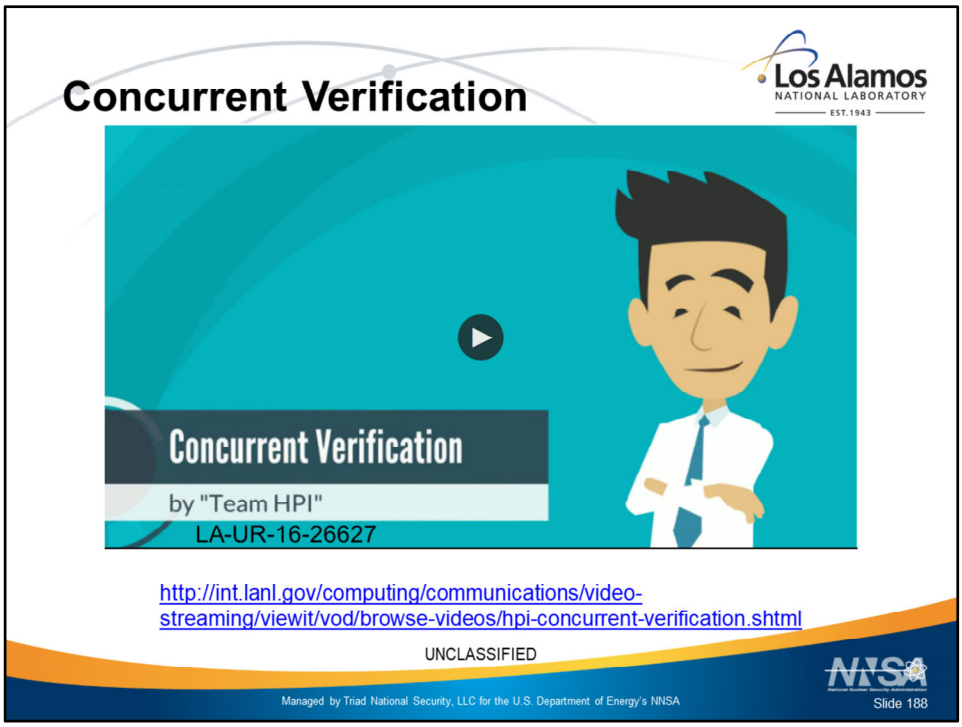
- By one or more of the following methods, the **performer** and the **verifier** separately confirm that the condition and the expected response are correct.
- Hands-on check (preferred).
- System response.
- Remote indication—if multiple remote indicators are available, use as many as possible; if possible, perform at least one check locally to confirm the validity of the remote indication.

6. The **performer** and **verifier** sign or initial the guiding document to record the verification.

P315, Conduct of Operations Manual,

10.3.6 Concurrent Dual Verification

The OM must approve the use of concurrent dual verification (i.e., verification performed at the same time as the original adjustment or reading). Concurrent dual verification will be used sparingly and the parameters of the verification documented in a procedure or Integrated Work Document (IWD). When using concurrent dual verification, independence is maintained to the maximum extent possible. (As an example, for a throttled valve: the operator shuts the valve and the verifier confirms the valve is shut. The operator opens the valve the specified number of turns while the verifier counts silently. The operator and verifier do not influence each other.) Upon completion of the verification of the adjustment or reading, the operator and the verifier communicate and agree that the adjustment or reading is correct.



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Independent verification (IV) confirms the condition of equipment or accuracy of documents or calculations required for safe operation. IV is a process by which one individual, separated by time and distance from the action changing the component's state or producing the document, confirms the condition of the component or document. IV is used when an improper component state or document could subsequently cause adverse consequences if the improper condition remains undetected.

The IV process tends to have a higher probability of catching an error than PC or CV, because the verifier is not involved in changing the component's state or producing the document and their knowledge of the system, component, or work situation is unaffected by the performer. The verifier physically checks the condition of the component or document without relying on observation of on oral confirmation by the performer.
Independence exists when the verifier has *freedom of thought* from the performer. Separating the acts of the performer and verifier in time and by distance promotes freedom of thought. *Separation in time* exists such that the verification occurs after initial alignment of the component (or initial verification).

Separation by distance is established when audible or visual cues of either person are not detectable by the other person. That means the performer, while establishing the desired condition, does not communicate with the verifier, and the verifier is not in a position to either observe or hear the performer.

The specific method used to perform IV will likely vary depending on the type of component, such as air-operated valves, manual-locked valves, fuses, switches, and circuit breakers; or documents. Therefore, management should designate which systems, components, and documents will be verified and the appropriate verification method that will meet the intent of IV, taking into account the physical constraints of the equipment. In many cases, IV occurs as each designated procedure step is performed. However, it may be desirable to perform all IVs at the conclusion of the evolution or document production, if no hazard exists in doing so. The procedure should be specific about the approach to be taken in completing IVs"

Use This Tool

- During system alignments of safety-related or safety-important equipment
- During placement and removal of clearance tags
- During restoration of equipment to service after maintenance
- During alignment of fire protection systems or components
- During installation and removal of temporary modifications such as jumpers, hoses, and so forth
- As-left position of Safety System process instrumentation after maintenance
- When changes in equipment status could adversely impact safety basis
- Verification of design and safety basis calculations
- Verification of operating or maintenance procedures

Recommended Practices when Using This Tool

The **performer** performs the following actions.

1. Self-check the correct component/document.
2. Perform the action specified in the guiding document or applicable codes and standards.
3. Confirm the expected results.
4. Sign or initial the procedure or document.
5. Inform the supervisor upon completion of the task or notify the assigned verifier.

When notified, the **verifier** performs the following actions.

1. Self-check the correct component/document.

Caution: Use verification methods specified in approved instructions to verify the condition of various component types.

2. Determine the as-found condition, without changing it, using one or more of the following means:

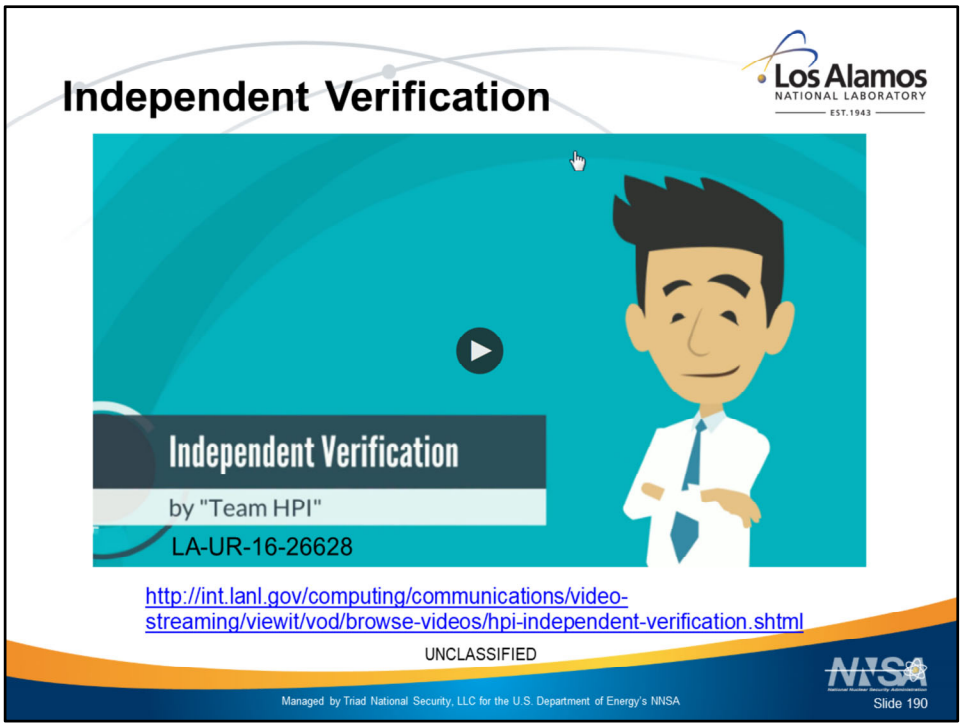
• physical hands-on check (preferred);

• remote indication—if multiple remote indicators are available, use as many as possible; if possible, perform at least one check locally to confirm remote indication; and system response.

3. Compare the as-found condition with the guiding document or applicable codes and standards.
4. Notify the supervisor if the component/document condition does not agree with the governing documents.
5. Sign or initial the guiding document if the component condition agrees with the guiding

document.
6. Notify the supervisor or performer upon completion of the IV.

P315, Conduct of Operations Manual
Attachment 10



http://int.lanl.gov/computing/communications/video-streaming/viewit/vod/browse-videos/hpi-independent-verification.shtml
LA-UR-16-26628

Overview

A reviewer provides a defense to detect errors and defects before the completion of documents by reading and checking the quality of another's work product. The purpose of peer-review is to catch errors with a risk-important work product or to verify that a decision or plan of action is appropriate before proceeding. A peer review takes advantage of a fresh set of eyes that may see problems or flaws the responsible preparer did not see or consider. However, the document preparer and the reviewer are equally accountable for the quality of the document.

This tool provides a structured method to help the reviewer identify errors that could lead to failure-likely situations with the product and to obtain assurance that a design-related document meets its intended purpose. This method aids the reviewer in clarifying the purpose and scope of the review, identifying critical attributes of the document, and applying a questioning attitude to the review using the FACTS questioning attitude tool. The peer review is an informal technique and does not supplant procedurally required checklists.

The following practices will help reduce the occurrence of review errors.

- Use qualified reviewers.
- Define the scope of the review. Use review aids (checklists).
- Provide the reviewer with technical input documents.
- Allow sufficient time.
- Avoid an excessive number of reviewers (to avoid team errors).
- Incorporate accountability into the process through periodic work product reviews by management/supervision.

To take advantage of these elements, a peer review involves multiple readings, integrating the above features. These separate readings (reviews) help the reviewer stay focused, minimizing the person's mental workload during each reading while studying the documents associated with the product.

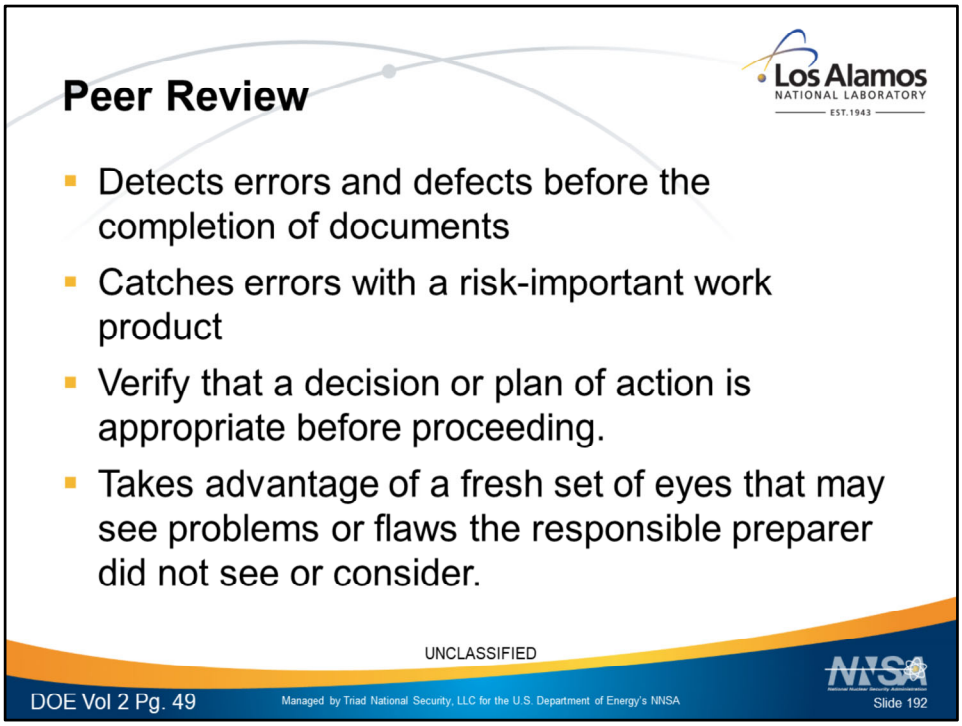
Depending on the purposes of each review, each may be done separately. Depending on the complexity and risk significance of the product, the engineering organization may institute specific administrative standards for certain reviews, such as calculation reviews. Also, for the review to be effective, the reviewer has the same or greater level of qualifications as the preparer with respect to the product or project under review. Documenting the results of a review provides a learning opportunity. Errors with the product can be trended, and comment resolutions can benefit those assigned similar tasks in the future.

- SD601, *Conduct of Research and Development*

3.5 Researcher as a Professional and Peer Reviewer

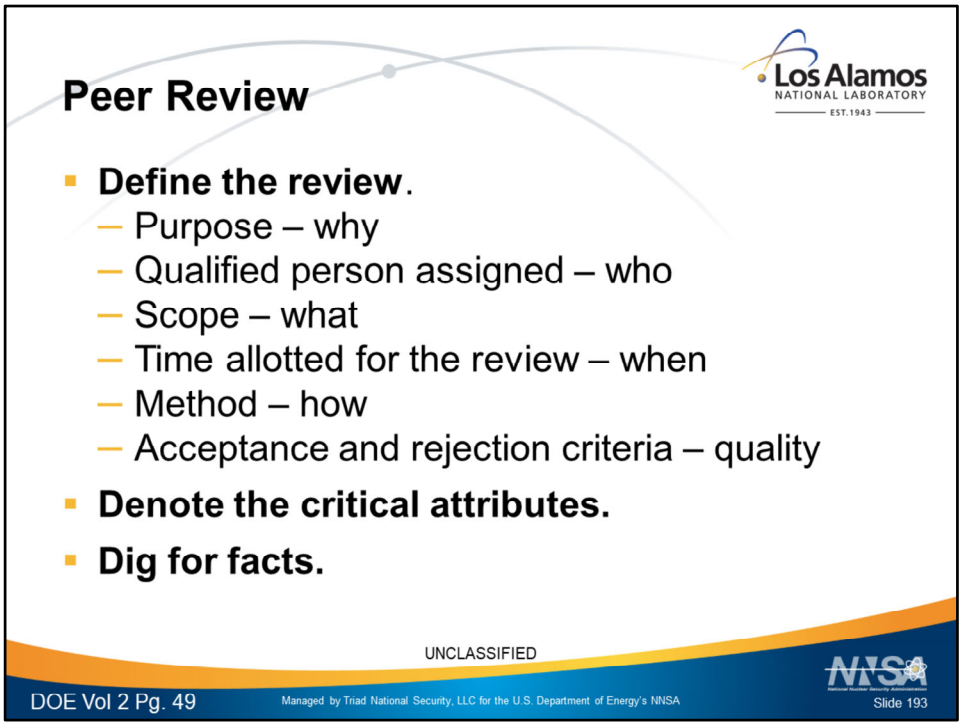
LANL R&D workers are also expected to be professionals within a technical community. As such, they participate in varied ways in the functions of that community, and may, for example, be asked to serve on review boards, as editors of technical journals, or in administrative functions of a professional society. A common contribution to the professional community and to science, technology, and engineering is service as a peer reviewer for others. Just as LANL R&D is opened to peer review, LANL R&D workers are encouraged to serve science and their professions by serving as peer reviewers on request, when appropriate (having appropriate expertise in the subject, and avoiding conflicts of interest from direct competitive, collaborative, or other relationships). Peer reviews should be fair, thorough, and objective.

Generally, all unpublished material provided for peer review is considered privileged information. It must not be used to the benefit of the reviewer, including for obtaining competitive advantage. See also PD801, *Ethics Program;* and P832-1, *Conflict of Interest: Technology Transfer.*



Use This Tool

- For reviews of new documents with no predecessor products
- For design documents; experimentation, operating, or maintenance procedures and work packages
- During engineering evaluations
- For informal requests for a review from a coworker
- When verifying a technical decision or plan of action



Recommended Practices When Using This Tool

1. Define the review. Clarify the following attributes of the review.

- Purpose – why
- Qualified person assigned – who
- Scope – what
- Time allotted for the review – when
- Method – how
- Acceptance and rejection criteria – quality

2. Denote the critical attributes. With the aid of operating experience and knowledge of the product's risk importance, pinpoint the key aspects of the engineering product that could directly affect one or more critical attributes.

3. Dig for facts. Using a questioning attitude, take the following steps.

- 1st reading – Develop a general overview that highlights critical attributes or conditions that could lead to failure.
- 2nd reading – Verify data and technical accuracy, and validate assumptions related to the critical attributes of the product.
- 3rd reading – Identify and document concerns and possible resolutions; using a

questioning attitude (FACTS), validate conclusions and that the product addresses the stated problem.

Avoid These At-Risk Practices

- Involving the reviewer in document development or preparation
- Using reviews to train less experienced personnel
- Being in a hurry; shortcutting the review time because of schedule pressure
- Performing a concurrent task(s)
- Being interrupted and distracted
- Not documenting the review
- Reviewer not having a questioning attitude

An event can result from an individual starting an activity on the wrong similar, but closely located, component or taking a break or being distracted from one component and subsequently going back to work on an adjacent, similar—but wrong—component. If a component is physically near other similar-looking components and is handled multiple times, flagging helps the user consistently touch the correct component. Using self-checking, an individual distinctly marks the correct component with a flagging device that helps the performer visually return to the correct component during the activity or after a distraction or interruption. Individuals can also use flagging to identify similar components that are not to be touched or manipulated.

Managers are encouraged to approve the flagging devices. Devices such as colored adhesive dots, ribbons, colored tags, rope, magnetic placards, or orange electrical tape may be used for this purpose. Flagging devices should not interfere with facility equipment, including the observation of meters and other operating indicators.

Use This Tool

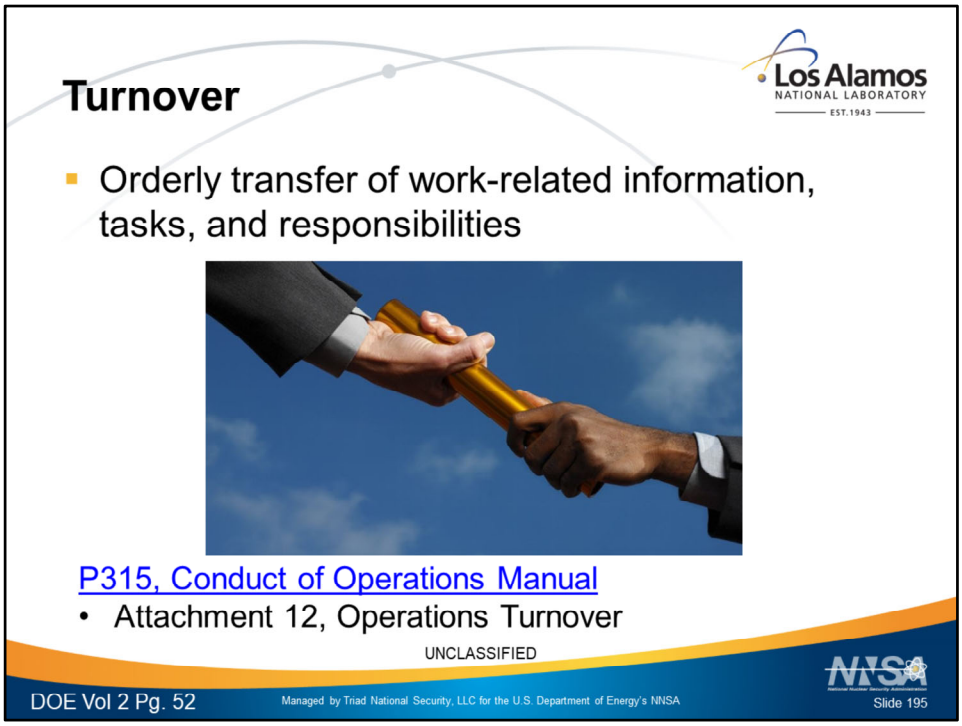
- When handling a component near similar-looking components
- While working on a component that will be manipulated multiple times
- During work near “trip-sensitive” or otherwise risk-important equipment
- When the need for flagging is identified during the pre-job briefing

Recommended Practices When Using This Tool

1. Identify the component to be flagged using self-checking.
2. Flag the designated component to be handled or worked on using an approved device.
Flagging remains in place while work is in progress.
3. Perform work assignment or equipment manipulation.
4. Remove flagging device(s) when work is complete.

Avoid These At-Risk Practices

- Using similar flags for components to handle and for those not to handle
- Not self-checking or peer-checking before applying flagging
- Using a flagging device that obscures indicators or interferes with equipment
- Using a flagging devise that can easily become dislodged such as a post-it-note
- Not removing a flagging device after completing the task
- Using electrically conductive material for flagging devices



Turnover is the orderly transfer of work-related information, tasks, and responsibilities between individuals or crews. A turnover provides time for the on-coming individual(s) to establish an accurate mental model of the work activity (situation awareness) before assuming responsibilities and commencing work. A good turnover helps every individual understand where things stand at the beginning of the shift and what is expected to occur during the shift. Turnovers occur during major facility activities, such as watch or shift exchange of information for the permanent transfer of project responsibilities between two individuals, between off-going and on-coming shifts, or for maintenance tasks exceeding one shift in length or multiple work groups.

Turnovers differ in detail and form depending on the risk importance of the task and the nature of the work involved. Yet all turnovers share a common purpose. Information critical to the successful continuation of a project or activity passes from one group or individual to another in a manner that limits interruption of work and promotes safe and efficient work completion.

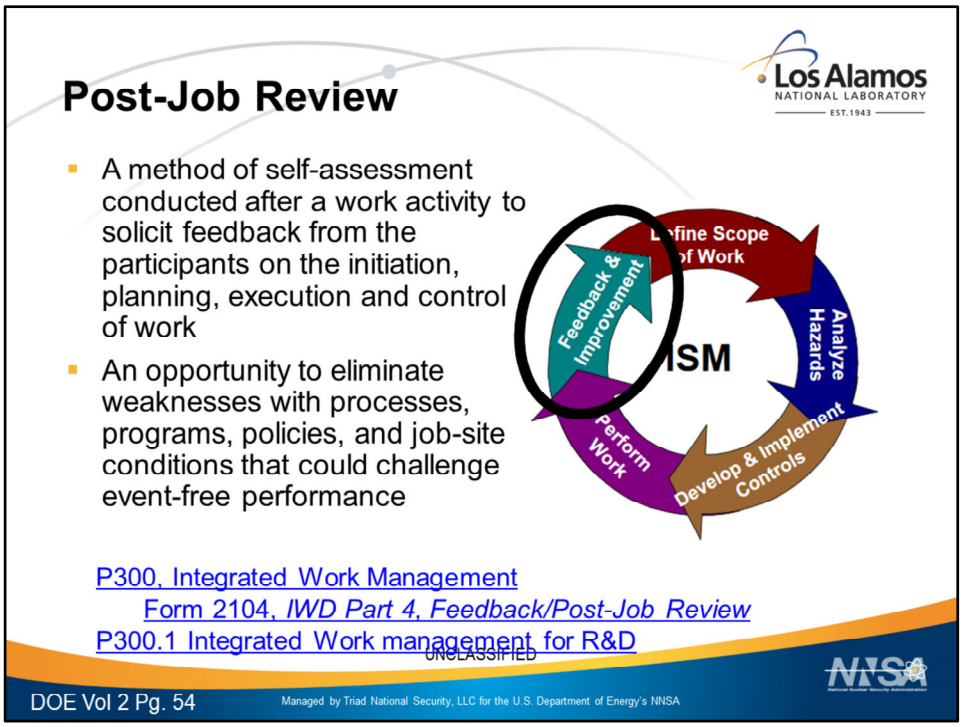
Turnovers should be thorough and accurate, as well as brief and simple. Individuals conduct turnovers visually, verbally, and in writing. Walk-down of the work location(s) offers visual confirmation of work and equipment status (for operations and maintenance). Both parties talk about the work situation. As a backup, individuals use three-way communication for risk-important information. The on-coming individual or group is given an opportunity to ask questions and resolve concerns. Oral communication of information, while more convenient, is prone to distortion and may be forgotten. Therefore, a written log guided by a checklist (where appropriate) is important to the safe continuation of the work in progress. The off-going person should be confident that the on-coming person is fully capable of assuming the duties and

responsibilities and planned tasks before handing over responsibility for the job.

Use This Tool
Before or during shift change
When responsibilities are transferred between people, work groups, or organizations (handoffs)
When performing emergent, critical, or complex activities over multiple shifts
When changing responsibilities for tasks in progress

Recommended Practices When Using This Tool
1. Start a turnover log. Document the items listed below. The log summarizing the key activities during a shift is also useful information for the relieving personnel.
2. Identify specific tasks. The relieving individual or group will perform this step. Consider the following factors during the turnover.
• Status of the job; work completed, work remaining, and equipment status, plus specific parameters and related values
• Schedule requirements, changes, and parallel activities
• Objectives/tasks in progress and milestones to be accomplished
• Procedures being used and last step(s) completed
• Problems, unusual conditions or system lineups and resolution or status
• Critical steps, possible error-likely situations, countermeasures, and contingencies
• Availability and location of resources associated with the tasks and activities
• Key contacts, support personnel, and organizational interfaces
3. Discuss the information. The principal individuals conduct a meeting face to face using formal three-way communication on critical information and responsibilities. Each person listens for and challenges assumptions, asking questions as needed.
(4 and 5 for operations and maintenance)
4. Review the turnover log and walk down the work area. The on-coming individual independently reviews the turnover log, relevant work documents, status boards, and logs, checking for consistency and accuracy of information before assuming responsibility. Additionally, he or she examines the work location(s), including controls, components, tools, and equipment. The on-coming and off-going individuals should walk down the work location together.
5. Transfer responsibility. Officially transfer responsibility for work activities from the off-going individual to the on-coming individual. The off-going person is confident that the on-coming person is fully capable of assuming the duties and responsibilities of the work station and planned tasks before handing over responsibility for the job.

P315, Conduct of Operations Manual
- Attachment 12, Operations Turnover



POST-JOB REVIEW — IN THE FIELD

Overview

Feedback on the initiation, planning, execution, and control of work is highly important for management. Procedure, work process, equipment, tool and supply problems and minor human error require management's attention. Such conditions tend to be latent in nature and accumulate within the organization when uncorrected. When individuals communicate the information, managers have the opportunity to improve. Post-job reviews provide management an opportunity to eliminate weaknesses with processes, programs, policies, and job-site conditions that could challenge event-free performance. A post-job review is a method of self-assessment conducted after a work activity to solicit feedback from the participants. Usually, the feedback involves a face-to-face meeting between the performer(s) and the supervisor(s). Meetings should be brief and concise, and give performers the opportunity to submit feedback. Individuals should reliably submit feedback on key aspects of work preparation and work performance. Performers and their supervisor should discuss what went well and identify potential enhancements and also identify opportunities for improvement. An effective post-job review identifies lessons learned to improve future task performance and aids closure of the paperwork related to the job.

Some of the more common topics addressed during post job reviews include the following.

- Surprises or unexpected outcomes
- Usability and quality of work documents
- Knowledge and skill shortcomings
- Minor errors during the activity
- Unanticipated job-site conditions and workarounds
- Effectiveness of supervisory support
- Adequacy of tools and resources
- Quality of work planning and scheduling
- Significant lessons learned to record for future reference
- Other obstacles or disturbing "gut feelings" about the work

To reinforce the occurrence and effectiveness of post-job reviews, managers provide timely feedback to supervisors and performers on the resolution of high-interest issues identified during reviews.

Use This Tool

- When completing any work in which complications occurred
- After completing a non-routine or important work activity
- After each high-risk phase of a risk-important project
- At the conclusion of emergent work
- After routine work and improvements have been identified

Recommended Practices When Using This Tool

1. Forum – Provide time for a conversation among all active participants or to document their feedback.

2. Feedback – Identify what worked well (pluses) that made the task successful and opportunities for improvement (deltas), especially related to critical steps, comparing what actually happened to what was planned to happen.

3. Forms – Record the pluses and deltas using the proper feedback forms or methods, and submit to the appropriate organizations to address the information, using the corrective action program as appropriate.

4. Follow Up – Provide feedback on the resolution of issues of high interest to the individual performers.

Avoid These At-Risk Practices

- Not performing a post job review or documenting feedback after working on risk-important facility equipment
- Principal participants not involved in the post job review
- No time allotted for the post job review or done in a hurry
- No method of follow-up identified to address issues
- No follow-up with principal performers for high-interest issues

- Post job review or follow-up not done face to face
- Important issues not documented for reference for future pre-job briefings

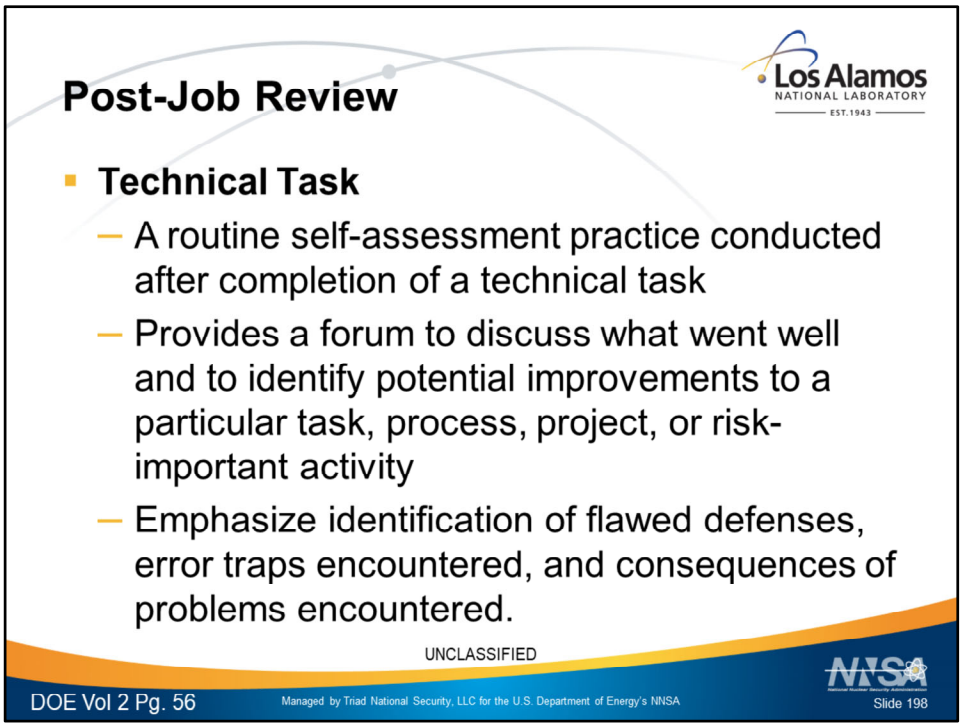
P300, Integrated Work Management

Form 2104, *IWD Part 4, Feedback/Post-Job Review*

P300.1 Integrated Work management for R&D

Post-Job Review

- Conduct a Post-Job Review:
  - When completing any work in which complications occurred
  - After completing a non-routine or important work activity
  - After each high-risk phase of a risk-important project
  - At the conclusion of emergent work
  - After routine work and improvements have been identified



TECHNICAL TASK POST-JOB REVIEW

Overview

Feedback on the initiation, planning, execution, and control of work is highly important for management. Errors that cause significant events are organizational failures. Consequently, feedback is critical to overall success in the facility, because the severity of consequences is dependent on organizational weaknesses. Post-job reviews provide an early opportunity to inform management about weaknesses in processes, programs, policies, and so forth that can adversely affect technical activity defenses and barriers. An effective post-job review can identify lessons learned to improve future task performance.

A post-job review is a routine self-assessment practice conducted after completion of a technical task. Post-job reviews provide workers and supervisors with a forum to discuss what went well and to identify potential improvements to a particular task, process, project, or risk-important activity. Post-job reviews emphasize identification of flawed defenses, error traps encountered,
and consequences of problems encountered. The responsible individuals and supervisors perform the review as soon as practicable after the task or each high-risk phase. The meeting is focused, not laborious. To reinforce the effectiveness of

post-job reviews, individuals who provide feedback are updated on the resolution of high-interest issues.

Use This Tool

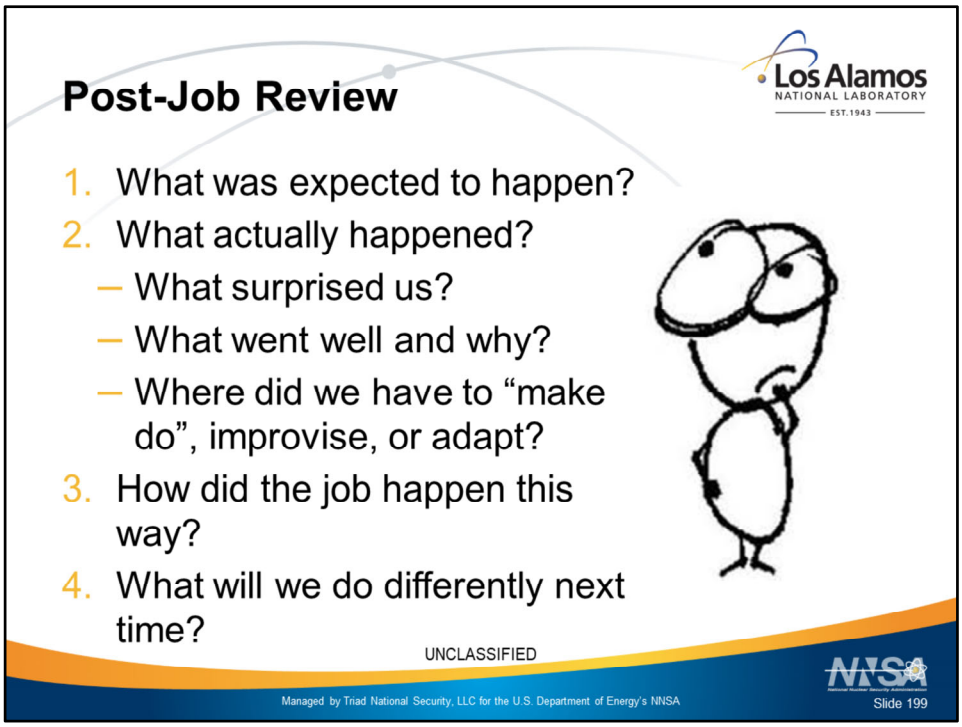
- As soon as practicable after completing project-level work
- After each high-risk phase of a risk-important project
- At the conclusion of emergent work

Recommended Practices When Using This Tool

1. Face-to-Face – Hold a face-to-face meeting of all active participants, led by the task lead.
2. Pluses – Identify and document what went well.
3. Deltas – Identify and document opportunities for improvement related to the critical activities.
4. Follow-Up – Determine the method(s) to follow up problems and successes.
5. Face-to-Face Again – Provide face-to-face feedback to individuals on the resolution of a particular performance issue and on issues of high interest to the individuals.

Avoid These At-Risk Practices

- Not performing a post-job review
- Not conducting a face-to-face follow-up
- Not allotting time for a post-job review, or conducting it hastily
- Not having responsible engineers present for the post-job review
- Not having a method of follow-up identified to address issues
- Not following up with engineers for high-interest issues
- Not documenting important issues for future pre-job briefing reference



BASIS: [IM-2018-41 (Screening Approved)]
IAS 2016-459 HPI POFMR PF 4: Post job reviews a. Discussion: Some people reported doing post job reviews which consisted of discussing what went well and what could be improved. Post job or After Action Reviews can be one of the most influential practices to develop competence in people and teams. These reviews can also help people notice how often and what type of surprise occurs with their work. b. Recommendations: Expand use of informal post job reviews for the purpose of developing people. Include additional questions such as "what surprised us?"

2017 HPI POFMR Performance Feedback:

Post job reviews

Discussion: Some people reported doing post job reviews which consisted of discussing what went well and what could be improved. Post job or After Action Reviews can be one of the most influential practices to develop competence in people and teams. These reviews can also help people notice how often and what type of surprise occurs with their work.

Recommendations: Expand use of informal post job reviews for the purpose of developing people. Include additional questions such as "what surprised us?" (See After Action Reviews in Industry Good Practices Appendix A.)

After Action Reviews (AAR) –

What – Structured, facilitated conversations held right after completion of a task, project, or

mission. AARs are more about developing people than correcting things. Make doing AARs part of the organization's DNA.
When- Quick and immediate. Hold an AAR anytime there are lessons to be learned – the more frequent and informal, the better - but especially if people were surprised, something unexpected happened, the task/project/mission is critical, and when things go right.
Who - People in all roles.
Why – To create learning that's focused on developing individuals and teams (versus cross-organization lessons). Probing surprise supports noticing how often we are surprised.
How – Create a safe environment, what is shared stays inside the team unless they choose to share more broadly. Start with team self-reflection by asking a few open ended questions such as 1. What was planned and expected to happen?

https://en.wikipedia.org/wiki/After-action_review

An **after action review** (**AAR**) is a structured review or de-brief (debriefing) process for analyzing *what* happened, *why* it happened, and *how* it can be done better by the participants and those responsible for the project or event.[1] After-action reviews in the formal sense were originally developed by the U.S. Army.[2] Formal AARs are used by all US military services and by many other non-US organizations.[3] Their use has extended to business as a knowledge management tool and a way to build a culture of accountability.[4]
An AAR occurs within a cycle of establishing the leader's intent, planning, preparation, action and review.[5] An AAR is distinct from a de-brief in that it begins with a clear comparison of intended vs. actual results achieved.[1] An AAR is distinct from a post-mortem in its tight focus on participant's own action; learning from the review is taken forward by the participants.[6] Recommendations for others are not produced. AARs in larger operations can be cascaded in order to keep each level of the organization focused on its own performance within a particular event or project.[6]
Formal AAR meetings are normally run by a facilitator, and can be chronological reviews or tightly focused on a few key issues selected by the team leader.[6] Short cycle informal AARs are typically run by the team leader or assistant and are very quick.[6]
After action reviews in the military
There are basically two types of military AARs—formal and informal. Formal AARs require more detailed planning, preparation, and resources. They are normally scheduled and conducted as a part of external and internal evaluations.[7] Informal AARs require less planning and preparation than formal AARs and are often on-the-spot reviews of soldier and collective training performance at crew, squad, or platoon level.[8]
Formal
Formal AARs are normally conducted at company level and above.[9] However, when a training event is focused at squad or platoon level, and resources are available, a formal AAR may be conducted to gain maximum training benefit.[10] Externally evaluated lane training, small-unit ARTEPs, and tank and BFV gunnery tables are prime examples. Informal crew, squad, and platoon AARs are held prior to company and higher-echelon AARs.[11]
The AAR facilitator (evaluator or controller) provides a mission and task overview and leads a discussion of events and activities that focuses on the objectives.[12] The discussion with

leaders and soldiers should orient on the use of terrain integration of key BOS (Battlefield Operating Systems), and leader actions[Department of the Army Publications 1]. The discussion should also examine the weapons systems and doctrine used by the enemy during the exercise. At the close, the AAR leader summarizes comments from the observers, covering strengths and weaknesses discussed during the AAR and what the unit needs to do to fix the weaknesses.[13]

An Observer/Controller-Trainer conducts a formal After-action review to assist a Reserve unit capture lessons learned from their exercise

Informal

Informal AARs are usually conducted for soldier and crew-, squad-, and platoon-level training or when resources are not available to conduct a formal review.[10] They are often held for lower echelons prior to a formal company- or higher-level AAR, though they may be conducted at company level. Informal AARs are extremely important since they involve all soldiers and leaders in the participating unit.[11] The formal company AARs for the training event depend on these thorough, informal reviews.[14] These are sometimes referred to as a hotwash.[9]

Informal AARs are conducted similar to formal AARs and may be done for large or small units. They may be scheduled, or leaders may do on-the-spot reviews during the training.[15] Discussion comments could be recorded to use in follow-on AARs or to apply immediately the lessons learned as the exercise is repeated.[2]

AAR must have:

1. Honest and professional feedback
2. A focus on the result(s) of an event
3. ENDSTATE: A plan to fix problems

http://int.lanl.gov/safety/integrated_work_management/toolbox/pre-post-job-reviews.shtml

Video:
http://int.lanl.gov/safety/integrated_work_management/toolbox/_assets/video/pre-job.html

NOTE: the Post-Job Review starts at 25:22

Overview

Project management fundamentals provide a structure for working on tasks with discrete start and end dates, such as modifications and improvement/upgrade initiatives. Usually guided by administrative instructions, project management tools help keep the scope, objectives, and deliverables aligned with the facility business plan. Additionally, a disciplined and structured approach minimizes re-work, assumptions, and omissions by prompting engineers to carefully plan and scope the work. Similarly, project management helps reduce stress and related time pressures by improving communication, foresight, and planning.

Project management includes those activities (or tasks) concerned with achieving a set of goals (project) while optimizing the use of scarce resources (time, money, space, people, and so forth). Such activities involve initiation, planning, controlling, and closure. A project work plan (PWP), as described in the “Recommended Practices” below, usually documents such activities. Applying a methodical approach to the management of any project will reduce the risk of human error.

Effective project management also maintains a low risk of failure over the lifetime of the project. The risk of failure arises primarily from the presence of uncertainty at all stages of a project. One aspect of that uncertainty involves the potential for human error. The human mind cannot reliably and consistently maintain awareness and recall all elements

of a project, especially complex projects. The planning, monitoring, and control of a project and the motivation of those involved in it help achieve project objectives on time, within budget, and without defect.

Project management is often the province and responsibility of an individual project manager. This individual seldom participates directly in the activities that produce the result, but rather strives to maintain the progress and productive mutual interaction of various parties in such a way as to reduce the overall risk of failure.

Use This Tool

- During design work
- During work not otherwise guided by established administrative procedures
- During work involving supplemental personnel (subcontractors)

(This tool is not typically used for work considered core business, program, and level-of-effort. These types of work are guided by administrative procedures.)

Recommended Practices When Using This Tool

The PWP may address the following elements (as applicable), which may be listed, referenced, or attached.

1. Initiate – Develop a charter that clearly defines the problem, opportunity, or challenge.

The following elements could be considered.

• Accountable project manager
• Team members
• Project purpose, objectives, and scope
• Design authority
• Customer and stakeholders
• Deliverables (definition of success)

2. Plan – Determine how to address the problem, opportunity, or challenge through use of the following.

• Project organization, roles, and responsibilities (accountabilities)
• Customer expectations and stakeholder involvement
• Organizational and technical interfaces
• Field walk-down (visual in-field inspection)
• Work activities schedule, including technical task pre-job briefing(s) and post-job review
• Project controls to minimize errors during critical activities
• resources, budget, and support (availability, location, special knowledge, and required skills)
• Workload management plan (base load versus emergent work)
• Principal design inputs/outputs and planned design reviews, including specifications, codes, standards, instructions, procedures, and drawings to accomplish work activities
• Lessons learned from a review of operating experience

• Risk sources, adverse outcomes to avoid, related critical attributes, and corresponding risk management approach; including project-specific error-prevention/quality requirements and methods that address, as a minimum.
o verification
o peer review
o validation
o integrated testing or commissioning

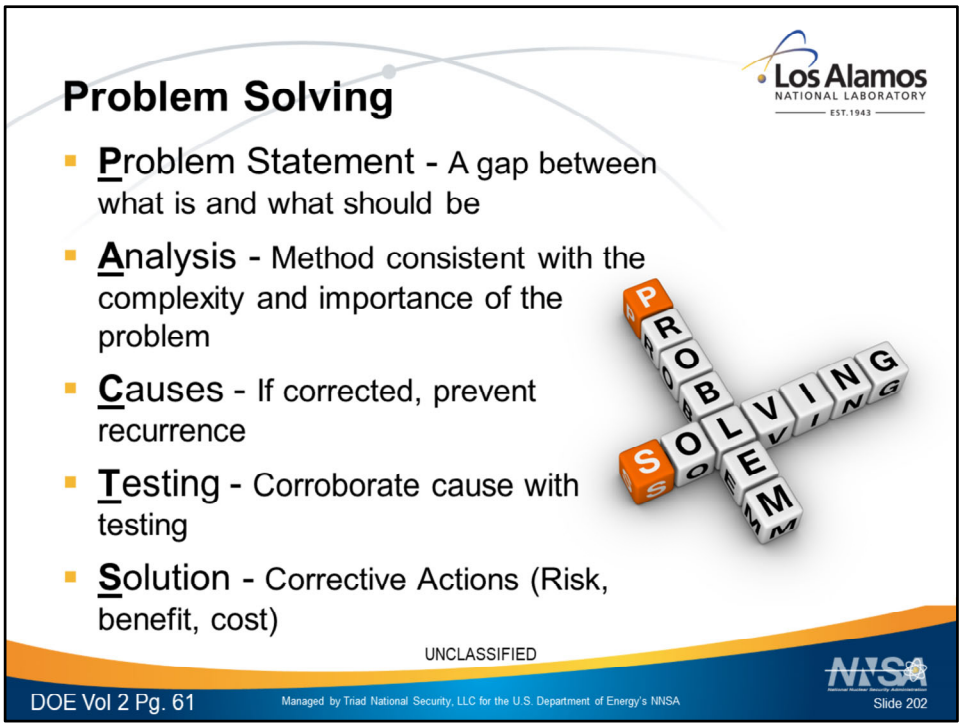
3. Control – Implement and adhere to the plan and expectations, using several of the following means.
• Periodic tracking of tasks, especially for critical activities
• Process adherence (progress/performance measures and reports)
• Meaningful performance indicators
• Conflict management
• Client and stakeholder collaboration and relationships
• Reinforce the use of the human performance tool
• Recognizing the impact of changes on the project
• Product review meeting schedule, internal/external communication procedures
• Vendor monitoring and control processes communication plan; information and data accessibility
• Document, data, and software control method(s), including control of electronic files and filing of records
• Rewards and celebrations (reinforcing in-process use of human performance tools)

4. Close – Hand off to the customer, which includes the following.
• Product quality evaluation and commissioning results
• Effectiveness measures (meeting objectives)
• Client satisfaction
• Lessons learned

Avoid These At-Risk Practices

- Communicating infrequently or ineffectively
- Excluding stakeholders or customers from the planning process and not obtaining their commitment/ownership of the project
- Spreading responsibility for a project to two or more people
- Treating risk lightly in light of the project's product
- Not having adequate configuration management of the project plan resulting in scope creep and unapproved changes.
- Not identifying human performance controls during planning
- Not publishing a project plan
- Not documenting intermediate decisions
- Not updating team members on changes to the PWP
- Not resolving competing priorities with respect to resources
- Not sufficiently defining or documenting scope

- Frequently changing project team members



Overview

Problem-solving is a knowledge-based performance situation. There is no apparent solution, no recognizable pattern, rule, or skill to call upon. Problem-solving involves chaining cause-and effect relationships in a backward direction to determine why the problem exists. Problems require systematic analysis to identify possible causes. The better approaches to problem-solving are structured, simple, and memorable; and complement well-known data-collection and analysis tools. The **P-A-C-T-S** technique, described below, provides one such structure for problem-solving.

When confronted with a situation that creates a question, a person is in unfamiliar territory—a knowledge-based performance situation. Given that the chances for error are particularly high in a knowledge-based situation (1:2 to 1:10), the best course of action, when unsure, is to pause the activity or task and get another person (at least) involved with the problem. An individual may initiate this tool after getting an unsatisfactory resolution using a questioning attitude (FACTS,). In addition to using a qualified peer, users and field personnel offer an additional wealth of information and insights that may be pertinent to the issue at hand.

Use This Tool

- During troubleshooting
- During conceptual design
- During preparation of product review presentations
- For causal analysis

- In knowledge-based performance situations for the individual
- When a situation cannot be resolved using the FACTS questioning attitude tool

Recommended Practices When Using The PACTS Tool

1. Problem Statement – Write a problem statement that describes a gap between what is and what should be, and that is agreed to by all stakeholders; especially those closest to the problem. Breaking large problems into smaller issues may help.

2. Analysis – Use structured, objective, repeatable, and approved methods that are consistent with the complexity and importance of the problem.

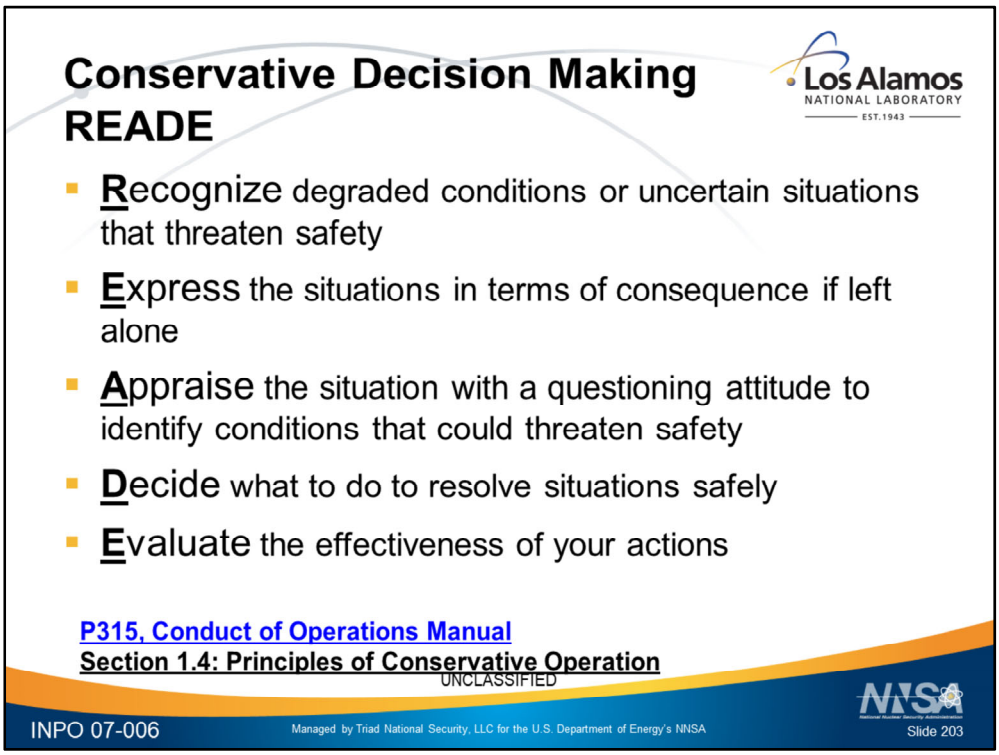
3. Causes – Summarize the cause(s) that, if corrected, will prevent recurrence of the problem and that is consistent with the facts of the analysis and sensitive to supporting and refuting evidence.

4. Testing – Corroborate the cause(s) using appropriate testing, independent review, and a questioning attitude; especially with those closest to the problem.

5. Solution – Suggest corrective actions for each cause, assessing each solution's risk, benefit, and cost.

Avoid These At-Risk Practices

- Defining the problem in terms of possible causes
- Attempting solutions or changes before defining the problem
- Concluding that a procedure change and/or training will always solve the problem
- Not taking immediate corrective action to prevent recurrence of the situation before implementing long-term corrective actions
- Using subjective, unstructured methods, such as intuition, experience, and brainstorming, for a risk-important issue
- Specifying a cause, if no direct cause can be determined
- Implementing a corrective action when uncertain of the cause
- Deciding without clearly understanding the risks ahead of time
- Ruling out potential causes without justification or facts
- Allowing an individual to dominate the problem-solving process with his or her ideas
- Not having all stakeholders involved, thereby limiting the suitability of the solution
- Avoiding controversy



INPO 07-006, Human Performance Tools for Managers and Supervisors, page 27

Conservative Decision-Making Background:

Conservatism is a state of mind that permeates an organization. A conservative attitude prioritizes the safety of the plant and personnel over the near-term production goals of the task at hand. When safety limits are approached or exceeded, or when equipment responds unpredictably, people act promptly to place the system in a safe state. Most often, the choice to make is clear. However, for knowledge-based situations, the choice may not be so apparent. A deliberate method to respond to such situations promotes better decision-making.

People are trained not to proceed with an activity if uncertainty materializes, to place the system or equipment in a safe, stable condition, and to obtain guidance before proceeding. This is particularly important when people perform work independently and guidance is unclear—knowledge-based performance. Knowledge-based decision-making is exacerbated in a time-critical crisis, multiplying the chances of a costly mistake. A crisis atmosphere exists under the following conditions:

- A decision must be made under pressure.
- A fixed deadline must be met.
- A wrong decision will result in grave consequences.
- Irregularities and/or uncertainties are present.
- How to handle the situation is unclear.

To respond safely to knowledge-based situations in a crisis atmosphere, a philosophy for conservatism must permeate the hearts and minds of the people in the organization. Through uncompromising

leadership, executives, senior managers, line managers and supervision, and even instructors continuously and consistently reinforce this philosophy. Management support for conservative decision-making must be communicated in clear, unequivocal terms and frequently reinforced during personnel training and daily interactions. When people take conservative actions (such as shutting down the plant or stopping a job) in response to unexpected situations, they should be commended publicly; not only to recognize them personally for the appropriateness of their actions, but to convey the importance of conservative decision-making to others in the organization.

This approach to conservative decision-making differs from *operational* decision-making in that this method is designed to aid conservatism in a crisis atmosphere, without the immediate support of experts or ready references. Without such support, people weigh the consequences of failure more heavily than the potential for success.

When to Use the Tool:

A conservative approach is necessary when encountering the following conditions, or others similar, during activities or processes that could affect safety:

- unexpected results
- uncertain, degraded, or unstable conditions
- no slack—low margin for error
- no opportunities to redo or recover—irreversible actions
- inability to improvise when things go wrong
- complexity—hard to understand
- limited guidance—unclear guidance in procedures
- need for high levels of precision
- significant degree of coordination
- multiple concurrent activities
- lack of feedback—inability to observe critical activities or parameters

Other situations that call for a conservative approach occur in the following situations:

- A serious performance gap to excellence exists.
- A significant change to an important plant process or program is being considered that could impact personnel performance.
- Fast-track job or work assignments are made.

Best Practice: READE

1. **Recognize** the degraded condition or uncertain situation that threatens safety.
2. **Express** the situation in terms of consequence, if left alone, related to the following:
    - plant safety and reliability
    - personal safety and well-being
    - environmental safety
3. **Appraise** the situation, with a questioning attitude, to identify conditions that could threaten safety, such as the following:
    - conflicts with safety and pressure to proceed with the plan
    - degree of familiarity with the situation—how novel it is
    - proximity to safety limits or reduced margins
    - degree of human involvement (increasing variation)
    - time available to make a decision

- degree of coordination, complexity, and margin
- sources of stress
- availability of resources and support
- assumptions that may need validation
- **NOTE**: The less time available to make an informed decision, then the more readily one should yield to safety.

4. **Decide** what to do to resolve the situation safely. Compare appraisal (step 3) to critical parameters, safety limits, or abort criteria. Consider what absolutely has to go right. Stop when unsure. **Do not proceed in the face of uncertainty.**
5. **Evaluate** the effectiveness of the action(s) (step 4) in achieving the desired results. Perform a post-job review or an after-action review.

At-Risk Practices:

- relaxing policies, rules, and expectations in times of crisis
- being insensitive to or not recognizing degraded or hazardous conditions
- not defining the problem clearly
- thinking in terms of likelihood (I will not make a mistake.) instead of potential consequences (What is the worst that can happen?)
- relying on rules of thumb
- focusing only on success; relying on past successes for a similar situation
- not evaluating the results of the decision
- not buying time to improve the decision-making process
- making key decisions without communicating the decision and the basis for the decision that affects multiple groups
- establishing unrealistic goals and schedules that put excessive
- pressure on personnel in critical roles

P315, Conduct of Operations Manual

1.4 Principles of Conservative Operation

Personnel must follow the Principles of Conservative Operations listed below; especially when faced with abnormal, off-normal, or emergency conditions that may threaten the health, safety, and well being of the public, employees, environment, or facilities and equipment:

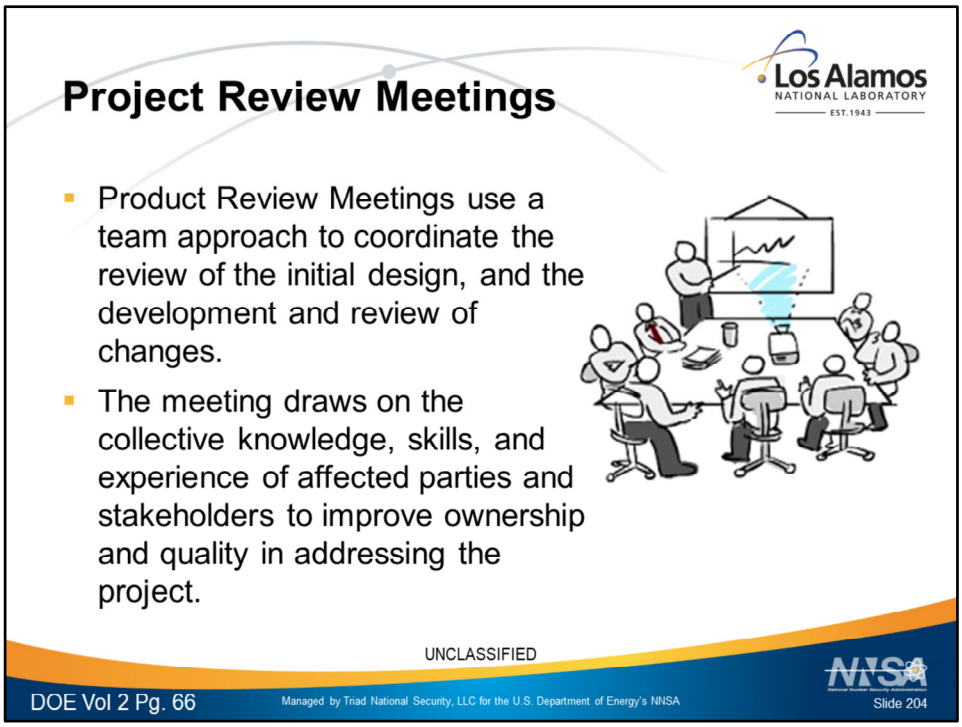
▪ Personnel will ensure the safety of the general public, workers, environment, and national security assets and will perform operations effectively by the proper operation and frequent monitoring of their equipment and facilities.

▪ Operations, maintenance, testing, engineering, and other activities will be conducted in an orderly and professional manner following approved procedures and in accordance with guidance spelled out in Conduct of Operations or Conduct of Maintenance manuals.

▪ Personnel will use "thinking compliance" when supervising activities, performing work, and using written procedures. Where the employee believes a procedure to be wrong, the employee will stop work and advise supervision.

▪ Management will conduct periodic assessments, including Management Observations and

Verifications (MOVs), relating to operating standards, work activities, and facility conditions. Believe all indications, alarms, and other process inputs; but follow up to confirm.



Overview

Science and engineering are not always exact. It involves judgment, uncertainty, and a degree of risk. To guide the development of the design or experiment, a structured process is necessary. Product Review Meetings use a team approach to coordinate the review of the initial design, and the development and review of changes. The meeting draws on the collective knowledge, skills, and experience of affected parties and stakeholders to improve ownership and quality in addressing the project. The project team clearly understands methods to be used, problems to overcome, and results to be achieved. Diverse and critical opinions are valued, and critical thinking is demanded for all product reviews. The project team will ultimately determine when the project

In general, meetings solve problems and aid decision-making that cannot or should not be handled individually. Every meeting requires a responsible person to keep the meeting on task, to address the issues, and to promote teamwork among the participants. An agenda, prepared for every meeting, specifies start/stop times and what to accomplish. Only people who have an important contribution to make should participate. Preferably, meetings conclude with personnel knowing what is to be done, by whom, and by when. For continuity and historical purposes, the chairperson prepares and distributes meeting minutes to the participants. Additionally, management can monitor these meetings through appropriate performance measures.

People may make errors during meetings. Team errors can occur. Meetings involve

communication among people who may possess inaccurate perceptions of the issues and who could promote potentially tragic misinterpretations of critical information. Open communication is a key success factor for a product review meeting. Any obstacle that hinders the free flow of communication, such as interpersonal conflicts, must be eliminated before individuals proceed with the task. Processes to identify and conscientiously examine differing professional opinions are widely known and applied. In some cases, the chairperson should designate a devil's advocate to challenge decision-making, assumptions, and various statements of belief that could lead people astray. is ready for implementation.

Use This Tool

- During meetings related to the initial design of or changes to experiments or engineering designs
- For design changes to safety-related structures, systems, and components subject to configuration control
- Before implementing any complex, temporary system modification
- At multiple points in the design process, to ensure design bases are being met to prevent significant rework or error potential

Recommended Practices When Using This Tool

1. Membership – Identify the product review team members by name before convening the initial product review meeting.

2. Agenda – Prepare and communicate an agenda for the respective product review meeting, along with the design documents, to the product review team members before the meeting.

3. Responsibilities – All product review team members are expected to adhere to the following.

- Attend and actively participate in all product review meetings.
- Review the product-related documents before the respective meeting.
- Prepare and submit comment sheets on the design documents before the meeting.
- Bring product-related documents and comment sheets to the meeting.
- Communicate stakeholder concerns, and address limitations.
- Identify commitments going forward, and assign owners. Identify commitments going forward, and assign owners.
- Avoid scope changes after the midcourse review.

Avoid These At-Risk Practices

- Not scheduling product review meetings far enough in advance to allow team members and stakeholders to attend
- Not issuing an agenda
- Stakeholder organizations not being involved in product review meetings until late in the project
- Inconsistent or unqualified representation from the stakeholder organizations
- Not being prepared for meetings, or not having required reviews completed before sending out meeting copy

- Required team members not being present at meetings
- Not following up on action items in meeting minutes

Overview

Typically DOE sites are operated by one or more primary contractors. In turn, a primary contractor may have a number of subcontractors performing work. For certain limited work scopes additional contractors may be brought in to perform limited scope or fixed-time special projects. For purposes of this tool, those limited-scope, special-project contractors are referred to as vendors. Vendors are at high risk for involvement in significant events in the facility. General Employee Training (GET) is often insufficient to compensate for vendors' lack of facility experience, especially with respect to **industrial safety, radiation protection,** and **human performance**.

Vendors need the same coaching and mentoring as facility personnel when they support the DOE contractor workforce. Supplemental personnel must understand that their work practices, especially regarding human performance, must meet the same standards required of facility staff even when the work is performed at their home office.

VENDOR is a mnemonic device (see "Recommended Practices" below) to aid the recall of those attributes, principles, and standards needed to effectively oversee the work of contractors/suppliers/vendors of products and services.

Use This Tool

- When formal processes governing interactions with vendors and contract personnel are not

available
- During the preparation of the contract for vendor services
- When purchasing new equipment
- When obtaining vendor services for on or off-site work
- Following the award of the contract, but before the start of work
- During actual vendor performance
- When returning equipment to a vendor for repair, troubleshooting, or maintenance
- Before completing the contracted job
- Following job completion
- When there is evidence, or suspicion, of improper execution or results
- Before using vendor-supplied information

Recommended Practices When Using This Tool

1. Validation of vendor-supplied data and assurances with objective evidence (trust, but verify).

2. Expectations related to product specifications, personnel training and qualifications, and station quality processes; especially industrial safety, radiological protection, and error prevention are clearly communicated. Be sensitive to areas of weakness revealed by operating experience.

3. iN-terdependency between vendor and customer/client; development of a close working relationship that generates a spirit of cooperation and an appreciation for safety and quality.

4. Documentation related to the product or service, which is clear, detailed, and understandable. Vendor problems are documented using the corrective action or nonconformance program.

5. Oversight of office and in-field vendor activities; assignment of a responsible individual to coach and mentor the vendor; development of a monitoring plan consistent with vendor's risk-significant role and past performance. Oversight can be designated as continuous, intermittent, or none.

6. Review and evaluation of vendor deliverables, documentation, and other products in light of critical attributes, using in-process reviews, inspections, vendor-specific operating experience, and post-job reviews

Avoid These At-Risk Practices

- Assuming the vendor is "expert" and will not make mistakes
- Assuming vendors have the same work standards as DOE facility workers
- Insufficiently verifying or testing vendor-supplied designs
- Providing insufficient oversight of vendor in-process activities
- Failing to avoid the appearance of co-employment.
- Assuming the vendor recognizes the effects of changes to his or her standard product

HPI Tools for TEAMS

	In the Field Ops, Maint., Field Support			In the Office Engineering, Science, Research		
HPI Tool	**Prior to start**	**Perform Work**	**Complete Work**	**Prior to start**	**Problem Solving**	**Complete Work**
Pre-Job Briefing	X			X Technical		
Peer-Checking		X				
Concurrent Verification		X				
Independent Verification		X				
Peer Review						X
Flagging (ROB)		X				

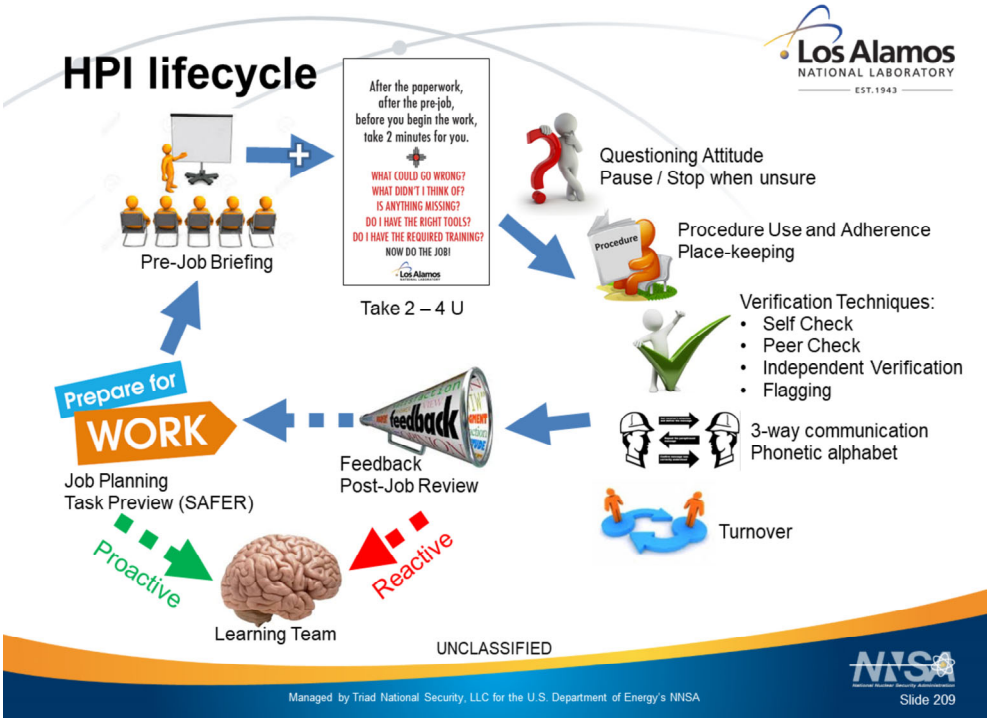
HPI Tools for TEAMS

	In the Field Ops, Maint., Field Support			In the Office Engineering, Science, Research		
HPI Tool	**Prior to start**	**Perform Work**	**Complete Work**	**Prior to start**	**Problem Solving**	**Complete Work**
Turnover		X			X	
Post-Job Review			X			X Technical
Project Planning	X			X		
Problem Solving (P-A-C-T-S)					X	
Decision Making					X	
Project Review Meeting						X
Vendor Oversight	X	X	X	X	X	X

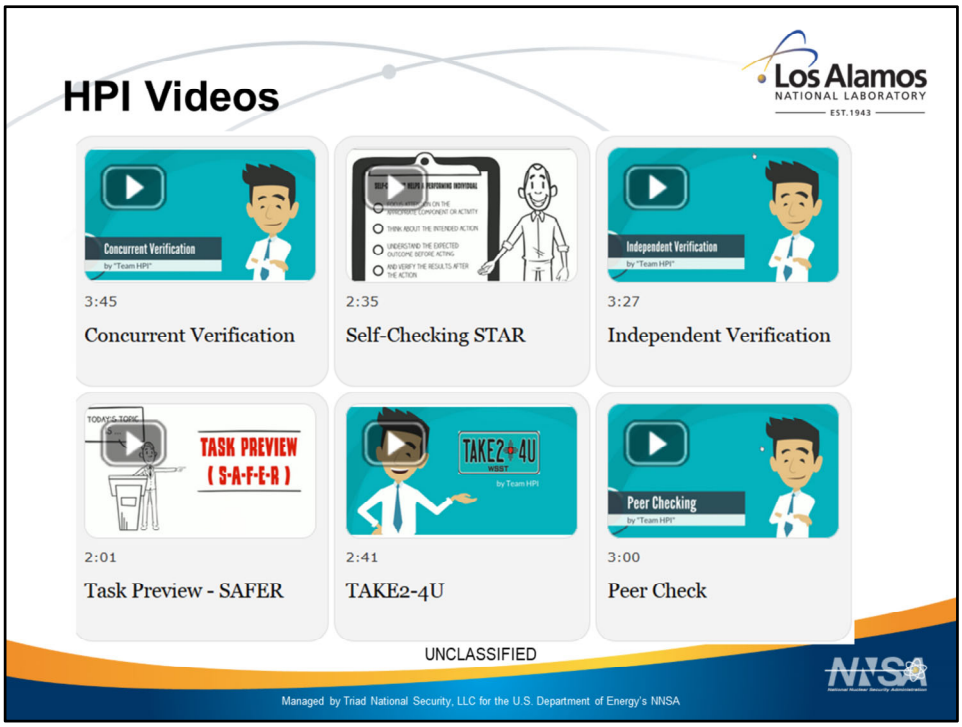
Pick the HPI tool for the condition

Condition	HPI Tool (s)
Prior to starting a job involving facility equipment. For a NEW task assignment	• Pre-Job Brief • Take 2-4 You (Job Site Review)
Prior to performing a Risk-Important or Critical step	• Peer Check • Concurrent Verification
After the completion of the action, but prior to experiencing a consequence. (LOTO, re-landing leads, reviewing a document/plan, etc.)	• Independent Verification • Peer Review
When working on similar looking equipment	• Flagging • Robust Operational Barriers
After completion of work	• Post-Job Review

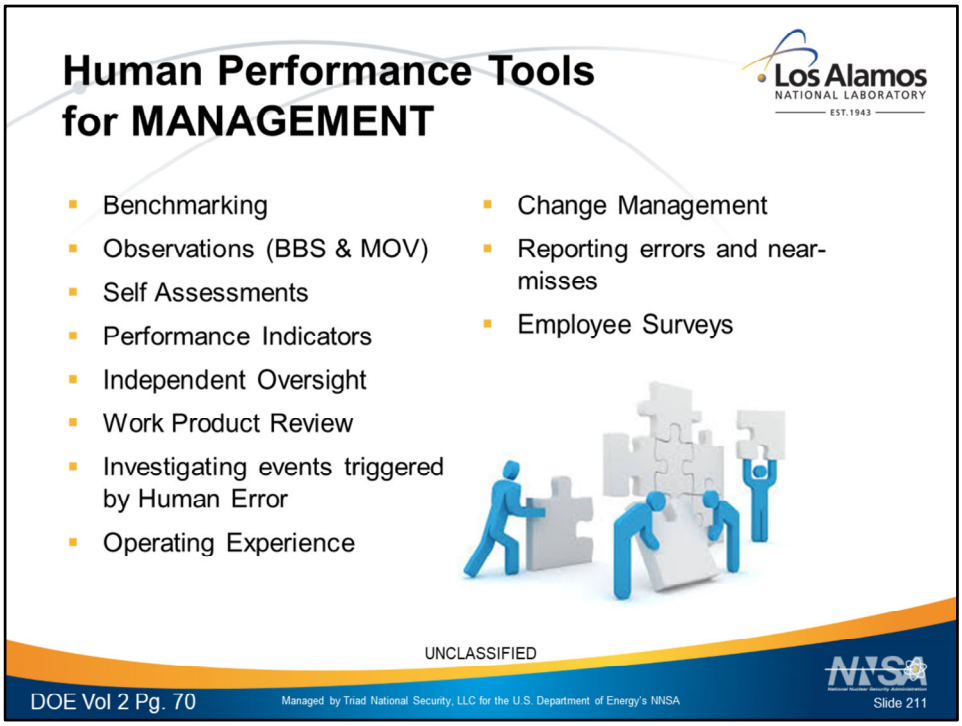
Present condition, solicit responses from students, then reveal possible HPI Tools



Review how it all fits together

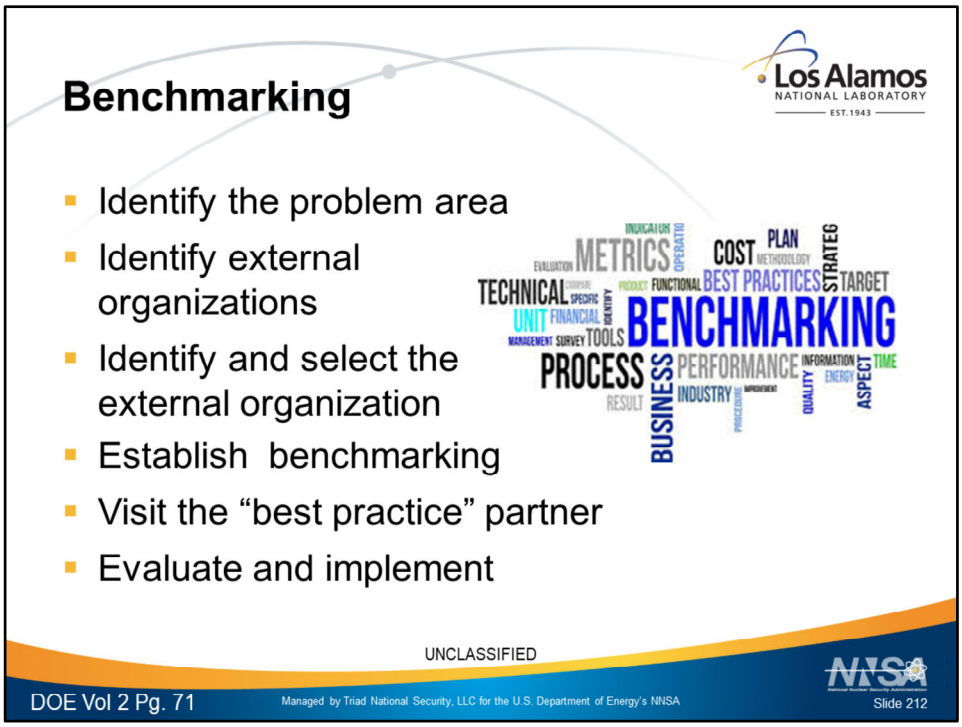


HPI Videos may be found on the LANL Videos on Demand – Human Performance Improvement



The *Management Human Performance Tools* in this section, describe various methods and techniques supervisors and managers can use to assist in the identification of latent weaknesses in the organization and the management system.

The tools in this category are designed to be used by managers (and supervisors) to help identify latent weaknesses in the organization. These are mainly undetected deficiencies in organizational processes or values that create workplace conditions that provoke error (error precursors) or degrade the integrity of defenses (flawed defenses). Undetected organizational deficiencies plague human performance. Latent errors or conditions are frequently difficult to identify. Once they are created they do not fade away but rather accumulate in the system. Because of their hidden characteristic, limiting the time these vulnerabilities exist is challenging. Managers should aggressively identify and correct vulnerabilities with defenses at the earliest opportunity.



Overview

Benchmarking is the process of comparing the performance of one's own organization in a particular area against other organizations that perform better in the same area and learning what the other organization does to achieve the high level of performance. This comparison may include the identification of beneficial practices, performance standards, and innovative thinking or approaches. Benchmarking is the process of measuring products, services, and practices against the toughest competitors or those companies recognized as industry leaders.

For benchmarking to be effective, managers must evaluate the various aspects of their own organization's performance to first determine performance gaps they agree need to be improved. With these results in hand, locate external organizations whose performance is exemplary and who are willing to share performance information. The learning process most often requires extensive communication between organizations and a visit to the host organization to observe first hand how business is done there. This sets the stage for the inquiring organization to develop plans on how to adopt such best performance practices. Some organizations consider benchmarking a continuous process in which they continually seek to challenge their practices.

Benchmarking is a powerful management tool because it overcomes "Paradigm Blindness." "Paradigm Blindness" can be summed up as the mode of thinking:

- "The way we do it is the best because this is the way we have always done it"; or
- "We can't learn from them because we are really smart and/or they don't understand our

situation".

Benchmarking opens organizations to new methods, ideas, and tools to improve their effectiveness. It helps crack through resistance to change by demonstrating other methods of operating than the one currently employed, and demonstrating that they work, because they are being used by others.

Use This Tool

- If a work process is found to be inefficient, ineffective, too costly, or too risk-ridden
- When errors, near-misses, and mishaps are on the rise in a particular area
- When the gap between actual performance varies widely from ideal performance in a given performance area
- When managers recognize the need to dramatically improve how they do business

Recommended Practices When Using This Tool

1. Identify the problem area. Gain a thorough understanding of the local process you intend to improve. A range of research techniques may be required that include gap analysis, informal conversations with employees, exploratory research techniques (e.g., focus groups), quantitative research, surveys, process mapping, and so on. Determine both the quantitative measures and qualitative information to be used in the benchmarking process.

2. Identify external organizations that have similar processes and challenges. Review their processes to identify similarities and transferability of the way business is carried out.

3. Identify and select the external organization that is "best in class" in the process you want to improve. Establish a partnership with this organization.

4. Establish benchmarking protocols and exchange information with the partner.

5. Visit the 'best practice' partner to witness leading edge practices. Companies usually agree to mutually exchange information beneficial to all parties in a benchmarking group.

6. Evaluate and implement using leading edge practices and local conditions to develop implementation plans which include identification of specific opportunities for use of the new acquisition of data, methods, and techniques. Sell the ideas to the local organization to gain demonstrated value from the adaptation of the process.

Avoid These At-Risk Practices

- Failing to pinpoint specific processes or practices that need improving
- Shortcutting the data collection phase in the rush to demonstrate improvement
- Selecting benchmarking partners that are not "best in class" but only different in how they perform
- Failing to account for important differences in the management systems or the processes of the two organizations that preclude successful adaptation of best practices
- Unwillingness to share information with a benchmarking partner
- Failing to follow through in implementing areas for improvement after visiting other facilities falling into the category of "industrial tourism"

In-the-field observation of individual performance is a good method to gain information of how well the organization supports work at the job site. The purpose of management behavior observations is to review the quality and effectiveness of work preparation, work practices, and work performance. The purpose is not to criticize or to judge people. Therefore, the main objective of these observations is to identify opportunities to improve the organization of work (work environment, tools, etc.), while monitoring individuals doing work.

The scope of observations should include the whole job, not just performer behavior. In addition to paying attention to performer practices and attention, observers monitor the job-site context, potential hazards, and the controls relevant to the work activity. The results of observations are recorded for trending purposes to help identify strengths and weaknesses over time. Behavior observations can flush out organizational weaknesses that may not be obvious by any other means. When managers and supervisors spend time in the field with individuals doing work, performance improves—error rates tend to decrease.

Use This Tool

- To verify how well the organization supports individuals' performance at the job site
- To reinforce desired behaviors and coach for improvements
- To document strengths and weaknesses of specific work activities
- To identify and document observable latent organizational weaknesses

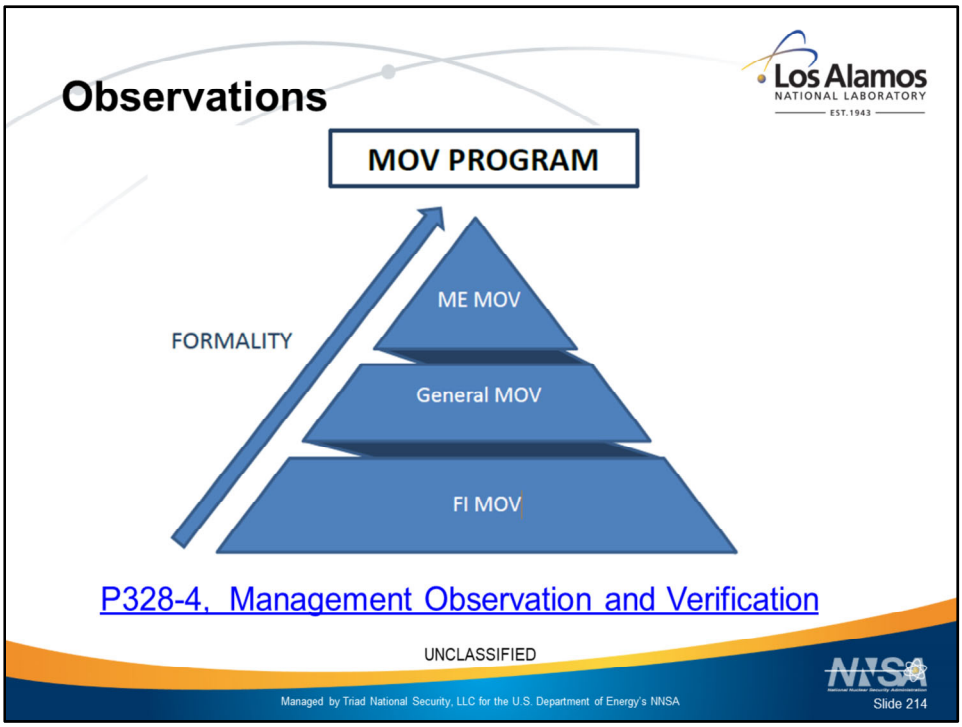
Recommended Practices When Using This Tool

1. Plan the observation to include watching specific activities and critical steps.
2. Know the critical steps, potential errors specific to the task, and performer weaknesses with the task and include these items in the scope of the observation.
3. Assess presence of obstacles to performance – solve related problems and remove obstacles where possible.
4. Verify availability of appropriate tools and spare parts.
5. Check that individuals possess the proper skills and accurately understand the risk and priorities associated with the task.
6. Reinforce and coach performers on observed behaviors.
7. Correct people on the spot for at-risk and unsafe practices.
8. Ask questions similar to the following to identify error precursors and latent organizational weaknesses that management can address.

- Was the task accomplished with expected results?
- Is this the way the job should be performed in the future?
- Are the procedures accurate?
- Were resources and information sufficient?
- Was training for the job adequate and effective?
- Were planning and scheduling optimized to reduce the potential for human error?
- Were work processes efficient and supportive?
- Did supervision provide needed support and appropriate guidance?
- Is the supervisor aware of performance traps that, if uncorrected, could lead to human error the next time the task is performed?

9. Record the findings and retain for trending and follow up.
10. Follow up on unresolved problems, performance obstacles, and organizational weaknesses.

LANL resources
ObserveIT (Behavior Based Safety): http://int.lanl.gov/org/padops/adesh/integration-office/behavior-based-safety/index.shtml
Behavior Based Safety: http://int.lanl.gov/org/padops/adesh/integration-office/timely-observation-measures/index.shtml
P328-4 Management Observation and Verification
LANL MOV Website: http://int.lanl.gov/performance-assurance/performance-center/mov/index.shtml
MOV Users Guide:
https://cms.lanl.gov/renderfile/d0894c8a80a504120002d14a6fc2d831/performance-assurance/performance-center/mov/_assets/docs/user-guide.pdf



P328-4, rev 6

3.0 PROCEDURE DESCRIPTION

This document describes the roles, responsibilities, and requirements necessary for implementation of the MOV process. Also included is a description of how the MOV process can enhance management effectiveness through integration and engagement with the Voluntary Protection Program (VPP), Worker Safety and Security Teams (WSSTs), and incorporation of Human Performance Improvement (HPI). The MOV process includes three types of MOVs: (1) General MOVs (with or without Guidance Cards), (2) Monitored Evolution MOVs (MEs), and (3) Field Interaction MOVs (FIs).

The MOV process provides managers with a standard method of conducting and reporting management observations and walk arounds, to observe processes and operations and to enhance manager/worker interaction.

3.1 Selecting MOV Focus Areas and Topics

A manager may select any focus area or topic, based on any identified risk or selection method. A manager may also recruit Subject Matter Experts (SMEs) to facilitate or to perform specified MOV activities, based on their expertise. Guidance Cards are available to managers to assist in selecting an MOV topic. Guidance cards provide information to managers about specific aspects of the selected focus areas and topics.

3.6.1 Human Performance Improvement (HPI)

HPI enhances the effectiveness of MOVs when employed by managers. HPI considers work situation factors, such as task demands, work environment, individual capabilities, and human nature. Managers and workers performing MOVs should focus on situational awareness to

- Summarize the critical steps
- Anticipate error-likely situations
- Foresee potential consequences
- Evaluate defenses

See the Human Performance Improvement webpage, this is known as the “SAFE dialogue” approach. An HPI-based MOV will help to identify organizational or process weaknesses that need to be strengthened and defenses that need to be improved.

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3.4 Field Interaction MOVs (FIs)

3.4.1 Discussion

The FI process provides specific guidance to the manager to help identify and address performance gaps and successes.

FIs include field-based questioning, observing, learning, coaching, mentoring, assessing, confirming desired performance, and correcting performance, as necessary.

It is important to monitor compliance with procedures; however, it is equally, if not more important, to understand how and why a gap between expected practice and current practice grows. FIs provide managers the information needed to redesign management systems and procedures.

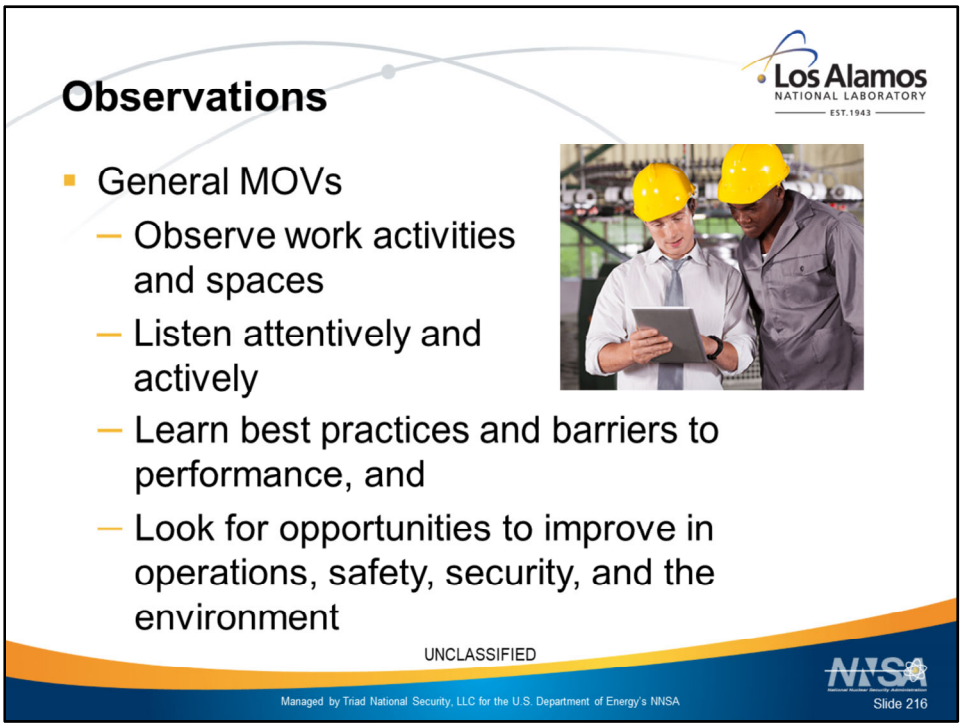
Degradation of compliance in behavior choices is more the result of system design and weaknesses than willful aberration by the person performing the activity. This is an important perspective for managers to have when performing an FI.

Where expected and current practices align, the FI is used as an opportunity to recognize good performance.

3.4.2 Performance of Field Interaction MOVs

In conducting an FI, the time is divided between:

- Questioning/feedback –the manager seeks input from staff on the efficacy of work documents and conditions and should comprise 20% to 30% of total time.
- Confirmation –the manager communicates with staff about ongoing work. The manager provides confirmation/reinforcement of performance considered to meet expectations, adjusting those expectations as the organization learns, and should comprise 50% to 70% of total time.
- Coaching/assessment/correction - the manager observes that performance meets expectations or does not meet expectations; provides assistance to staff in the form of clarification of expectations and demonstration/guidance on desired performance; determines potential for improved work documents and additional training; and provides other performance resources. Good performance is also



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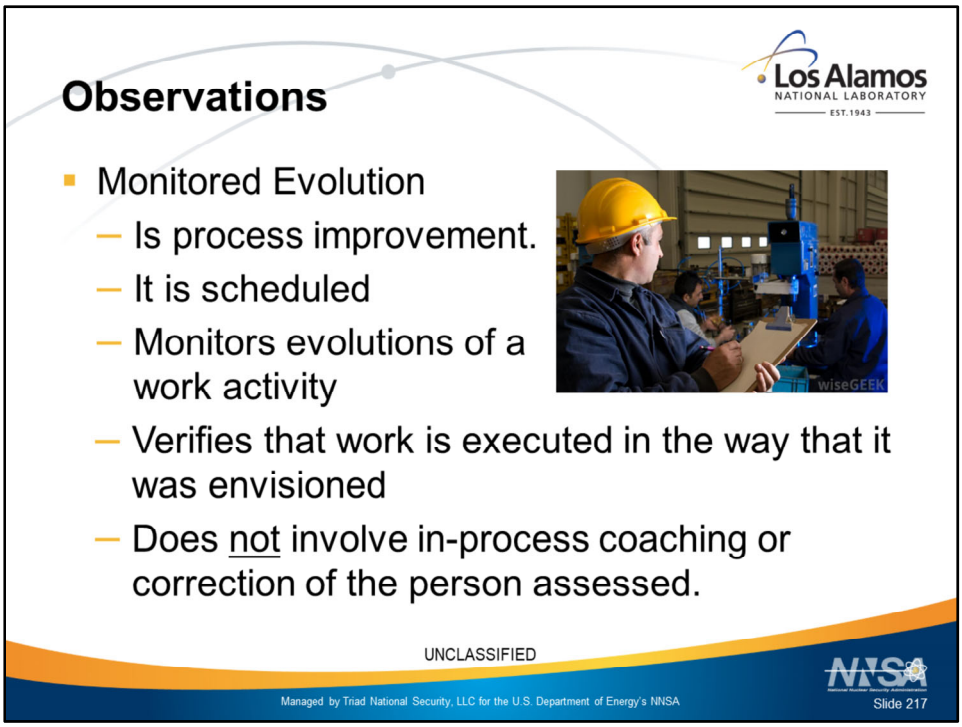
3.2 Performing MOVs of Any Type

When performing MOVs, managers and/or designated workers should:

- observe work activities and spaces
- listen attentively and actively
- learn best practices and barriers to performance, and
- look for opportunities to improve in operations, safety, security, and the environment.

Managers should acknowledge and reinforce good performance. Managers should also keep in mind that coaching, standard setting, and sharing expectations are excellent methods for setting examples. The more frequent the manager/worker interaction, the more opportunities can be identified, to improve operations, safety, security, and the environment. Managers, workers, and LANL benefit from frequent and meaningful manager/worker interactions.



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3.3 Monitored Evolution MOVs (MEs)

The ME process monitors evolutions of a work activity. A manager schedules an ME with a worker and observes the conduct of a work evolution.

A manager may observe a work activity either informally, through an MOV Guidance Card, or formally, via an ME checklist or implementing document (e.g., procedure, work instruction, drawing, etc.). Two distinguishing characteristics of the ME are:

1. It is an assessment of a work activity performed in accordance with the relevant ME Checklist or implementing document.
2. It is scheduled. Both the manager conducting the ME and the person assessed know when, why, and where the ME is to be conducted.

The ME typically does not involve in-process coaching or correction of the person assessed. The exception is pausing/stopping an assessed activity if harm or damage is imminent (refer to P101-18, *Procedure for Pause/Stop Work*, for further guidance). During an ME, managers are there to silently watch, listen, and, if desired, take notes.

There are six basic steps in conducting an ME:

1. Plan the ME.
2. Develop the ME Checklist or use an implementing document to evaluate the work activity.

Note: Refer to the ME Checklist Template if developing a new checklist.

1. Schedule the ME.
2. Conduct the ME.
3. Review the results of the ME, including performance gaps and successes, with the assessed person.
4. Evaluate the outcomes for issues that would require tracking in the institutional Issues Management system.

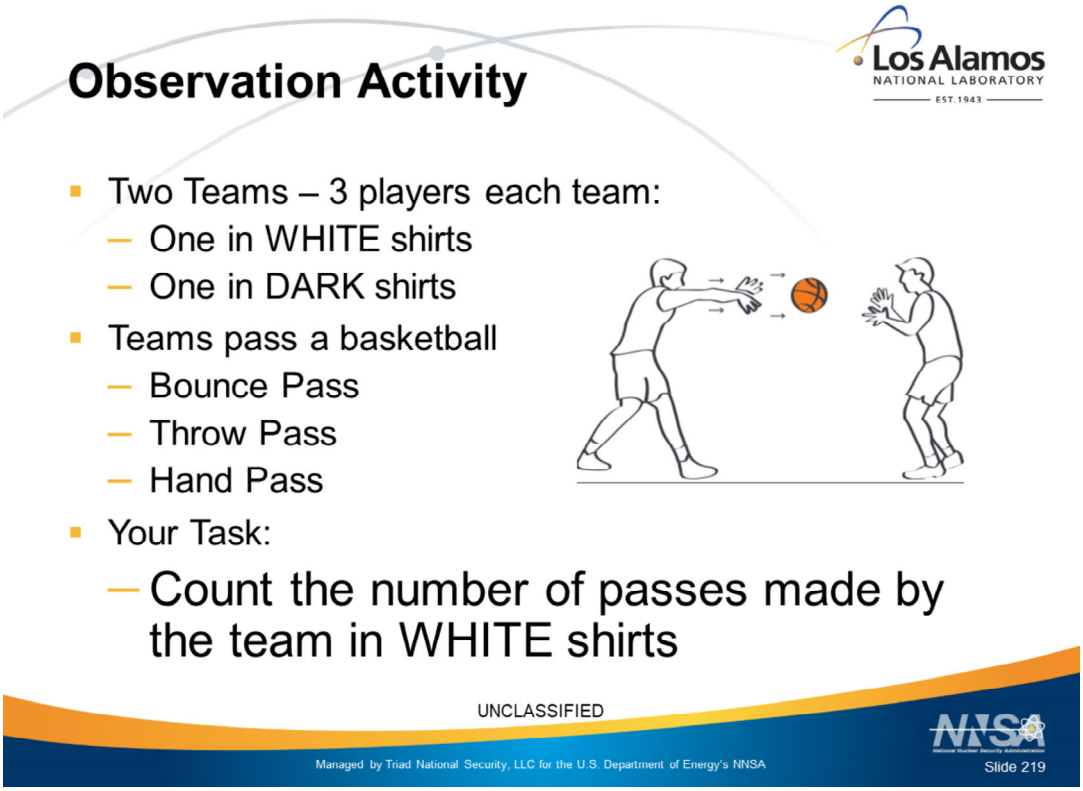
The process improvement occurs when the manager notes those steps executed in the evolution that do not match the ME Checklist or implementing document and the manager provides specific feedback to the person assessed.

http://int.lanl.gov/org/padops/adesh/integration-office/behavior-based-safety/index.shtml

ObserveIT, our new Behavior Based Safety tool, is now available for observational data entry.

Orientation sessions and self-guided training materials for the new system will be available in the near future. A Quick Guide is already available for your use.

The ATOMICs Behavior Based Safety system was retired on December 23, 2015, however ATOMICs legacy data is still available. Please contact the VPP Office and/or the ATOMICS team if you have any questions.



INSTRUCTIONS:

Explain to the students that there are two teams. One team in white shirts and one team in black shirts. Instruct the class to count the number of passes that the team in the white shirts make. It can be a bounce pass, a hand pass, or a throw pass.

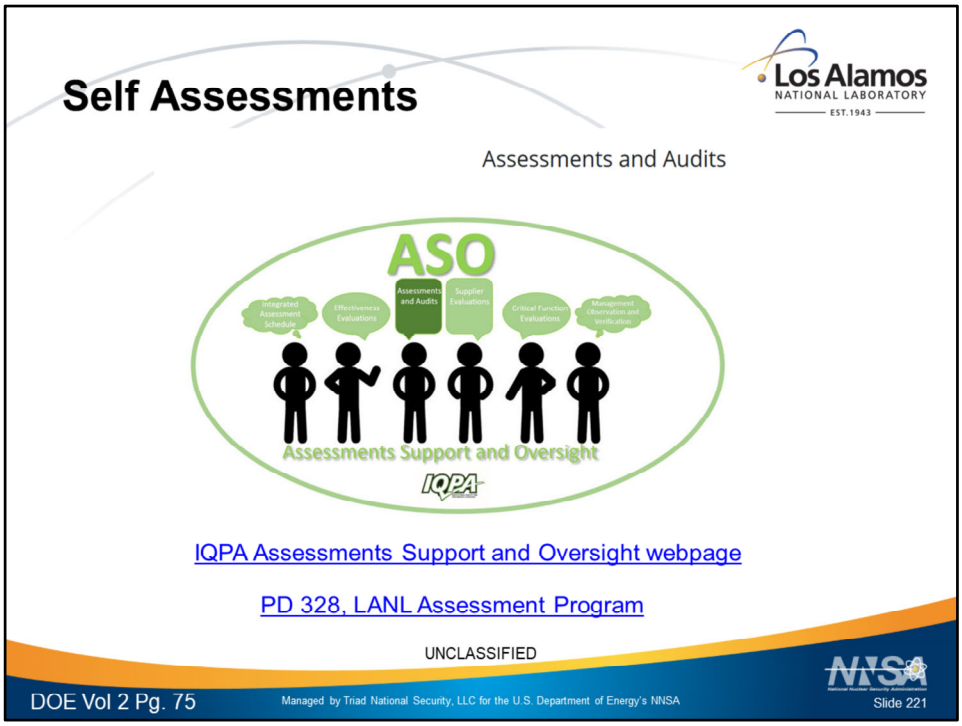
VIDEO: Attention Selective Attention Test
https://www.youtube.com/watch?v=vJG698U2Mvo
This video is used to create “tunnel vision” or to purposefully “limit the perspective” of people watching the video

INSTRUCTIONS:
Explain to the students that there are two teams. One team in white shirts and one team in black shirts. Instruct the class to count the number of passes that the team in the white shirts make. It can be a bounce pass, a hand pass, or a throw pass.

After the film has finished:
ASK: how many passes did you observe?
ASK: Did anyone see anything strange or unusual? – (There is a person in a gorilla suit that walks across the area)

Reshow the film. This time give the instructions just to observe. Do not count the passes.
Now what did the students see.

ASK: Why did you miss it the first time?
ANSWER: Focused on the task
Suggest using the “Take 2 – 4 you” card to “break the tunnel vision”.



PD 328, LANL Assessment Program

Overview

Self-assessment is the formal or informal process of identifying one's own opportunities for improvement by comparing present practices and results with desired practices, results, and standards. Because no one knows better how things are done in the facility than those working in the performing organizations, self-assessments can be the most effective means of identifying latent weaknesses in the organization and in the facility. Managers should be aggressive in the performance of self-assessments for their respective organizations and processes. Self assessments are required by DOE Order 226.1A, *Implementation of Department of Energy Oversight Policy.* It is not the intent here to supplant, or substitute in anyway, the 'Self-Assessment' process or program formally required by the Department. Rather, this tool is intended to assist managers and supervisors (and human performance practitioners) who do self-assessments make use of the information acquired there to evaluate organizational processes and values against expectations and identify conditions that may adversely affect defenses or provoke error likely situations that set individuals up for failure. Hence, this tool is meant to

assist people in assessing the human performance factors associated with self-assessments.

Use This Tool

When using a regularly scheduled self-assessment plan to evaluate current performance and results of management processes against the ideal or expected

- When trends and conditions suggest human performance is waning
- If present practices and results are misaligned with desired goals and objectives
- To evaluate how well the organization is complying with safety codes, regulations, and Requirements

Recommended Practices When Using This Tool

1. Determine the scope of the organizational processes to address in a self-assessment schedule. These may include procedure development and review, work planning and scheduling, tools and resources, training programs, design and modifications, work processes, management visibility, communication methods and practices, priorities and emphasis (health and safety or production), and so on. In some cases, there are more topics to assess than can reasonably be addressed in a single year, and lists should include multiple years. Annual schedule updates can keep the focus on important areas while not losing sight of areas believed to be performing well.

2. Define performance objectives that cover the scope of the processes selected. These should include health, safety, environment, and security requirements; quality requirements; and human performance principles.

3. Determine appropriate measures and assessments for each objective. Where appropriate identify an approach for achieving each objective. Measurement and assessment activities should consider the following.

- Risk (environmental, safety, health, security, and programmatic)
- Results of previous evaluations and assessments
- Lessons learned
- Priorities and resources

4. Develop a schedule for conducting the performance self-assessments. Address all topics at some periodicity, but concentrate on problem or critical areas.

5. Assign responsibilities for performing assessments and for evaluating results and reporting them to organizational managers. Involve knowledgeable individuals in the organization as well as supervision.

6. Conduct self-assessments as planned. Assessments should not interfere with the work flow or be the cause of individuals putting in long hours to support the effort. The objective of self-assessments is to investigate how work is accomplished—to see workplace activities and conditions as is customary and not contrived for the benefit of the assessment.
7. Ensure that assessment results are documented and reported, including areas that are performing well and areas needing improvement.
8. Take corrective actions as warranted where performance needs improvement and latent weaknesses are identified.
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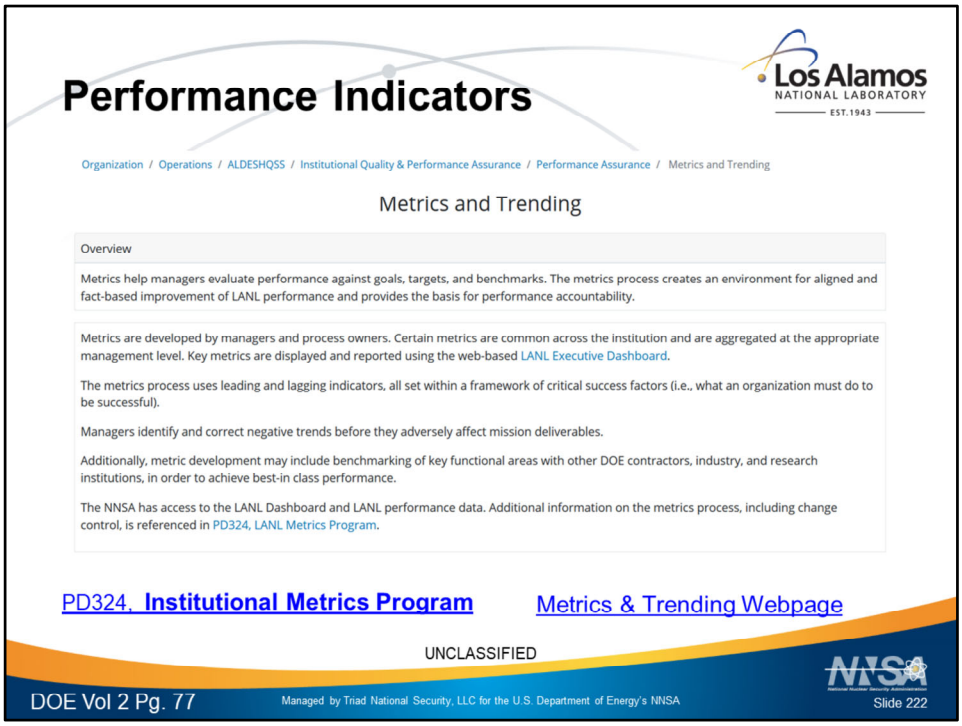


PD324, Institutional Metrics Program

Overview

Performance indicators or metrics are parameters measured to reflect the critical success factors of an organization. The purpose of these measures is to provide facility personnel with a way of knowing whether planned activities are occurring as originally intended as well as warning of developing problems.

There are two types of indicators:

- **Lagging** – Measures of **results or outcomes** which represent where you are and what you have accomplished, but do not necessarily predict future accomplishments, and
- **Leading** – Measures of **system conditions,** which provide a forecast of future performance; measures of **organizational "health,"** which can predict results and achievements.

Selecting appropriate and useful performance indicators is a difficult process which requires careful thought, recurring refinement, collaborations, and understanding. Frequently, things are counted because they can be, but provide little insight as to

how the organization is functioning now and no clue to future performance. Monitoring results, either good or bad, is a lagging indicator—it may be a worthwhile indicator, but it does not prove that current or past performance will continue. Monitoring processes or behaviors considered important to success provides a leading indicator—a forecast of things to come.

Examples of lagging indicators include the following: industrial safety lost-time injuries per 200,000 man-hours worked, collective radiation exposure, frequency of contamination events, rework (defined broadly as any action that results in loss of time, labor, money, or other resources within a particular period of time), ratio of repeat activities (within 18 months after maintenance) to work orders completed, recurring corrective actions, recurring causal factors. Examples of leading indicators include the following: time to implement corrective actions, overtime and absenteeism, self-reporting ratio (number of problems identified by workers vs. total number of problems identified), backlogs (e.g., procedure revisions, temporary
modifications, leak repairs, work-arounds, work orders, maintenance items), attitudinal/culture surveys, number of in-field observations, suggestions/deficiencies submitted per person per month, number of employee concerns submitted.
Trend Analysis and response is another challenging aspect of using performance indicators.
Simple graphing of raw data is sufficient when there are reasonable quantities of data and trending is obvious. However, where there is limited data (e.g., lost time accidents per month) a single event could appear to be a trend. Rolling averages do not improve the analysis of this type of data. Statistical data analysis is required to meaningfully use this data—ensuring appropriate reaction vice knee-jerk response. There are experts, books, and courses which address statistical data analysis far beyond the scope of this document. The point here is to highlight that beyond selecting the “right” metrics, they must be properly analyzed to achieve their real value.

Use This Tool

- When selecting indicators for a performance monitoring program
- To document trends in errors, mishaps and near misses over time

Steps When Selecting Performance Indicators

1. Clarify the results statements. Good performance indicators start with good

results statements that people can understand and agree on.
• Carefully consider the result desired – precise wording and intention.
• Avoid overly broad results statements – use aspects believed to make the greatest difference to improved performance.
• Be clear about what type of change is implied. What is expected to change – a situation, a condition, level of knowledge, an attitude, or a behavior?
• Study the activities and strategies directed at achieving change.
2. Develop a list of possible indicators. Use internal brainstorming and experience of other operating units with similar indicators, as well as consultations with experts
• Be inclusive.
• Allow free flow of ideas and creativity.
• Consider the message or unintended consequence of the measurement.
3. Assess each possible indicator using the following criteria for judging appropriateness and utility.
• **Direct** – Meaning the indicator should measure as closely as possible the result it is intended to measure.
• **Objective** – An objective indicator has no ambiguity about what is being measured, that is., there is general agreement over interpretation of the results.
• **Adequate** – Taken as a group, a performance indicator and its companion indicators should adequately measure the result in question.
• **Quantitative, where possible** – Quantitative indicators are numerical. The numerical precision of quantitative indicators lends them to more agreement on interpretation of results data. Qualitative indicators can supplement the numbers and percentages with a richness of information.
• **Disaggregate, where appropriate** – Disaggregating people-level program results by gender, age, work group, or some other dimension is often important from a management or reporting point of view.
• **Practical** – An indicator is practical if data can be obtained in a timely way and at a reasonable cost. Managers require data that can be collected frequently enough to inform them of progress and influence decisions.
• **Reliable** – Is the data from the indicator of sufficiently reliable quality for confident decision-making to be obtained?
When assessing and comparing possible indicators, it is helpful to use a matrix with the seven criteria arrayed across the top and the candidate indicators listed down the left side.
With a simple scoring scale, for example 1-5, rate each candidate indicator

against each criterion. These ratings will help give an overall sense of the indicator's relative merit, and help in the selection process. Be flexible and recognize that all seven criteria may
not be equally important.

10. Select the "best" performance indicators.

• They should be the optimum set that meets the need for management—useful information at a reasonable cost.

• Leading indicators are more valuable than lagging indicators, but normally more difficult to select and use.

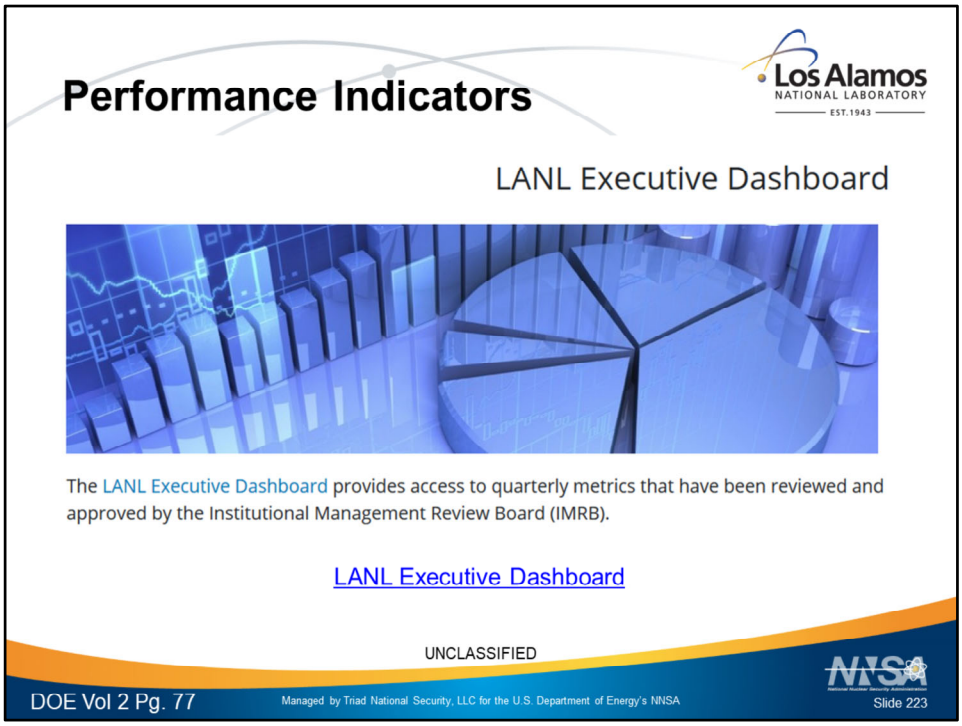
• Remember the costs associated with data collection and analysis. Limit the number of indicators used to track each objective or result to a few (2-3). Select only those that represent the most basic and important dimensions of your objectives.

11. Determine analysis technique

1. Assign an owner for the indicator
2. Evaluate targets, limits, and trending methodology and periodicity
3. Employ statistical expertise to improve analysis
4. Where possible, analyze past data to evaluate the usefulness of the indicator and analysis technique

Avoid These At-Risk Practices

- Using certain parameters primarily because they are easy to measure
- Failing to obtain general management agreement on the selection of performance indicators
- Selecting indicators, collecting and assessing data and doing nothing with it
- Not being selective about the number indicators and/or the quality of their usefulness

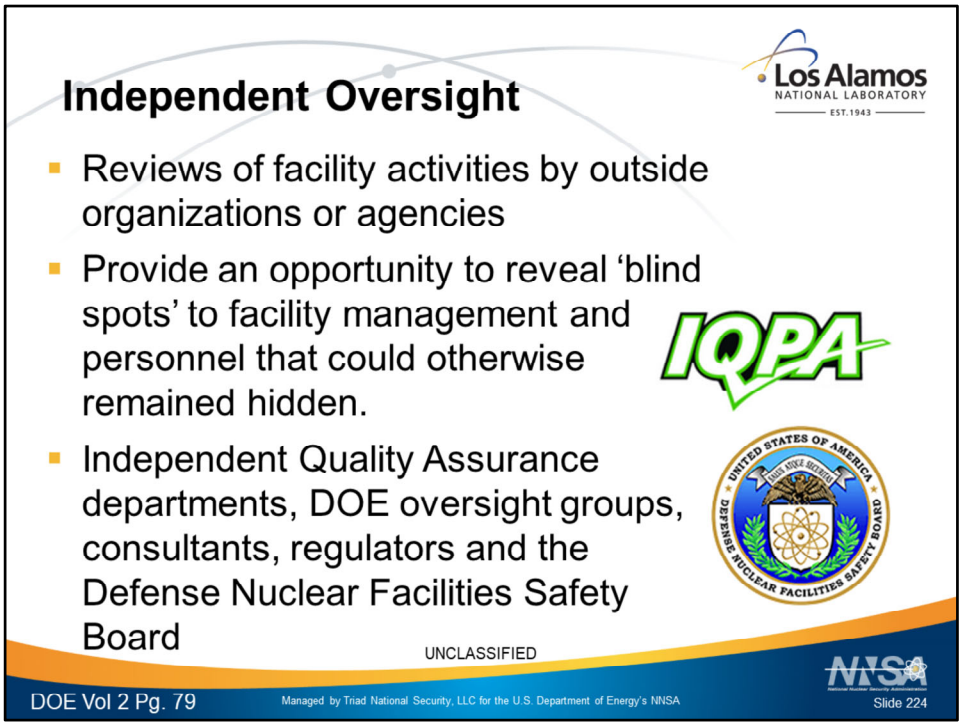


The Briefing Book

NA-LA and Lab employees with a cryptocard may access this book on the yellow network. The briefing book displays a summary of all metrics in the LANL Dashboard. Metrics are arranged by functional areas and include Mission, ST&E, Operations, Business, Environmental Programs, and Management System metrics.

Dashboard Views

NA-LA and Lab employees who receive authorities and training in the performance software may access this link to view the Dashboard. The View option allows users the ability to view metrics in several displays and to enter data and commentary for selected metrics. View the entire LANL corporate dashboard as well as key institutional metrics.



Overview

Reviews of facility activities by outside organizations or agencies provide an opportunity to reveal 'blind spots' to facility management and personnel that could otherwise remained hidden. Independent Quality Assurance departments, DOE oversight groups, consultants, regulators and the Defense Nuclear Facilities Safety Board evaluations and assessments provide opportunities to identify these latent conditions. Independent oversight can identify conditions, processes, and practices that fall short of industry best practices and those that could lead to degraded facility performance if uncorrected.

DOE P 226.1A, *Department of Energy Oversight Policy,* establishes a Department-wide oversight process to protect the public, workers, environment, and national security assets effectively through continuous improvement. It includes the full range of oversight, from external independent reviews through self-assessment, which involve evaluation of contractor organizations and Federal organizations that manage or operate DOE sites, facilities, or operations. DOE O 226.1A, *Implementation of Department of Energy Oversight Policy*, promulgates the requirements of this policy.

DOE O 470.2B, *Independent Oversight and Performance Assurance Program,* describes the formal DOE independent oversight program applicable to program and operations offices and to contractor organizations, alike. The Office of Independent Oversight (HS-60) has responsibility for independent oversight within the Department in the areas of safeguards and security; cyber

security; emergency management; and environment, safety, and health. An external independent assessment is essentially a reverse benchmarking exercise. As opposed to doing the research on "best in class" and to travel in order to learn about relevant best practices in other organizations, an external independent assessment group comes to the organization to review its operations and processes against industry standards. In both benchmarking and independent assessments, facility personnel learn first hand just how well their practices and processes compare with industry best practices and standards.

Most independent assessments are not conducted at the recipient managers' invitation. Hence, the supposition is that "if I am being evaluated from outside there must be something wrong." Most managers and supervisors are passionately committed to their work and their organization. Telling a manager his/her operation is below par and requires correcting has the same affect as telling a young mother her baby is ugly—they both become defensive. There is a natural human tendency to resent outsider involvement in local operations. This is partly related to the fact that people don't like to be told what is below standard from those who "don't work here and can't know as much as we do about the operation."

However, people with broad knowledge and experience outside the organization may spot troubled areas and process weaknesses far more readily than individuals living within the system. Managers and supervisors can benefit greatly from the findings of an independent oversight. This is especially true when they remain dispassionate and objective, remembering that the assessment is evaluating facility processes, practices, and behaviors, not targeting individuals.

Use This Tool

- To gain information that can be used to make improvements in operations and maintenance to comply with best practices and high standards
- To strengthen organizational processes and values
- Following recognition of a need to improve the way business is being done
- To identify issues in an organization at the manager's request

Recommended Practices When Using This Tool

1. Designate points of contact (POCs) with the responsibility of assisting members of the independent oversight team with their assessment. POCs can answer questions, refer team members to the right references, and point them to the right people and locations needed to carry out their assignments.

2. Conduct daily briefings with POCs for the purpose of communicating status of the oversight and to coordinate how better to support the team's needs.

3. Attend in-process and close-out debriefs conducted by the team when invited to acquire input on observations and findings. In doing so, managers more readily understand the developing issues and the team's findings.

4. Carefully review the draft report with the assessment team for accuracy and applicability, and provide timely feedback. Resolve misunderstandings, and help correct incorrect

statements and conclusions.

5. Provide copies of the draft and final report to individuals in the organization for review in order to develop a corrective action plan that addresses findings.

6. Develop a corrective action plan indicating the following for each finding.

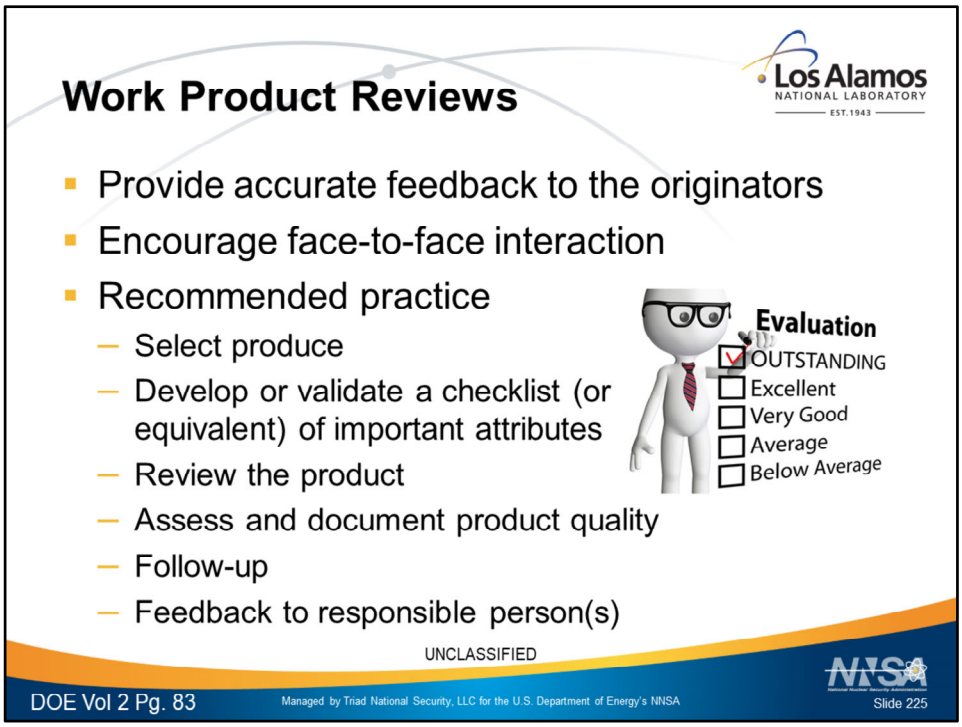
- Individuals and organizations responsible for the finding and resolution
- An analysis of the underlying causal factors (to determine if there are systemic program weaknesses)
- Steps to address the cause(s) of the finding
- Planned actions to prevent recurrence of the finding
- Action completion dates
- How actions will be tracked to completion
- Mechanisms for verifying closure to ensure that actions are appropriate to prevent recurrence of the finding.

7. Implement the corrective actions and track progress to completion. Comply with the assessment requirements for communicating progress.

8. Follow up with periodic management self assessments to ensure corrective actions have been institutionalized and are engrained in facility operations and behavior.

Avoid These At-Risk Practices

- Becoming defensive and resistant to outside evaluations and the resulting findings, thereby missing the opportunity to learn and improve from the experience
- Failing to effectively include staff in the process of reviewing the findings, developing the action plan, and working corrective actions, so ownership and commitment to the changes undertaken are diluted
- Doing a cursory analysis of findings that precludes deeper discovery of systemic/ program weaknesses, so the mindset that the “system is fine” prevails and nothing really changes
- Neglecting to perform self-assessments or management reviews to confirm that corrective actions are being thoroughly implemented



Overview

Work product reviews provide accurate feedback to the originators regarding their performance on specific products. Such reviews encourage face-to-face interaction between supervisors and scientists, engineers, procedure writers, and other knowledge workers. Not only are areas for improvement identified on an individual basis, but also strengths are highlighted and communicated to others for emulation. Supervisors can use the results of a review to communicate, coach, and reinforce expectations.

Technical work products are selected periodically. Some products, because of their risk importance, receive routine reviews. Managers can monitor the results of these reviews via the observation process to identify improvement opportunities and factor them into the related training programs. Using a checklist and assigning a grade offers another way to track improvement.

Use This Tool

- Periodically by each manager, supervisor, or team lead
- As required by administrative instructions
- During apparent cause evaluations and root cause analyses

Recommended Practices When Using This Tool

1. Select Product – On a periodic basis, select a sample of products for review.

2. Develop or validate a checklist (or equivalent) of important attributes to use in the review such as the following. (*Note: These attributes are examples only and should not be considered comprehensive.)*

- Problem statement and/or solution(s)
- Project work plan content (if applicable)
- Potential outcomes related to critical attributes
- Methods and analytical techniques used
- Operating experience and lessons learned
- Risks, hazards, and user-centered design considerations
- Requirements, standards, and code compliance
- Implementation planning, oversight, and acceptance testing
- Input data and sources
- Assumptions
- Documentation and reference software used
- Technical accuracy and usability of procedures
- Reviews and approvals
- Program or procedural obstacles to desired performance
- Surprise situations; for example, unanticipated risk factors, schedule or scope changes, and organizational issues
- Engineering human performance tool(s) applicable to product(s) or related activities

3. Review the Product – Use a cross-functional team of knowledgeable personnel to conduct the review. Identify what went well (pluses), opportunities for improvement (deltas), and problems (minuses) for the particular product.

4. Assess and Document Product Quality – Document and trend the results of the review. A grade may be assigned, using objective criteria similar to the following.

- A. Excellent: no defects identified or errors found with the delivered product
- B. Satisfactory: errors with little or no impact on product quality or its conclusions
- C. Unsatisfactory: several errors found, or minor rework required
- D. Unacceptable: errors that require significant rework or changes to product conclusions, invalidating the integrity of the product

5. Follow-Up – Follow up successes and opportunities for improvement (using methods such as recognition and condition report).

6. Feedback to Responsible Person(s) – After the responsible person reviews the written comments, provide face-to-face feedback on the resolution of a particular issue and those of high interest to the responsible person. Provide specific feedback on “excellent,” “unsatisfactory,” and “unacceptable” grades.

Avoid These At-Risk Practices

- Performing a cursory review of the package—performing a review only to meet a requirement or quota; not carefully evaluating the quality of the work product
- Not gaining a cross-functional perspective on the product
- Not holding subordinate managers or supervising engineers accountable for performing work product reviews
- Not performing the work product reviews early enough to allow for feedback into the normal work cycle for repetitive tasks

P322-4, Issues Management (pdf)
P322-3, Performance Improvement from Abnormal Events (pdf)

Overview

A traditional view of events and accidents is that they are caused by shortcomings in human competence, attention, or attitude. It may be under the label of "loss of situation awareness," procedural "violation," or "poor" management. A new and different view is that human error is not the cause of failure, but a symptom of failure—trouble deeper inside the system. Human error is not the chief threat to system safety, but rather latent organizational conditions set the stage for error and determine the severity of the consequences. Human error is not just random. It is tied to features of people's tools, the tasks they perform, and the operating environment in which they work. In this perspective, human error is not the conclusion but rather the starting point of investigations. The point of these investigations should be to prevent recurrence, not simply to find people to punish.

Investigations of accidents or events triggered by active error are usually distorted

by hindsight—the analyst's knowledge of facts after the event that were not known, or possibly even knowable, by the individual(s) involved in the event. In traditional investigations, the investigators interview the people involved after gaining an understanding of the requirements and after becoming very familiar with the details of the event. Hindsight predisposes the investigator to search for information that confirms the individual's apparent shortcomings. Further, explaining what people could have or should have done says nothing about why they did what they did. Analyzing events from the perspective of "why did the actions taken seem appropriate at the time?" goes a long way to preventing the same thing from happening in the future.

In human error investigations, a key approach is to recreate the mindsets of those involved in the accident or incident scenario. Knowing the mindset does not mean getting into the mind of the individuals, but rather determining the environment they found themselves in at the time that may have influenced their decision-making process. The challenge, therefore, is to determine why actions of the individuals made sense to them at the time. With this new approach, investigators are encouraged to interview those involved with the incident before acquiring detailed knowledge of the event. This allows the gathering of information without having been biased with previous assumptions and information. This process of recreating the decision-making environment is an attempt to assess the decisions and behaviors in their "context." It is important to obtain a meaningful understanding of how facts—including decisions and behaviors—were influenced. Understanding context is the key to a successful human error investigation and to providing lessons learned for the future."

Use This Tool

- When preventing recurrence is more important than personnel punishment
- To identify latent organizational conditions that create error-likely situations or weaken defenses – contributing to the severity of the incident or accident

Recommended Practices When Using This Tool

Given a description of the event consequences (fatality, injury, facility shutdown, equipment damage, near miss, etc.) follow these steps.

1. Debrief the participants to help reconstruct the situation that surrounded them at the time and receive their point of view on the situation.

- Ask participants to tell the story from their point of view

- Tell the story back to them to check whether you understand the story as the participants understood it
- Identify with participants the critical junctures (moments in time when decisions and/or actions were required) in the sequence of events
- Progressively probe and rebuild how the world looked to people on the inside of the situation at each juncture. At each juncture in the sequence of events, you want to get to know
    - Which cues were observed (noticed or seen or did not notice what he/she had expected to notice?)
    - What knowledge was used to deal with the situation? Did participants have any experience with similar situations that was useful in dealing with this one?
    - What expectations did participants have about how things were going to develop, and what options did they think they had to influence the course of events?
    - How did other operations or organizational influences help determine how they interpreted the situation and how they would act?

2. Use Questions to find out how the situation looked to people on the inside at critical junctions.

- ***Cues***
    a. What were you seeing?
    b. What were you focusing on?
    c. What were you expecting to happen?
    If you had to describe the situation to your crew member at that point, what would you have said?
- ***Errors***
    - What mistakes were likely at this point (for example in interpretation)?
- ***Previous experience and knowledge***
    a. Were you reminded of any previous experience?
    b. Did this situation fit a standard scenario?
    c. Were you trained to deal with this situation?
    d. Were there any rules that applied clearly here?
    e. Did you rely on other sources of knowledge to tell you what to do?
- ***Goals***
    a. What goals governed your actions at the time?
    b. Were there conflicts or trade-offs to make between goals?
- ***Taking action***

a. Was there time pressure?
b. How did you judge you could influence the course of events?
c. Did you discuss or mentally imagine a number of options or did you know right away what to do?

- ***Outcome***
  a. Did the outcome fit your expectation?
  b. Did you have to update your assessment of the situation?

3. Review the job-site conditions for each individual involved in the accident.
- Look for procedures, logs, computer printouts, recorders traces,
- Review the workplace and the equipment

4. Assemble all the data acquired to this point
– These data should indicate a sequence of events and activities.

5. Lay out the sequence of events in context-specific language – The data as the investigator found them (or factual information) using time and space as organizing bases. Include people's actions and observations and changes in a process that happened.

6. Divide the sequence of events into episodes (chapters). An episode is a longer stretch of time that (initially) makes sense from the point of view of the domain. Example: the time taken to taxi out to a runway is a meaningful chunk of time in which particular
actions and assessments need to be made to prepare for the next episode (taking off).

7. Find out what the world looked like during each episode. Find the data known to have been available to people during each episode (what their process was doing, what data was available). This is the first step toward coupling behavior and situation. Link
up all the events that have been identified with the unfolding process.

- Find out how process parameters were changing over time, both as a result of human influences and of the process moving along. Trace changing pressures, ratios, settings, quantities, modes, rates and so forth.
- Find out how the values of these parameters were available to people – dials, displays, knobs that pointed certain ways, sounds, mode annunciations, alarms, warnings. There will be mismatches between what was available and what people observed or used that do not explain anything by itself.
- Decide which of all the parameters counted as a stimulus for behavior under investigation, and which did not. Which of these indications or parameters were actually instrumental in influencing the behavior in the mishap

sequence?

8. Identify knowledge, focus of attention, and goals. Reconstruct people's unfolding mindset. Explain why their assessments or actions made sense to them at the time. This is done by re-establishing people's knowledge, goals, and attention at the time.

- People have goals. They are in a situation to get a job done; to achieve a particular aim. People have knowledge. They use this to interpret what goes on around them. People's goals and knowledge together determine their focus of attention..
- Use the principle that people do reasonable things given their knowledge, their objectives, their point of view and limited resources. This is the step that takes most work

Using the *Anatomy of an Event* model as a guide, complete the following steps.

9. Identify the task(s) or activities associated with the initiating action.

10. Identify the defenses or barriers that failed to prevent, catch, or mitigate the consequences of the event (the behavior of the individual).

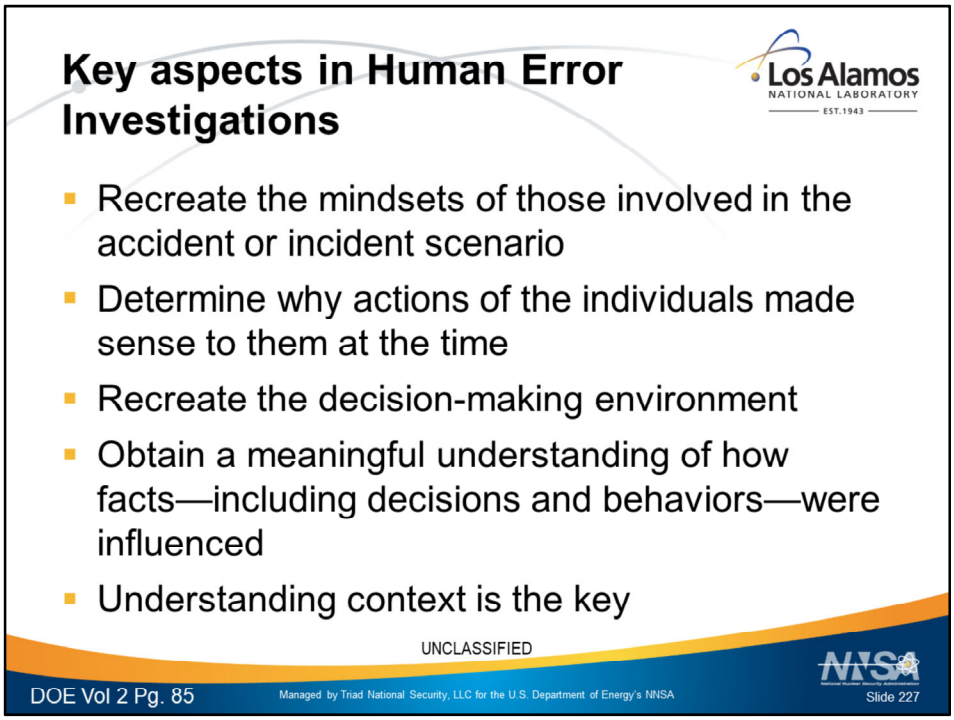
11. Identify the defenses or barriers that failed to prevent or mitigate the consequences of the event (the results to the facility).

12. Identify job-site conditions and error-precursors that provoked active errors or encouraged violations.

13. For the factors identified in 10, 11, and 12 above **trace the organizational process or cultural contributors**.

Avoid These At-Risk Practices

- Learning too much about the event before debriefing the individuals involved
- Failing to debrief all the individuals involved in the event
- Failing to ask all the questions needed to establish the individuals' frame of mind (context of actions)
- Failing to adequately reconstruct the sequence of events as they occurred
- Assuming the system is sound; and free of latent weaknesses, conditions, or failures
- Ignoring the results of the front-end error investigation in the back-end analysis of flawed defenses, job-site conditions, and organizational contributors
- Concluding that the cause of the event was that the people involved in the event did not act reasonably and not identifying why



Overview

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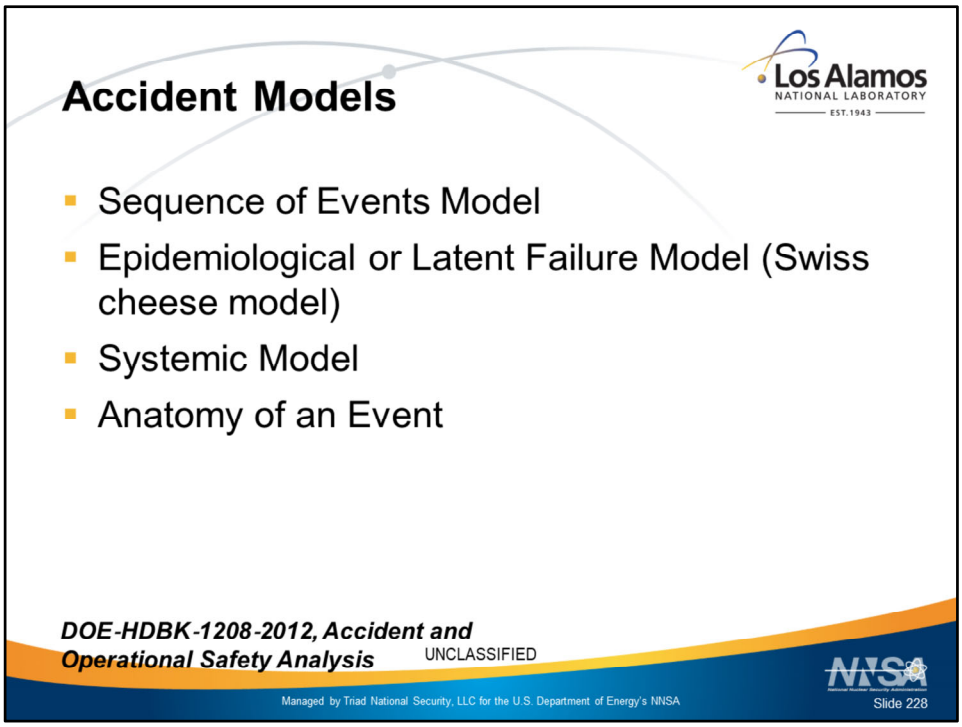
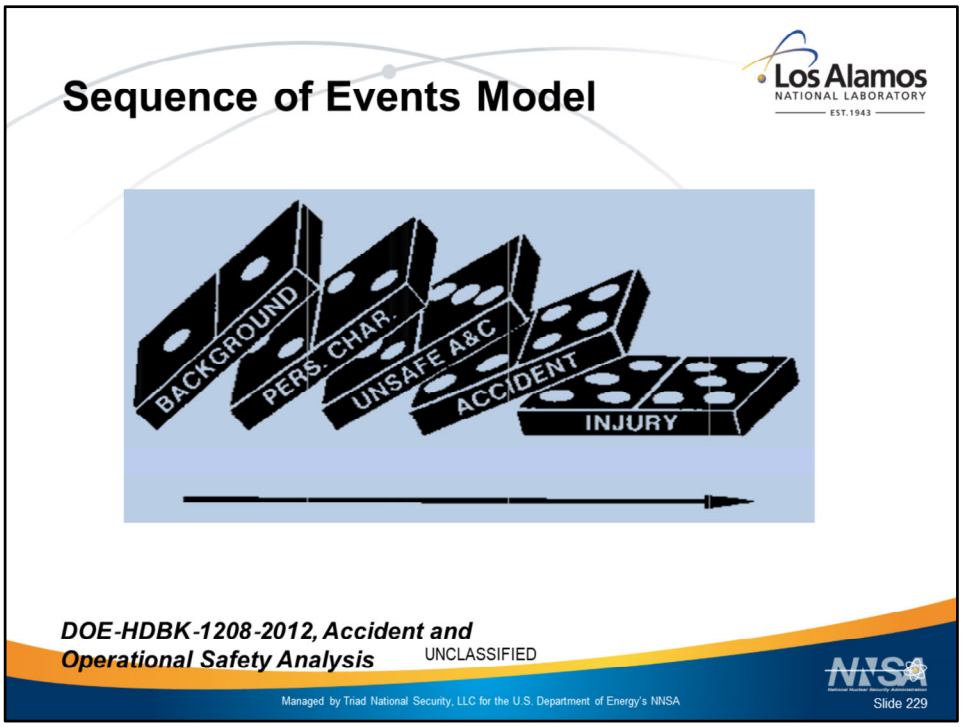


Excerpt from DOE-HDBK-1208-2012, Accident and Operational Safety Analysis

An accident model is the frame of reference, or stereotypical way of thinking about an accident, that are used in trying to understand how an accident happened. The frame of reference is often an unspoken, but commonly held understanding, of how accidents occur. The advantage is that communication and understanding become more efficient because some things (e.g., common terminology, common experiences, common points-of-reference, or typical sequences) can be taken for granted. The disadvantage is that it favors a single point of view and does not consider alternate explanations (i.e., the hypothesis model creates a recognized solution, causing the user to discard or ignore information inconsistent with the model). This is particularly important when addressing human component because preconceived ideas of how the accident occurred can influence the investigators' assumptions of the peoples' roles and affect the line of questioning. [Hollnagel, 2004]

What investigators look for when trying to understand and analyze an accident depends on how it is believed an accident happens. A model, whether formal or simply what you believe, is extremely helpful because it brings order to a confusing situation and suggests ways you can explain relationships. But the model is also constraining because it views the accident in a particular way, to the exclusion of other viewpoints. Accident models have evolved over time and can be characterized by the three models below. [Hollnagel, 2004]

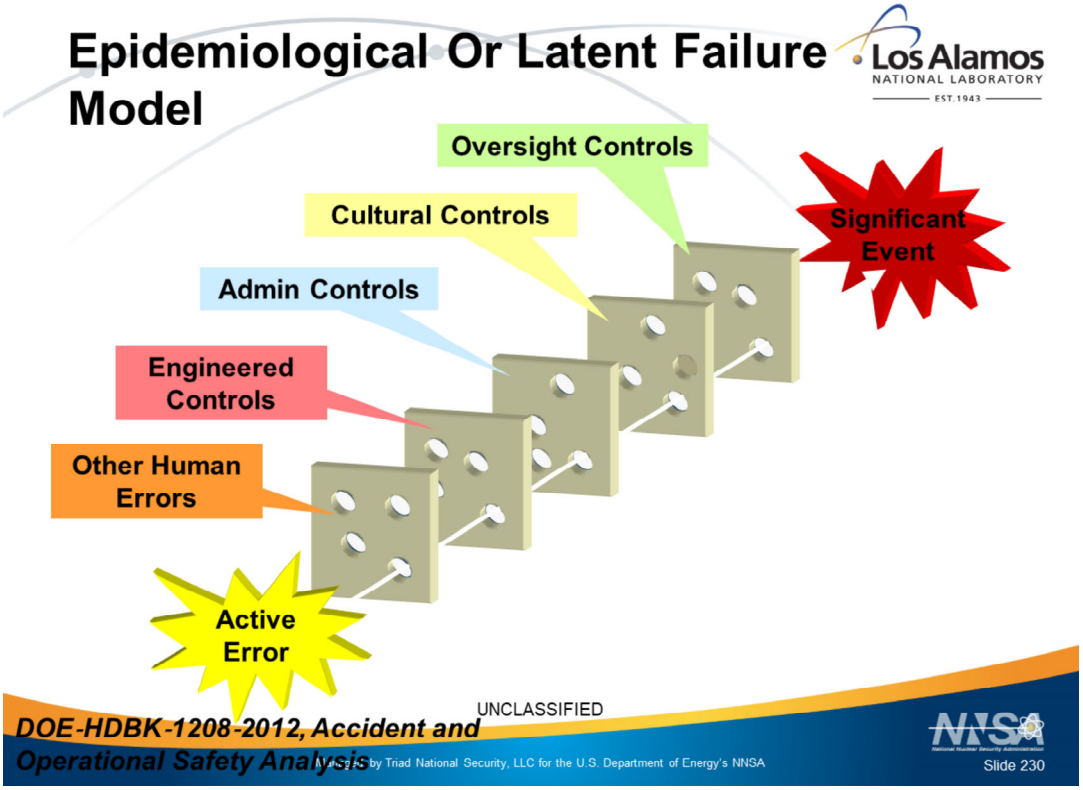


Excerpt from DOE-HDBK-1208-2012, Accident and Operational Safety Analysis
This is a simple, linear cause and effect model where accidents are seen the natural culmination of a series of events or circumstances, which occur in a specific and recognizable order. The model is often represented by a chain with a weak link or a series of falling dominos. In this model, accidents are prevented by fixing or eliminating the weak link, by removing a domino, or placing a barrier between two dominos to interrupt the series of events. The Domino Theory of Accident Causation developed by H.W. Heinrich in 1931 is an example of a sequence of events model. [Heinrich, 1931]

The sequential model is not limited to a simple series and may utilize multiple sequences or hierarchies such as event trees, fault trees, or critical path models. Sequential models are attractive because they encourage thinking in causal series, which is easier to represent graphically and easier to understand. In this model, an unexpected event initiates a sequence of consequences culminating in the unwanted outcome. The unexpected event is typically taken to be an unsafe act, with human error as the predominant cause.

The sequential model is also limited because it requires strong cause and effect relationships that typically do not exist outside the technical or mechanistic aspect of the accident. In other words, true cause and effect relationships can be found when analyzing the equipment failures, but causal relationships are extremely weak when addressing the human or organizational aspect of the accident. For example: While it is easy to assert that “time pressure caused workers to take shortcuts,” it is also apparent that workers do not always take shortcuts when under time pressure.

In response to large scale industrial accidents in the 1970’s and 1980’s, the epidemiological models were developed that viewed an accident the outcome of a combination of factors, some active and some latent, that existed together at the time of the accident. [Hollnagel, 2004]



Excerpt from DOE-HDBK-1208-2012, Accident and Operational Safety Analysis

This is a complex, linear cause and effect model where accidents are seen as the result of a combination of active failures (unsafe acts) and latent conditions (unsafe conditions). These are often referred to as epidemiological models, using a medical metaphor that likens the latent conditions to pathogens in the human body that lay dormant until triggered by the unsafe act. In this model, accidents are prevented by strengthening barriers and defenses. The "Swiss Cheese" model developed by James Reason is an example of the epidemiological model. [Reason, 1997] This model views the accident to be the result of long standing deficiencies that are triggered by the active failures. The focus is on the organizational contributions to the failure and views the human error as an effect, instead of a cause.

The epidemiological models differ from the sequential models on four main points:

- Performance Deviation – The concept of unsafe acts shifted from being synonymous with human error to the notion of deviation from the expected performance.
- Conditions – The model also considers the contributing factors that

could lead to the performance deviation, which directs analysis upstream from the worker and process deviations.

- Barriers – The consideration of barriers or defenses at all stages of the accident development.
- Latent Conditions – The introduction of latent or dormant conditions that are present within the system well before there is any recognizable accident sequence.

The epidemiological model allows the investigator to think in terms other than causal series, offers the possibility of seeing some complex interaction, and focuses attention on the organizational issues. The model is still sequential, however, with a clear trajectory through the ordered defenses. Because it is linear, it tends to oversimplify the complex interactions between the multitude of active failures and latent conditions.

The limitation of epidemiological models is that they rely on "failures" up and down the organizational hierarchy, but does nothing to explain why these conditions or decisions were seen as normal or rational before the accident. The recently developed systemic models start to understand accidents as unexpected combinations of normal variability. [Hollnagel, 2004]10 [Dekker, 2006]15

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Engineered Controls: Engineered design controls are all those hardware, software, and equipment items in the physical environment that affect people's behavior, choices, and attitudes, and are a result of engineering design. Engineered controls act either actively or passively. *Active controls include equipment such as pumps or valves that perform a specific safety-related function. Passive controls include pipes, vessels, and berms that provide containment and generally do not have moving parts.* The most reliable defense mechanisms are passive because they require no operational or maintenance support to remain effective, eliminating dependence on human involvement.

Administrative controls, such as procedures, inform people about what to do, when to do it, where it is to be done, and how well to do it, and are usually documented in various written policies, programs, and plans. Administrative controls rely on human judgment, training, and personal initiative to follow the direction contained in documents. Consequently, administrative controls are not as reliable as engineered controls.

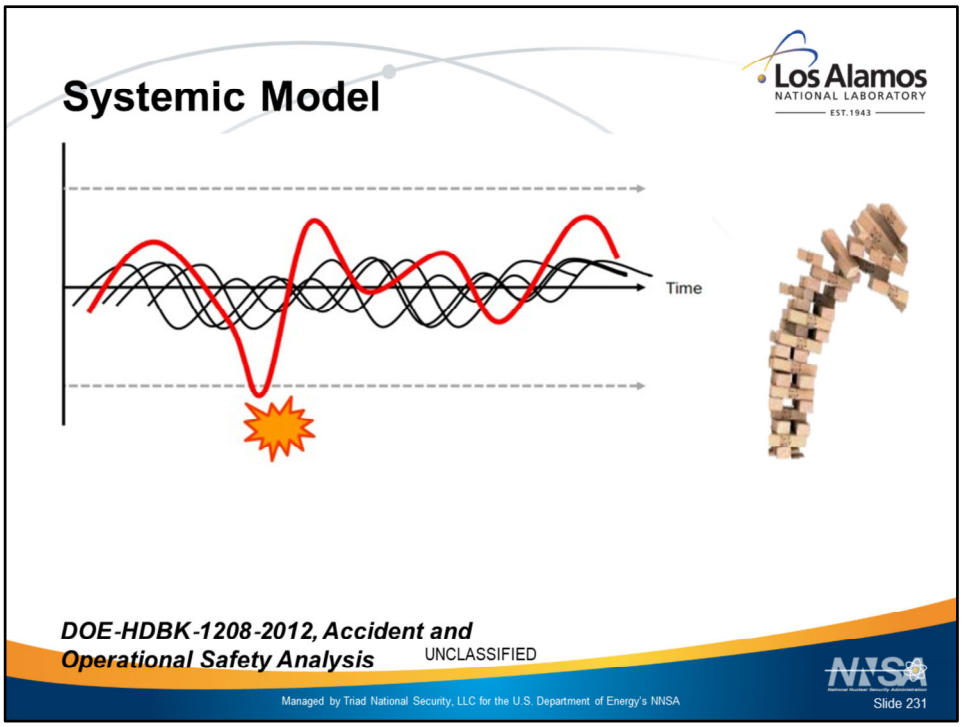
Cultural Controls – Values, Beliefs, Attitudes - An effective safety culture

engenders the belief that when production and safety conflict, safety will prevail. Cultural controls include those leadership practices that teach (consciously or unconsciously) people how to perceive, think, feel, and behave toward challenges to safety. Culture is defined by people's behavior, and safe behavior is value-driven. What an organization says its values are may not be reflected in its behavior. The true values of an organization are reflected in the observed acts of its people, especially its managers. For instance, when procedures are vague or incomplete, people tend to default to what they think is important for success as they define it.

- **Values** What managers place importance on and what is considered "high priority" becomes valued in the organization, whether this is publicly espoused or not. Key management values are usually visible at the site or at the facility in meeting rooms and conspicuous, high-traffic areas (both in the facility and outside the facility) where everyone sees them. When workforce behaviors become consistent with management's espoused values over the long term, then the organization has truly internalized those values.
- **Beliefs** What people believe (or perceive) to be true tends to drive their attitudes and behavior. A belief is an acceptance of and conviction in the truth, existence, or validity of something, including assumptions about what will be successful. People erroneously believe they can always maintain control whenever and wherever. Typically, this is the case when people decide to take shortcuts or violate a safety policy. This belief changes as people understand the realities associated with human performance. The following beliefs have a significant positive impact on event-free performance.
- **Attitudes** An attitude is a state of mind, or feeling, toward an object or subject. Importantly, attitudes affect people's choices and behaviors toward safety and error prevention. Positive feelings follow safe behaviors when people experience positive and consistent feedback from supervisors and peers and they understand why the feelings are important. If people experience negative feelings when they use safe behaviors (pain, fear, anxiety, frustration, humiliation, embarrassment, boredom, or discomfort) they will tend to avoid those behaviors and practices.
- **Work Group Norms** - A person's peer group is the largest, single determinant of an individual's behavior on the job. Norms tell people what they are supposed to do, wear, say, and believe; what is

acceptable and what is unacceptable; what to look for; what to ignore; how to see things; and how to interpret what they see and hear. Norms are passed on by word of mouth and are enforced by how a person's peers respond when a norm is broken.9 If work group members think one person is working too hard, they may make jokes and unkind remarks to the person until he/she adopts the group's norm for what is considered an appropriate level of effort. In extreme cases, the peer group may shun or attack the person until he or she complies with the group's "rules."

Oversight Controls - Vulnerabilities with controls can be found and corrected when management decides it is important enough to devote resources to the effort. The very nature of latent conditions is such that they will not self-reveal, they must be discovered. The fundamental aim of oversight is to improve facility resilience to significant events triggered by active errors in the workplace—that is, to minimize the severity of events. Oversight controls provide opportunities to see what is actually going on in the facility, to identify specific vulnerabilities or performance gaps, to take action to address those vulnerabilities and performance gaps, and to verify that they have been resolved.



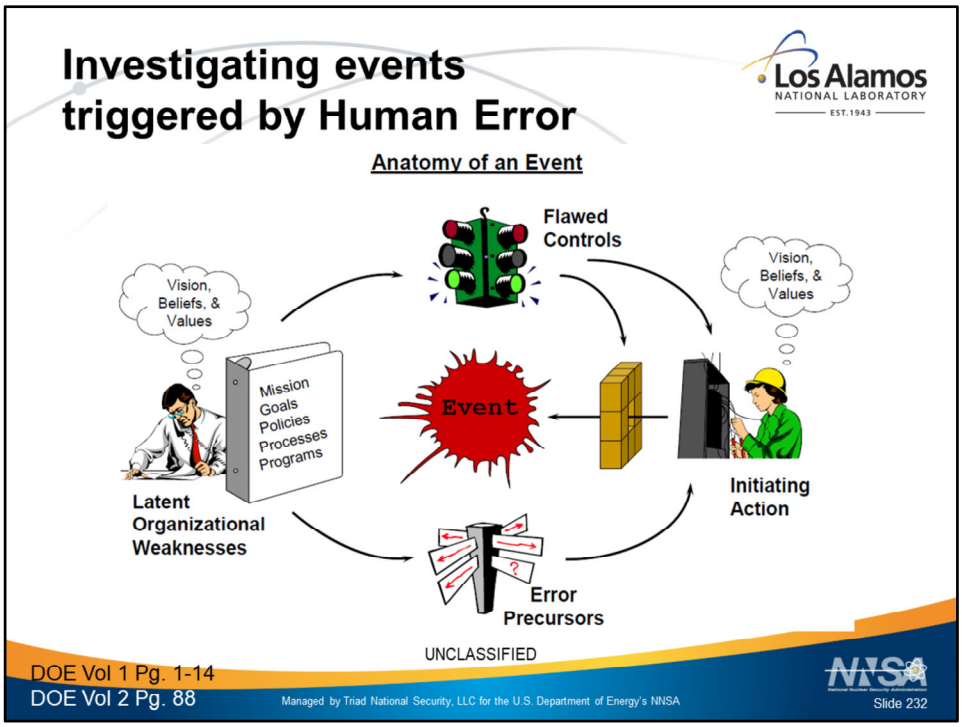
Excerpt from DOE-HDBK-1208-2012, Accident and Operational Safety Analysis

This is a complex, non-linear model where both accidents (and success) are seen to emerge from unexpected combinations of normal variability in the system. In this model, accidents are triggered by unexpected combinations of normal actions, rather than action failures, which combine, or resonate, with other normal variability in the process to produce the necessary and jointly sufficient conditions for failure to succeed. Because of the complex, non-linear nature of this model, it is difficult to represent graphically. The Functional Resonance model from Erik Hollnagel uses a signal metaphor to visualize this model with the undetectable variabilities unexpectedly resonating to result in a detectable outcome.

The Jenga™ game is also an excellent metaphor for describing the complex, non-linear accident model. Every time a block is pulled from the stack, it has subtle interactions with the other blocks that cause them to loosen or tighten in the stack. The missing blocks represent the sources of variability in the process and are typically described as organizational weaknesses or latent conditions. Realistically, these labels are applied retrospectively only after what was seen as normal before

the accident, is seen as having contributed to the event, but only in combination with other factors. Often, the worker makes an error or takes an action that seems appropriate, but when combined with the other variables, brings the stack crashing down. The first response is to blame the worker because his action demonstrably led to the failure, but it must be recognized that without the other missing blocks, there would have been no consequence.

A major benefit of the systemic model is that it provides a more complete understanding of the subtle interactions that contributed to the event. Because the model views accidents as resulting from unexpected combinations of normal variability, it seeks an understanding of how normal variability combined to create the accident. From this understanding of contributing interactions, latent conditions or organizational weaknesses can be identified.



Start by reviewing "Recommended Practices" found in Human Performance Management Tool "Investigating Events Triggered by Human Error in Volume 2, page 85
For steps 9-13 REFERENCE that additional information for the Anatomy of an Event may be found in Volume 1, pages 1-14 thru 1-15.

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DOE Volume 1, page 1-14

Typically, events are triggered by human action. In most cases, the human action causing the event 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. The "Anatomy of an Event" graphic provides an illustration of the elements that exist before a typical event occurs. Breaking the linkages may prevent events.

Event

An event, as defined earlier, is an unwanted, undesirable change in the state of facility structures, systems, or components or human/organizational conditions (health, behavior, administrative controls, environment, etc.) that exceeds

established significance criteria. Events involve serious degradation or termination of the equipment's ability to perform its required function. Other definitions include: an outcome that must be undone; any facility condition that does not achieve its goals; any undesirable consequence; and a difference between what is and what ought to be.

Initiating Action

The initiating action is an action by an individual, either correct, in error, or in violation, that results in a facility event. An *error* is an action that unintentionally departs from an expected behavior. A *violation* is a deliberate, intentional act to evade a known policy or procedure requirement and that deviates from sanctioned organizational practices. Active errors are those errors that have immediate, observable, undesirable outcomes and can be either acts of commission or omission. The majority of initiating actions are active errors. Therefore, a strategic approach to preventing events should include the anticipation and prevention of active errors.

Flawed Controls

Flawed controls are defects that, under the right circumstances, may inhibit the ability of defensive measures to protect facility 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 injury, equipment damage, environmental contamination, cost); and
- promote consistent behavior.

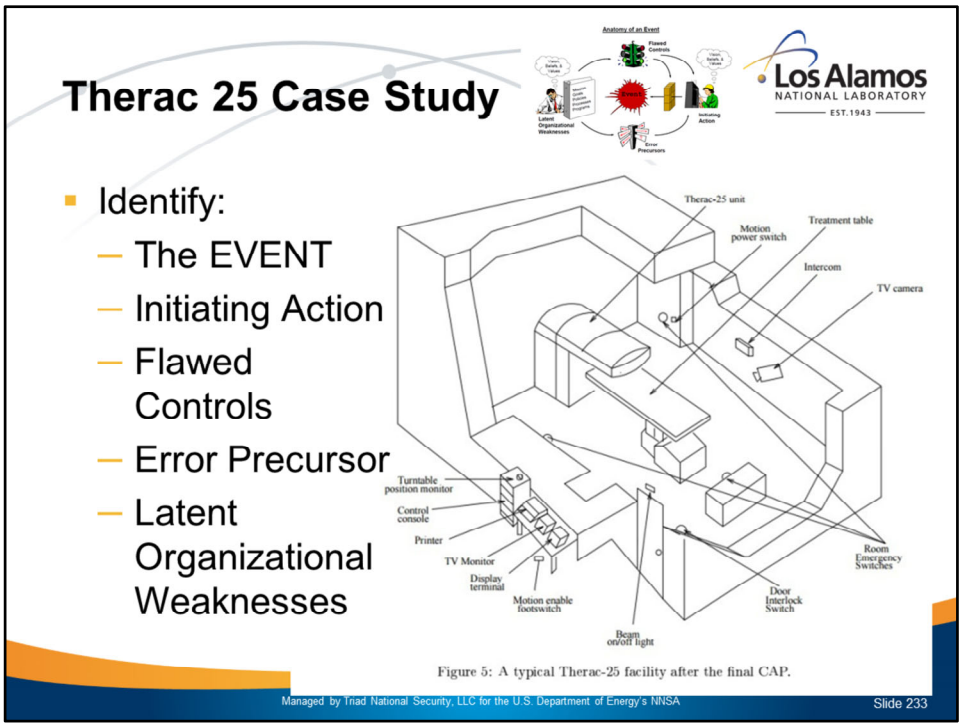
When an event occurs, there is either a flaw with existing controls or appropriate controls are not in place.

Error Precursors

Error precursors are unfavorable prior conditions at the job site that increase the probability for error during a specific action; that is, error-likely situations. An error-likely situation—an error about to happen—typically exists when the demands of the task exceed the capabilities of the individual or when work conditions aggravate the limitations of human nature. Error-likely situations are also known as error traps.

Latent Organizational Weaknesses

Latent organizational weaknesses are hidden deficiencies in management control processes (for example, strategy, policies, work control, training, and resource allocation) or values (shared beliefs, attitudes, norms, and assumptions) that create work place conditions that can provoke errors (precursors) and degrade the integrity of controls (flawed controls). Latent organizational weaknesses 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. The decisions and activities of managers and supervisors determine what is done, how well it is done, and when it is done, either contributing to the health of the system(s) or further weakening its resistance to error and events. System-level weaknesses are aggregately referred to as latent organizational weaknesses. Consequently, managers and supervisors should perform their duties with the same uneasy respect for error-prone work environments as workers. A second strategic thrust to preventing events should be the identification and elimination of latent organizational weaknesses.



Hand out Therac 25 case study
Use this illustration to explain the layout of the room, where the technician was located, and varous features they will discover in the case study
Direct students to look for the "Anatomy of an Event" components and be ready to discuss
IF class size is large enough, break into groups for report-out on components
Give students a few minutes to read (and discuss if in groups)

Use the next slide to explain what happened, prior to report out

Have students report out on their findings
Use Instructor answer key to record student responses…fill in where necessary.

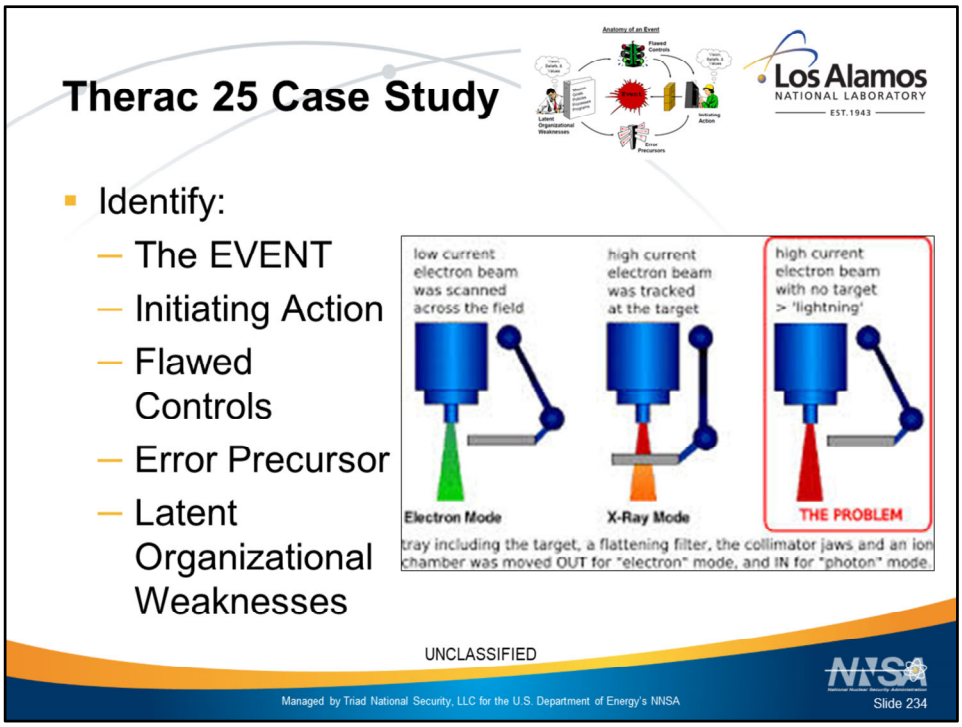
****

The **Therac-25** was a radiation therapy machine produced by Atomic Energy of Canada Limited (AECL) in 1982 after the Therac-6 and Therac-20 units (the earlier units had been produced in partnership with CGR of France).
It was involved in at least six accidents between 1985 and 1987, in which patients were given massive overdoses of radiation.[1]:425 Because of concurrent programming errors, it sometimes gave its patients radiation doses that were hundreds of times greater than normal, resulting in death or serious injury.[2] These accidents highlighted the dangers of software control of safety-

critical systems, and they have become a standard case study in health informatics and software engineering. Additionally the overconfidence of the engineers[1]:428 and lack of proper due diligence to resolve reported software bugs, is highlighted as an extreme case where the engineer's overconfidence in their initial work and failure to believe the end users' claims caused drastic repercussions.

he accidents occurred when the high-power electron beam was activated instead of the intended low power beam, and without the beam spreader plate rotated into place. Previous models had hardware interlocks in place to prevent this, but Therac-25 had removed them, depending instead on software interlocks for safety. The software interlock could fail due to a race condition. The defect was as follows: a one-byte counter in a testing routine frequently overflowed; if an operator provided manual input to the machine at the precise moment that this counter overflowed, the interlock would fail.[2]

The high-powered electron beam struck the patients with approximately 100 times the intended dose of radiation, delivering a potentially lethal dose of beta radiation. The feeling was described by patient Ray Cox as "an intense electric shock", causing him to scream and run out of the treatment room.[3] Several days later, radiation burns appeared and the patients showed the symptoms of radiation poisoning; in three cases, the injured patients later died as a result of the overdose. [4]

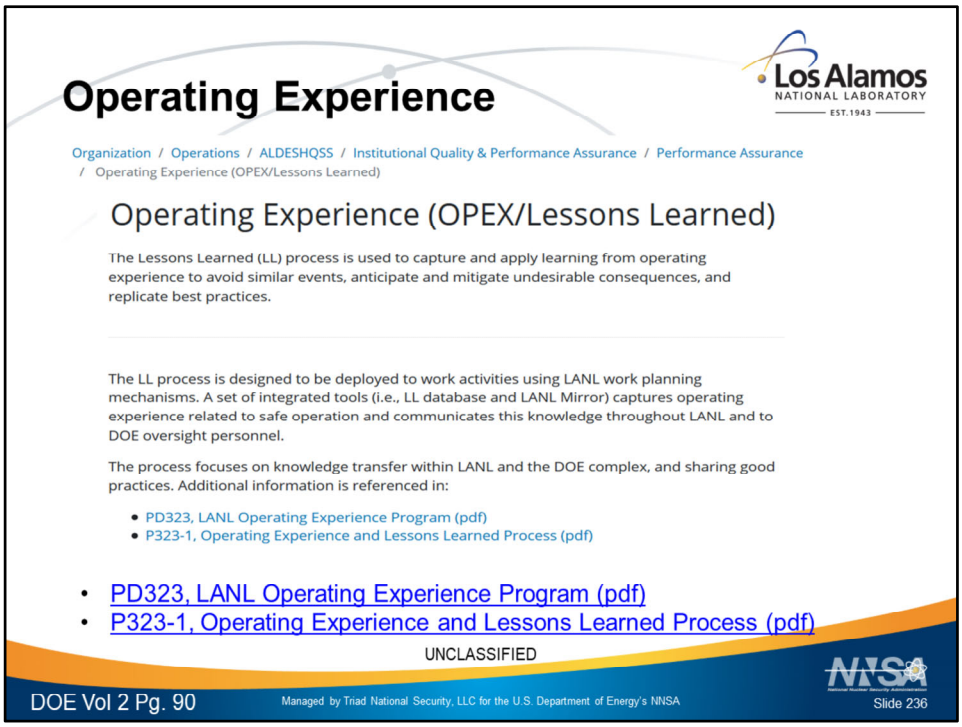


Therac 25 Case Study Support slide

Common Error Precursors

Task Demands	Individual Capabilities
• Time pressure (in a hurry)	• Unfamiliarity with task / First time
• High Workload (large memory requirements)	• Lack of knowledge (faulty mental model)
• Simultaneous, multiple tasks	• New technique not used before
• Repetitive actions / monotony	• Imprecise communication habits
• Irreversible actions	• Lack of proficiency / Inexperience
• Interpretation requirements	• Indistinct problem-solving skills
• Unclear goals, roles, or responsibilities	• Unsafe attitude
• Lack of or unclear standards	• Illness or Fatigue; general poor health or injury
Work Environment	**Human Nature**
• Distractions / Interruptions	• Stress
• Changes / Departures from routine	• Habit patterns
• Confusing displays or controls	• Assumptions
• Workarounds / Out of Service instruments	• Complacency / Overconfidence
• Hidden system / equipment response	• Mindset (intention)
• Unexpected equipment conditions	• Inaccurate risk perception
• Lack of alternative indication	• Mental shortcuts or biases
• Personality conflicts	• Limited short-term memory

Use this slide when discussing “Error Precursors” in Therac 25 EXERCISE.
Discuss each section, having student identify the applicable error precursor (including their reason for selection),



- PD323, LANL Operating Experience Program (pdf)
- P323-1, Operating Experience and Lessons Learned Process (pdf)

Overview

The basic logic behind the need for a thorough operating experience program is that serious accidents are almost always preceded by less serious "precursor events." A precursor event is an actual event or condition that has some of the characteristics of a serious accident, but falls short of significant consequence. By taking actions to prevent recurrence of similar events, one is thereby reducing the probability of serious accidents. All major facilities experience individual component and system failures from time to time, almost always with limited to no safety consequences. Many of these operating events include contributions from human and organizational factors. If no steps are taken to correct the fundamental causes of these failures, they will recur and accompanied by other failures or perhaps human errors, will lead to a more serious event or accident. Therefore, an effective Operating Experience (OE) program is a key factor in maintaining the strength of the defense-in-depth concept. The rationale for the importance of a vigorous OE program to promote effective human performance (safety, quality, and productivity) is to:

- learn from the local experience as well as other organizations' experiences with successes, failures, and near-misses;
- identify processes to be improved by "best industry practices";
- identify processes to be improved by "best industry practices";

- identify local organizational conditions similar to those which have led to problems in other organizations;
- identify and quantify events and conditions that are precursors to more serious events;
- discover emerging trends or patterns of potential safety significance; and
- recommend steps to prevent the recurrence of similar events.

In its broad application, OE is defined as all events, conditions, observations, and new information that could affect how work is conducted. This broad definition includes the following categories.

- Actual operating events accompanied by equipment failures, human errors or other anomalous behavior
- Actual failures of systems, structures or components, or human errors, that may or may not have caused an accident
- Adverse safety conditions such as design weaknesses, degraded safety equipment or aging effects that could lead to failures of systems, structures or components
- Organizational or human factor issues such as a degraded safety culture at the facility, high human error rates, weak quality assurance programs, inadequate procedures, inadequate training
- External challenges such as vulnerability to severe weather, flooding, high winds or security threats
- Successes achieved by processes or methods put in place to improve performance

Use This Tool

- To acquire and communicate brief examples of problems and mistakes encountered in actual cases and to present points to consider for avoiding similar occurrences
- To provide relevant information on lessons learned to individuals just in time
- When work history associated with specific jobs is pertinent to the tasks being performed
- To combat the natural human tendency to think “It can’t happen here”
- To expand the sharing of good work practices

Recommended Practices When Using This Tool

1. Collect all relevant OE information – DOE Order 210.2, *DOE Corporate Operating Experience Program*, outlines how the Department collects and makes available to field elements and contractors OE information through reports, alerts, bulletins, advisories, and summaries, and on its website.

2. Screen the OE information for safety significance – Applicable contractor organizations have a designated OE Program Coordinator who functions as a point of contact with the DOE Corporate OE Program. The coordinator does the screening, the internal and external OE communications, and is the primary resource for contractor organizations.

3. Analyze the OE events or conditions – Determine local applicability.

4. Distribute applicable corporate, external and local OE documents to local potentially affected personnel for review, analysis and implementation of corrective actions.

5. Develop, implement and track actions to correct problems in the causal analysis of operating experience. Be sensitive to organizational or human factor issues such as a degraded safety culture at the facility, high human error rates, and latent organizational weaknesses (e.g., training shortfalls, design flaws, inadequate procedures, deficient equipment or tools, etc.).

6. Develop lessons learned on successes. Ensure lessons learned are factored into training, maintenance and work planning, work processes, and design and construction as well as operations.
7. Follow-up to ensure the actions are completed satisfactorily.
8. Establish metrics to measure program performance and evaluate the effectiveness of actions implemented from lessons learned.

Avoid These At-Risk Practices

- Not retaining the lessons learned and subsequently forgetting them over time
- Doing nothing in response to information learned about others' experiences
- Focusing only on local OE and lessons learned, and disregarding OE information from DOE corporate and from external sources (other industries, other agencies, professional societies, trade associations, universities, other countries)
- Failure to establish performance indicators and track trends on the effectiveness of the corrective actions and lessons learned
- Neglecting to factor OE lessons learned into training or to consider application outside of operations

- PD323, LANL Operating Experience Program (pdf)
- P323-1, Operating Experience and Lessons Learned Process (pdf)

OPEX at LANL (http://opex.lanl.gov/) may be accessed from the Inside LANL home page in three ways:

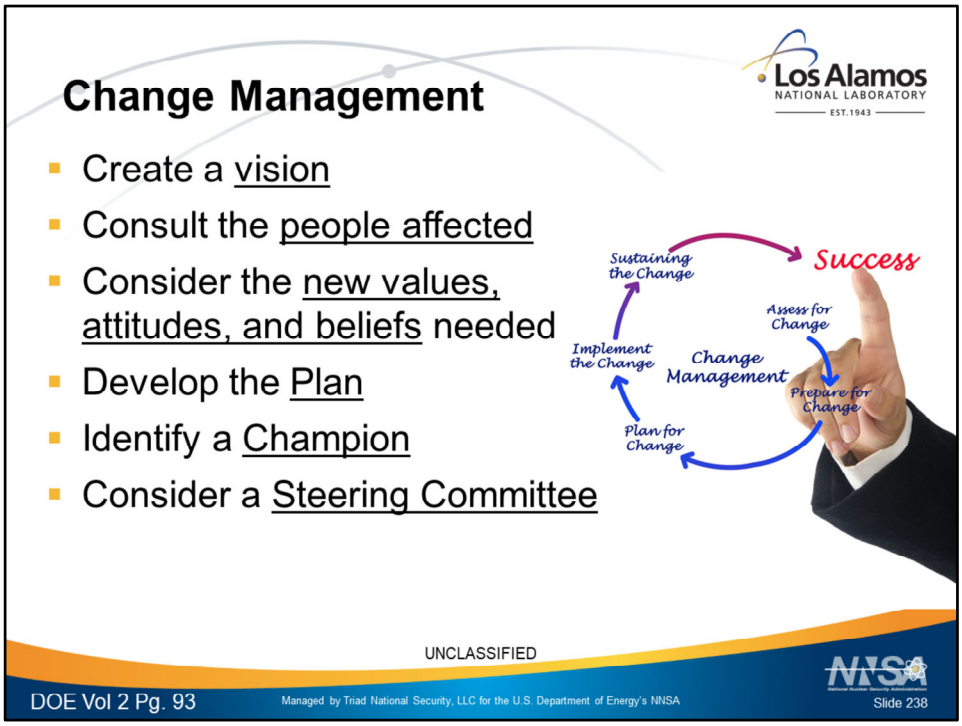
1. Safety – OPEX at LANL
2. Security – OPEX at LANL
3. Toolkit - Lessons Learned

Demonstrate the abilities of OPEX at LANL

- HOME
- CREATE
- My OPEX
    - Subscriptions
    - Favorites
- ABOUT
    - PURPOSE, what's available, etc.
    - DIRECTORY of OPEX coordinators
- RESOURCES
    - How to's, FAQ's
    - Document resources, such as PD323 and P323-1
    - Internal resources
    - External resources
- REPORTS

    - Permission required, typically for OPEX coordinators
- LOGIN
    - Login with cryptocard
- Carousel – Picture to prompt interest
    - Short description
    - Ability to VIEW actual OPEX
    - Ability to provide FEEDBACK if logged in
- Most recent
- Most Popular
- News
- View by Type
- View by DIR/PAD/AD
- View by FOD
- About

- PD323, LANL Operating Experience Program (pdf)
- P323-1, Operating Experience and Lessons Learned Process (pdf)



Part 1

Overview

For the purposes of this document, change management is defined as a methodical planning process to establish the direction of change, align people and resources, and implement the selected modification throughout an organization, large or small.

A methodical approach involving management and leadership is necessary for change to take place in an effective and timely manner. Typically, change management has been reserved for large-scale organizational change and is not considered for day-to-day activities. However, most daily management activity involves some degree of change, such as changes in crew composition, maintenance schedule, policies, procedures, and equipment.

Effective change management reduces the potential for error by managers when they modify their way of doing business. Without a structured approach to planning and implementing change, the error potential for managers and the support staff is unacceptably greater. The following change process is one of many. It is used here as an example because it specifically relates to human performance improvement.

Use This Tool

- To guide implementation of process improvement initiatives

Recommended Practices When Using This Tool

1. Create a vision – Conceive a vivid realization of what can be.

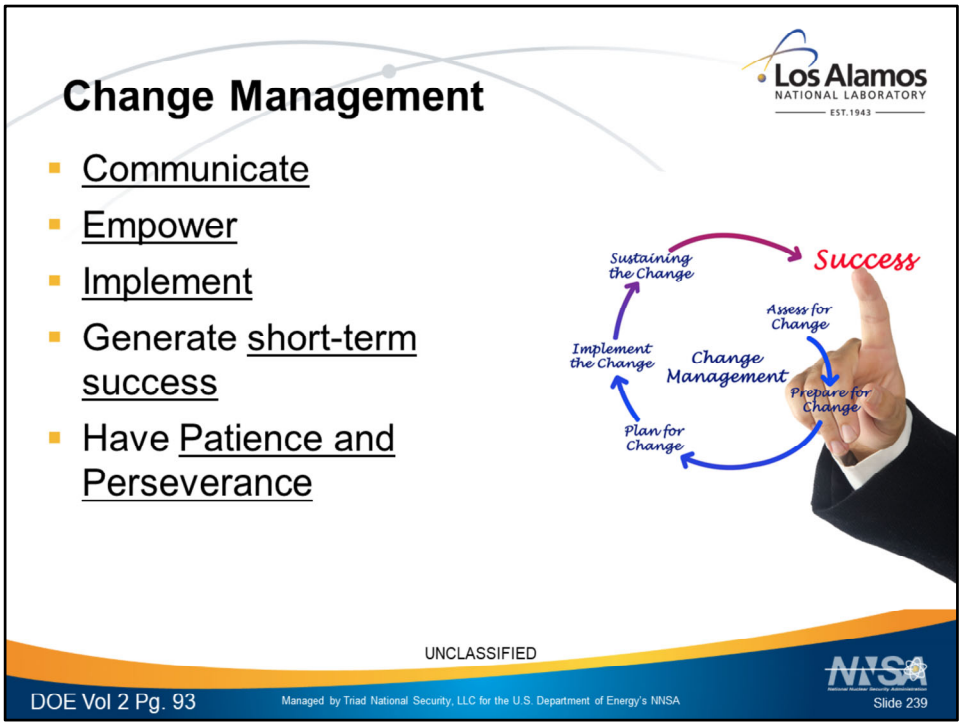
2. Consult the people affected – Talk to your folks about the proposed change; explain the value and establish the urgency to change from the present way of doing business and get their feedback on the end-game.

3. Consider the new values, attitudes, and beliefs needed – Determine what fundamental changes are required to achieve this new way of doing things.

4. Develop the plan – Make a vision-oriented implementation plan based on the principles of human performance, input from front-line workers, and on an accurate self-assessment of the present reality; clear goals and next steps—how you are going to achieve the objective.

5. Identify a Champion – A member of the management team intimately involved in the change management effort (a sponsor), preferably someone with a passion for improving human performance who possesses the authority to devote resources to the change effort.

6. Consider a Steering Committee – Knowledgeable and reputable members of line management and dedicated members of the workforce willing to take a leadership role; a temporary organization established in an advisory capacity; not a problem-solving committee (the need for a steering committee is dependent upon the significance of the change).



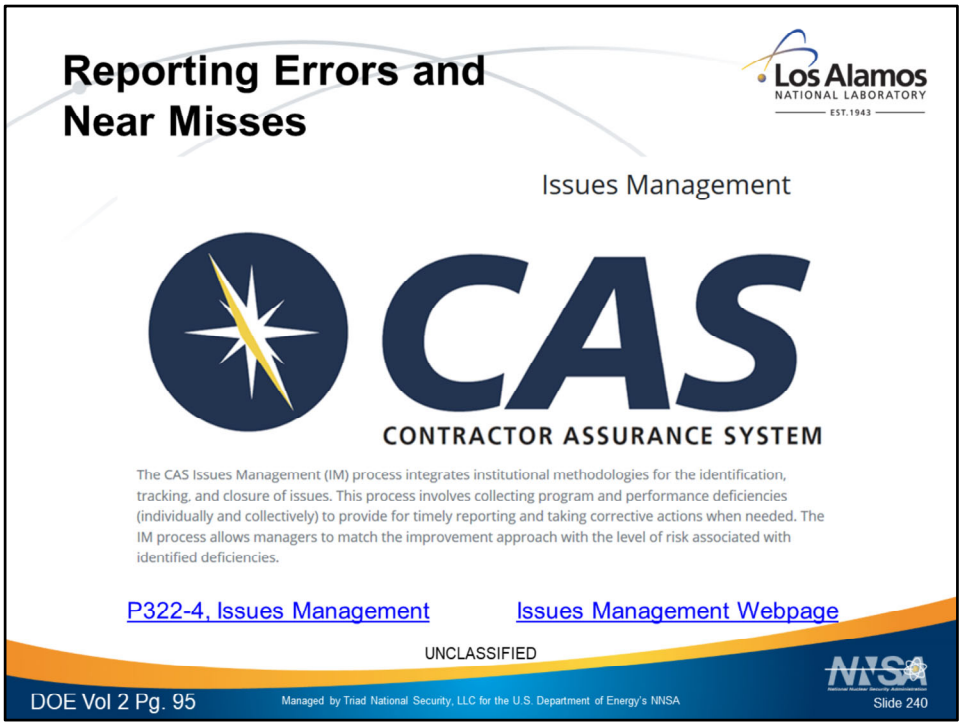
Part 2 – continued from previous slide

7. Communicate – Line management's repetitive efforts to create a shared understanding of the vision, the gap between the present and the vision's future state, and the strategy using multiple forums and mediums; include active clear explanations of expectations and account-abilities.
8. Empower – Educate people and align organizational processes to remove barriers to implementation of the strategy.
9. Implement – Work the plan, reinforce the desired behavior
10. Generate short-term successes – Identify examples that indicate the changes are working and confirm the validity of the vision; reward those who exhibit new behaviors, and build momentum for the rest of the organization.
11. Have Patience and Perseverance – Realize change does not normally happen overnight; consolidate gains in behavior via modifications to organizational processes and via leadership focus and attention; promote ongoing efforts for continuous improvement.

Avoid These At-Risk Practices

- Not setting a clear vision
- Not involving affected personnel in the vision or plan
- Failing to set expectations, establish urgency or share understanding of the need for change

- Failing to consider the new values, attitudes and beliefs needed
- Not taking the time to inform people about the coming change
- Assuming that members of the organization know about the change and the value of changing
- Being impatient and failing to stay-the-course when you have done your homework and know this is the proper approach



P322-4, Issues Management

Overview

DOE contractor organizations use various means to acquire workers' feedback on concerns, conditions, situations, and problems they encounter in the facility. Common feedback mechanisms include employee concerns programs, "hotline" (telephone or internet) for reporting concerns, pre-job briefs, job hazard walk-downs, post-job reviews, employee suggestion forms, safety meetings, and employee participation in committees and working groups. Feedback acquired from these various means primarily addresses irregularities or anomalies associated with the facility, with work processes or with equipment and machinery. Individuals are generally conscientious about reporting such things as the following.

- Physical safety hazards (dysfunctional alarms, burned out warning lamps, deficient tools, leaks and spills, radiation detection equipment malfunctions, personal protection equipment shortfalls, etc.)
- Facility deficiencies (loose stair treads, broken fixtures, HVAC problems, ice on walkways, leaky roof and the like)
- Equipment issues – both plant and office (condition, status, malfunctions, misuse maintenance, etc.)
- Security problems (violations, theft, etc.)
- Work processes (inefficiencies, quality problems, coordination failures, documentation anomalies, etc.)

Organizations that embrace human performance principles and concepts strongly encourage members of their organization to report errors and near misses. Management uses this feedback to identify organizational problems and help individuals and teams learn from these mistakes in order to perform better in the future. Documenting and learning from patterns of failure provide free lessons for organizations that are successful in acquiring this kind of feedback. It is used in training, briefings, drills, exercises, and dry runs. However, most organizations do not do a good job of acquiring feedback on human errors. The focus of this tool is to lay out the prerequisites to establishing an error reporting system. It must be recognized that a change in culture may be required within many organizations before an error reporting system can be undertaken.

Use This Tool

- To obtain information about the nature and extent of active errors taking place
- As a basis for seeking ways to alter practices that provoke error
- To strengthen training and development activities to improve performance
- When management is ready to look beyond the 'tip of the iceberg'

Recommended Practices in the Development of This Tool

A. Create a "Just Culture" – This is a required prerequisite. It involves management getting the balance right between how unintentional errors and willful violations are addressed in the organization. Ideally there should be zero tolerance for reckless conduct balanced by widespread confidence among managers that the vast majority of unintended unsafe acts will go unpunished as honest errors.

1. **Stop naming, blaming, shaming, and retraining** individuals for honest errors. Remember an error is an unintentional departure from an expected behavior—it is something the performer did not intend to do.
   - There is an overwhelming tendency to point fingers at people based on the consequence of their action and not on the intent of the action. If either the violation or error they committed causes an accident or an event of some kind, they are disciplined, but the very same actions (violations and errors) that have no consequence, are ignored or allowed to slide.
   - This means that someone who inadvertently errs is held accountable for their actions in the same way that an individual is who intentionally performs work that violates policy, procedure, or standard.
2. **Select and implement a method** to help determine culpability for serious incidents in which unsafe acts are involved. (These example methods are described in more detail in Volume I, Chapter 4, of the *Human Performance Improvement Handbook*.)
   - The Foresight Test – Ask the question of other people in the workgroup, "Did the individual involved in the incident engage in behavior that others (when asked individually) recognize as being likely to increase the probability of making a safetycritical error?"
   - Culpability Test – If the individual was working while under the influence; was clowning around with equipment or vehicles; was taking unwarranted short cuts;

or consciously selected sub-standard or inappropriate tools, equipment, or parts, then they are likely more culpable for their actions

- The Substitution Test – The following question is asked of several peers of the individual involved in the event: "In light of how events unfolded and were perceived by those involved in real time, is it likely that you (a different person with similar skills and training) would have behaved any differently?" The question can be worded differently: "given the circumstances that prevailed at the time, could you be sure that you would not have committed the same or a similar type of unsafe act?" If the answers are "no," then blame is likely inappropriate.
- Culpability Decision Tree (CDT) – This is used in conjunction with an organization's accountability policy. The CDT is a logic diagram that managers can follow as they ask questions to determine an individual's intent, expectations, prior knowledge, and prior performance problems associated with their recent unsafe act. By following the logic on the CDT, the manager can gage both individual culpability (for an intentional act to cause harm, reckless violation, and negligent error) and organizational culpability (for induced violation and induced error). See attachment.

3. **Hold the reckless violators accountable**

- Members of the organization need to know that management is getting the balance right, that willful violators are being disciplined, and that those who commit unintentional errors are not punished.
- Once people know they are not going to be punished for making an honest mistake or one likely made due to organizational conditions, the climate is ready to introduce an error reporting system.

B. Steps needed to make a successful reporting system. – Once a Just Culture is in place there are challenges to creating an effective reporting system. Listed here are several common barriers followed by a solution for resolving the barrier.

1. ***Natural disinclination*** to confess one's blunders – people do not want to be held up to ridicule

Solution – *De-identification:* make error reports anonymous or at least confidential (known to a limited few). It is a compromise as total anonymity precludes any follow-up and limited confidentiality may cause some people not to report.

2. ***Suspicion*** that such a report might go on the record and count against the individual in the future.

Solutions – *Protection:* top management must endorse a policy of indemnity (or at least partial indemnity) against disciplinary procedures for self-reporting. *Separation of Functions:* the group that collects reports should not be in a position to initiate disciplinary action.

3. ***Skepticism*** – "if we go to the trouble of writing a report that reveals system weaknesses, how can we be sure that management will act to improve matters?"

Solution – *Feedback:* rapid, useful, accessible, and intelligible feedback to the reporting community is essential. Reporting will dry-up if it is perceived that it goes into a 'black hole.'

4. ***Too much time and effort*** – Writing the report is time-consuming. Why should we do it?

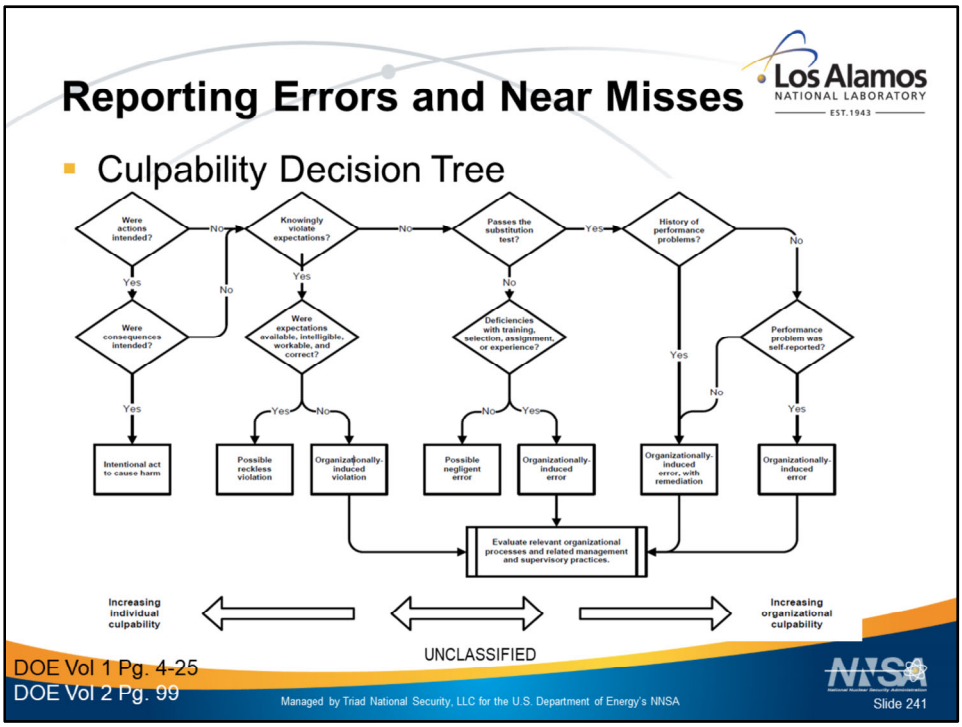
Solution – *Ease of making the report:* should be available to all. Provide for free-form input. A constrained format is less preferred.

C. A Sound Reporting Strategy – Carry out the following activities with the help of a human performance improvement committee or equivalent.

1. **Inform** people of the forthcoming reporting system. In managers' meetings with employees explain why it is important to obtain feedback on errors and events. Describe expectations and discuss how information will be used.
2. **Designate** an event report coordinator. The coordinator's responsibilities should include tracking and trending reports, providing feedback to the workforce, keeping management informed of significant mishaps and events with a high probability of similar outcomes in the future.
3. **Develop** a report format that is easy to use and complete with useful designators that can help managers better identify latent weaknesses in the system.
4. **Make the report form readily available** in the workplace or on computer desktops. Facility computers should have an icon on the desk top that takes users directly to the reporting form. When they have completed the form, the click of their mouse should send the document to a designated electronic address.
5. **Provide examples** of hypothetical reports. Give people a template representing the level of detail, specificity, and facility reference points that makes clear the expectations.
6. **Encourage** people to report errors and mishaps and reinforce the behavior. Inform people periodically of the significance of their reporting and how the data is being used.
7. **Track and trend errors** from the reporting system. Use this important feedback information to identify areas of high risk or process weaknesses where corrective actions can be taken to reduce error.
8. **Use data** from the reports in ongoing training and lessons learned.

Avoid These At-Risk Practices

- Launching a reporting system without first establishing a Just Culture
- Failing to address the primary reporting barriers that have to be overcome when establishing an error reporting system
- Acquiring data on errors and events and doing nothing with the information
- Using the input from the reporting system in ways that were unintended
- Failing to encourage and reinforce reporting
- Failing to provide timely feedback on reporting errors to members of the organization



The Culpability Decision Tree

The logic diagram in this slide is a proven management tool intended to help determine the culpability level of an individual in response to events or near misses triggered by human error. When used in conjunction with the organization's accountability policy, the tool supports the fair and consistent application of disciplinary outcomes across all departments and work groups. An explanation of how to make use of the Culpability Decision Tree is provided in Appendix B. The tool is an adaptation of Dr. James Reason's Culpability Decision Tree in his book, *Managing the Risks of Organizational Accidents*, which provides further in-depth description of the use of the diagram.

When an event is initiated by an *honest* error, as determined by one or more of the tools described above, the entire system that supports the performance in question should be evaluated (see "systems-thinking" in Chapter 3). Events triggered by human error are often symptomatic of a *system failure*. Instead of asking how the individual failed the organization, the question "how did the organization fail the individual?" would be more appropriate. In addition to the individual, what or who could have *prevented* the event? What flaws or oversights in work processes, policies, or procedures contributed, promoted, or allowed the error and event to occur? Because the majority of the causes of events originate in the system of controls, processes, and values established by the management team, management's first reaction to events should be to look within the organization.

INPO 07-006 – Culpability Model Questions:

Were actions intended?

This question helps determine the person's intent relative to the person's immediate objective. If the actions were not intended ("I meant to push button A, but somehow pushed button B"), then a slip or lapse occurred. If the answer is "No," proceed to the question regarding procedures and expectations.

Were consequences intended?

If the person intended to perform the action but did not intend the consequence, then the action is likely a mistake or a possible routine violation or shortcut. If the answer is "No," proceed to the next question regarding expectations. <u>However, if the answer is "Yes," then the performance situation does not involve an honest mistake but a deliberate, malevolent act intended to cause harm.</u>

Intentional act to cause harm

Performance involves a willful act intended to cause harm. A disgruntled worker whose purpose is to undermine or destroy the employer's efforts, accomplishments, or products might sabotage the workplace. Immediate management attention is required. There may be broad ramifications to the person's actions.

Explore performance management options...

Typically, individuals receive penalties in a progressive fashion, usually in the order of verbal warnings, written warnings, and then termination. Disciplinary action is sometimes necessary. Occasionally, termination is the best option for unruly individuals, who can be a troublesome and dangerous influence to the rest of the workforce. However, disciplinary action can seriously damage the perception of trust, respect, and fairness if handled uncaringly. However, if the performance problem seriously threatens safety and reliability, then risking undesirable side effects to stop the behavior immediately is warranted.

Knowingly violated procedures or expectations?

A violation involves a conscious decision on the part of the individual to bend or break the rules. Did the individual recognize the risk of the action; and was the individual's intent in light of the risk proper? The answer to the question at the left is "Yes" if the individual was aware of the expectation but *consciously* chose not to conform to it.

However, a person's care or rigor of execution of an expectation sometimes drifts from the written standard to something different than intended by management. The current practice may have become acceptable by the lack of correction by managers or supervisors. The violation or shortcut may have become the work group's norm—a routine violation—and the individual may not have consciously violated the written expectation. If so, a "No" answer should be considered and the substitution test evaluated next.

Were procedures or expectations available, intelligible, workable, and correct?

Proper procedures and reasonable expectations are to be sensible, logical, and practical for the work situation. The procedure or expectation may not accurately match the work situation, requiring the individual to work around the situation to get the job done. Such work situations tempt the individual to make a judgment call in the field. Managers and supervisors develop procedures and expectations with imperfect knowledge of all work situations that workers could encounter. A procedure or expectation for a particular situation

may, in fact, create an unsafe condition, and it would be prudent for the person to disregard the expectation so as to avoid the obvious consequences. If it can be argued that the individual was attempting to achieve the desired outcome but the situation rendered the expectation or procedure unsuitable, then a "No" answer is appropriate. If the answer is "No" or cannot be established, then the error or violation may have been system induced. However, if procedures and expectations were readily available, workable given the work situation, intelligible, and correct and were communicated to the individual, then "Yes" is a proper response, and the individual is culpable for a possible reckless violation.

Possible reckless violation

Recklessness involves taking a deliberate and unjustifiable risk—one that is foreseeable and where a bad outcome is likely though not certain. Obviously, the justification for any action depends on 1) its value to the organization and the emphasis leadership places on it and 2) the probability of foreseeable and harmful consequences. Although not as serious as sabotage, such acts require immediate management action and investigation.

System-induced violation

People perform within a system designed to facilitate the accomplishment of the organization's mission and goals. The system comprises the technology, organizational processes and procedures, standards, values, and beliefs, among others, that management uses to govern people's behaviors and practices in a facility. Deficiencies with one or more of these organizational factors likely created the conditions for violation. The quality and usability of procedures require further scrutiny; the sensibility or suitability of the expectation(s) in question needs review; or management or supervisory practices are questionable.

At this point, it seems appropriate to apply the substitution test to substantiate the culpability of the individual once deliberate noncompliance has been eliminated as a factor in the event.

Passes the substitution test?

The analyst can apply a simple mental test by asking him- or herself the following question: "*In light of how events unfolded at the time as perceived by the individual in real time, could one or more motivated, comparably qualified and experienced individuals take the same action under similar circumstances*?" If the answer is "probably," then the person passes the substitution test (a "Yes" answer). Assigning blame obscures discovery of systemic or organizational deficiencies.

Another way to evaluate the substitution test is to personally ask the individual's peers, "*Given the circumstances that prevailed at that time, could you be certain that you would* ***not*** *have committed the same or similar action?"* If the answer is "probably not," then the individual passes the substitution test (a "Yes" answer). If the individual does not pass the substitution test, then the performance problem is specific to the individual or the work setting.

Deficiencies with work setting, training, selection, resources, or incentives?

If factors exist regarding the work setting; the person's training and qualification; selection; resources; or incentives relevant to the job, then it is likely that the unsafe act was induced by the organization. Proficiency, experience, fatigue, and fitness for duty are other factors to consider. A person may be qualified and experienced but may not have performed the task

recently enough to stay current with its demands. If no deficiencies exist with the work setting, training, selection, resources, or incentives, then a possible negligent error is considered.

Possible negligent error

Negligence involves bringing about a consequence that a reasonable and prudent person would have foreseen and avoided. A reasonable person would have been aware of the potential consequence and avoided the act. There is much less culpability associated with negligence than with recklessness. This is a situation in which the person's intent was honorable, but his or her action, in retrospect, was unwise. Usually, there are extenuating circumstances that may explain why the person was unaware of the potential consequence: Why did he or she think it was the proper action to take? Absentmindedness, which varies considerably between individuals, may have played a role. However, it must remain clear that absentmindedness has nothing to do with a person's ability or intelligence. Depending on the preponderance of evidence and the person's performance history, some form of training, counseling, or disciplinary action may be appropriate.

System-induced error

The conditions associated with the person's actions were shaped by organizational processes or the prevailing culture—the system. Error precursors possibly existed at the job site during performance that provoked the error. For instance, when the control room reduces the number of concurrent maintenance activities allowed, and the work control process does not revise the maintenance schedule to correspond with the new tempo, craft personnel will be tempted to rush through their work to stay on schedule. While hurrying through a work activity, the worker makes a mistake.

It is important to remember at this point in the assessment that the severity of the event consequences is the outcome of flawed or missing defenses, not the individual's action or inaction. In significant events, it is the organizational weaknesses that diminish the integrity, robustness, and the presence of defenses.

History of performance problems?

This question helps determine the focus of performance improvement. Either improve the individual's performance in the current position, or consider other career options that he or she may be more suited to. The process of selecting people for the job may be suspect in that the person may have been placed in a job for which he or she is unsuitable. The person may not have the aptitude necessary for the task. Discipline should not be an automatic response.

People's personal error rates and how they err vary widely but consistently. If the person has a history of unsafe acts, errors, or disciplinary action, it may not be relevant to this occasion. However, it may constitute a pattern of poor performance, and the individual may be a habitual or repeat offender.

System-induced error, with remediation

If the person has a history of unsafe acts, errors, or disciplinary action, it probably indicates the need to consider performance management options, which may include alternate career options, the need for counseling, or special training for the individual.

If the error was system induced, identify the organizational contributors. Most *blameless* errors contain system-induced elements. Identification and resolution of the conditions that

provoked the error can be addressed through the corrective action program.

Was performance problem self-reported?

All persons involved in or having knowledge of a human error or mistake are required to do the following:

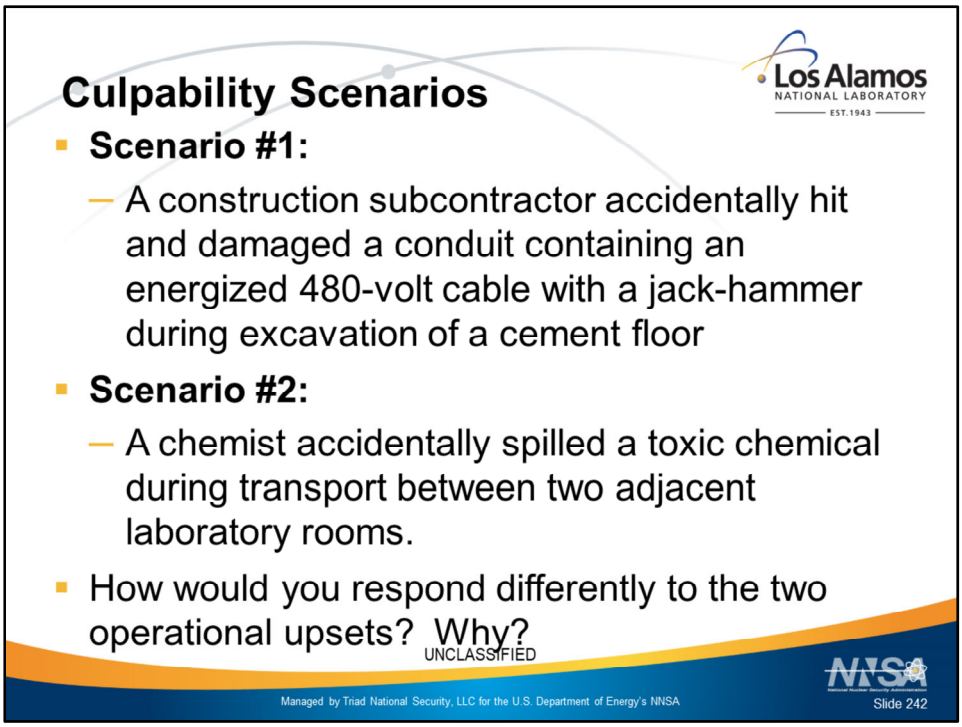
- Promptly report the error to one's immediate supervisor or other appropriate authority.
- Cooperate in any resulting investigation, and provide input to or assist in determining corrective actions.

However, if the individual avoided reporting the error for fear of retribution, there may be concerns regarding the organization's management style or the immediate work group's norms and values.

Evaluate relevant organizational processes, standards, and related management/supervisory practices.

The challenge here is to identify how the organization shaped the individual's behavior. The key is identifying those specific job-site conditions that influenced performance, whether error precursors or other factors. Knowing how processes, standards, technologies, and culture influenced worker behavior offers insight into how to improve.

A self-assessment of related processes and cultural factors and a performance gap analysis offer two methods, among others, to isolate the specific organizational contributors to the particular performance issue.



SOURCE: LANL Human Performance Improvement Concepts Guide (October 2006) page 27 (LA-UR-07-0176)

EXERCISE: For the following two scenarios, use the culpability decision tree to determine the intent of the worker's actions.

Scenario 1

A construction subcontractor, with an unblemished safety record and a clean bill of health, accidentally hit and damaged a conduit containing an energized 480-volt cable with a jack-hammer during excavation of a cement floor. The worker had successfully completed a planned and authorized excavation in an adjacent building ahead of schedule. He began the excavation that resulted in the damaged conduit immediately afterward. Because the second operation had not been covered in the pre-job briefing for that day, the work was not authorized. The contractor did not know that the paint markings indicating the conduit had been worn away (a problem that would have been addressed in the next day's pre-job briefing).

When investigators questioned other subcontractors assigned to the project, <u>the majority responded that due to time constraints and deadlines they too would have worked ahead and begun the operation that was scheduled for the next day</u>. Although the prime contractor's written policies forbade authorization to do work without a pre-job briefing, the <u>subcontractor's policies and training made no mention of that requirement</u>.

What type of error or violation did the construction subcontractor commit? ANSWER: system educed error

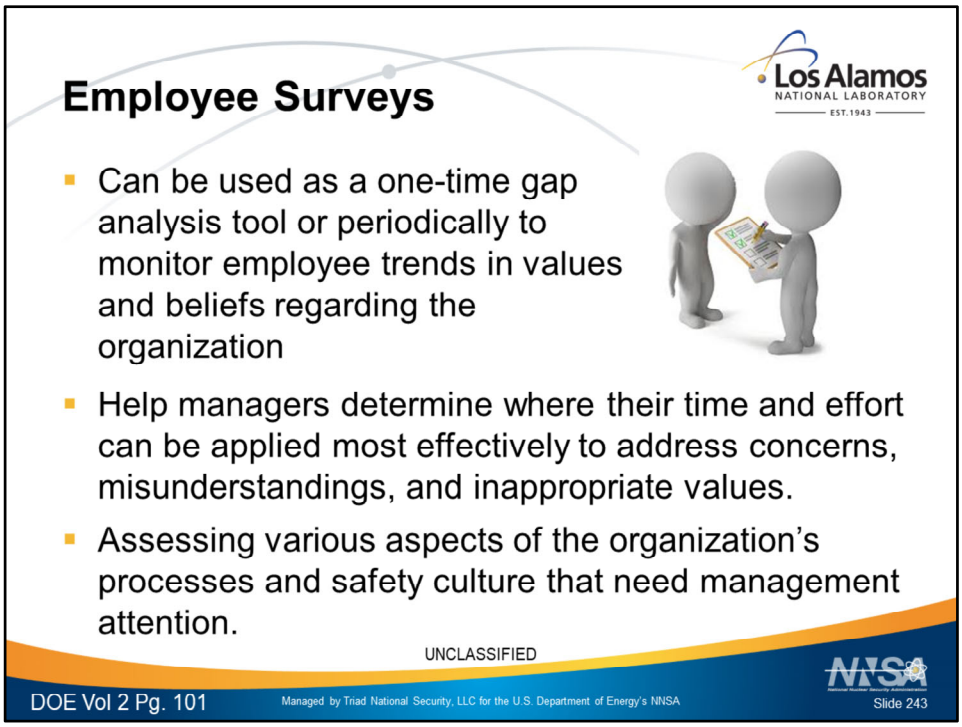
Scenario 2

A chemist accidentally spilled a toxic chemical during transport between two adjacent laboratory rooms. The chemical was transported in an open container without secondary containment. Although regulations and policies prohibited the chemical from being moved without proper containment and authorization, the scientist proceeded because the laboratory rooms were located next to each other and the chemical would be returned to its original location within an hour. He assumed his steady hand and expertise would protect hin1 from having an accident.

When investigators questioned other chemists at the laboratory, they unanimously responded that they would not have transported the chemical without proper containment and authorization, especially given the risks associated with the chemical and their training in proper transportation procedures. The chemist who spilled the chemical had attended training and was aware of the policies and regulations.

What type of error or violation did the chemist commit? ANSWER: possible negligent error

How would you respond differently to the two operational upsets? Why?



These surveys can be used as a one-time gap analysis tool or periodically to monitor employee trends in values and beliefs regarding the organization. Survey results help managers determine where their time and effort can be applied most effectively to address concerns, misunderstandings, and inappropriate values. Employee responses to surveys can be very useful in assessing various aspects of the organization's processes and safety culture that need management attention. Surveys have also proven useful tools in discovering issues related to human performance awareness and related matters. The survey instruments are presented in the pages below as examples. A brief introduction to each of them follows.

- The <u>Organizational Safety Climate Assessment Questionnaire</u>
    - DOE Volume 2 pages 103-111
    - Provides a means to gain feedback from employees regarding safety issues, notably their attitudes and perceptions of the organization's operational practices from a safety perspective.
- The <u>Human Performance Gap Analysis Tool</u>
    - DOE Volume 2 pages 112-120
    - Is intended to be completed by the human performance improvement site leadership team in the process of implementing HPI to identify soft spots where the leadership team should focus its attention.
- The <u>Job-Site Conditions Self-Assessment Questionnaire</u>
    - DOE Volume 2 pages 122-127

- Captures the opinions of supervisors and managers on their views of job-site conditions from a human performance-based perspective. When completed, the results shed light on potential organizational weaknesses that provoke specific undesirable conditions.

Use These Tools

- To assess employees' beliefs and attitudes about the organizational safety culture in which they operate
- When initiating a human performance improvement initiative
- Periodically to trend changes in individuals' perceptions of operational practices
- When indicators suggest that human performance factors associated with mishaps and incidences are increasing
- When there is a need to identify potential latent organizational weaknesses

Recommended Practices When Using These Tools

1. **Follow the site regulations** for conducting human subject questionnaires and surveys to ensure workers' privacy and rights are protected**.**
2. **Review and validate** the questions to be used. Develop additional questions and make changes to existing questions as appropriate to fit local conditions.
3. **Determine** how and when to administer the questionnaire.
4. **Inform the** members of the organization to be surveyed of the purpose for doing this activity and answer questions, including how the feedback will be used.
5. **Administer** the questionnaire or survey instrument and assemble the data (consider making the questionnaire or survey available on facility computer desktops so individuals can respond electronically)
6. **Analyze** and interpret the data; obtain management concurrence on the results
7. **Establish** an action plan to address priority problem areas
8**. Inform** the workforce of the results of the survey and action plan and elicit their support.

Avoid These At-Risk Practices

- Failing to validate the questions for use with a specific organization or facility
- Allowing an unstructured and uncontrolled approach to administering the survey
- Neglecting to inform the workforce of the forthcoming survey and its importance
- Failing to keep management informed of the analysis results, interpretation of the data and proposed action plan
- Collecting the data and doing nothing with it
- Failing to provide feedback of the results to the employees who participated

Pick the HPI tool for the condition

Condition	HPI Tool (s)
Work process is found to be inefficient, ineffective, too costly, or too risk-ridden	• Benchmarking
Reinforce desired behaviors and coach for improvements	• Observations
Present practices and results are misaligned with desired goals and objectives	• Self-Assessment
When preventing recurrence is more important than personnel punishment	• Investigations
To provide relevant information on lessons learned to individuals just in time	• Operating Experience

Present condition, solicit responses from students, then reveal possible HPI Tools

This slide revisits ISM and associated HPI Tools that may be applied in each section

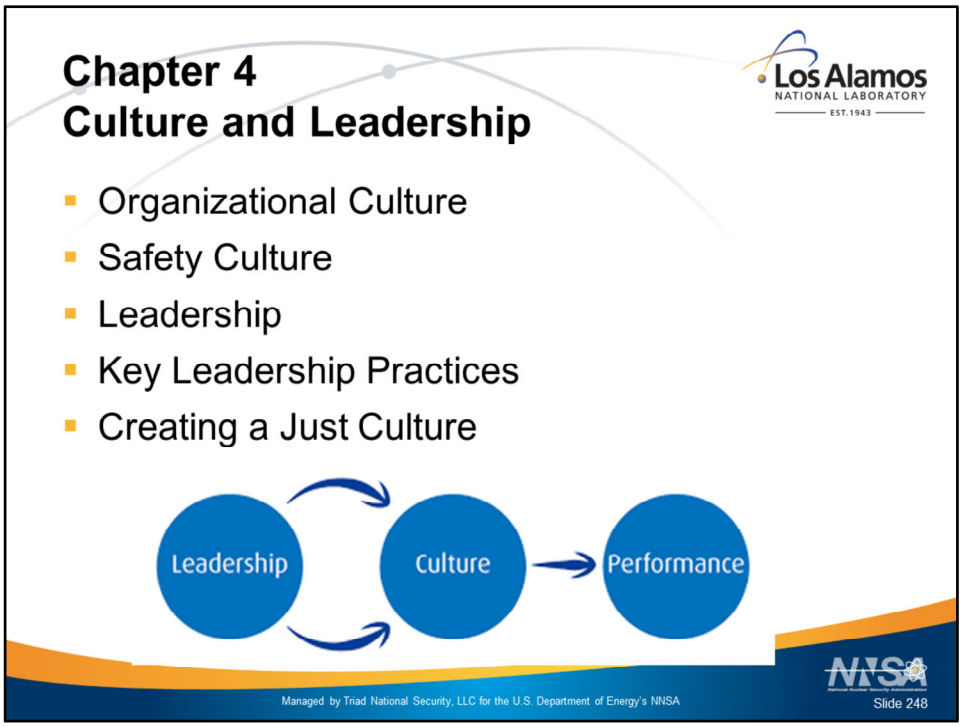
Here's the problem with tools

- Employees learn the tools
- Employees use tools
  - or management requires use of tools
- Events happen
- Leaders frame incident as a failure to use tools
  - Could you have_____?
  - Workers get defensive
- Management concludes tools don't work

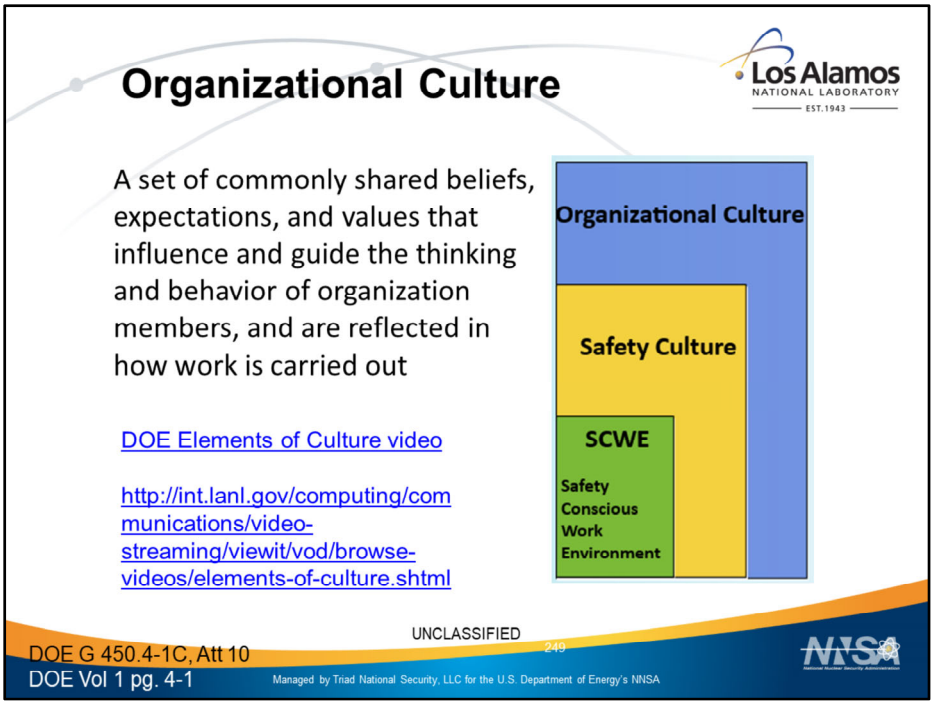
Alternatives to HPI tools

- Human Factors
  - Design with human fallibility in mind

- Systems-based Thinking
  - Make it hard for people to fail
  - Make it easy for people to do the right thing



Introduction slide for Volume 1 Chapter 4
Have students return to Volume 1, chapter 4 in DOE HPI Handbook



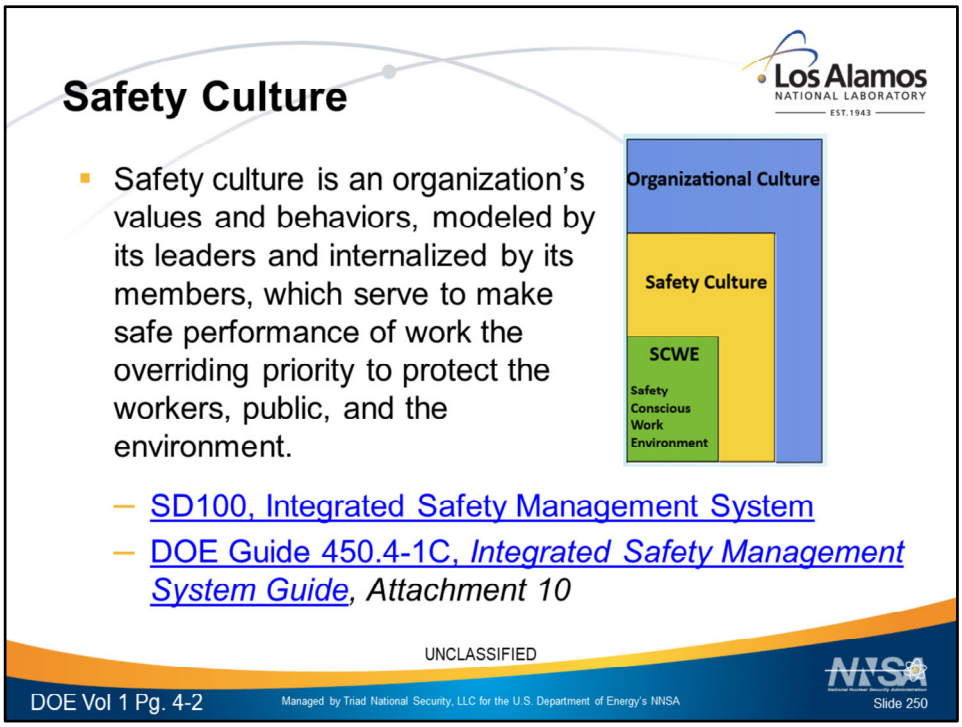
DOE Elements of Culture video
http://int.lanl.gov/computing/communications/video-streaming/viewit/vod/browse-videos/elements-of-culture.shtml
https://dti.doe.gov/hub/SiteAssets/Elements-of-Culture.mp4

ADESH-PLAN-302, rev 1, section 1.5

1.5 The Role of Culture in Operational Leadership
A cohesive relationship between leadership commitment, employee engagement, and enabling systems is a reflection of an organization's *culture*. Culture is a term that represents the sum total of a group's learning and progression and is for the group what character and personality are for the individual. As an organization experiences success and learns from problems, those experiences shape the beliefs and values that help produce desired actions that result in excellent operations. Over time, these beliefs and values become cultural norms and are taught to new members of the organization.

Because of the necessary complexity of LANL work and the unique hazards that are present, the institution, organizations, and individuals must commit to a *healthy culture* in order to succeed.

Operational Leadership creates a set of shared, principle-centered expectations that embody LANL beliefs and character and that strengthen a healthy culture. Operational Leadership is characterized by shared values that are founded on a collective commitment to a common goal, which is to support and achieve the mission to protect the nation.



SD100, Integrated Safety Management System
DOE Guide 450.4-1C, *Integrated Safety Management System Guide*, *Attachment 10*

3.9.4 Safety Conscious Work Environment (SCWE)

The Laboratory's ISMS is further enhanced by the formal identification of focus areas and attributes that are important in a having a strong safety culture that supports operational excellence at the Laboratory. Many of the techniques and methods used by the VPP program are approaches used by the Safety Culture Focus Areas and Associated Attributes as described in DOE G 450.4-1C, *Integrated Safety Management System Guide*. LANL continues to align the implementation of VPP, ISMS, and HPI attributes through initiatives that facilitate operational excellence. These initiatives focus on leadership, employee/worker engagement, organizational learning, continuous improvement, and long-term performance.

A healthy and effective SCWE includes various attributes such as:

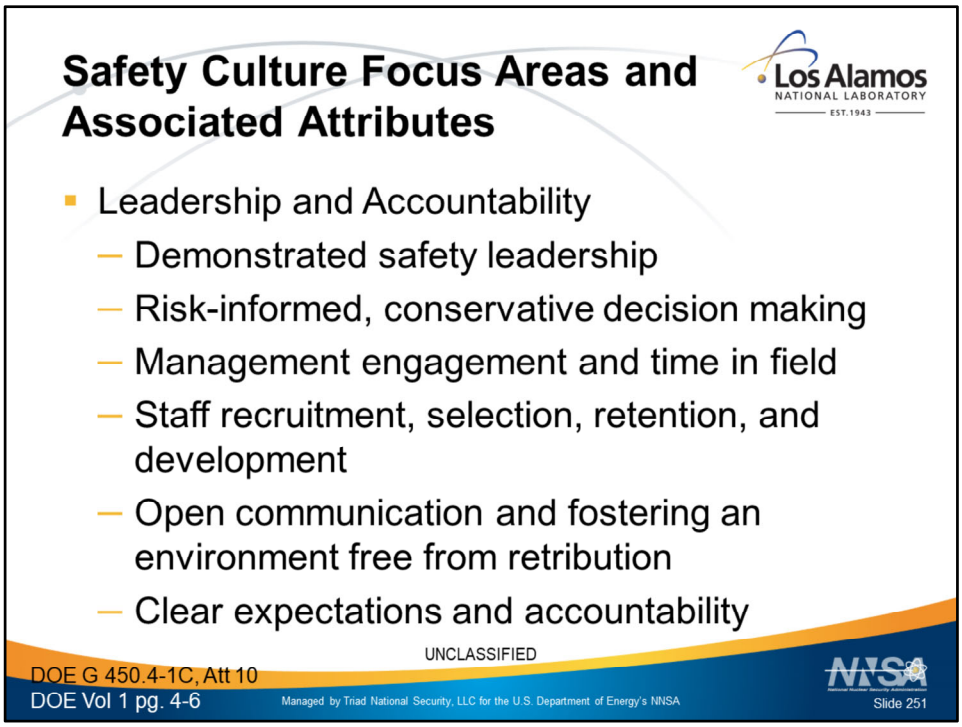
- Demonstrated safety leadership
- Management engagement and time in the field
- Open communication and fostering an environment free from retribution
- Clear expectations and accountability
- Teamwork and mutual respect
- Credibility, trust, and reporting errors and problems
- Effective resolution of reported problems

- Performance monitoring through multiple means
- Questioning attitude

LANL strives to provide an environment that includes these attributes. SCWE is an essential aspect of the LANL ISMS and is integrated into all work performed. Because LANL's safety culture evolves over time, it is important to review various culture indicators on a periodic basis, identify improvement opportunities, and take action to strengthen the culture. Personnel and organizational changes, budget challenges, handling of emergent issues, and day-to-day organizational dynamics can have an impact on what is viewed as important and can influence the behaviors of employees and our collective culture.

LANL performs a periodic self-evaluation using the DOE-VPP criteria. This self-evaluation is performed by LANL workers and is led by WSST members. The self-evaluation includes a variety of techniques including review of documentation, direct observations, and face-to face interviews.

Some interviews include select leadership within directorates as well as their WSST members and workers.



LEADERSHIP

Demonstrated safety leadership

- Line managers (from the Secretary to the DOE Cognizant Secretarial Officer to the DOE Field Office Manager, and from the contractor senior manager, to the front-line employee) understand and accept their safety responsibilities as integral to mission accomplishment.
- Line managers enhance work activities, procedures and process with safety practices and policies.
- Leaders acknowledge and address external influences that may impose changes that could result in safety concerns.
- Line managers clearly understand their work activities and performance objectives, and how to safely conduct their work activities to accomplish their performance objectives.
- Line managers demonstrate their commitment to safety through their actions and behaviors, and support the organization in successfully implementing safety culture attributes, by conducting walk-throughs, personal visits, and verifying that their expectations are met.
- The organizational mission and operational goals clearly identify that production and safety goals are intertwined, demonstrating commitments consistent with highly reliable organizations.

Risk-informed, conservative decision making

- Line managers support and reinforce conservative decisions based on available information

and risks. Managers and employees are systematic and rigorous in making informed decisions that support safe, reliable operations. Employees are expected, authorized and supported by managers to take conservative actions when faced with unexpected or uncertain conditions.

- Managers and employees are intolerant of conditions or behaviors that have the potential to reduce operating or design margins. Anomalies are thoroughly investigated, promptly mitigated, and periodically analyzed. The bias is set on proving that work activities are safe before proceeding, rather than proving them unsafe before halting. Personnel do not proceed, and do not allow others to proceed, when safety is uncertain and management is supportive of these decisions.

Management engagement and time in field

- Maintaining operational awareness is a priority. Line managers are in close contact with the front-line employees. Line managers listen and act on real-time operational information. Line managers identify critical performance elements and monitor them closely.
- Line managers spend time on the floor and in employee work areas. Line managers practice visible leadership by placing ―eyes on the work,‖ asking questions, coaching, mentoring, and reinforcing standards and positive behaviors. Deviations from expectations are corrected promptly and, when appropriate, collectively analyzed to understand why the behaviors occurred.
- Managers set an example for safety through their personal commitment to continuous learning and by direct involvement in high-quality training that consistently reinforces expected employee behaviors.

Staff recruitment, selection, retention, and development

- People and their professional capabilities, experiences, and values are regarded as the organization's most valuable assets. Organizational leaders place a high personal priority and time commitment on recruiting, selecting, and retaining an excellent technical staff.
- The organization maintains a highly knowledgeable workforce to support a broad spectrum of operational and technical decisions. Technical and safety expertise is embedded in the organization. Outside expertise is employed when necessary.
- The organization is able to build and sustain a flexible, resilient, robust technical staff and staffing capacity. Staffing is sufficient to ensure adequate resources exist to ensure redundancy in coverage as well as cope with and respond to unexpected changes in a timely manner.
- The organization values and practices continuous learning. Professional and technical growth is formally supported and tracked to build organizational capability. Employees are required to improve knowledge, skills, and abilities by participating in recurrent and relevant training and strongly encouraged to pursue educational opportunities.
- Line managers encourage and make training available to broaden individual skills and improve organizational performance. Training should include the ability to appreciate the potential for unexpected conditions; to recognize and respond to a variety of problems and anomalies; to understand complex technologies and capabilities to respond to

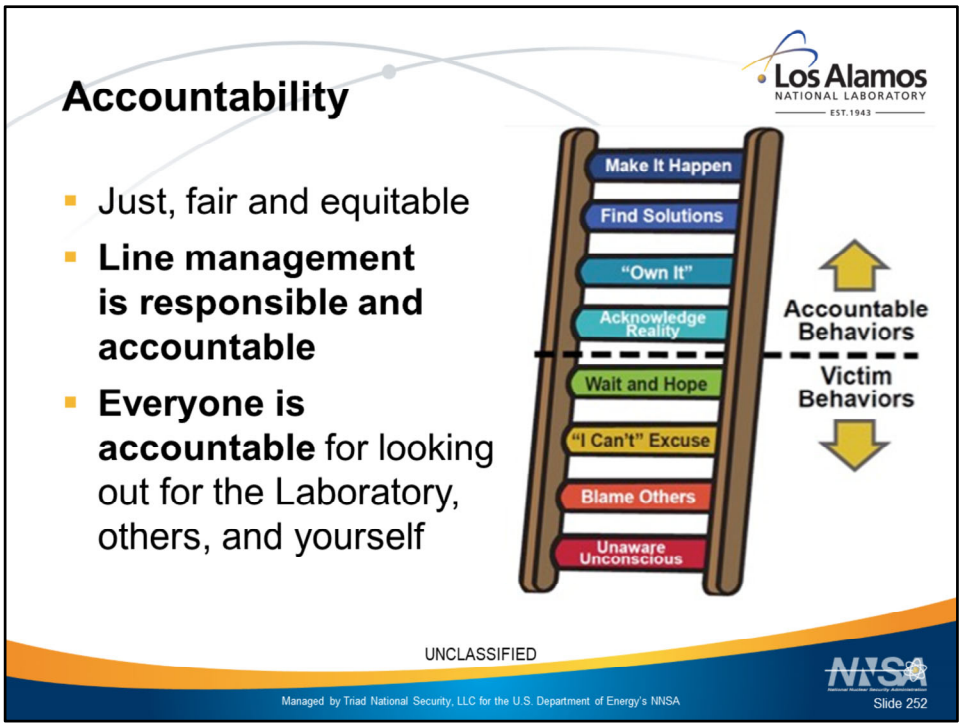
complex events; to develop flexibility at applying existing knowledge and skills in new situations; to improve communications; and to learn from significant industry and DOE events.

Open communication and fostering an environment free from retribution

- A high level of trust is established in the organization.
- Reporting individual errors is encouraged and valued. Individuals feel safe from reprisal when reporting errors and incidents.
- Individuals at all levels of the organization promptly report errors and incidents and offer suggestions for improvements.
- A variety of methods are available for personnel to raise safety issues and line managers promptly and effectively respond to personnel who raise safety issues.
- Leaders proactively detect situations that could result in retaliation and take effective action to prevent a chilling effect.
- The organization addresses disciplinary actions in a consistent manner; disciplinary actions are reviewed to ensure fair and consistent treatment of employees at all levels of the organization.

Clear expectations and accountability

- Line managers provide ongoing performance reviews of assigned roles and responsibilities reinforcing expectations and ensuring key safety responsibilities and expectations are being met.
- Personnel at all organizational levels are held accountable for standards and expectations. Accountability is demonstrated both by recognizing excellent performance as well as identifying less-than-adequate performance. Accountability considers intent and organizational factors that may contribute to undesirable outcomes.
- Willful violations of requirements and performance norms are rare. Individuals and organizations are held accountable in the context of a just culture. Unintended failures to follow requirements are promptly reported, and personnel and organizations are acknowledged for self-identification and reporting errors.



BASIS: IM-2018-44
IAS 2016-459 HPI POFMR OFI-03: There is a varied understanding and application of accountability as it is used in Operational Leadership. An effort should be undertaken to further refine, communicate and apply a definition of accountability consistent with the Lab's core values.

Source: *High Reliability Team – Final Report*
Accountability - Just, fair and equitable
Line management is responsible and accountable
Everyone is accountable for looking out for the Laboratory, others, and yourself

Source: LANL News Stories (August 4, 2017)
What does it mean to be accountable?
During the all-employee address last month, Director **Charlie McMillan** asked you to think about what it means to be accountable for the work you perform every day. Let's take a step back and think about what it means to be accountable. Simply speaking, it is the obligation or willingness to accept responsibility for one's actions, as well as, identifying and helping others do the right thing.
7 signs to know
You know you're being personally accountable if you
• Understand what your manager and customers expect of you and your colleagues in terms of work methods and goals

• Make sure you possess requisite knowledge, tools and information to execute your responsibilities
• Clarify with your manager what decisions you can make on your own and what decisions you need to elevate to them
• Understand how your work impacts other people and groups, especially your customers
• Spend time in the workplace discussing work with your manager, clarifying expectations and adjusting work methods to match needs and expectations
• Spend time with collaborators before taking significant actions and before major energy is extended, to be sure all parties are on the same page
• Keep in mind that how you achieve your work—how you treat people—is just as important as accomplishing the goal
This is a message from the High Reliability Team.

Source: LANL News Stories (August 18, 2017)

Exercising accountability

Forward-looking focus

Exercising accountability is primarily a forward-looking activity. Building from expectations that you have agreed to with your manager, you now have opportunity to gain confirmation and improved understanding of those expectations through interactions with your manager and your work team, in the field. This is done by discussing the implementing methods and outcomes, in the context of the roles/responsibilities of members of your team. You accomplish this through routine conversations about your work and methods to produce products. Your focus is guided by **what must go right in the high consequence activities of your organization**. Your accountability and the collective accountability of the work group as a whole are verified and strengthened by your conversations. Around 95 to 99 percent of the time, you can expect to be satisfied. Sometimes however, you will discover that expectations are clearly not being met, due to confusion, reluctance, differing profession opinion, etc. This is good and gives you the opportunity to clarify and gain agreement with your manager, both individually and as a group. Examples of the types of behavior typical of 'below the line' are found here.

Backward-looking focus

There will also be times when, despite clear expectations, roles/responsibility assignment, and clear accountability, performance departs from what is desirable. This is where a backward focus is important to establish potential culpability.

The U.S. Department of Energy Human Performance Improvement Handbook provides a **decision tree** that helps us evaluate behavior in these situations. You will find through the use of this tool unwanted outcomes have both human performance and organizational influences. It's important that we strive to create and maintain a culture based on trust and mutual respect.

Note: This a message from the High Reliability Team, which aims apply the principles of Operational Leadership to diminish the risk profile of the Laboratory in order to realize a dramatic reduction in the possibility of significant upset events occurring.

Source: LANL News Stories (August 18, 2017)

Recognizing different types of accountability behaviors

Last week, an article by the High Reliability Team explored seven signs of knowing whether or not you are being accountable, which is the obligation or willingness to accept responsibility for one's actions, as well as identifying and helping others do the right thing. This week, we are going to look at different types of accountable behaviors and how to recognize them in yourselves and others.

The accountability ladder, shown above, is a great illustration of accountable behaviors and a useful way to analyze different situations.

Let's explore the ladder by looking at "above the line" and "below the line" behaviors. The "above the line" behaviors are those that we want to encourage and recognize in each other every day. When we acknowledge reality by identifying an issue and engaging others to find solutions, then we are exhibiting positive accountable behaviors.

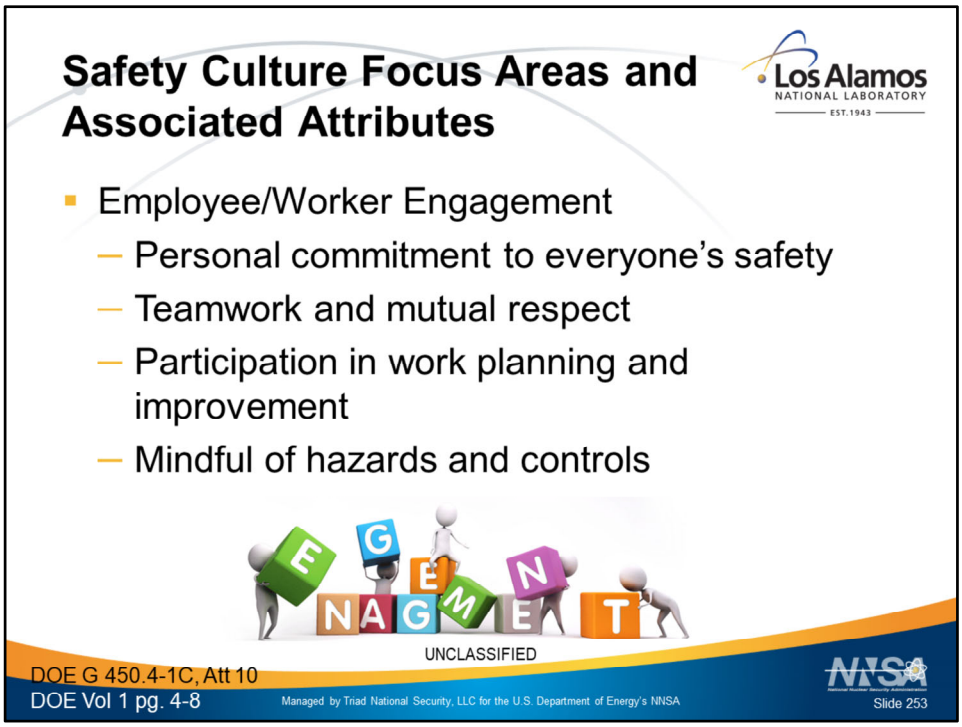
If we look at "below the line" behaviors, these are the behaviors that hold us back from identifying and taking ownership of issues. These behaviors can manifest in counterproductive ways like blaming others when mistakes occur and waiting for someone else to say something about a potential issue instead of raising the issue ourselves.

Questions to ask

Please take a moment to identify a current challenge that you are facing at work.

- Where on the accountability ladder is your current stance regarding this challenge?
- What do you need to do to move up the ladder at least one step?
- What support or resources do you need to move up that step?
- What would you risk in shifting your stance?

The newly formed High Reliability Team aims to apply the principles of Operational Leadership to diminish the risk profile of the Laboratory in order to realize a dramatic reduction in the possibility of significant upset events occurring.



EMPLOYEE/WORKER ENGAGEMENT

Personal commitment to everyone's safety

- Responsibility and authority for safety are well defined and clearly understood as an integral part of performing work.
- The line of authority and responsibility for safety is defined from the Secretary and contractor senior manager to the individual contributor. Roles and responsibilities, authorities and accountabilities are clearly defined in writing and are understood by each individual.
- Individuals understand and demonstrate responsibility for safety. Safety and its ownership are apparent in everyone's actions and deeds.
- Individuals outside of the organization (including subcontractors, temporary employees, visiting researchers, vendor representatives, etc.) understand their safety responsibilities.
- The organization knows the expertise of its personnel. Line managers defer to qualified individuals with relevant expertise during operational upset conditions. Qualified and capable people closest to operational upsets are empowered to make important decisions, and are held accountable justly.

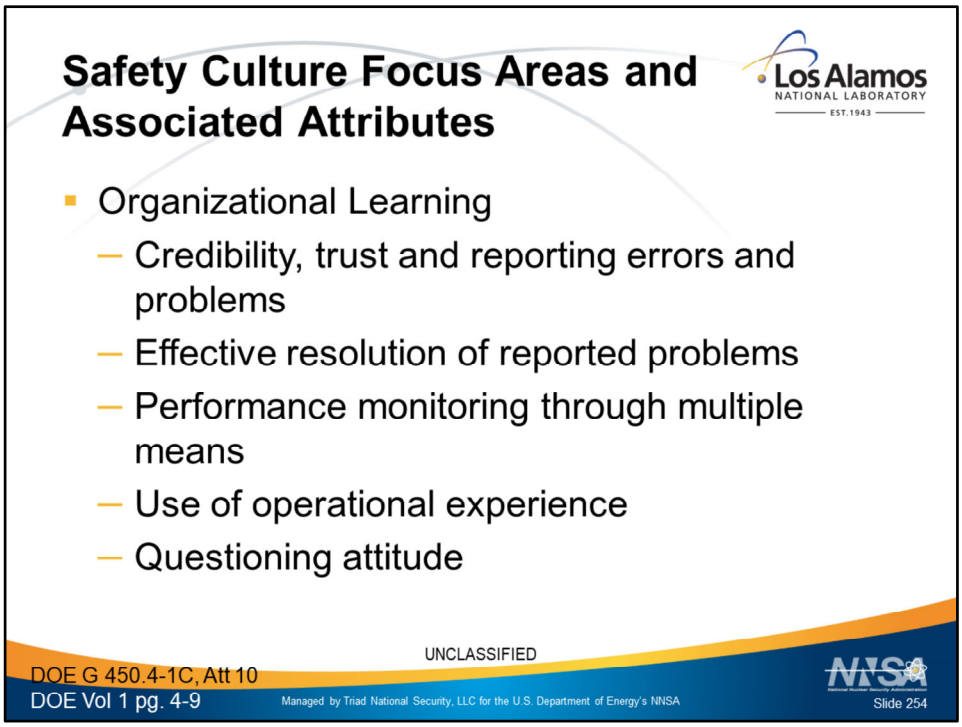
Teamwork and mutual respect

- Open communications and teamwork are the norm.
- Individuals at all levels of the organization listen to each other and effectively engage in crucial

conversations to ensure meaning, intent and viewpoints are understood; and that differing points of view are acknowledged.
- Discussion on issues focus on problem solving rather than on individuals.
- Good news and bad news are both valued and shared.

Participation in work planning and improvement
- Individuals are actively involved in identification, planning, and improvement of work and work practices.
- Individuals follow approved work practices and procedures.
- Individuals at all levels can stop unsafe work or work during unexpected conditions.
- Design, analysis and continuous improvement of work practices and processes are valued as core organizational competencies; expertise in these competencies is evaluated and rewarded.

Mindful of hazards and controls
- Organizational safety responsibilities are sufficiently comprehensive to address the work activities and hazards involved.
- Work hazards are identified and controlled to prevent or mitigate accidents, with particular attention to high consequence events with unacceptable consequences.
- Individuals understand and proactively identify hazards and controls before beginning work activities.
- Individuals are mindful of the potential impact of equipment and process failures, demonstrate constructive skepticism and are sensitive to the potential of faulty assumptions and errors. They appreciate that mindfulness requires effort.



ORGANIZATIONAL LEARNING

Credibility, trust and reporting errors and problems

- Credibility and trust are present and continuously nurtured so that a high level of trust is established in the organization.
- Organizations, managers and line supervisors provide accurate, relevant and timely information to employees. Line managers are skilled in responding to employee questions in an open, honest manner.
- Reporting individual errors is encouraged and valued. Individuals are recognized and rewarded for self-identification of errors.
- Line managers encourage and appreciate safety issue and error reporting.
- Managers and line supervisors demonstrate integrity and adhere to ethical values and practices to foster trust.
- Managers and line supervisors demonstrate consistency in approach and a commitment to the vision, mission, values and success of the organization as well as the individuals (people).
- Mistakes are used for opportunities to learn rather than blame.
- Individuals are recognized and rewarded for demonstrating behaviors consistent with the safety culture principles.

Effective resolution of reported problems

- Vigorous corrective and improvement action programs are established and effectively

implemented, providing both transparency and traceability of all corrective actions. Corrective action programs effectively prioritize issues, enabling rapid response to imminent problems while closing minor issues in a timely manner to prevent them from escalating into major issues.

- Results from performance assurance activities are effectively integrated into the performance improvement processes, such that they receive adequate and timely attention. Linkages with other performance monitoring inputs are examined, high-quality causal analyses are conducted, as needed, and corrective actions are tracked to closure with effectiveness verified to prevent future occurrences.
- Processes identify, examine and communicate latent organizational weaknesses that can aggravate relatively minor events if not corrected. Organizational trends are examined and communicated.
- Organizational systems and processes are designed to provide layers of defenses, recognizing that people are fallible. Lessons learned are shared frequently; prevention and mitigation measures are used to preclude errors from occurring or propagating. Error-likely situations are sought out and corrected, and recurrent errors are carefully examined as indicators of latent organizational weaknesses.
- Incident reviews are conducted promptly after an incident to ensure data quality and to identify improvement opportunities. Causal analysis expertise is applied effectively to examine events and improve safe work performance. High-quality causal analysis using multi-discipline analytical perspectives is the norm. Causal analysis is performed on a graded approach for major and minor incidents, and near-misses, to identify causes and follow-up actions. Even small failures are viewed as windows into the system that can spur learning.
- Performance improvement processes require direct worker participation. Individuals are encouraged, recognized and rewarded for offering innovative ideas to improve performance and to solve problems.

Performance monitoring through multiple means

- Line managers maintain a strong focus on the safe conduct of work activities. Line managers maintain awareness of key performance indicators related to safe work accomplishment, watch carefully for adverse trends or indications, and take prompt action to understand adverse trends and anomalies. Management employs processes and special expertise to be vigilant for organizational drift.
- Performance assurance consists of robust, frequent, and independent oversight conducted at all levels of the organization. Performance assurance includes independent evaluation of performance indicators and trend analysis.
- Line managers throughout the organization set an example for safety through their direct involvement in oversight activities and associated performance improvement.
- The organization actively and systematically monitors performance through multiple means, including leader walkarounds, issue reporting, performance indicators, trend analysis, benchmarking, industry experience reviews, self-assessments, peer reviews, and performance assessments.
- The organization demonstrates continuous improvement by integrating the information

obtained from performance monitoring to improve systems, structures, processes, and procedures.
- Line managers are actively involved in all phases of performance monitoring, problem analysis, solution planning, and solution implementation to resolve safety issues.
- The organization maintains an awareness of its safety culture maturity. It actively and formally monitors and assesses its safety culture on a periodic basis.

Use of operational experience
- Operating experience is highly valued and the capacity to learn from experience is well developed. The organization regularly examines and learns from operating experiences, both internal and in related industries.
- Organization members convene to swiftly uncover lessons and learn from mistakes and successes.
- The organization embraces feedback from peer reviews, independent oversight, and other external sources.
- The organization documents and shares operating experiences (lessons learned and best practices) within the organization and with industry.

Questioning attitude
- Line managers encourage a vigorous questioning attitude toward safety, and foster constructive dialogues and discussions on safety matters.
- Individuals cultivate a constructive, questioning attitude and healthy skepticism when it comes to safety. Individuals question deviations, and avoid complacency or arrogance based on past successes. Team members support one another through both awareness of each other's actions and constructive feedback when necessary.
- Individuals pay keen attention to current operations and focus on identifying situations where conditions and/or actions are diverging from what was assumed, expected, or planned. Individuals and leaders act to resolve these deviations early before issues escalate and consequences become large.

The Safe Conduct of Research was produced through a collaborative effort across Battelle-affiliated laboratories and has been informed by our own experiences as well as those that have gone before us. The purpose of this booklet is to codify the principles and practices that we believe ensure our science is performed without unnecessary risk and is sustained without operational disruption. In short, the principles outlined here form the underpinnings of the strong safety culture we embrace.

Organizational culture is DEFINED BY the shared assumptions that develop as an organization learns from problems and achieves success. Basic assumptions that have worked well enough to be considered valid are taught to new members of the organization, either explicitly or through demonstration, as the correct way to perceive, think, and act. Culture is the sum total of a group's learning. Culture is for the group what character and personality are for the individual.
Because of the special characteristics and unique hazards of R&D, the organizational culture of research facilities must incorporate a healthy safety culture, founded on a collective commitment to put safety first. This commitment applies to everyone in the organization, from the laboratory director to the individual contributor. No one

is exempt from the obligation to ensure protection of people, the environment, and the facility.
We have articulated a set of principles that shape our behavior and form the basis for a strong safety culture. Whether you are a principal investigator, visiting scientist, group leader, project manager, program manager, senior scientific leader, or craftsman, your behavior creates our culture.

1. Everyone is personally responsible for ensuring safe operations.
• As a research staff member or as a guest researcher, you are accountable for safety. Your organization has safety professionals available to support you. Use them.
• You should know the hazards that your work activities create better than anyone else. If you don't, ask questions until you do.
• Human error is inevitable, but you can reduce its likelihood and consequences.
• Anyone can stop work, and you are expected to use that authority when there is uncertainty about the safe conduct of work.
• Safety requirements and processes are there to protect you, your co-workers, facility, and the environment. Working around those requirements and processes is never a good idea.
2. Leaders value the safety legacy they create in their discipline
• Leaders exhibit behaviors that set the standard for safety.
• Being in research areas and engaging staff is the best way to understand whether your staff are prepared to work safely; coach, mentor, and reinforce expectations about safety during such engagements.
• Expectations for safe performance are communicated often and in many forums.
• Science leaders strive to keep safety at the forefront by being conscious of the complexity of the research, the preparedness of their staff, and the pressure to perform.
3. Staff raise safety concerns because trust permeates the organization.
• You can't fix what you don't understand; staff are encouraged to raise concerns and report problems.
• Science leaders create an environment of inquisitiveness as the norm to counteract the tendency of students, postdoctoral fellows, and junior staff to view uncertainty as a sign of professional weakness.
• Anyone can respectfully challenge unsafe behavior regardless of his or her position in the organization, and these challenges are accepted graciously as an opportunity to improve.
4. Cutting-edge science requires cutting-edge safety
• A conservative posture is assumed when the impact of hazards is uncertain.
5. A questioning attitude is cultivated
• In the face of uncertainty, researchers do not proceed with work until potential impacts have been evaluated and controls are in place to mitigate them .

• Anomalies are thoroughly investigated and mitigated.
• Opposing views are encouraged and used to advance everyone's understanding
• Differing opinions are welcomed and respected, but debate doesn't paralyze sound decision making.

6. Learning never stops

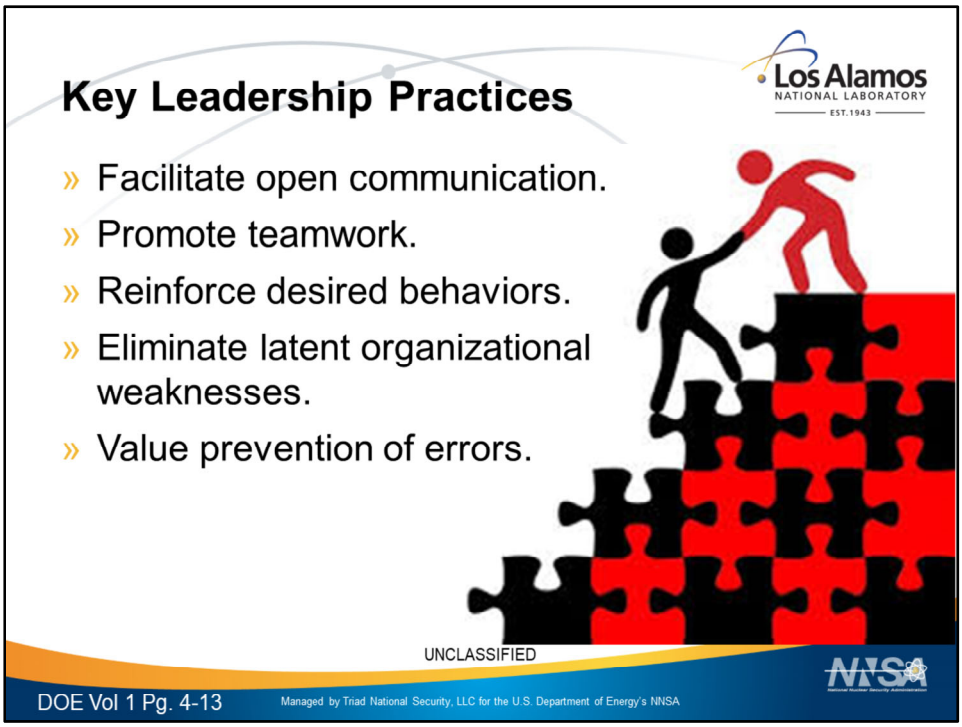
• Every experiment, event, or project provides opportunities to improve safety.
• You know your issues better than anyone else, reflect on them and assess lessons learned.
• Mistakes are treated as opportunities to learn.
• When challenged by someone, you view it as a chance to get better.
• Safety techniques and lessons learned are routine topics in research discussions.

7. Hazards are identified and evaluated for every task, every time

• Research staff are expected to understand the hazards associated with their work, the controls necessary to do the work safely, and the rationale behind the selection of the controls used.
• Procedures and safety components are constantly reevaluated to ensure they still provide the protection assumed.
• "Work-arounds" are viewed as unnecessarily taking on risk and are avoided.
• Peer involvement is encouraged; it helps to avoid blind spots to new risks.

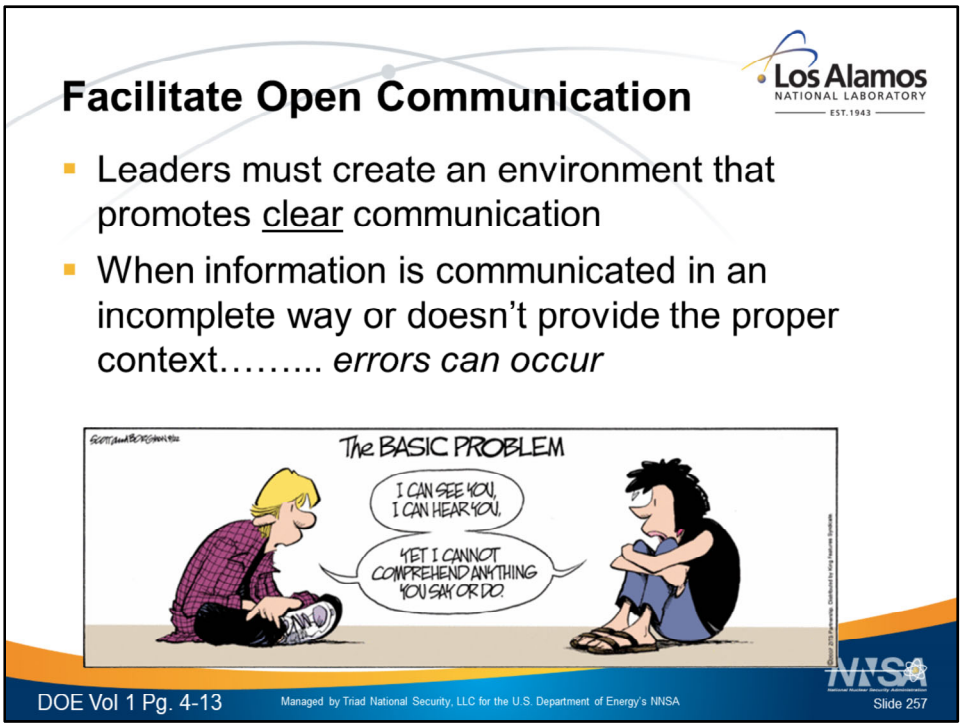
8. A healthy respect is maintained for what can go wrong

• Avoid complacency; routine tasks can result in serious injuries or operational upsets.
• Time pressure is a setup for mistakes; it is openly acknowledged when present and attention to safety is heightened during those times.
• Small failures and mistakes are seen as clues to more consequential failures and thus are highlighted and shared.
• External reviews and management engagement are viewed as opportunities to challenge assumptions and reinforce what is right.
• First-time operations are never conducted without thorough discussion of contingencies.



Five leader behaviors that promote excellence in human performance have been identified. Leaders act to influence both individual and organizational performance in order to achieve high levels of facility safety and performance through the following practices:

- facilitate open communication;
- promote teamwork;
- reinforce desired behaviors;
- eliminate latent organizational weaknesses; and
- value error prevention

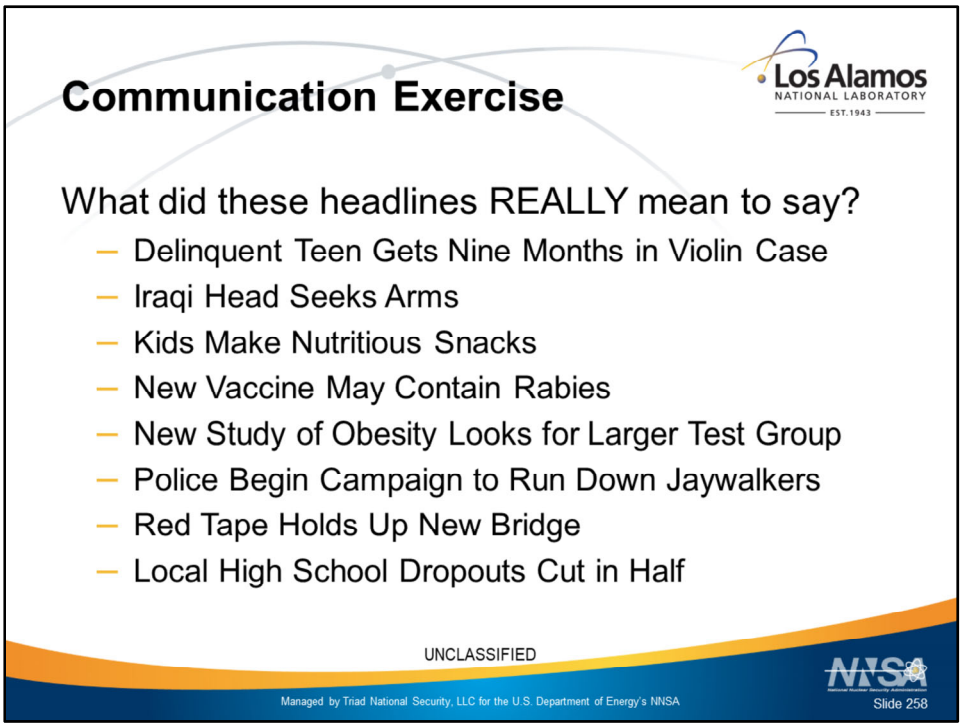


Facilitate Open Communication

In many major accidents there was someone who knew something that if it had been communicated in time to the right people could have prevented the accident from taking place. It is this knowledge that reinforces the dictum that communication is the most effective defense against significant events. Effective leaders work hard to root out any obstacles to communication. The organizational atmosphere must promote open, candid conversations about safety. Leaders, no matter what positions they hold, actively encourage others to identify error-likely situations and latent organizational weaknesses.

A safe atmosphere is cultivated when people treat each other with honesty, fairness, and respect—when they establish healthy relationships. An atmosphere of camaraderie, teamwork and collaboration motivates individuals to improve the effectiveness of the organization. Eventually, people become more willing to be held accountable and they seek assistance by admitting to and learning from errors.

If an individual believes his or her errors will be punished, then information related to those errors will likely remain obscure. In a *just* environment, the likelihood that a problem will be reported increases. High-performing organizations do not punish employees who make errors while trying to do the right thing. Healthy organizations view error as an opportunity to learn.

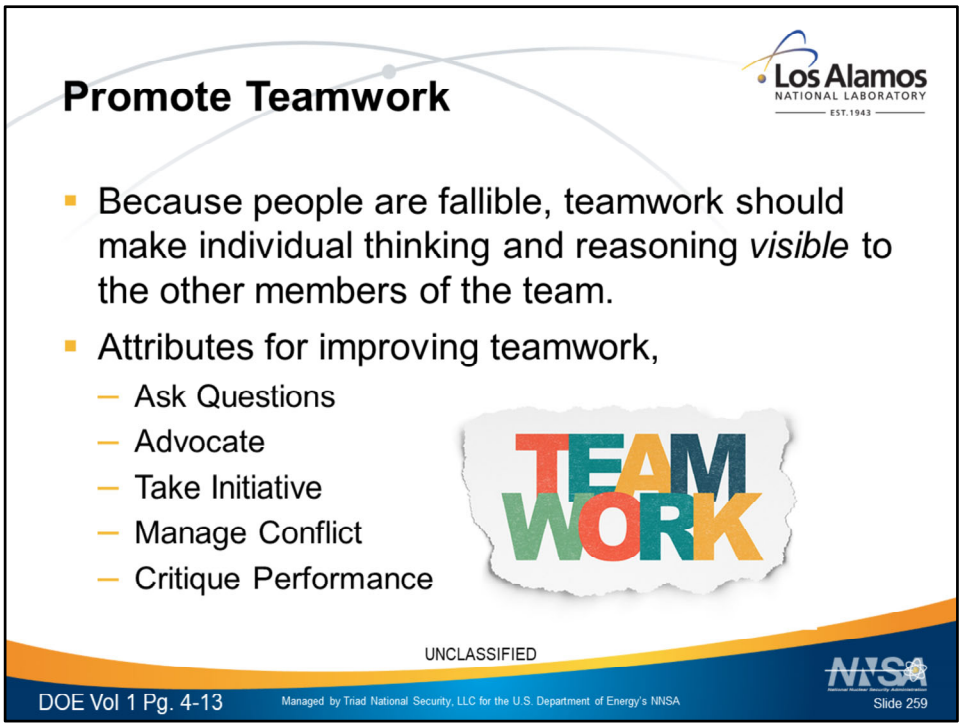


SOURCE: LANL Human Performance Improvement Concepts Guide (October 2006) page 38 (LA-UR-07-0176)

These headlines provide examples of ambiguity. The meaning depends on what you believe the context of the sentence to be. Although one meaning is intended, a distinctly different meaning appears without the proper context.

EXERCISE ACTION: Rewrite each headline to clearly say what was intended
Possible Answers:

- Delinquent Teen Gets Nine Months in Violin Case - Teen gets nine-month sentence for stealing violin
- Iraqi Head Seeks Arms - Iraqi leader seeks to buy weapons
- Kids Make Nutritious Snacks - Kids are taught to prepare nutritious snacks
- New Vaccine May Contain Rabies - New vaccine may contain the spread of rabies
- New Study of Obesity Looks for Larger Test Group - Study on obesity seeks to include more people in new test group
- Police Begin Campaign to Run Down Jaywalkers - Police start a campaign to reduce jaywalking violations
- Red Tape Holds Up New Bridge - New bridge construction is delayed due to bureaucratic issues
- Local High School Dropouts Cut in Half - The number of high school dropouts is reduced by half



Promote Teamwork

People have difficulty seeing their own errors, especially when they are working alone. Teamwork may improve the ability of individual team members to collectively prevent human performance problems. Because people are fallible, teamwork should make individual thinking and reasoning *visible* to the other members of the team. Dialogue between members of a team gives each one the opportunity to challenge assumptions and to detect team errors.

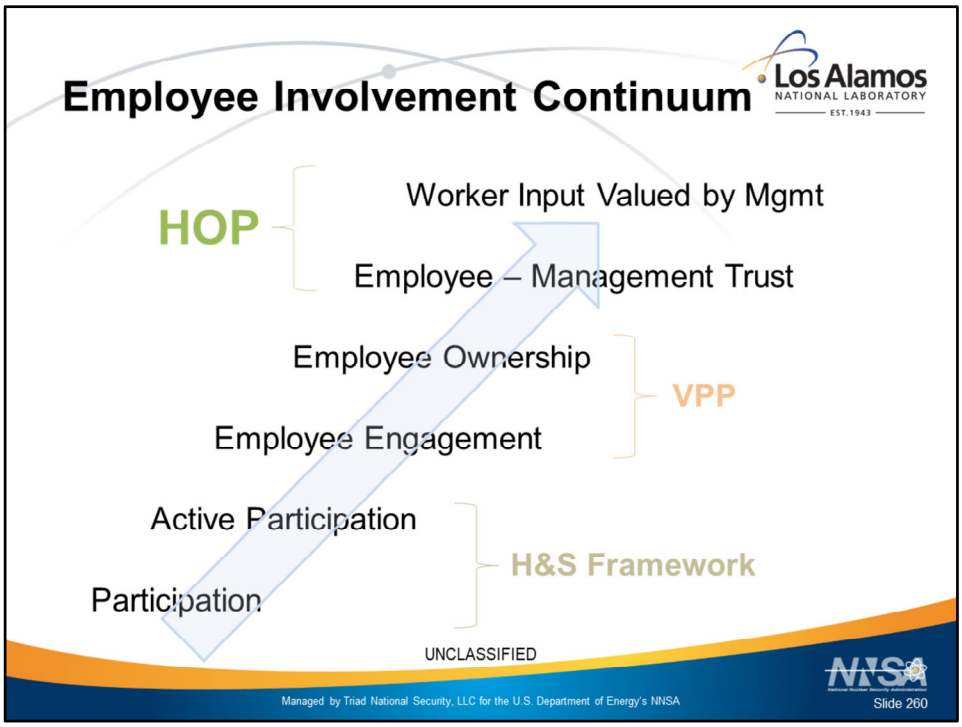
Accident research conducted in the aviation industry in the late 1970s showed repeatedly that failures in the cockpit to work as a team had devastating consequences. Sixty-six percent of air carrier, 79 percent of commuter, and 88 percent of general aviation accidents involved flight crew failures in interpersonal communications, decision-making, and leadership. In fact, more accidents were caused by these failures than by lack of technical flying skills. These findings led the airlines to create training programs to improve teamwork in the cockpit. Key goals of the "Crew Resource Management" (CRM) training included the following, among others:
teaching team members how to pool their intellectual resources;

- acquiring collective situational awareness that admits challenges from junior team members;
- improving communication skills; and
- emphasizing the importance of teamwork.

The behavioral characteristics important to the success of pilot performance on the flight deck from the CRM training were adopted in the nuclear power industry in the early 1990s, with the development of the Control Room Teamwork Development Course. The following attributes for

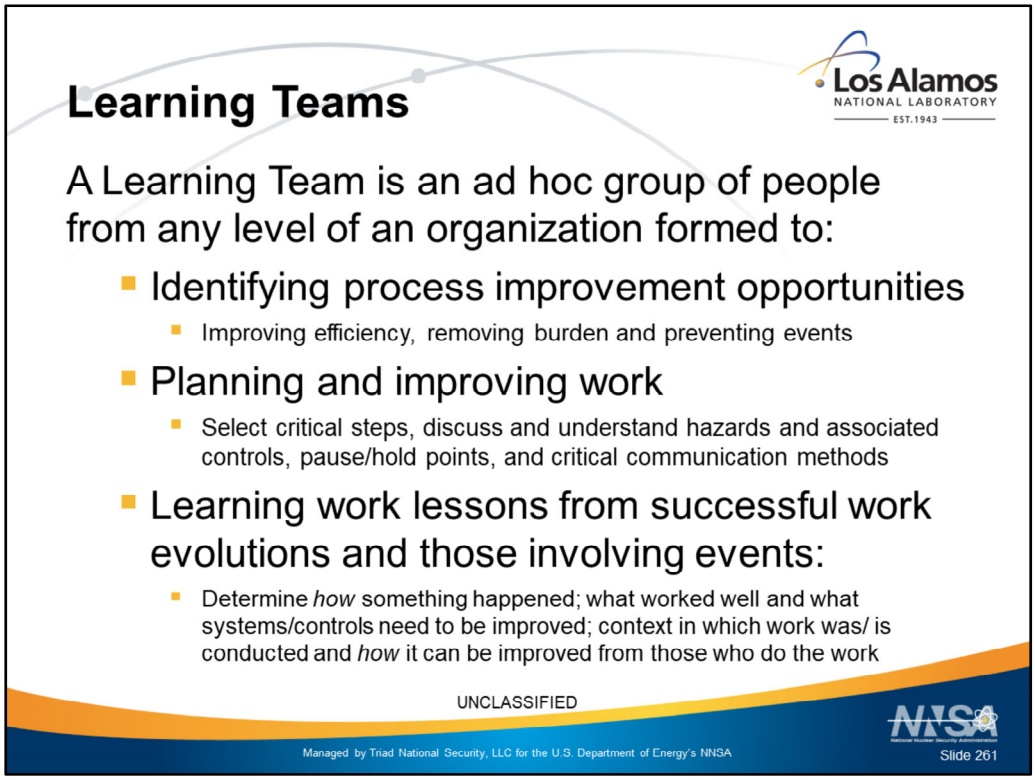
improving teamwork, proven essential to pilot performance and control room operator performance are applicable to teams working at DOE facilities.

- **Ask Questions** – asking a series of questions to understand what is happening with the facility.
- **Advocate** – expressing a concern, position, or solution and making certain others understand what the individual knows.
- **Take Initiative** – taking the initiative to influence the behavior of others, especially when it comes to the condition of the physical plant (facility).
- **Manage Conflict** – resolving differences of opinion and getting all information on the table to reach the best solution; maintaining open communication channels among team members.
- **Critique Performance** – learning from experience, identifying what works well, and pinpointing what areas need improvement.



VPP has continued to be success story. The point is we learned is there are levels of our relationship with employees that remained available to us that HOP can help us reach.

Example of cross-discipline synergies: Part of a successful strategy must include integrating HOP principles into some existing LEAN tools.



Learning teams are in place and have been working at LANL for years.

However, the approach to date has been more spray and pray than target and integrate – give everyone the principles and hope that they can figure out how to apply – we can take it another step by careful integration of HPI concepts and tools into the mission work approach

IAEA In fact, the idea that HPI should be a separate initiative or program is contrary to the very foundation of the concept.

Only useful as helps work progress
Useful in 3 ways

- Event Learning
- Process Learning
- Work Learning – circles right back to events and process learning

- Examples follow

A Learning Team identified an error likely situation and made a process improvement

Issue: Black and yellow hoses were crossed – near miss that was discovered prior to pressurization

Potential consequence – Equipment malfunction and/or damage, personnel injury if high/low pressure swapped

***How* did this happen** – Human error: even though hoses are color coded, the fittings are all the same size

Resolution – Make each pair unique, so they cannot be interchangeable (engineering solution is a strong defense)

Normal Hose Configuration

Black and Yellow Hoses Crossed

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Managed by Triad National Security, LLC for the U.S. Department of Energy's NNSA

Slide 262

Learning Team identified switched hoses during test, 2 low pressure switched, fortunately
Engineering team sought fix,
Rapid fix
advertising availability,
influencing planning process afterwords
design process

A work control improvement to improve clarity and execution

Los Alamos NATIONAL LABORATORY EST. 1943

Challenges:

- Work had not been performed in several years
- Work Control Document identified many hazards and controls
  - Some at a "Cognizant" level
  - Some at a "Crucial" level

Resolution – Learning Team identified what was really important and put on one page:

- "Critical" Steps – consequence will occur if not done right
- Controls to ensure those steps were executed flawlessly
- Clear "pause/stop work" criteria
- Performance Mode (skill, rule, or knowledge)
- Post-job lessons learned

Replace Cyclone Canister on Process Exhaust System

Results – Clarity on the work elements that must go right.

- Empowerment thru engagement.

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Slide 263

Provided a structured conversation for technically competent workers, SMEs, managers to evaluate, plan work
Beryllium risk
Team based
Rapid distillation of critical steps and what must go right
Pause/Stop
Controls with hierarchy
Design interactions during performance
clarification through streamlining –
flawless execution

Learning key in outcomes

From IAEA – the principles and tools for excellence in human performance should be effectively **integrated** into all ongoing processes and programs at a facility to ensure the desired results.

Event Learning Team identified issues with personnel exiting work site without appropriate survey

Issue: Hand and Foot monitoring requirement not met prior to leaving area

Potential consequence – spread of radioactive contamination

***How* did this happen**

- Group had gone to work location to discuss a future job
- Group still discussing future task as they were exiting the area

Resolution – Consider visual cues/ verbal stimulants to draw attention to H&F monitor

Group of workers having a discussion as one of them pass by Hand and Foot monitor

UNCLASSIFIED

Managed by Triad National Security, LLC for the U.S. Department of Energy's NNSA

Slide 264

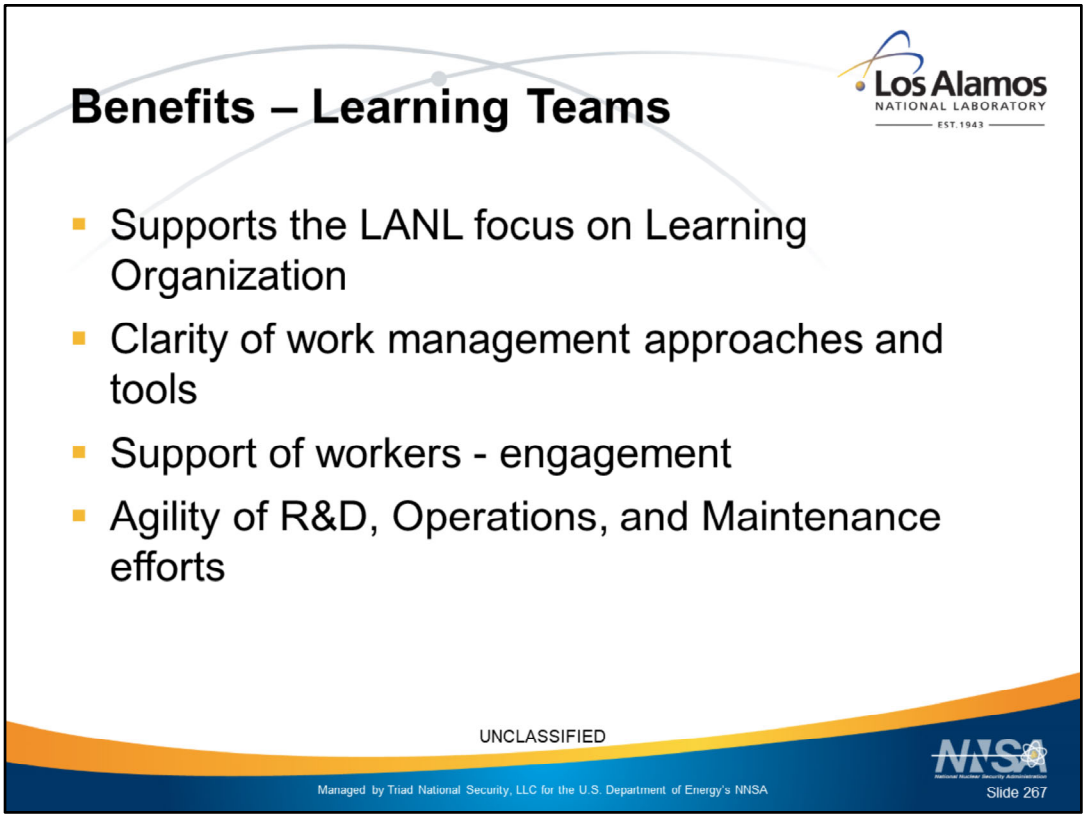
- Provided a supportive environment to kind of break down the problem into better visible pieces
- Draw attention to the potential for distraction to interrupt the usual flow of work – in this case, the team members knew of the requirement and indicated that they routinely perform hand and foot monitoring prior to entering - however, engrossed in addressing the planning need, one member forgot .
- Consider improvements to building configuration that will provide channeling through the hand and foot monitor space for persons exiting the building.
- Consider standardization of hand and foot monitor placement at each exit door.
- Consider visual cues/stimulants to highlight the existence of hand and foot monitors to distinguish them from other lab-based research and operations equipment.
- Discuss the hand and foot monitor hazard mitigation action and drivers with affected persons with the intent of gaining feedback on ongoing need.
- Install verbal cue at door, have you frisked?

Process approximates normal work management

Only useful as helps work progress

1 – opportunity to learn more about what we don't know? Process need? Event Learning – post fact finding
2 – Asking **how** instead of why, moves you from who to what – worker led - work focused – HPI influenced – safe environment, no finger pointing, second guessing
3 – time for "ahas" and reflection
4 - Continue learning, recap ahah's and new questions
5 - Strengthen existing defenses and add only if necessary
6 - Use existing action tracking system, don't create a new or separate tracking system
7 - Share what was learned, with the group, directorate, or institution

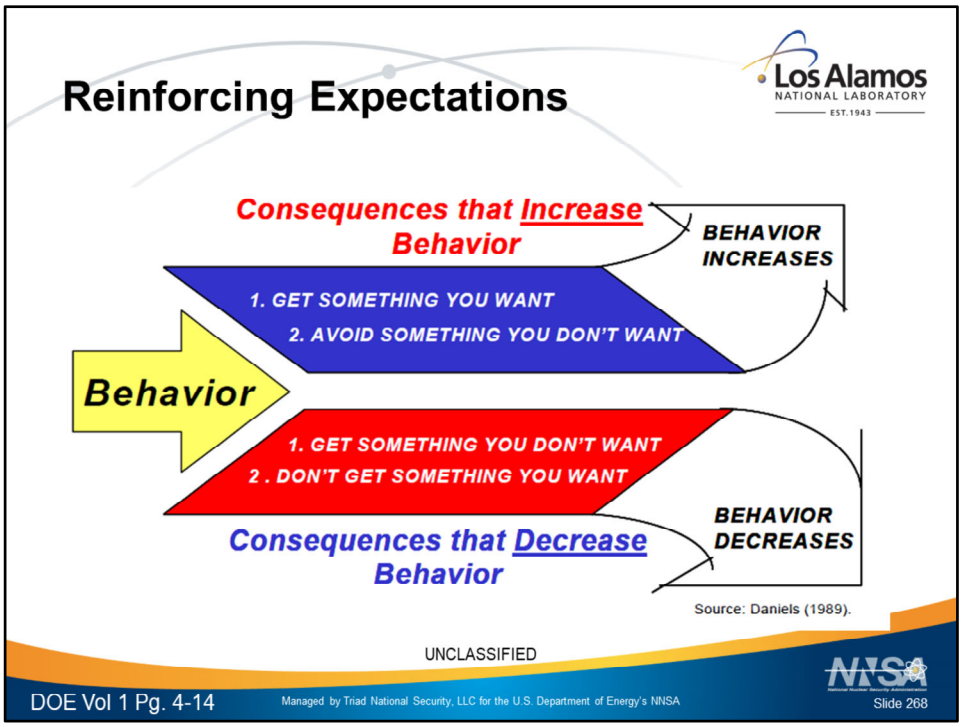
SOURCE: Human Performance Improvement Webpage – HPI Videos
http://int.lanl.gov/safety/human-performance-improvement/_assets/videos/learning-team-orientation.html



Workers experts in their own disciplines – enable and support their work

Sigmund Freud
"Love and work are the cornerstones of our humanness." Instructor - and one source of our sense of fulfillment? Is our behavior enabling or constraining these cornerstones?

Tailoring work management to help experts in their field? Enable vs. constrain, help vs hold back.



Reinforce Expectations

There is a direct cause-and-effect relationship between a manager's actions and an employee's behavior precisely because *behavior is motivated by its consequences*. Consequences, far more than training, directives, or threats, reinforce behavior. People tend to seek and do things they like and avoid things they do not like. This is a fundamental principle of human behavior. If people are to make a habit of applying human performance tools, then positive consequences must be associated with their behaviors.
Managers and leaders need to positively reinforce individuals who obtain value-added results through safe behaviors. Individuals who cut corners to get jobs done on schedule and under budget at the expense of quality and safety should be corrected, coached, or, perhaps, counseled. Consequences either keep the behavior going or stop it in the long term. Leaders should take time to understand and learn how to use reinforcement to promote targeted behaviors.

All behavior that is occurring in the facility now is the result of consequences that are also occurring now. Similarly, the organization is perfectly attuned to get the

performance it is getting, right now. All behavior is reinforced. If at-risk behavior is common, it is because management has not made a difference with appropriate negative consequences. Behavior has four basic consequences. The model on this slide describes the effect consequences have on behavior.

The following consequences can be used to get the desired performance by targeting specific behaviors.

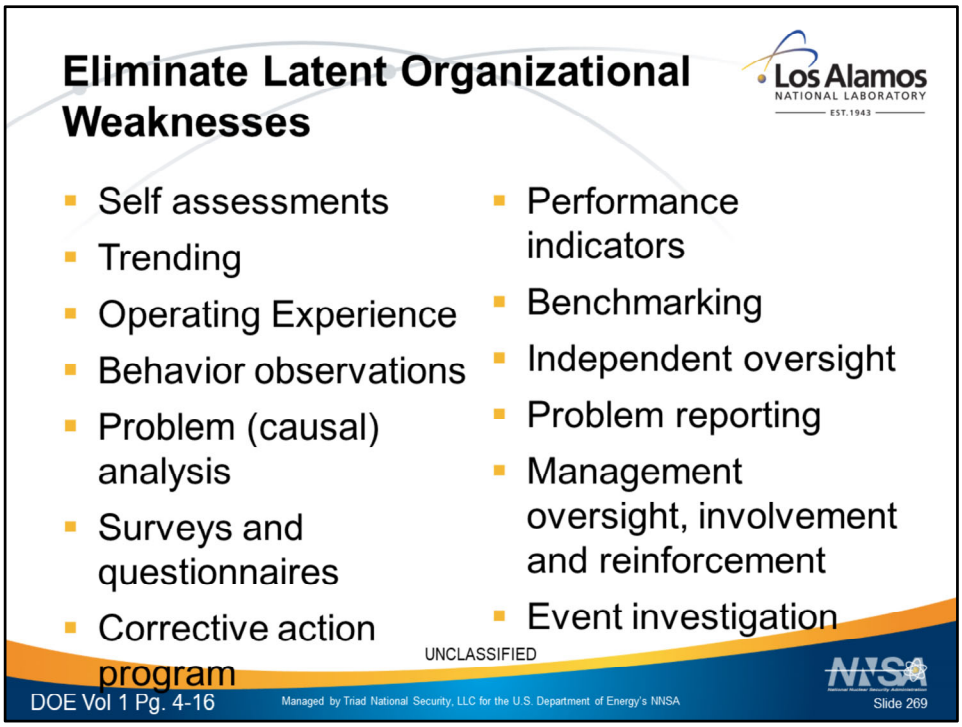
Positive Reinforcement – "Get something you want" enhances the probability that the preferred behavior will recur and maximizes performance. This optimizes use of discretionary effort by the individual.

Negative Reinforcement – "Avoid something you don't want" enhances the probability that the preferred behavior will recur, but only to meet the minimum standard.

> **Note**: Consequences that cause behavior to either increase or continue at a high standard are known as "reinforcers."

Punishment – "Get something you don't want" reduces the probability that undesired behavior will recur if unwanted consequences are consistently coupled with the behavior. Punishment may also involve "losing something you don't want to lose"—a penalty. Sometimes this is necessary to get the new expectation started for an individual. However, it should not be used for the long term.

Extinction – "Don't get something you want" reduces the probability that undesired behavior recurs, since nothing happens when that behavior occurs. Usually, the behavior eventually disappears after several repeated attempts.



Eliminate Latent Organizational Weaknesses

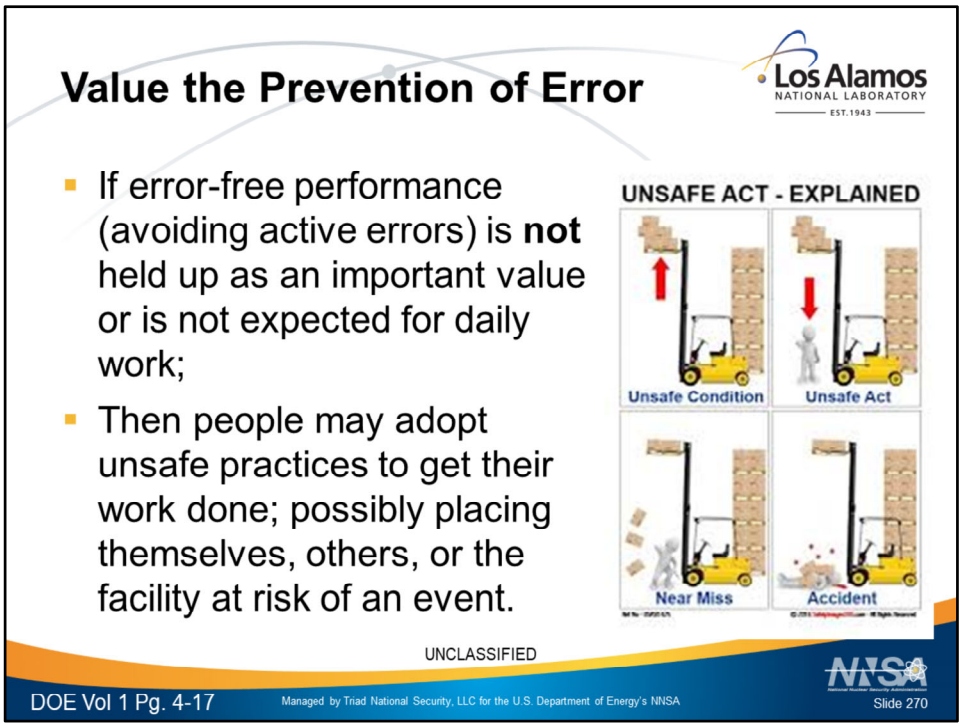
Organizational weaknesses show up as vulnerabilities, flaws, and defects in controls and controls (engineered, administrative, cultural, and oversight controls). Methodically searching for and eliminating latent organizational weaknesses eliminates factors that contribute to significant events. Chapter 3 decribes several methods of finding latent organizational weaknesses, which are listed here below for reference:

• self assessments • performance indicators
• trending • benchmarking
• operating experience • independent oversight
• behavior observations • problem reporting
• problem (causal) analysis • management oversight, involvement and reinforcement
• surveys and questionnaires • event investigation
• corrective action programs

The use of a systematic diagnostic approach for discovering recurring individual or work group performance problems provides another means of identifying organizational weaknesses. Managers and supervisors need a tool that helps them develop a clear understanding of a performance discrepancy and why it is happening. With the aid of the Behavior Engineering Model (BEM) discussed below, performance analysis helps define the performance gap by contrasting current performance with desired performance and systematically identifying the

factors that contribute to the performance gap. Once valid reasons for the performance gap are understood, the manager or supervisor can develop more effective and efficient corrective actions. A sample *Performance Gap Analysis* form is provided in Appendix A to help in the analysis and solution to human performance problems. Starting with a known performance problem, the user(s) searches for answers to a series of questions that help in determining the performance discrepancy and selecting potential corrective actions.

- What is the performance problem?
- Is the problem worth solving?
- Is there clear direction to perform as desired?
- Are there appropriate consequences for performance (behavior)?
- Do the workers already know how? (Could they do it if their lives depended on it?)
- Are there other obstacles to desired performance?



Value the Prevention of Error

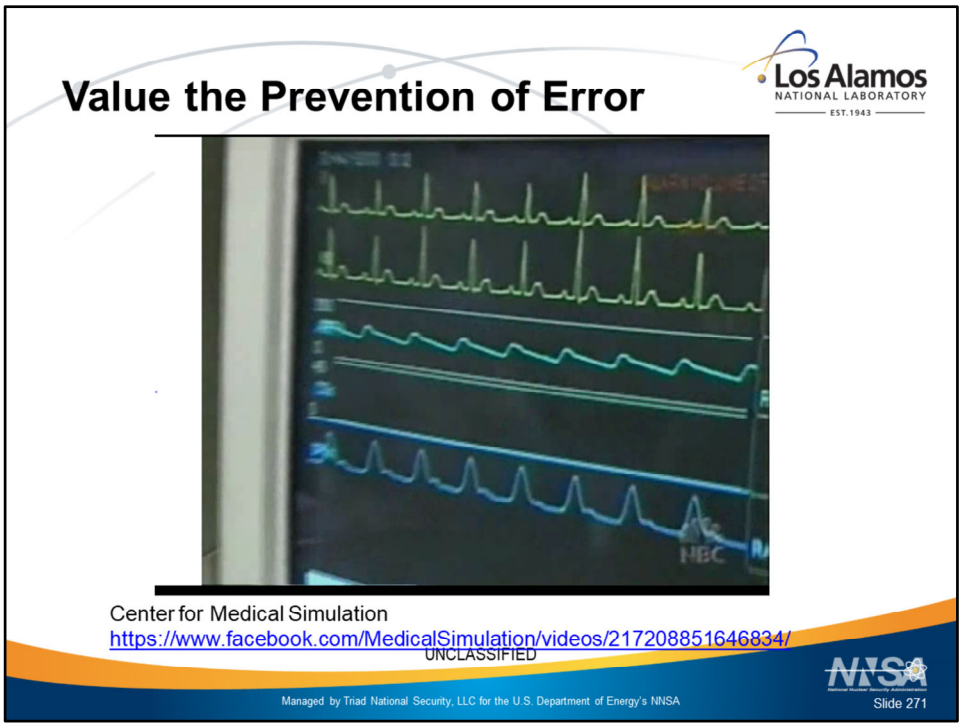
People's beliefs and attitudes toward hazards and error traps affect their adherence to high standards. If error-free performance (avoiding active errors) is **not** held up as an important value or is not expected for daily work; then people may adopt unsafe practices to get their work done; possibly placing themselves, others, or the facility at risk of an event. Consistently maintaining high standards communicates the value of error prevention. By clinging to high standards regardless of the perceived risk, adherence to expectations will become the norm.

Positive attitudes about error prevention depend greatly on what is rewarded and which behaviors are reinforced. It is easier to change behavior when positive attitudes exist. Positive values and attitudes follow behaviors that consistently result in success for the individual. It is not necessary for values and attitudes to precede behavior, but it is preferable. The most effective way to communicate values is to act in accordance with them while reinforcing people when they apply them. The following leader behaviors convey the values of the organization, in order of influence:

- what managers pay attention to, measure, and control;
- reactions to an accident, event, or crisis;
- allocation of resources;
- deliberate attempts to coach or role model;
- criteria for allocation of rewards and punishment; and

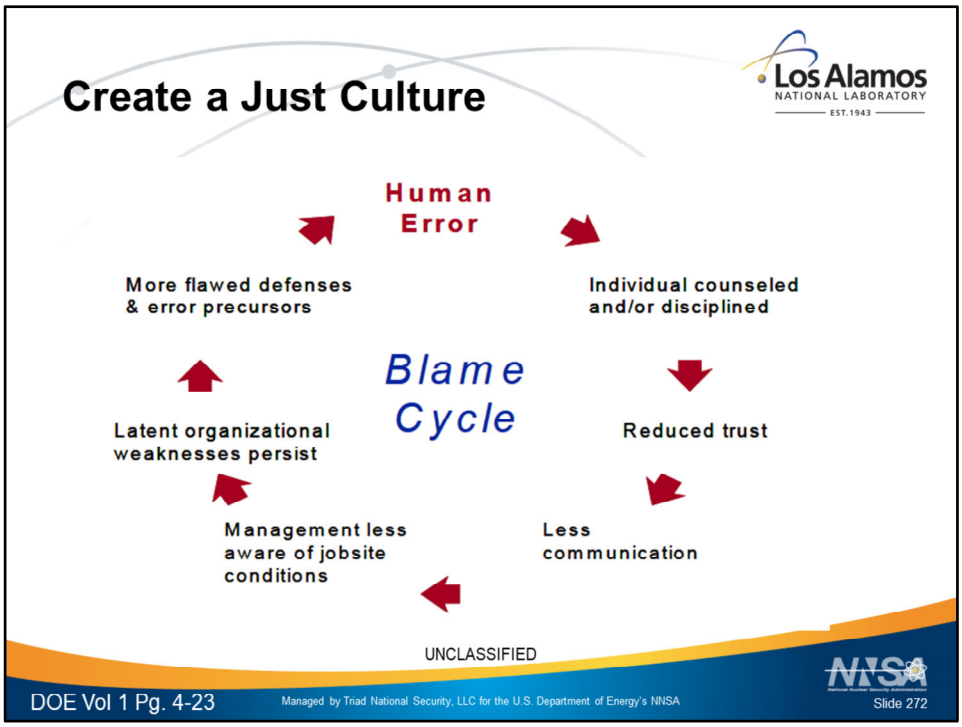
- criteria for selection, advancement, and termination.

If those in positions of responsibility and influence react appropriately, with integrity, and consistent with stated values, people will adopt safe behaviors.



VIDEO: (Medical Mistakes.wmv, 43.6 MB)
This video is of a “simulator” where operating crews can learn from their mistakes

Center for Medical Simulation
Old video about CMS from NBC Dateline (Do No Harm – medical mistakes)
https://www.facebook.com/MedicalSimulation/videos/217208851646834/



The "blame cycle" depicted below is urged on by the belief that human error occurs because people are not properly motivated. In reality, no matter how motivated an individual is, active errors will continue to occur, occasionally. Events will continue as long as event investigations stop prematurely at the active human error. The true causes (typically organizational weaknesses) will not be discovered—will remain latent or hidden—and errors and events will persist.

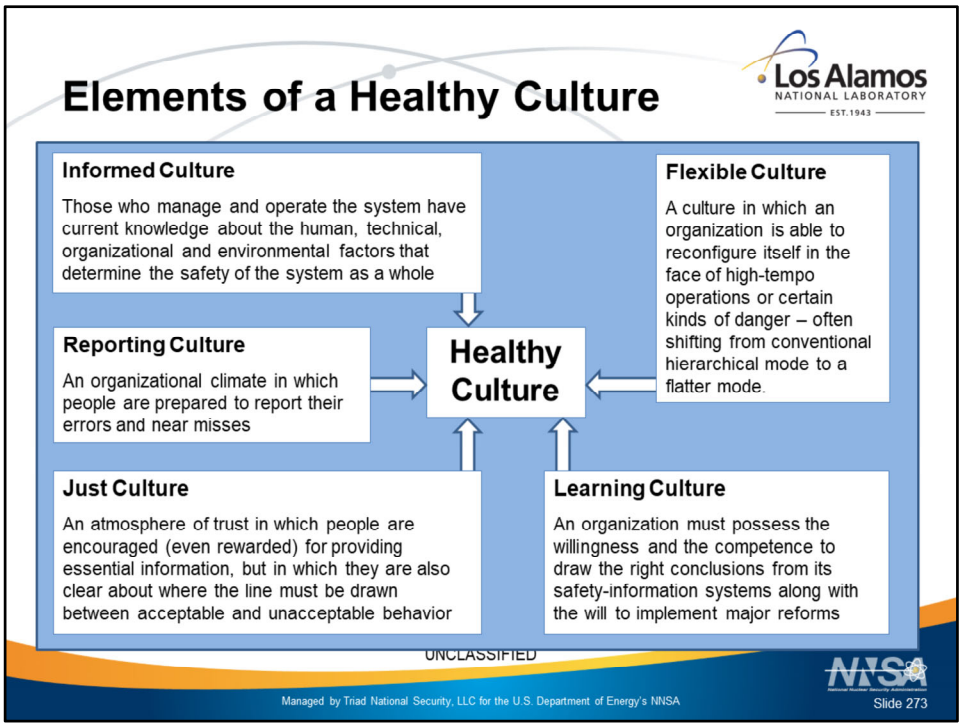
Categories of Violations

It is important to recognize that there are at least two major categories of violations—*routine and thrill-seeking or optimizing*. Routine violations typically involve corner-cutting at the skill-based level of performance by taking the path of least effort between two task-related points. These shortcuts can become a habitual part of a person's behavior, particularly when the work environment is one that rarely sanctions violations or rewards compliance. Routine violations are also prompted by "clumsy" procedures that direct actions along what seems to be a longer-than-necessary pathway. Routine violations are not necessarily reckless. Routine violations often look like latent weaknesses.

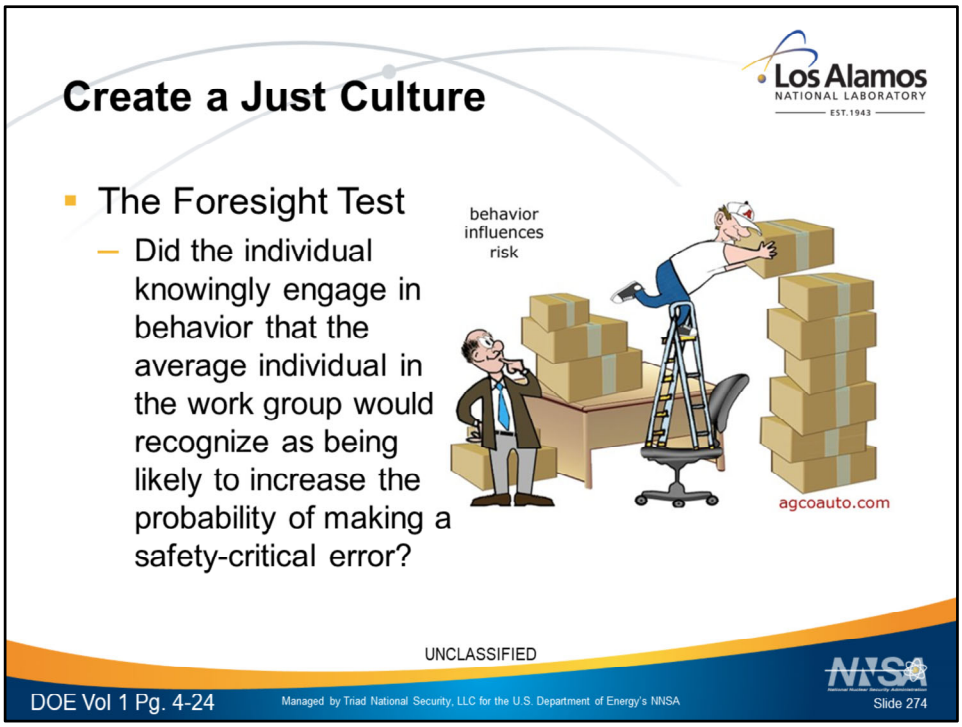
Thrill-seeking or optimizing violations are violations "for the thrill of it." Thrill-seeking violations reflect that human actions serve a variety of motivational goals and that some of these are quite unrelated to the functional aspects of the task. These violations are committed to appear macho, to avoid boredom, or simply for kicks. This category of violation is reckless. In some organizations employees are named, blamed, shamed, and re-trained based on the consequence of their

action, not the intent of the action. If either the violation or error they committed caused an accident or an event of some kind, they are disciplined, but the very same actions (both violations and errors) without a consequence, are ignored or allowed to slide. In some organizations people are allowed to commit violations right along until there is an event, then all hell breaks loose. What this means is that someone who inadvertently errs is held accountable for their actions in the same fashion that someone who intentionally performs work he or she knows is contrary to known standards.

A just environment is all about getting the balance right between how willful violations and unintentional errors are addressed in the organization. All too often organizations do not make clear the distinctions between errors and violations. A just organization clears the smoke in the air between erring and violating. To do so, management sets a zero tolerance policy for reckless conduct—bad acts that we call violations. Zero tolerance for violations is balanced by the belief and the widespread confidence among the leadership that the vast majority of unintended unsafe acts will go unpunished as honest errors—unintended departures from expected behavior—on the part of the performer. There are proven methods to help organizations determine culpability for serious incidences in which unsafe acts are involved.



- Just – we won't know if we don't have dialogue with those doing the work – blame vs trust
- Reporting – we can't manage what we don't understand
- Learning – complex systems are a constant source of challenge – need to be refining all the time – as soon as we believe we have arrived at an optimized system we have likely begun our decline
- Flexible – a culture steeped in involvement and adaptability. These are highly creative companies that quickly respond to customer and employees changing needs.

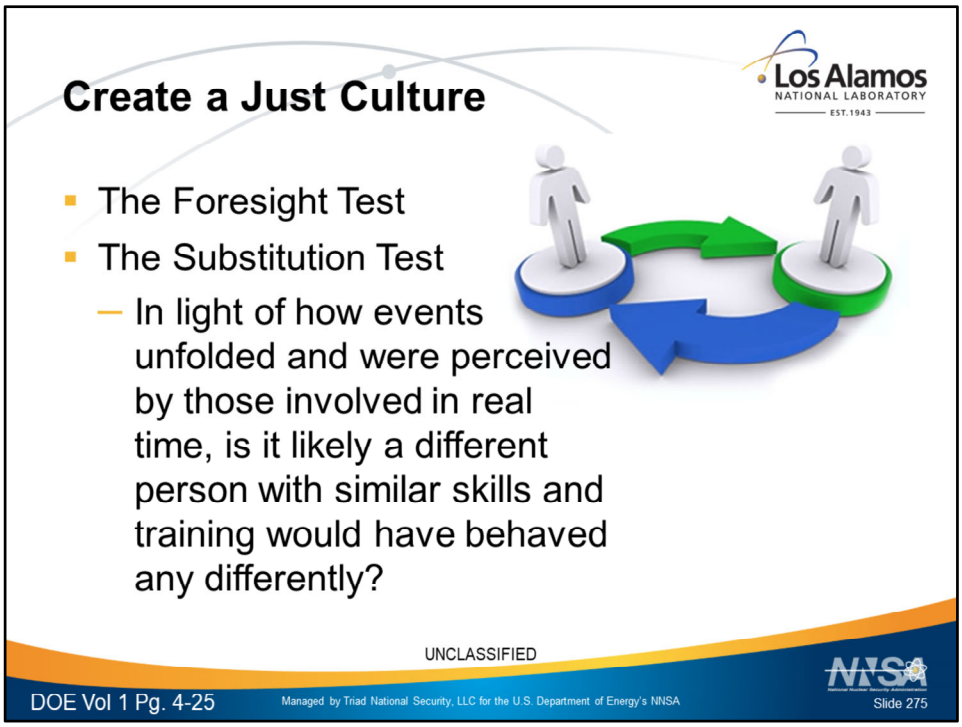


The Foresight Test

The question to ask is: "Did the individual knowingly engage in behavior that the average individual in the work group would recognize as being likely to increase the probability of making a safety-critical error?" If the individual's peers respond that they would have recognized the action as promoting an error, then it is likely the individual in question should also have recognized the same thing. If the peers failed to see the connection between the action taken and increased risk, then it is reasonable to assume that the individual also did not see the connection. In any one of the following situations, however, the answer to this question is likely "yes" and as such is indicative of culpability:

- performing work under the influence of a drug or substance known to impair performance;
- clowning around while driving a towing vehicle or forklift truck or while handling other potentially damaging equipment;
- taking unwarranted shortcuts like signing off on jobs before they are completed; and
- using tools, equipment, or parts known to be sub=standard or inappropriate.

Keep in mind the Foresight Test is a "rule of thumb" measure. There will likely also be extenuating circumstances associated with any of these situations.

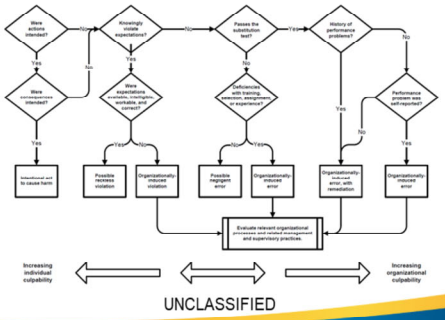


The Substitution Test

This test is in keeping with the principle that the best people can make the worst errors. This exercise involves substituting the individual concerned in the event with other individuals who do the same kind of work and who have comparable training and experience. Then the question is asked: “In light of how events unfolded and were perceived by those involved in real time, is it likely a different person with similar skills and training would have behaved any differently?” If the answer repeatedly comes back from the selected peers, “probably not,” then apportioning blame has no place here and would likely obscure the underlying systemic deficiencies. Another way to use the substitution test is to ask the question in a different way of a small number of the erring individual’s work mates: “Given the circumstances that prevailed at the time, could you be sure that you would not have committed the same or a similar type of unsafe act?” If the response is ”probably not,” then blame is very likely to be inappropriate. It is a “blameless” error.” The substitution test is often used in conjunction with the Culpability Decision Tree, which is discussed below.

Create a Just Culture

- The Foresight Test
- The Substitution Test
- The Culpability Decision Tree



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DOE Vol 1 Pg. 4-25
DOE Vol 1 Pg. 4-29

Managed by Triad National Security, LLC for the U.S. Department of Energy's NNSA

Slide 276

Explained in a previous slide

This video presents a near miss electrocution event at Palo Verde Nuclear Plant.
This is a good Segway to the TA-53 Arc Flash event (coming up in a few slides) where an employee ended up performing work on a similar looking piece pf equipment, that was energized.

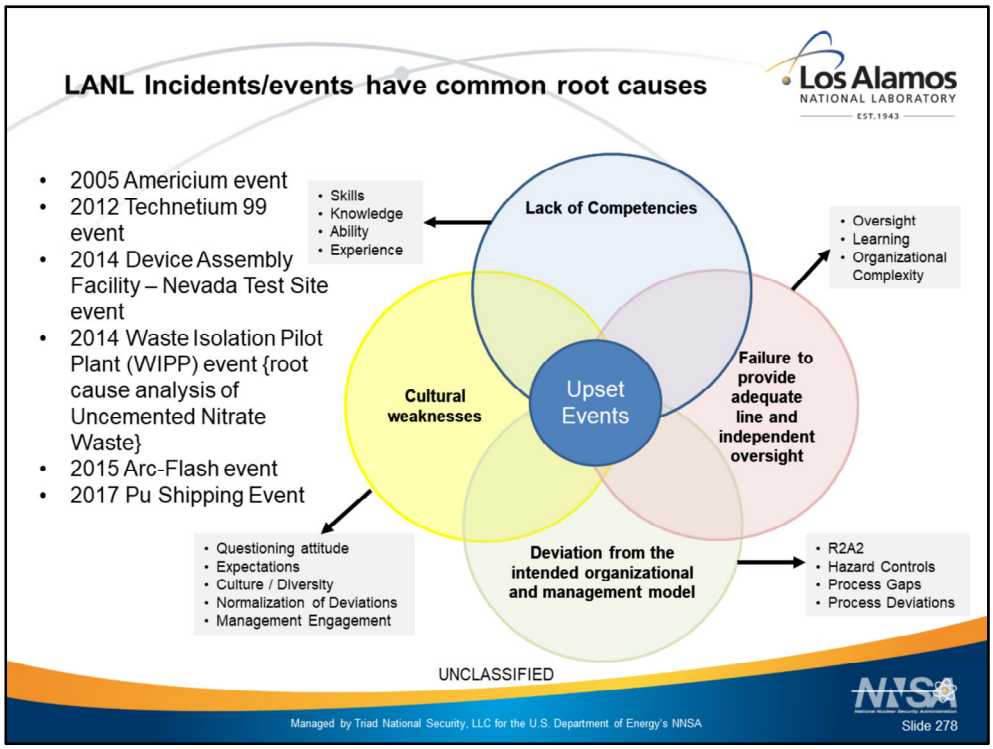


Illustration and content obtained from LA-UR-17-25477, Type B Plutonium Shipping Event Causal Analysis and Expanded Common Cause Analysis of Related Events.

Executive Summary

An event specific causal analysis was conducted to determine the direct, root, and contributing causes in the Pu shipping incident of June 16, 2017. Once the nature of the event was examined, a common cause analysis was conducted to investigate if the shipping incident shared characteristics with other events that have occurred at the institution. The following Occurrence Reporting and Process System (ORPS) reportable incidents were examined:

- 2005 Americium event {ORPS report}
- 2012 Technetium 99 (Tc-99) event {ORPS report}
- 2014 Device Assembly Facility – Nevada Test Site (DAF-NTS) event
- 2014 Waste Isolation Pilot Plant (WIPP) event {root cause analysis of Uncemented Nitrate Waste}
- 2015 Arc-Flash event {JAIT report}

In the WIPP event root cause analysis, it was concluded that four root causes were evident, per the diagram below. These root causes were used as the basis for investigating common cause across all of the referenced events (including the Pu shipping incident).

Expanded Common Cause Analysis

A review was conducted of five significant Laboratory incidents and several Occurrence Reporting and

Process System (ORPS) events with cause codes similar to the root causes of the Waste Isolation Pilot Plant (WIPP) event to determine if the current (Pu shipment) event was a symptom of larger, systemic issues. The five significant events were:

- 2005 Americium event {ORPS report}
- 2012 Technetium 99 (Tc-99) event {ORPS report}
- 2014 Device Assembly Facility – Nevada Test Site (DAF-NTS) event
- 2014 WIPP event {root cause analysis of Un-cemented Nitrate Waste}
- 2015 Arc-Flash event {Joint Accident Investigation Team report}

The conclusions, causes, and contributing factors of the five significant events were analyzed with the Affinity Diagram causal analysis tool. An affinity diagram is the organized output from a brainstorming session used to generate, organize, and consolidate information related to a product, process, complex issue, or problem. After generating ideas, they are grouped according to their affinity, or similarity.

The groupings were structured by using the root causes identified in the Longenecker & Associates Independent Review Team Report regarding Un-cemented Nitrate Waste at Los Alamos National Laboratory (WIPP): (1) Lack of competencies, (2) Cultural weaknesses, (3) Deviation from the intended organizational and management model and (4) Failure to provide adequate line and independent oversight. The root causes were further organized into sub-groups (see illustration in this slide).

2005 Americium event

On July 14, 2005, a worker at the Sigma Facility of Los Alamos National Laboratory (LANL) received a shipment of 18 uranium nitride pellets from LANL's Plutonium Facility (PF-4). The pellets had been produced in a glovebox line in PF-4 that was also used to produce pellets for a different research program that were a mixture of plutonium and americium (referred to as 'actinide pellets'). The Sigma worker's task was to weld the pellets into specially designed individual cans so that the pellets could undergo test irradiations in a reactor. The welding work was to be done with a laser-welder enclosed in a glovebox designed to maintain an inert atmosphere for the welding process. The 18 uranium nitride pellets were contained in 9 Swagelok® couplings sealed with end caps to maintain an inert atmosphere on the pellets during the transfer between the facilities. The Sigma worker assumed that the components were not contaminated except for the possibility of low levels of uranium. In contrast, the PF-4 staff that had produced the pellets and loaded the Swageloks® knew that there was a good probability for contamination on the Swageloks®, and that there was no intention to decontaminate the parts after removal from the PF-4 gloveboxes. Regardless, they did not attempt to evaluate the contamination levels on the Swageloks®, nor did they explicitly inform the Sigma worker of the potential for contamination. They knew that the parts were to be placed in the glovebox at Sigma and they assumed that the worker was prepared to accept the parts with contamination. Therefore, neither party was aware that the Swageloks® had inadvertently become highly contaminated with americium-241 from an unrelated activity performed in the same glovebox and adjacent to where the Swageloks® were loaded. After accepting the shipment, the Sigma worker took it to the laser-welding

glovebox. He opened the outer drum and placed the inner container with the Swageloks® into the glovebox to maintain the inert atmosphere on the parts. When he opened the inner container, he found that the parts had been sealed inside multiple plastic bags, so he passed his knife into the glovebox and sliced open the plastic bags. He then removed the plastic bags and knife from the glovebox and placed the knife in its sheath on his belt and the plastic bags on a nearby table. The worker then confirmed the serial numbers on the Swageloks®, gave a piece of paper with those numbers to the nuclear materials custodian for the records, and left the facility for a three day weekend. Since the room was not in an established radiological control area, there was no personnel contamination monitoring necessary in order to leave the facility. On that day the worker's spouse, currently working in Colorado, drove to Los Alamos to meet him The next morning they drove together to Kansas to visit a relative for the weekend. The following week, the worker's spouse returned to Colorado, and the worker returned to Sigma and continued to work in the laser-welding glovebox, although not with the Swageloks®. He also worked in other areas of Sigma and attended meetings at other LANL locations. Unknown to him, he was contaminated both during the initial work and during work of the following week, and was tracking the contamination to the various locations that he visited. Also, he handled and contaminated some non-radioactive weld coupons that were then shipped to Bettis Atomic Power Laboratory, in Pennsylvania, that week. On July 25, the Sigma radiological control technician supervisor was in the room containing the laser-welding glovebox, and discovered that the worker had opened the shipment. She conducted a limited radiological survey to check for contamination. The results indicated high levels of contamination of a nature that was not expected in Sigma; she expanded the surveys, assigned a technician to survey the worker, submitted samples for more extensive evaluation, and made notifications to appropriate management. As the surveys began to discover contamination in other areas and on the worker, the scope of the response expanded rapidly. During the afternoon of July 25, a DOE Radiological Assistance Program team was deployed to the worker's residence and verified the presence of americium-241 contamination there.

2012 Technetium 99 (Tc-99) event

On August 25, 2012, radioactive contamination was identified on Flight Path 04 of the Lujan Center, an experimental area that is part of the Los Alamos Neutron Science Center at the Los Alamos National Laboratory in New Mexico. Los Alamos National Laboratory is operated by Los Alamos National Security, LLC. The Operating Contractor quickly determined that the contamination had spread offsite, and response teams were immediately brought in. The Operating Contractor restricted access to the affected facilities, recalled personnel who may have been contaminated, and requested that they bring potentially affected clothing and vehicles so they could be surveyed. These responses, along with actions of the offsite response teams, stopped the spread of contamination offsite, retrieved contaminated items that could not be cleared for release, and decontaminated items where needed. The Operating Contractor preserved the onsite accident scene and initiated an internal investigation. The contamination found offsite was above DOE's release criteria in some instances, however it was at levels far below those expected to have a discernible health effect, and the safety of the workers, public, and the environment was not affected by the

event.
Precise estimates of the extent of personnel contamination and maximum doses are outside the scope of this report. However, based on the amount of contamination, no dose is expected to exceed 1 millirem. Note that persons living in the United States typically receive between 300 and 600 millirem annually from routine, natural and manmade sources (such as cosmic radiation and medical procedures).
On August 29, 2012, the Administrator of the National Nuclear Security Administration appointed a Federal Accident Investigation Board (AIB) to determine how the accident occurred and prevent recurrence.
From September 4-18, 2012, the AIB interviewed witnesses and reviewed evidence. Because the area where the most significant events occurred was contaminated with radioactive material, the AIB relied heavily on the preliminary Contractor investigation (including voluminous photographic evidence), as well as information gathered in response to AIB requests. AIB members did not physically enter the rooms in the Lujan Center that were contaminated.

2014 Device Assembly Facility – Nevada Test Site event
On June 16, 2014, a loss of contamination control of highly enriched uranium occurred at the Nevada National Security Site's National Criticality Experiments Research Center at the Devise Assembly Facility. On June 16th NSTec radiation control technicians (RCT's) discovered radiological contamination outside the previously identified Godiva critical assembly device (Godiva) contamination area. Subsequent bioassays of potentially affected personnel revealed that 31 tested positive for uranium intakes. The assessed doses ranged from less than 0.001 rem to 0.131 rem committed effective (50 year).

2014 Waste Isolation Pilot Plant (WIPP) event {root cause analysis of Uncemented Nitrate
On February 14, 2014, a radiation release occurred at the WIPP from a compromised drum of contact-handled transuranic waste emplaced underground in the WIPP facility. The drum contained nitrate salts, processed and emplaced at the WIPP in late 2013. The Department of Energy Accident Investigation Board determined the cause of the radiation release was an exothermic reaction due to the use of incompatible, organic sorbent material instead of inorganic sorbents for absorbing free liquids in sludge waste containers.
The source of contamination was later found to be a barrel that exploded on February 14 because contractors at Los Alamos National Laboratory packed it with organic cat litter instead of clay cat litter. Other barrels with the same problem were then sealed in larger containers.[

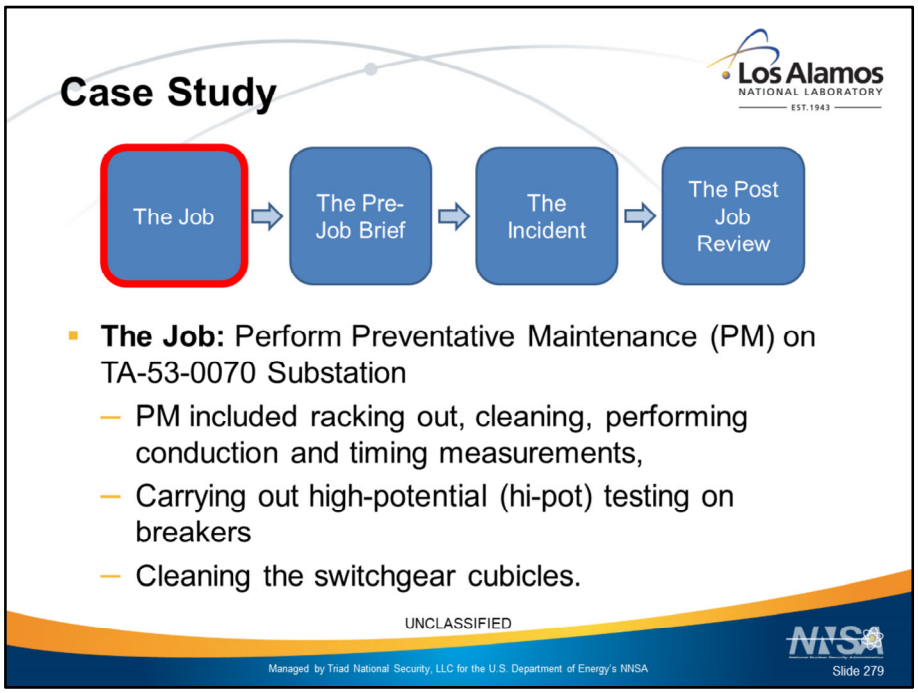
2015 Arc-Flash event
On May 3, 2015, at Los Alamos National Laboratory (LANL) Technical Area 53 (TA-53), during Preventive Maintenance (PM) on an electrical substation, a wireman (W1) entered a cubicle on the energized portion of the switchgear to clean it with a commercial spray cleaner and suffered severe injuries from the resulting arc flash and blast. The cleaning solution created a path to ground between the 13.8-kV bus and the grounded cubicle wall, and the force of the arc flash/blast ejected W1 from the cubicle. In addition to suffering significant burns, W1

lacerated his head when he fell backward and struck nearby test equipment. He was airlifted to the regional burn center in critical condition.
The Team identified the *direct cause* as W1 entering the energized cubical and spraying cleaning fluid into the air gap between the bus bars and the grounded enclosure, where the spray created a path to ground and resulted in an arc flash. The Team identified the overall *root cause* as less-than-adequate management of control implementation, which the Team considered a combination of two specific root causes:

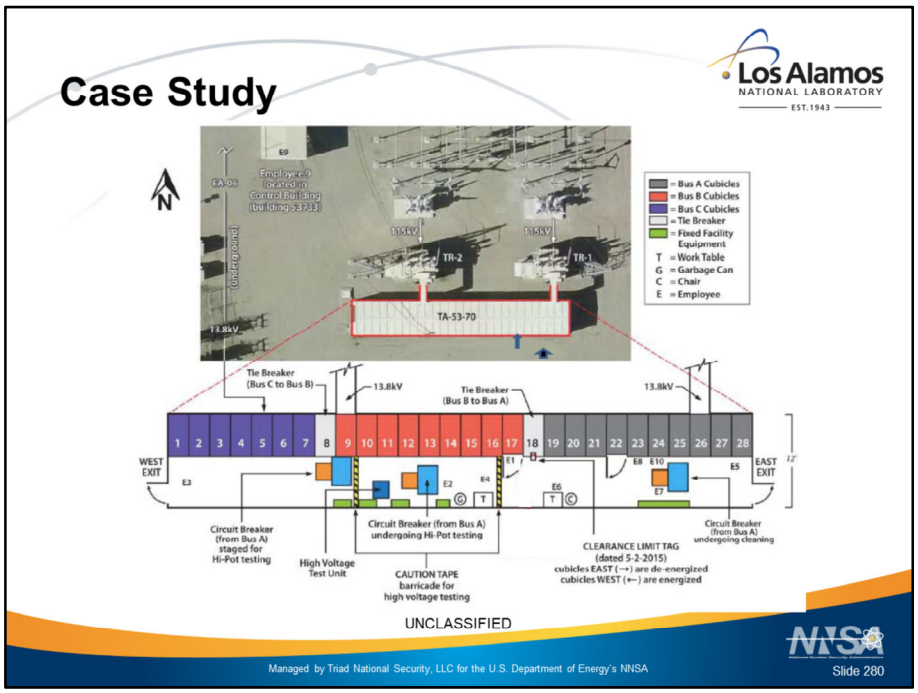
- Failure to require and implement zero-voltage checks; and
- Lack of established physical barriers.

2017 Pu Shipping Event

Shipment was made to Lawrence Livermore National Laboratory (LLNL) and Savannah River Site (SRS) in the form of three Type B containers (one to LLNL, two to SRS). Both shipments were conducted at the same time by the same Shipper, resulting in two separate violations of federal regulations, as multiple aircraft were involved.

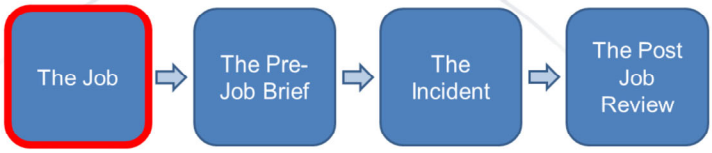


1. Tell the story. Make listeners curious to hear what happened next.
2. Include critical details that the original crew noticed (or could have noticed), but don't
3. Reveal only what happened before

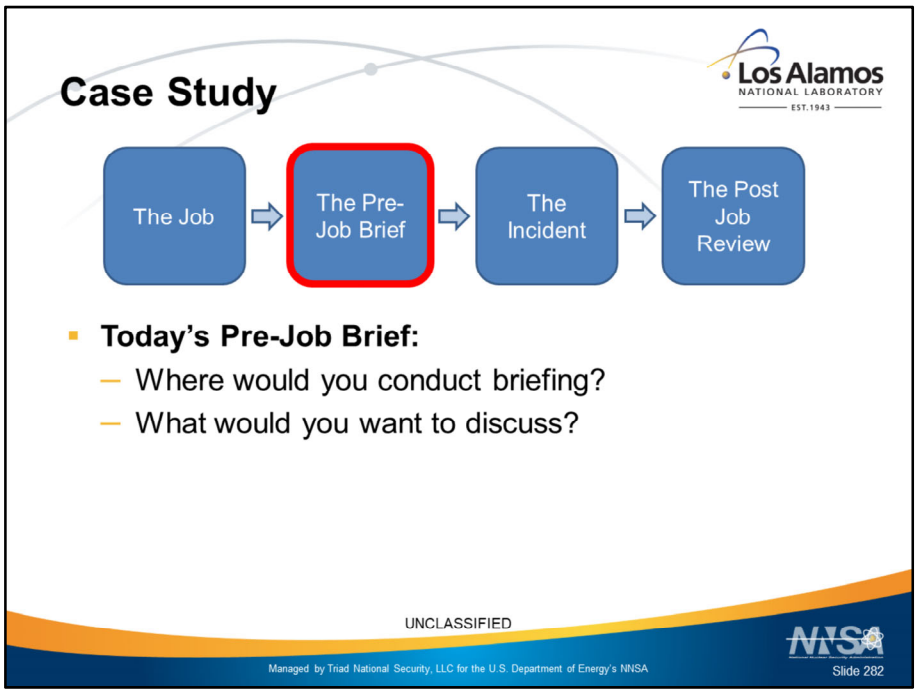


1. Tell the story. Make listeners curious to hear what happened next.
2. Include critical details that the original crew noticed (or could have noticed), but don't
3. Reveal only what happened before

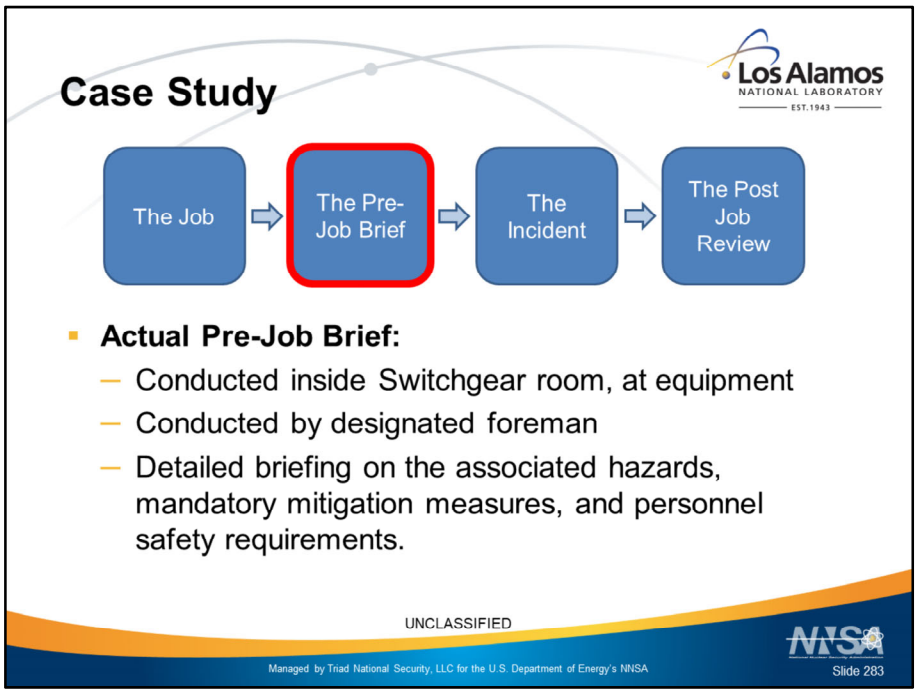
Case Study



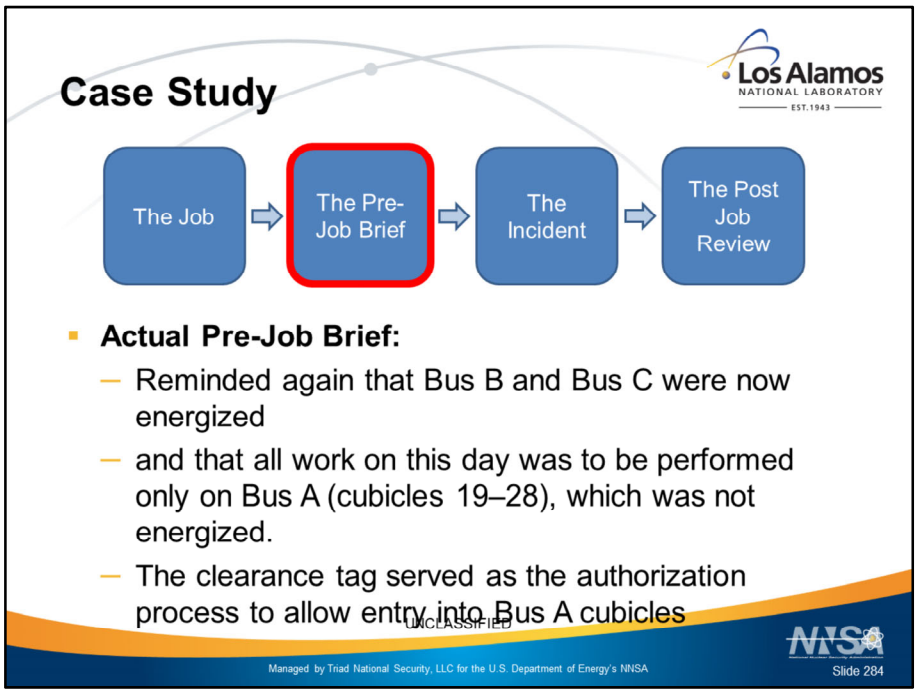
- **Yesterday's work:**
  - *The combined PMs were performed on Buses B and C, with the entire switchgear deenergized.*
  - *After work was complete for the day, Buses B and C were re-energized.*



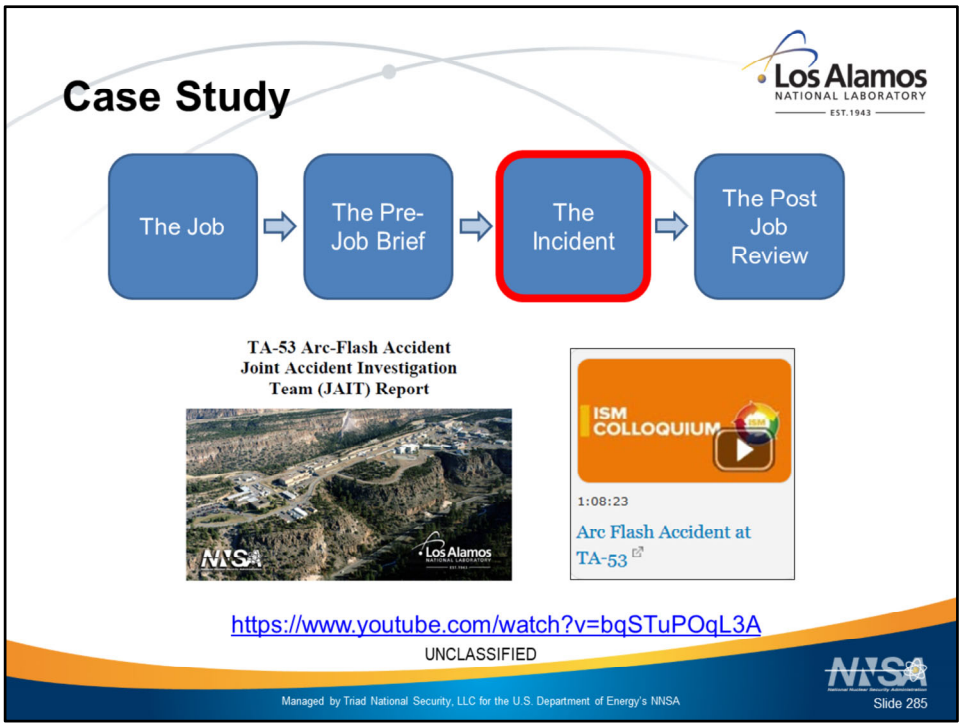
1. Get participants to pair up and work on the Pretask brief together.
2. Walk around, watch and listen. Keep them on task. Coach only when essential.



Discuss what actually happened



Discuss what actually happened



Hyperlinked video is a presentation by Tommy Martinez at the 2017 ISM Colloquium hosed by ARGONNE
http://int.lanl.gov/safety/safety-leadership/_assets/docs/TA53-arc-flash-accident-report.pdf

Anatomy of an Incident and Lessons Learned: Arc Flash Accident at Los Alamos National Laboratory
https://www.youtube.com/watch?v=bqSTuPOqL3A

ANL Training
Uploaded on Aug 29, 2017
"Anatomy of an Incident and Lessons Learned: Arc Flash Accident at Los Alamos National Laboratory (LANL) Technical Area 53," an Integrated Safety Management (ISM) colloquium, will be presented by Tommy R. Martinez,
Category - Science & Technology
License - Standard YouTube License

Evolution of Events

- Sunday, May 3, 2015 - Accident occurred at LANL's technical area 53, building 70 substation
  - LANSCE (Los Alamos Neutron Science Center)
- Injured Worker was treated for arc burns at the University of New Mexico Trauma Center, Albuquerque, NM
- May 5 – Fact Finding Meeting at LANL
- Joint Accident Investigation Team (JAIT) was immediately convened by NNSA and LANS
  - May 8 – JAIT supports re-energizing switchgear to feed affected buildings
  - May 12 - Accident Scene Released to the Utilities Division (FOD)
  - July 9, 2015 – JAIT Final Report was approved
  - September 21, 2015 - LANS TA-53 Arc-Flash Corrective Action Plan was transmitted

Joint Accident Investigation Team (JAIT)

- NNSA and Laboratory Joint team included strong independent NNSA Leadership combined with LANL and member company leaders/expertise
- Facilitated partnering and collaboration between NNSA and the Laboratory
- Brought NNSA Federal complex-wide experience and AI process expertise combined with LANL knowledge and insight into Laboratory policies, processes, and procedures facilitating greater investigative insight
- Improved "ownership" of the investigation results by LANL and provided greater assurance of follow-through

NNSA/LANL Joint Team investigation resulted in a thorough, robust investigation, and promoted LANL ownership of the conclusions and Judgements of Need

Arc-Flash Occurred in a Small Substation

Los Alamos NATIONAL LABORATORY EST. 1943

Technical Area (TA) 53
LANSCE

Building 70 substation

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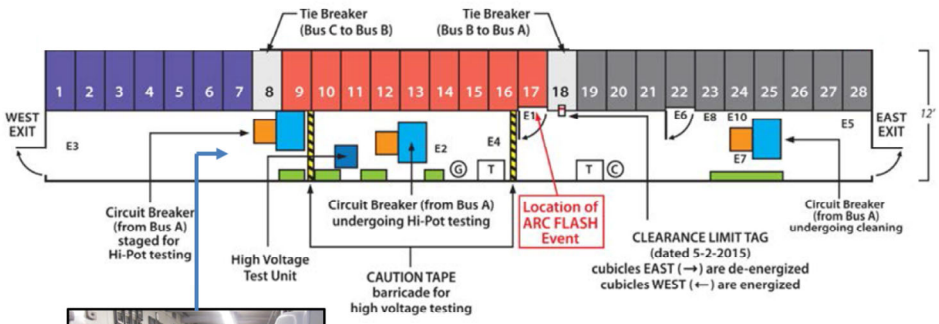
Diagram of Work Area



MSS - Maintenance and Site Services
UI - Utilities and Institutional Facilities

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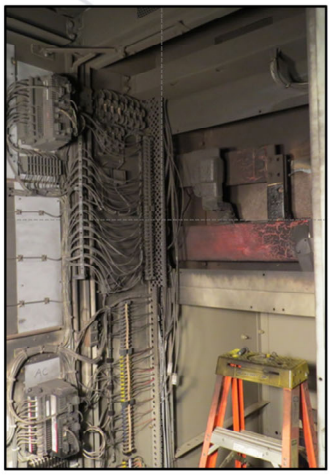
Accident Scene – Cubicle 17

Door Open



Inside View

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Arc Flash Damage

Injured Worker's Clothing

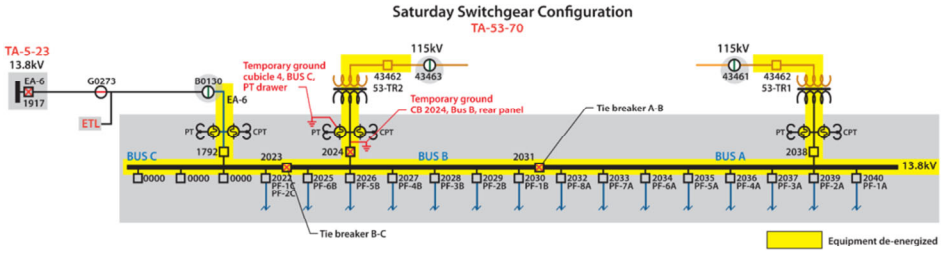
- As a result of the arc flash, the worker suffered burn injuries to the hands, wrists, face, neck, and torso. Due to the fall, the worker also received a minor laceration to the back of the head.
- Based on viewing this photo, an industry expert estimated that this event was likely around 20-30 cal/cm² on the arms or a little more.
- LANL Engineering calculated that the worker exposure was 30-40 cal/cm².
- The onset of a second degree burn is 1.2 cal/cm².

May 3rd Accident Timeline

- 0630 Pre-Job Brief for cubicle cleaning and breaker testing (hi-pot)
- 0700 Start tasks with Buses B and C energized, Bus A remains isolated (de-energized)
- ~1100 worker opens and enters cubicle 17 (energized, with clearance tag on cubicle 18) and starts working
- 1108 worker starts spraying, ensuing Arc Flash and Blast injures worker
- 1235 worker flown from LAMC to UNM Trauma Center
- Other workers transported to LAMC evaluated and treated as appropriate

Saturday Electrical Lineup

All switchgear buses are isolated, linemen complete cleaning back (outside); wiremen complete Buses B and C cleaning and circuit breaker testing (inside).



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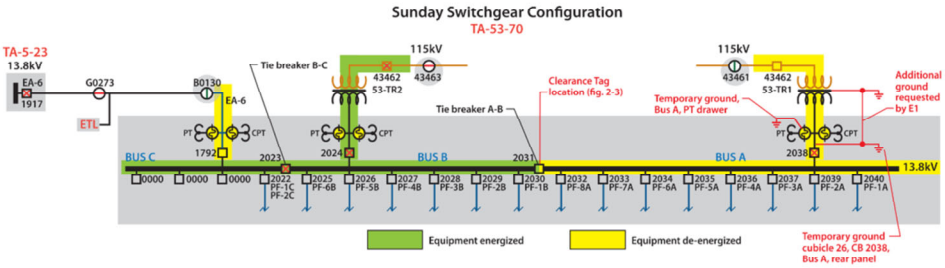
Sunday Electrical Lineup

Buses B and C complete, re-energized. Bus A de-energized for work to be performed.



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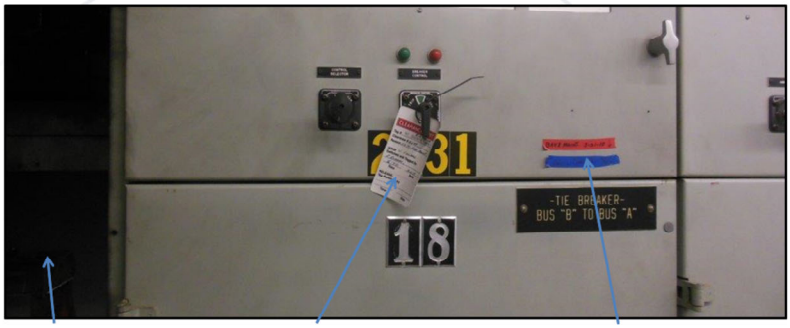
Crew Composition

Work Crew is composed of linemen and electricians, described as linemen and wiremen with varying switchgear experience.

Clearance Point Established for Sunday



Accident scene, no tape found on cubicle 17 (metering cubicle)

Formal Clearance Tag

Informal completion tracking Blue=Clean Red=Breaker Tested

Human Factors

Hi-pot testing area, marked by caution yellow tape –signifies to workers to keep clear when testing

- Circuit breaker modules wheeled in and out
- Congested work area

JAIT Arc Flash Event Analysis

Example of a typical industrial arc flash

- ***Direct Cause: Cleaning fluid sprayed into the air gap between the bus bars and the grounded enclosure of an energized cubicle.***
- ***Root Cause: Less-than-adequate management of control implementation.***
- ***Thirteen Judgements of Need (JONs) identified by the JAIT.***

JAIT Contributing Factors

- Planning process did not adequately evaluate:
  - Impact of performing two jobs concurrently
  - Working in a partially energized environment/look-alike equipment
- Environment established did NOT mitigate human error
  - Lack of robust controls
  - Failed to implement zero-energy (voltage) checks consistently
  - Cluttered/congested work environment
  - Possibly confusing visual cues
  - PPE requirements not uniformly enforced
- While an electrical accident, shortfalls are attributed to work planning and control implementation

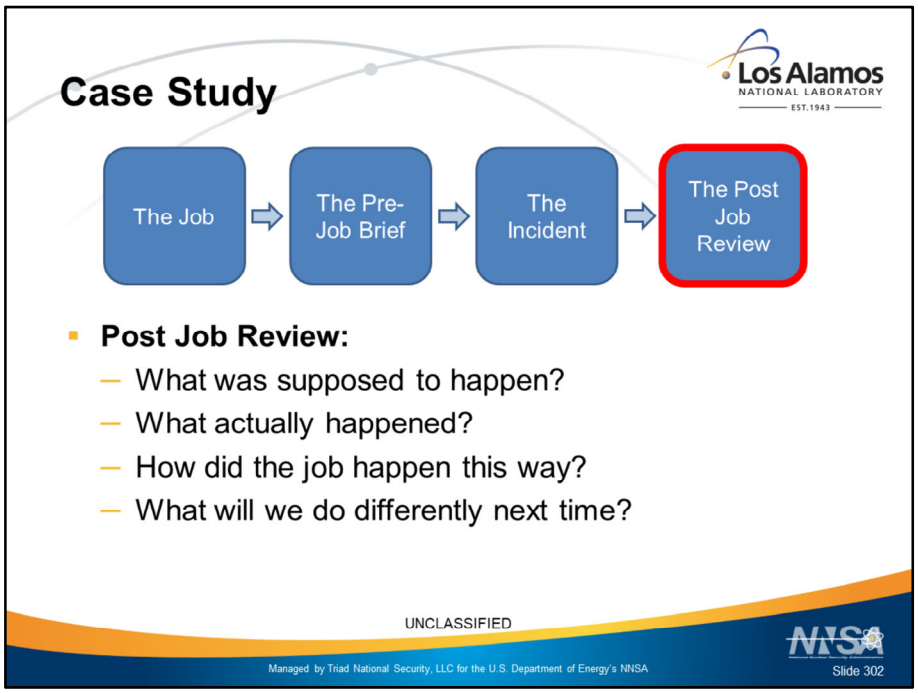
  - *Either a zero-energy check or robust barrier to restrict access would have prevented this accident*
  - *Actions should focus on implementation, clear expectations, effective verification - not addition of more procedures, policies, or requirements*

Human Performance Investigation

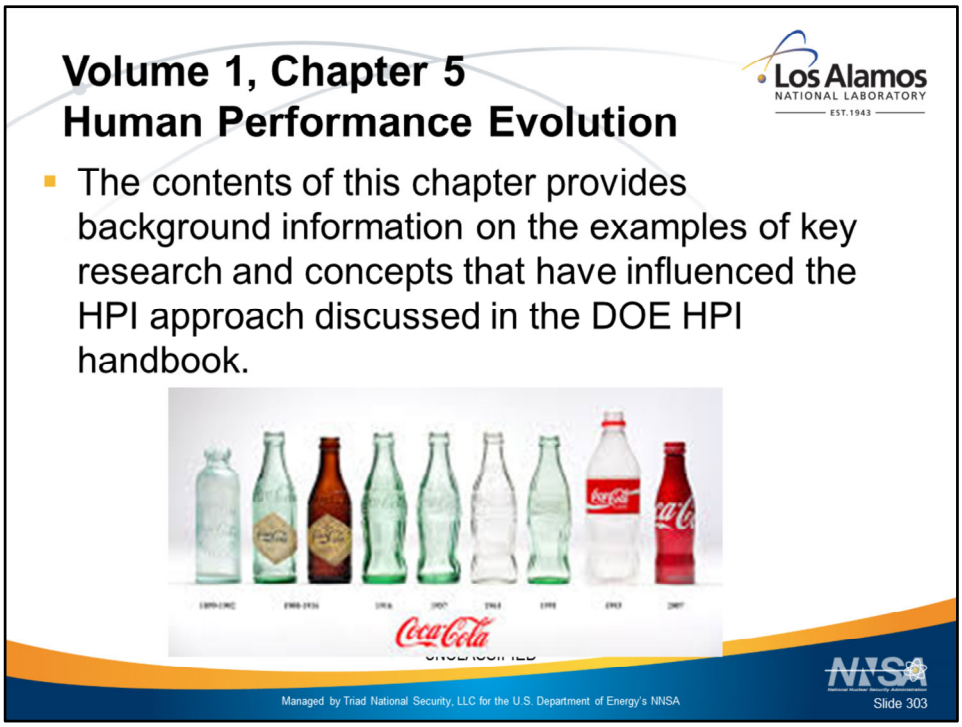
Task Demands	Individual Capabilities
Time considerations Need to re-energize B&C Saturday Night Need to be finished by Sunday night May get finished early	**Lack of knowledge (faulty mental mode)** Loss of bearings and missed visual demarcation Lack of PPE adherence Numbers of workers non routine to Substation work One person first time ever on the job
Repetitive actions Clean a cubicle mark it move on to another unmarked cubicle	**Illness or fatigue** 14-hour day on Saturday
Irreversible actions Opened cubicle 17 and cleaning started E1 sprayed cleaning fluid into cubicle 17	
Interpretation of requirements Only clean to the East Side of the clearance tag on cubicle 18 West of the clearance is energized	

Human Performance Investigation

Work Environment	Human Nature
Unclear goals roles or responsibilities Clean cubicle should not have led to an energized cubicle being opened	
Changes/departure from routine For some, doing two PM's simultaneously Working beside re-energized equipment Not completing the job without de-energization the whole time	**Assumptions** If the cubicle needs cleaned it is de-energized If cubicle does not have colored tape it needs cleaning
Confusing displays or controls Red/blue tape signifies complete, missing from cubicle 17 (which is energized) Clearance tags more normal for linemen, not wiremen E1 is an wireman Yellow caution tape directly next to cubicle 17	**Mindset (intentions)** E1 is a hard worker and does not like to sit around Desire to help the team get finished
Unexpected equipment conditions Cubicle17 had no colored tape to signify it had been completed, implication therefore it needed cleaning and must be de-energized	
Lack of alternative indication No physical deterrent from opening an energized cubicle	



1. Get participants to pair up and work on the Post Job Review (After Action Review) together.
2. Walk around, watch and listen. Correct any factual mistakes, but let them draw their own conclusions
3. Discuss answers



The contents of this chapter provides background information on the examples of key research and concepts that have influenced the HPI approach discussed in this handbook. As one would expect, it is within the organization that performance improvement has evolved over time. The reader is introduced here to several significant influences and forces that have helped shape organizations' thinking about human performance and how organizations adjusted their approach to doing business in order to improve the way people work. Improving performance has been a linchpin not only for increasing efficiency, augmenting quality and meeting productivity expectations, but also for reducing human error and eliminating unwanted events. The lessons learned from failures in safety at Bhopal, Chernobyl, Challenger, Exxon Valdez, Three-Mile Island and elsewhere have given rise to new ways of thinking about the organization and its role in creating and sustaining a safety climate. The objective of this chapter is to illustrate how the organizational forces that evolved over time contributed to the development of human performance improvement as described in this handbook and promoted within DOE through training interventions in recent years. HPI builds upon these historical approaches to improve performance. The DOE/INPO HPI approach is one example of how improvement may be achieved.

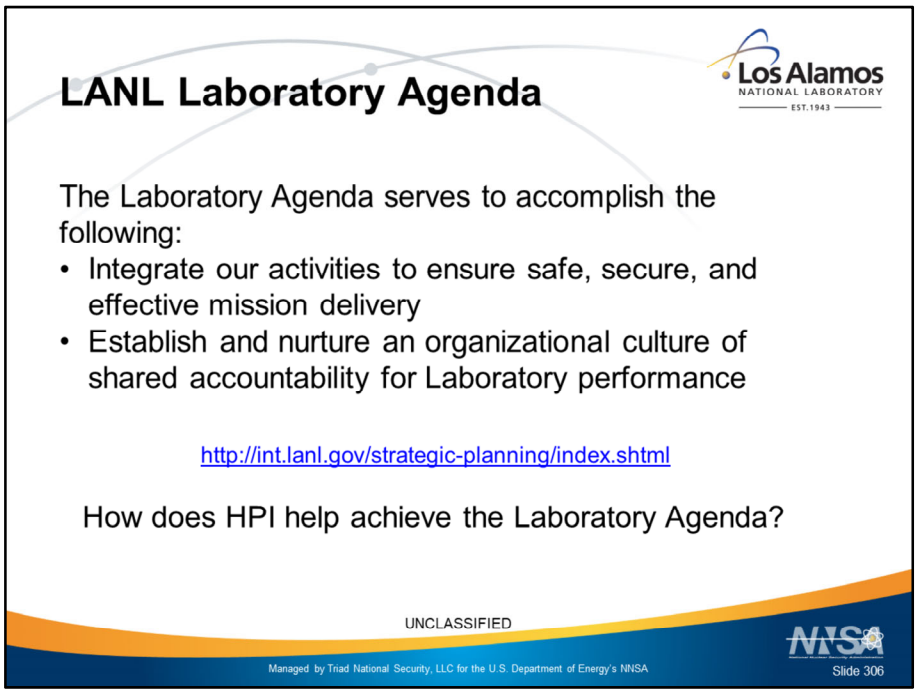
Simultaneous Excellence

Delivering science and technology to protect our nation and promote world stability

Each of these objectives is essential to our success.

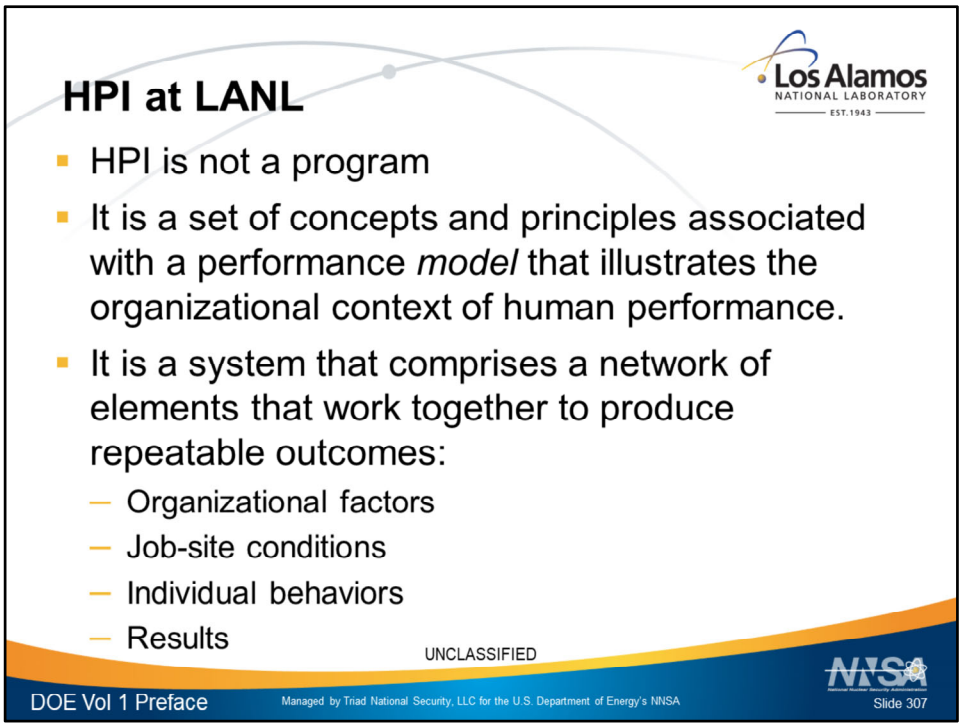
The balanced approach will ensure that the Laboratory can deliver on its mission.

Simultaneous Excellence



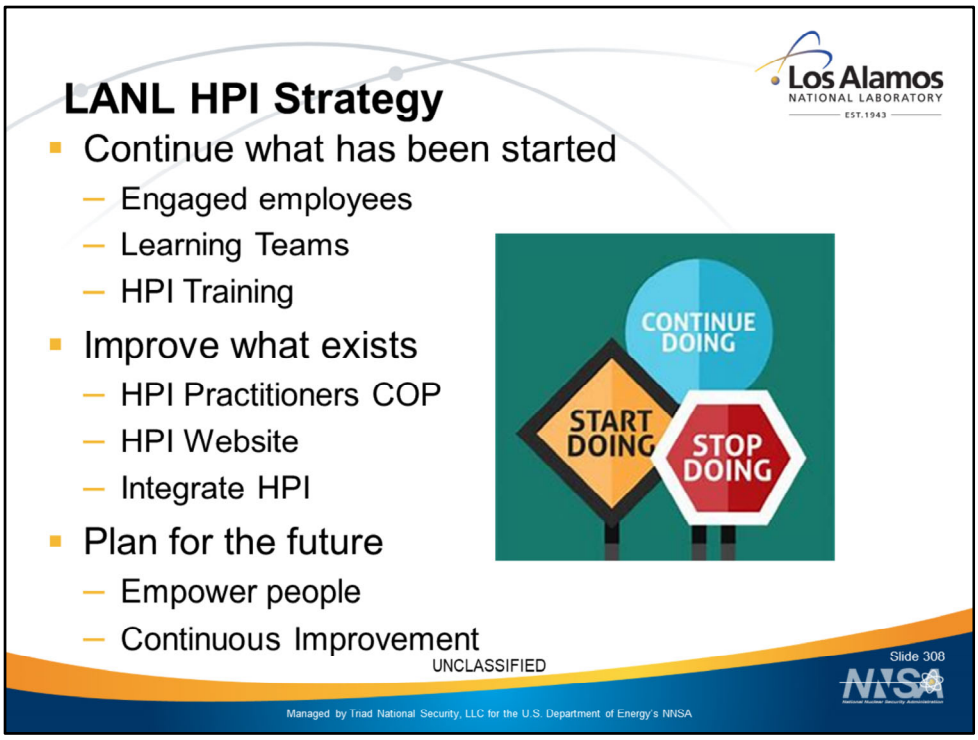
Use the hyperlink to open the current Laboratory Agenda
Review sections where HPI is integrated (or could be integrated) to help achieve that objective.
Examples from the 2019 Laboratory Agenda include:

- Page 2 of 20 – Manufacturing mission to deliver 30 pits per year: any of the HPI tools for individuals, teams, and Management
- Page 6 of 20 – Refresh and refine the LANL capability pillar framework – Questioning attitude, collaboration and teamwork, validating assumptions
- Page 11 of 20 – Achieving culture change with an emphasis on organizational learning – OPEX at LANL, Learning Teams,
- Page 14 of 20 – Implement systematic process improvements to drive increased rigor and efficiency in work execution – Implement an integrated CAS, Management systems, Identify performance gaps
- Page 16 of 20 – Institute a personal commitment to community service by LANL Leadership – Establish trust among the Laboratory, its employees, and its stakeholders by ensuring transparency and timely communications both internally and externally.



DOE, Volume 1 Preface

Human performance improvement (HPI) is not a program per se, such as Six Sigma, Total Quality Management, and the like. Rather, it is a set of concepts and principles associated with a performance *model* that illustrates the organizational context of human performance. The model contends that human performance is a system that comprises a network of elements that work together to produce repeatable outcomes. The system encompasses organizational factors, job-site conditions, individual behavior, and results. The system approach puts new perspective on human error: it is not a cause of failure, alone, but rather the effect or symptom of deeper trouble in the system. Human error is not random; it is systematically connected to features of people's tools, the tasks they perform, and the operating environment in which they work.



Summary from "LANL HPI Game Plan"

HPI Training at all levels throughout the organization: Leadership, Practitioners, and employees

Integrate HPI - Translate HPI (Human Performance) tools and usage into normal safety culture behaviors

Empower People: HPI Team will be coaches and mentors. Each organization will own and implement HPI

Continuous improvement of the HPI program, through observation and feedback, to ensure that it meets the needs of the Lab and its Mission.

Achieving Excellent Human Performance

- To achieve excellent human performance
  - The organization must focus on and reinforce the desired behaviors during all processes and phases of operation.
  - These behaviors become the basis for our professional principles that drive safe, reliable and event-free operation.

Achieving Excellent Human Performance

- Experience with error prevention and human performance improvement has revealed that the most capable defenses against events are open communication and positive reinforcement of desired behaviors.

- To optimize successful performance, appropriate individual and leader behaviors must occur in concert with appropriate organizational processes and values

Achieving Excellent Human Performance

Four key elements

1. Establishing a work environment that promotes behavior in people, leaders and the organization that leads to safe, reliable operations.
2. Clearly describing, communicating and reinforcing the correct behaviors so that they may be understood and practiced.
3. Preventing human errors caused by inappropriate behavior, leadership practices or organizational weaknesses.
4. Minimizing error-causing conditions by promoting a culture where all employees aggressively seek out and correct these conditions.

Questions - Comments

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