



Exploratory Barrier Analysis

2010 DOE ISM Workshop

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Discussion Points

- **Exploratory Barrier Analysis?**
- **Why Barriers Are Important to an HRO**
- **Questions of Your Barriers**
- **How Does One Capture the Information?**
- **Lessons Learned**
- **Next Steps**

Exploratory Barrier Analysis

- **Barriers, everybody uses them, but what are they?**
- **We talk about defense in depth in terms of reducing the probability of an event, what does this mean in practice?**
- **We talk about multiple barriers, typically this is a fix for past mistakes, does this hold true to reducing probabilities?**
- **Barrier-as-imagined vs. barrier-as-done***

Why Barriers Are Important to an HRO

Keep the most important thing, the most important thing

GOAL

Ensure Viability of U.S. Nuclear Deterrent

Consequence to Avoid

Shutting Down Pantex

Pinnacle
Events

Event #1

Event #2

Event #3

Event #4

Hazards

Hazards

Hazards

Hazards

Barriers

Barriers

Barriers

Barriers

Break-the-
Chain
Framework

Error
Precursors

Error
Precursors

Error
Precursors

Error
Precursors

Culture

Culture

Culture

Culture

Org.
Learning

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Learning

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Learning

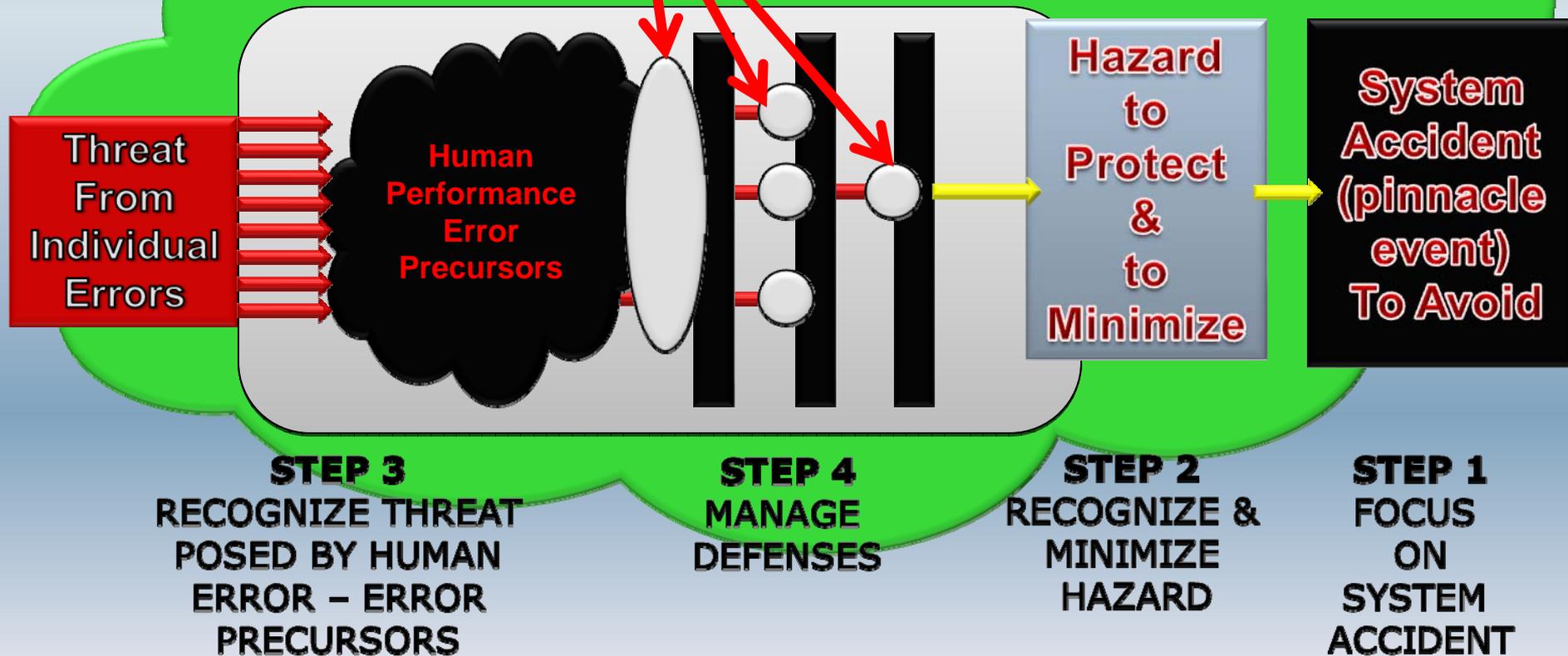
Org.
Learning

Why Barriers Are Important to an HRO

Break-the-Chain Framework

STEP 6 - LEARN FROM SMALL ERRORS

**STEP 5
FOSTER A CULTURE OF RELIABILITY**



Questions You Should Ask of Your Barriers

Question #1: Are Barriers Rigorously Designed?

- Are they in the right location in the process?
- Are they the right barriers for the threat?

Question #1
Design?

Question #2: Are Barriers Fully Implemented and Effective?

- Are they in place?
- Does the worker know about them and use them?
- Do they work as designed?

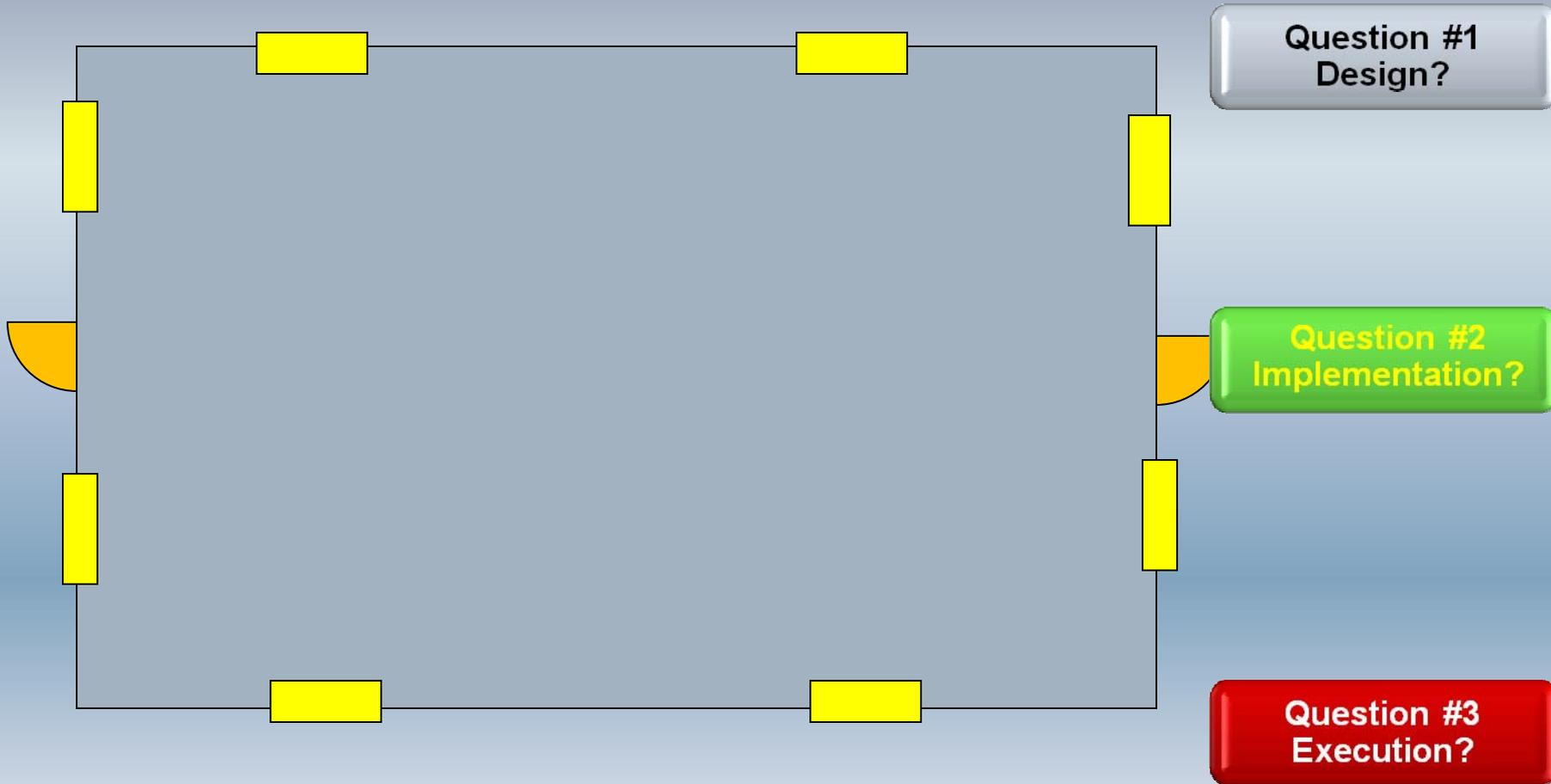
Question #2
Implementation?

Question #3: Are Barriers Maintained Implemented and Effective and Verified Operational Before Work Begins?

- Do you have some type of configuration management?
- Does the worker know about them and use them?
- Do you verify barriers operational before work begun?

Question #3
Execution?

Questions You Should Ask of Your Barriers



Are Right Barriers In Right Location

Where Can Threats and Hazards Come Together?



Threats*

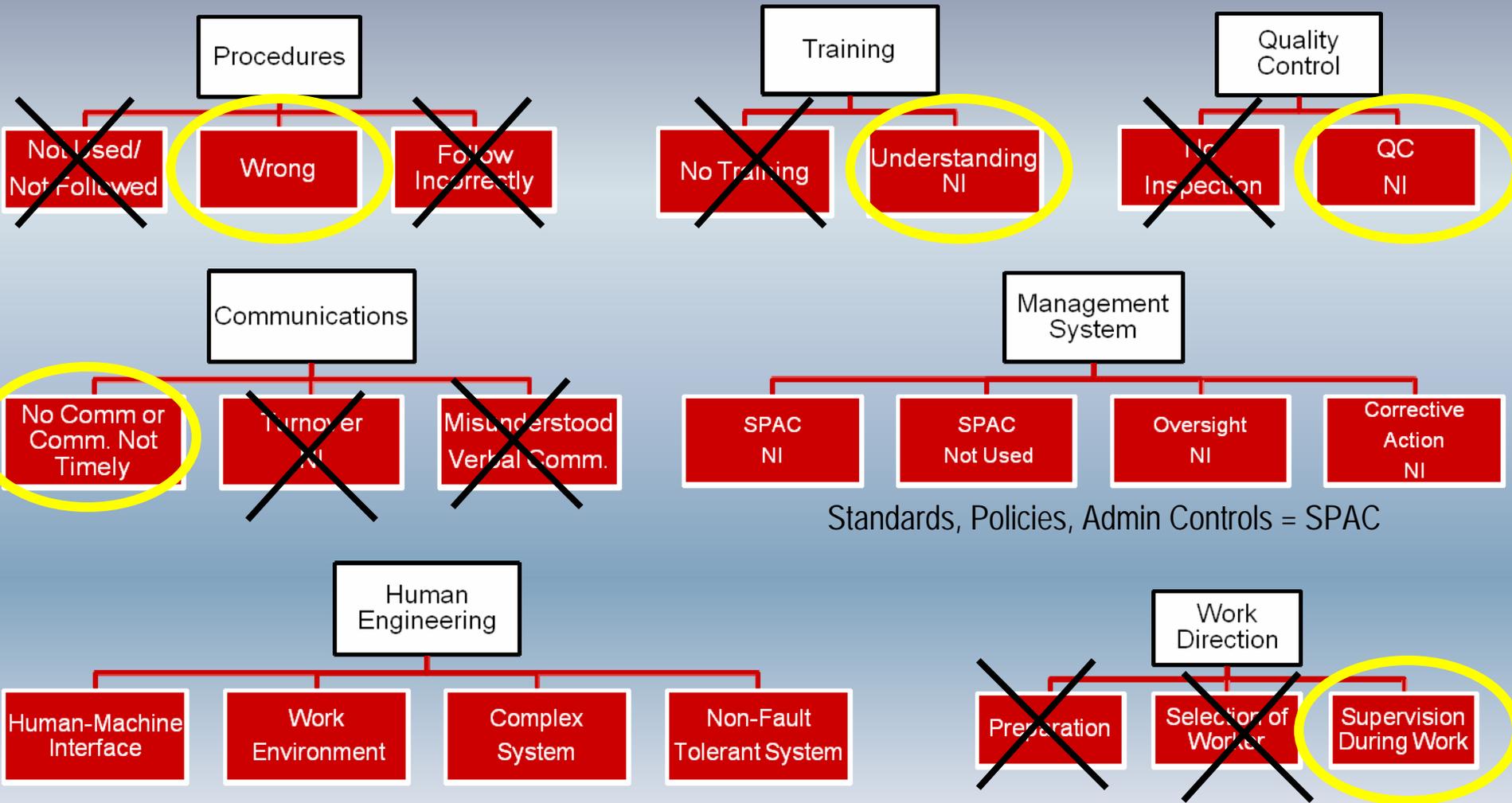
- **Human Performance?**
 - Individual or team performance?
 - Categories:
 - Procedures
 - Training
 - Quality Control
 - Communications
 - Management Systems
 - Human Engineering
 - Work Direction
- **Equipment, Tooling, or Facility Problem?**
 - Tolerable failure?
 - Design (specs or review)?
 - Equipment defective (procurement, manufacture, handling, storage, quality control)?
 - Preventive/predictive maintenance
 - Repeat failure
- **Natural Disaster or Sabotage?**
- **Other (specify)?**

Question #1
Design?

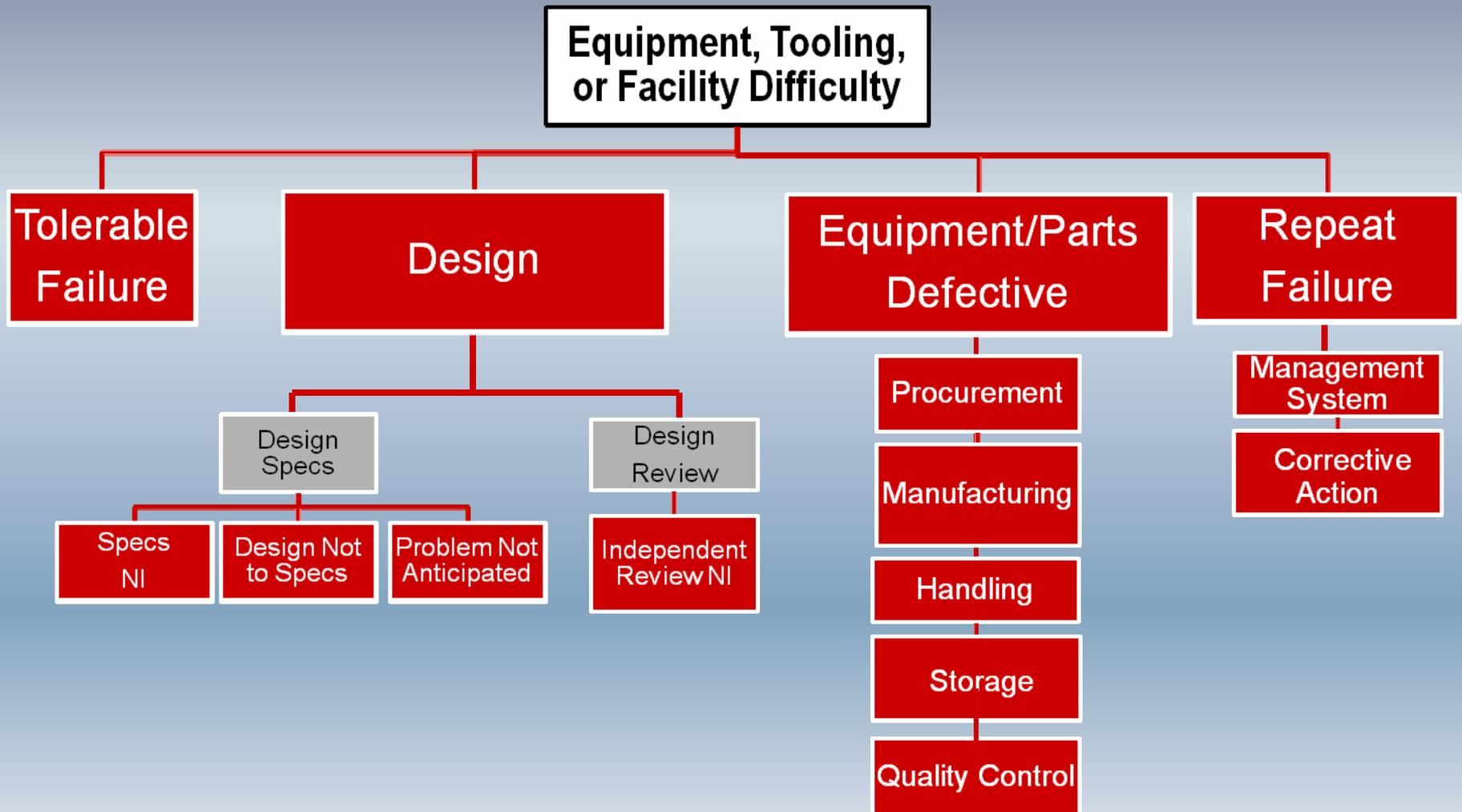
Question #2
Implementation?

Question #3
Execution?

Human Performance Threat*



Equipment, Tooling, or Facility Threat*



How Does One Capture Barrier Information ?

Design of the Barrier Analysis Matrix (BAM)

Threats from Task tree. Designed to help people consider threats.

Obtained from process map and walking process down

Hazard identified at top of BAM

Has barrier been implemented?
Is it known to the worker?
Are there impediments to its use?
Is it available every day?

Additional barriers beyond those already existing?

Primary barriers to minimize and protect: Previous Slides

Column #1	Column #2	Column #3	Column #4	Column #5	Column #6
Threat to Hazard	Existing Barrier Between Threat & Hazard	Hazard Minimized or Protected	Effectiveness of Barrier	Significance of Barrier in Protecting Hazard	Additional Barrier Needed
Results	Results	Results	Results	Results	Results
Results	Results	Results	Results	Results	Results

Lessons Learned

- **Everyone thought the experience was worthwhile**
- **Confirmed suspicions on barriers (at least in two processes examined)**
 - No common terminology, no clear understanding where deployed, varying levels of implementation and verification, no consolidated documentation, varying levels of configuration management . . .
- **Lots of interesting questions, few good answers, yet!**
 - **Must Barriers Be Rigorously Designed?**
 - ◆ How do you know you have barriers in the right locations in your process if you don't know what your process looks like?
 - ◆ How do you know you have the right types of barriers if you don't know what type of threat you have?
 - ◆ If you intend to use multiple and independent barriers to avoid a consequence, what does multiple and independent physically mean? Can you go around a barrier?
 - **Must Barriers Be Fully Implemented and Effective?**
 - ◆ How do you know if the barriers you designed are fully implemented?
 - ◆ How do you know if the worker knows?
 - ◆ How do you know if the barriers you designed are effective at blocking threat from hazard?
 - **Must Barriers Be Maintained Implemented and Effective and Verified Operational Before Work Is Begun?**
 - ◆ How do you know if the barriers you implemented stay implemented?
 - ◆ Do you need some type of configuration management on the process and barriers?
 - **If you Can't Answer the Above, Are You Really Safer or Just Kidding Yourself?**

Next Steps

- **Barrier analysis process is in its infancy**
 - List of pinnacle and plateau events to focus efforts – Oct. 30, 2010
 - Modify BAM for next round of barrier analyses – Nov 30, 2010
 - Explore and improve barrier analysis process as it is used – Sept. 30, 2011
- **Common language/terminology for “Barriers”**
- **Simplify and standardize process for production use**
 - Standard methodology for process mapping
 - “Check list” for consistent application
 - Conduct barrier analysis twice – once with workers (“barrier-as-done”) and once with engineers and managers (barrier-as-imagined)
- **Explore use of barriers as a risk control methodology**
 - Verify barriers in place before work starts
 - If not, two options:
 - ◆ Stop/limit/curtail work within limits of remaining barriers
 - ◆ Provide temporary replacement barrier – increased monitoring by workers

Exploratory Barrier Analysis #1 – CSA



Exploratory Barrier Analysis #2 – CFO



Summary

- **Rationale of Conducting an “Exploratory Barrier Analysis”**
- **Why Barriers Are Important to an HRO**
- **Questions You Should Ask of Your Barriers**
- **How One Captures the Barrier Information**
- **Results of Two Exploratory Barrier Analyses
–it’s not results, it’s the learning**
- **Lessons Learned and Next Steps**

Support Slides



Common Language

- Barrier vs. control
- Administrative barrier/control vs. engineered barrier/control
- Defense-in-depth
- A barrier at one tier should prevent a barrier from a higher tier (closer to pinnacle event) from being challenged (i.e. a barrier at a higher tier should not fail unless the barrier below it at the lower tier fails first).
- Barrier analysis
- Redundant control/barrier
- Independent control/barrier
- Visible vs. invisible barrier/control
- Active vs. passive barrier/control
- Exercised vs. not exercised
- Preventive vs. mitigative barriers

Common Language

- HPI – Human Performance Improvement
- Apparent Cause - AxxBxxCxx
- LOW – Latent Organizational Weakness
- Precursors
- Graded Approach
- Extent of Condition – Generic Implications
- Missed Opportunity
- Causal Factors Analysis (CFA)
- Set-up Factors
- Trigger
- Failed Barrier
- Mitigator
- Exacerbator
- Root cause
- Direct Cause
- Contributing Cause
- Consequence / Significance
- Why-Why Tree (Staircase)
- Event and Causal Factor Analysis
- Structure
- Work as imagined
- Recurrence Controls
- Eight Questions for Insight
- Change Analysis
- Barrier Analysis
- Team Lead
- Facilitator
- PER/ESTARS
- DPOC
- ISM
- Critique
- CA/MP – Cause Analysis/Mistake Proofing
- Causal Factor
- Couplet
- Timeline / Comparative Timeline
- HRO – High Reliability Organization
- PAAA – NTS, LT, WSH
- Defenses
- Knowledge Based, Rule Based, Skill Based
- Error-likely situation
- Process Map
- Work as done
- Goal Conflict
- TWIN analysis

Individual Accident

- An accident occurs wherein the worker is not protected from the plant and is injured (e.g. radiation exposure, trips, slips, falls, industrial accident, etc.)



Focus:

Protect the worker from the plant

Systems Accident

- An accident wherein the system fails allowing a threat (human errors) to release hazard and as a result **many** people are adversely affected
 - Workers, Enterprise, Surrounding Community, Country

Human Errors
(threat)

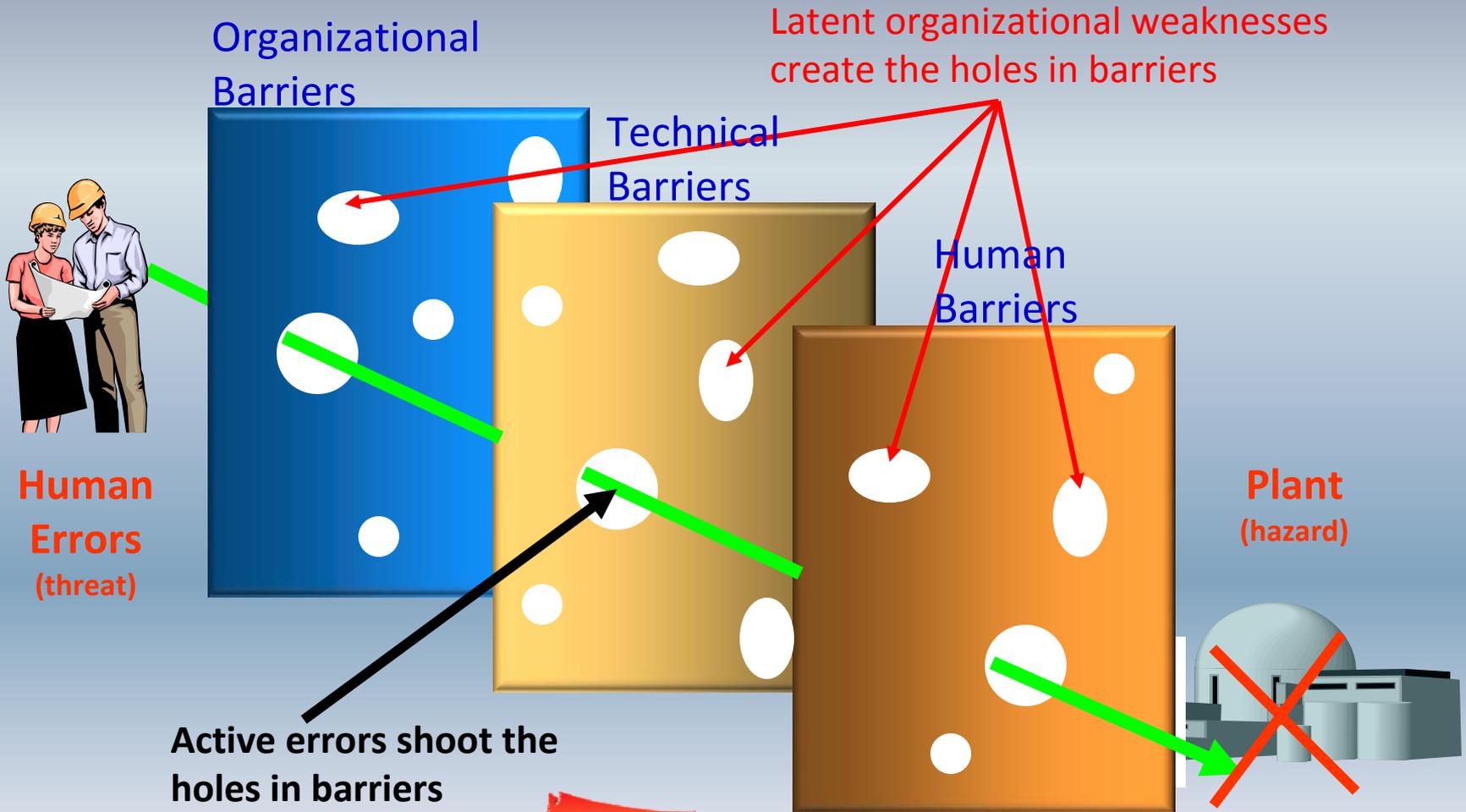


Focus:

Protect the
plant from
the worker

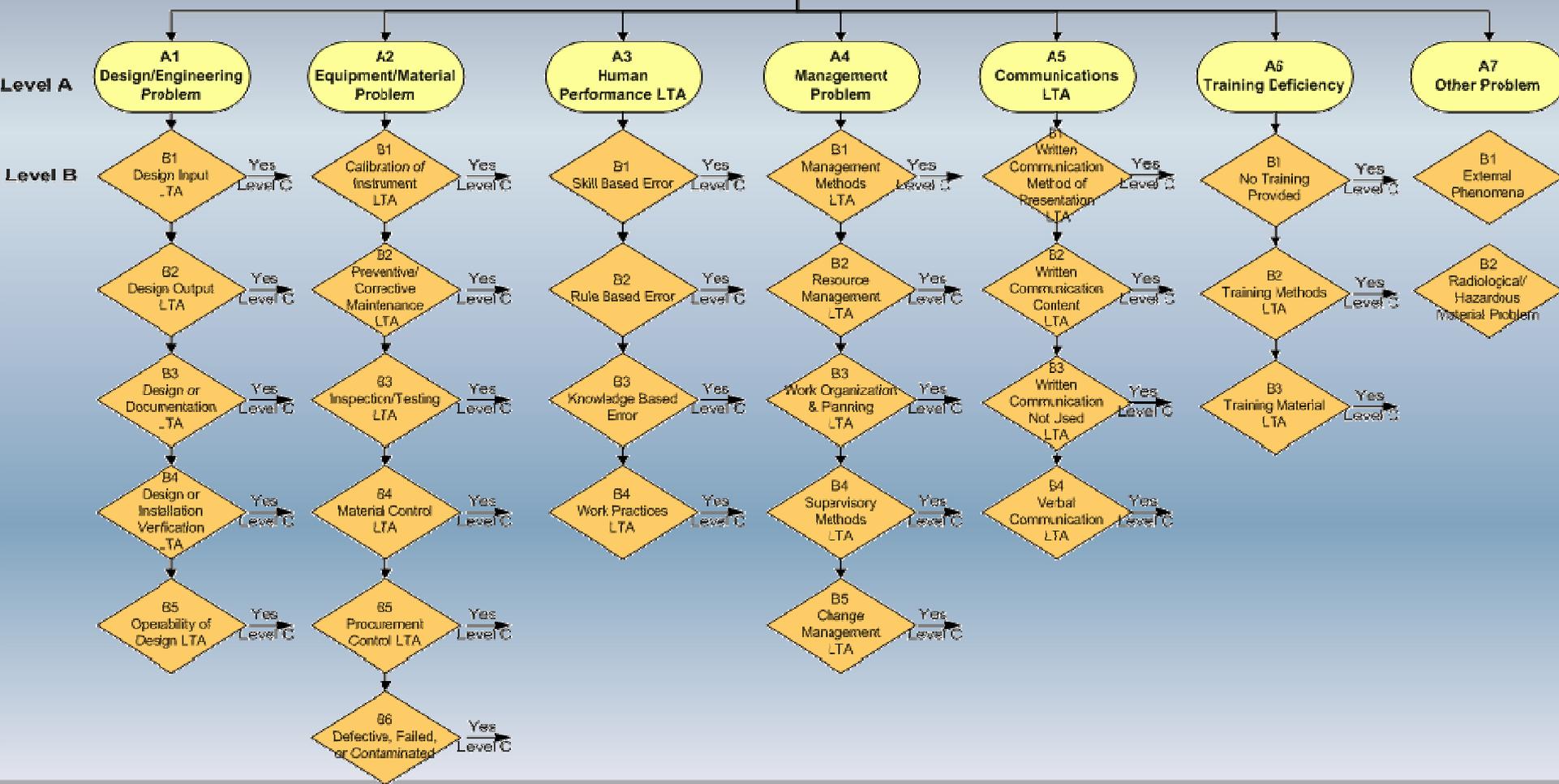
Defeating Defense -in-Depth

Affect of active and latent errors on barriers

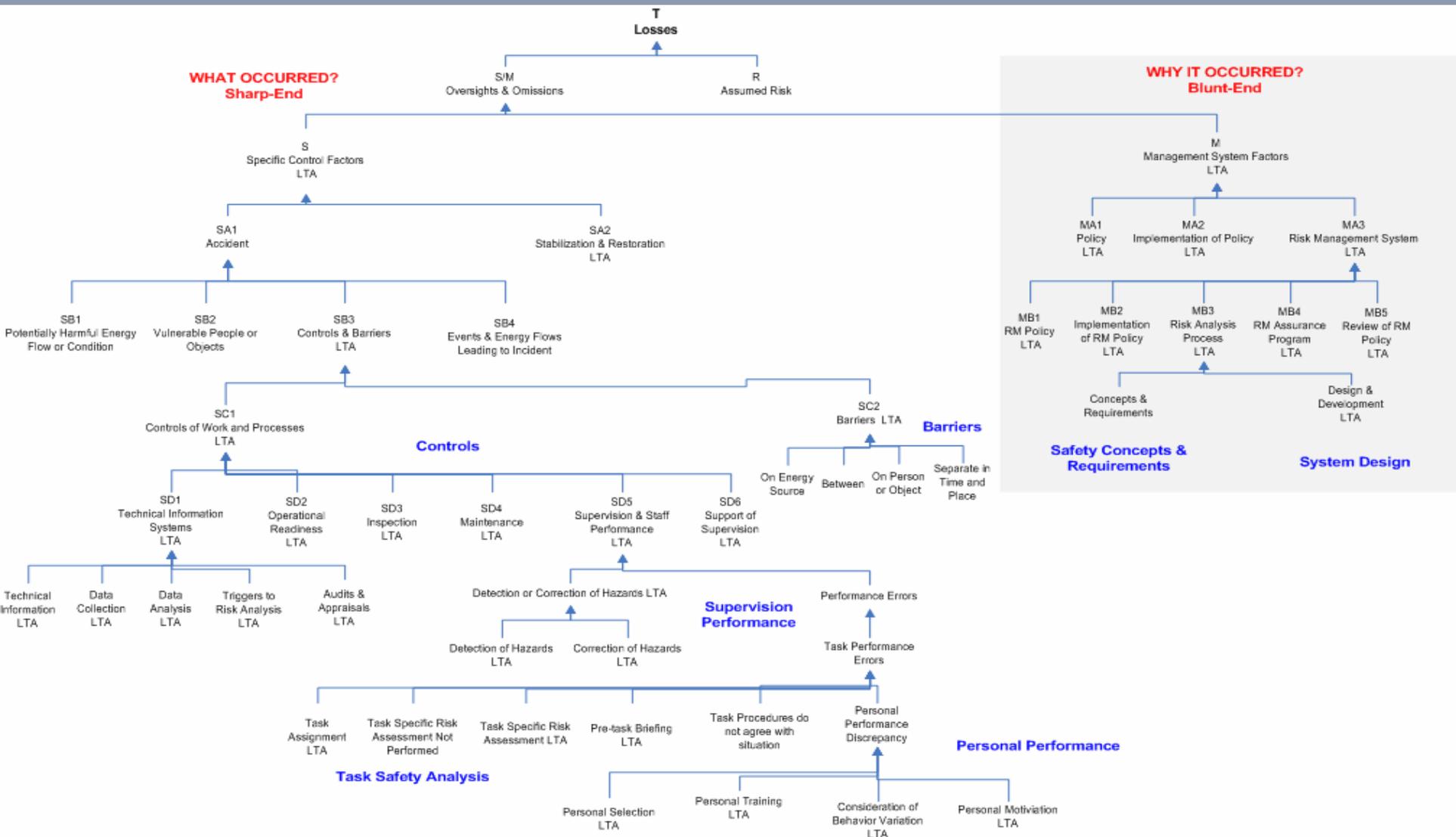


Other Tools To Evaluate Threat*

For Critical Step in Process, Select or Eliminate Each Category that could pose a Threat or Act as a Barrier



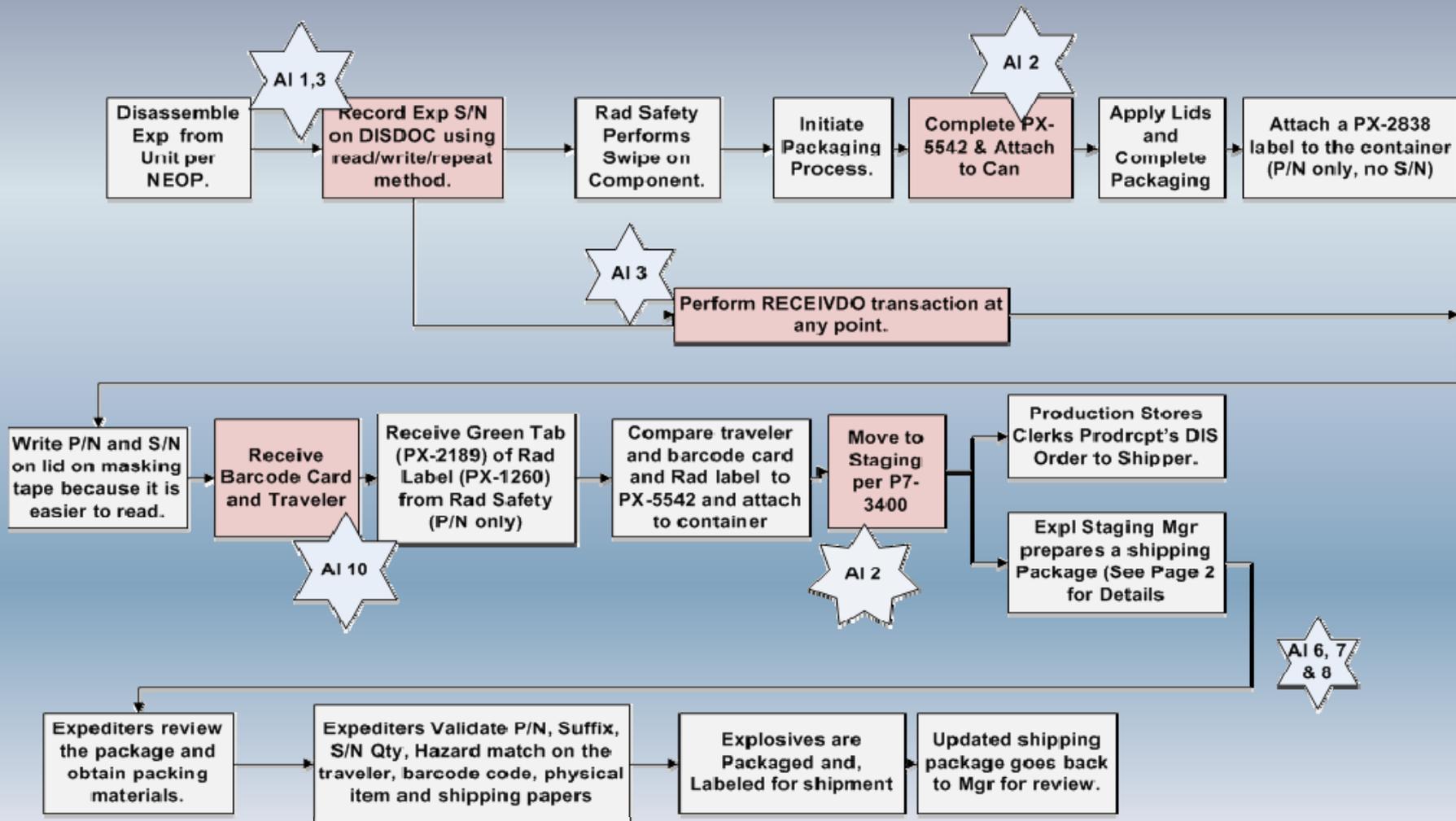
Other Tools To Evaluate Threat*



* Figure 5 of NRI-1, the Noordwijk Risk Initiative Foundation, 2009

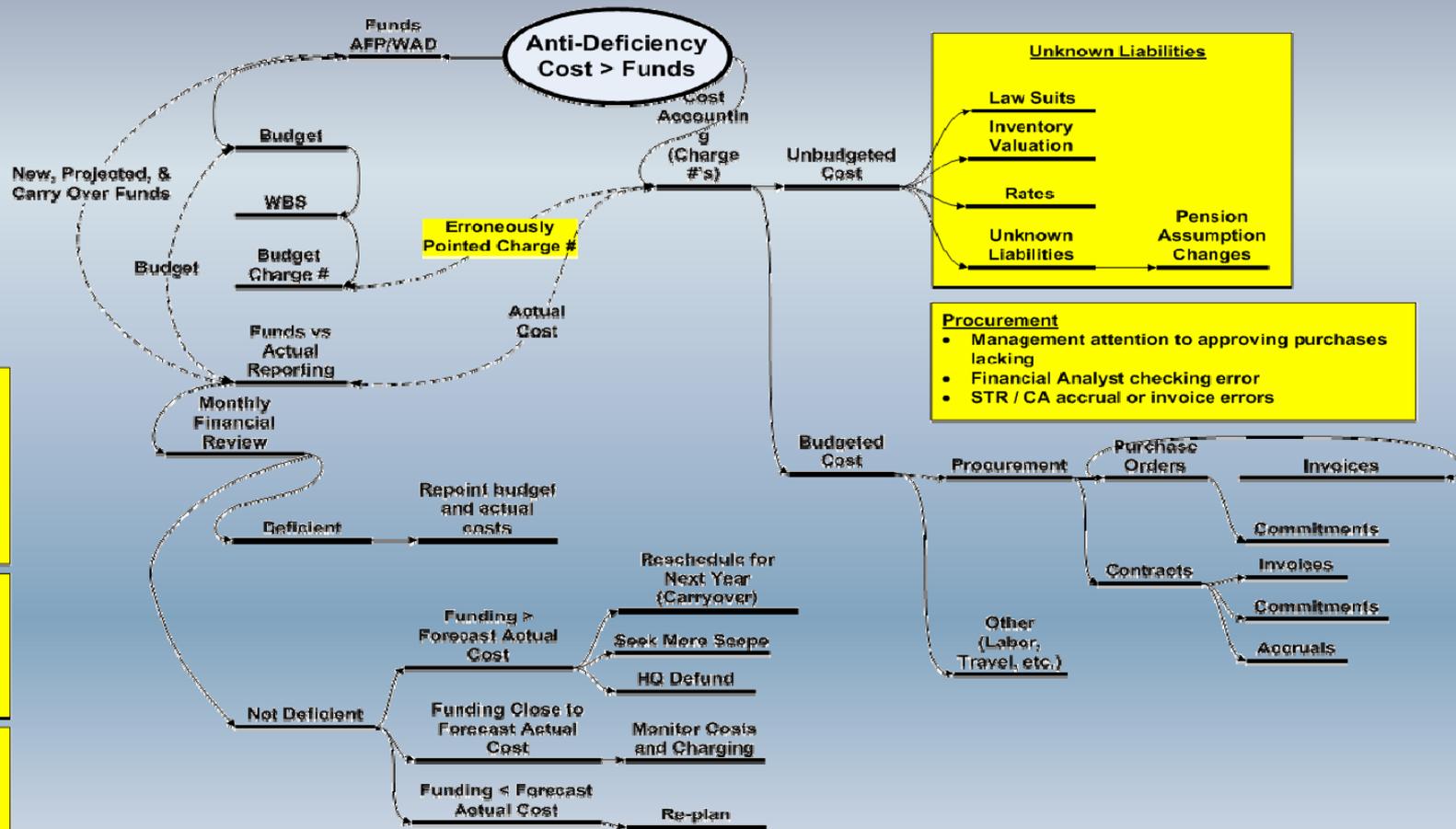
Process Map – Technical Process

Explosives Process for Shipment



Process Map - Non-Technical

CFO High Reliability Organization (HRO) Study – Anti-Deficiency Violations



Note: Pantex judges anti-deficiency by comparing funds to actual cost plus commitments.