Why Did They Do That?

How To Conduct A Human Factors Incident Investigation

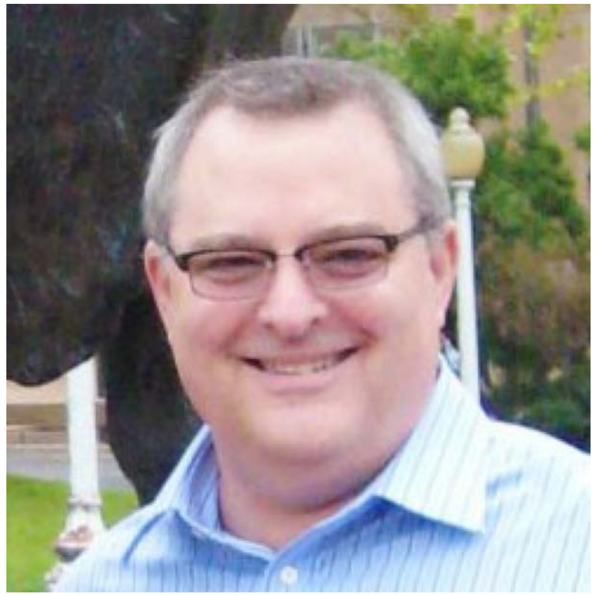
IChemE Hazards 31 Process Safety Conference

November 16-18, 2021

Steve Cutchen, Investigator, U.S. Chemical Safety Board, Retired

https://www.linkedin.com/in/steve-cutchen-15b02227/

Steve Cutchen



Investigator, U.S. Chemical Safety Board

November 2011 - November 2019

SUBJECT MATTER EXPERTISE:

- **Chemical Engineering**
- **Human Factors**

LyondellBasell and predecessors Lyondell, ARCO Chemical, Oxirane

August 1978 - October 2011

- **INCIDENT INVESTIGATION:**
  Worldwide instructor for Advanced Incident Investigation, specializing in causes of Human Actions.
  HFACS certification (Human Factors Analysis and Classification System).
- **PROCESS RISK ASSESSMENT AND CLASSIFICATION:**
  OSHA 29 Process Safety Management implementation and ISA-84 Safety Instrumented Systems design.
- **DATABASE-DRIVEN SAFETY INSTRUMENTED FUNCTION NARRATIVES:**
  Automatically generated SIF Narratives (Description, Initiators, Alarms, Bypasses, Actions, Reset Requirements, Special Testing, SIL Dependencies in PHAs, Revision Tracking).

Why Did They Do That? Human Factors Incident Investigation

Incident Investigation

- Mechanical Failure
- People in the Causal Chain

Investigating Human Causal Factors

- Human Factors Analysis and Classification System
- Cause and Effect Chart Refresher in Two Slides
- Interviewing
- Effective Recommendations

Incident Investigation – Mechanical Failure

We tend to be excellent at determining Mechanical Factors which cause incidents.

We are technical experts, and this is what we thrive on.

- **The pump fire resulted from a seal failure**
- **The seal was recently replaced**
- **The new seal had incorrect elastomers**

We even have excellent systems in place to

- **Analyze investigation findings for failure trends**
- **Communicate the most important of these findings across the company**
- **Make changes and corrections to mitigate leveraging causal factors**

Incident Investigation – People in the Casual Chain

We are not so good when it comes to Human Factors.

Almost every investigation includes decisions and actions by people.

But we often stumble when trying to answer: Why did they do that?

- **Investigations tend toward blame; causal factors are personality or ability based.**
- **We Undergo Hindsight Bias because we know what happened.**
- **We judge Good or Bad based on how it turned out regardless of why; Outcome Bias.**
- **We make recommendations for devices and training.**

Incident Investigation – People in the Casual Chain

We need a method to guide our analysis of human actions.

HFACS, Human Factors Analysis and Classification System

We need a method to organize our hypotheses, evidence, causes, and effects.

Cause and Effect Chart Refresher in Two Slides

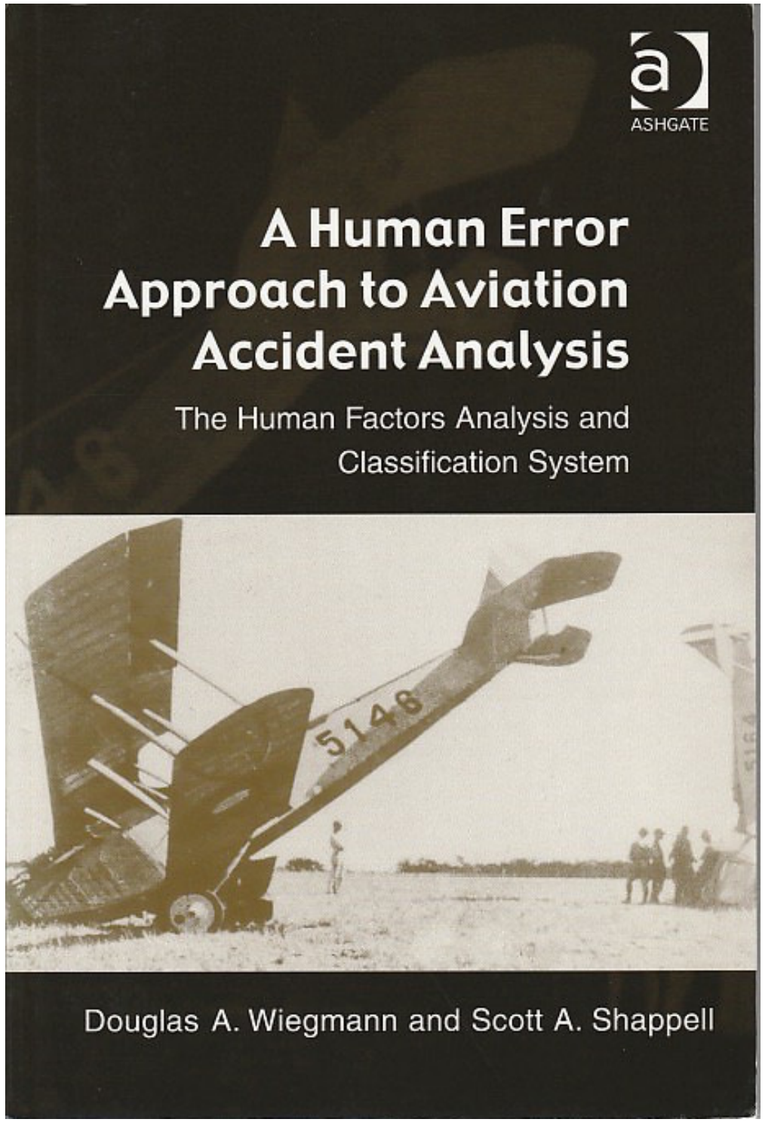
We need a method to interface with people during an investigation

Incident Investigation Interviewing

We need a method to prevent recurrences

Effective Recommendations

Human Factors Analysis and Classification System



Reference: http://hfacs.com/about-hfacs.html

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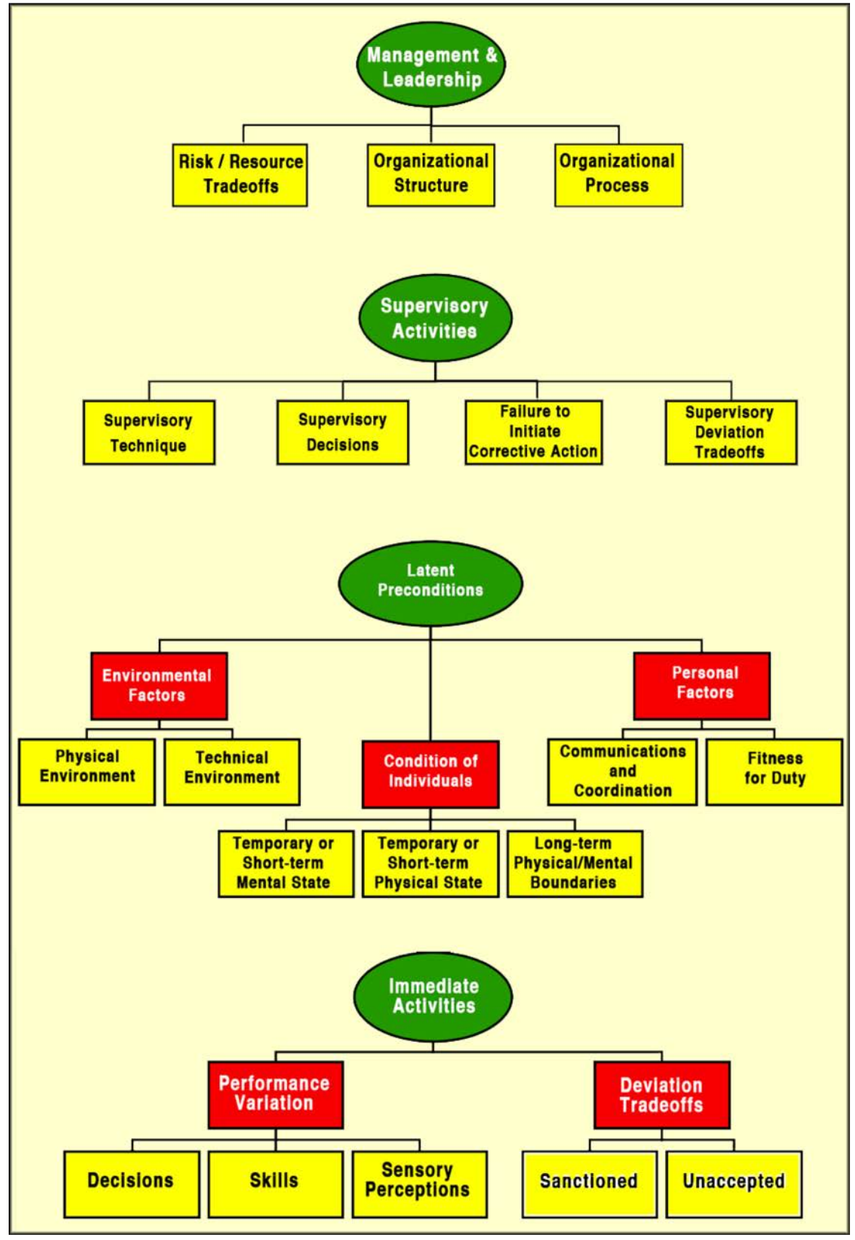
HFACS is a tool.

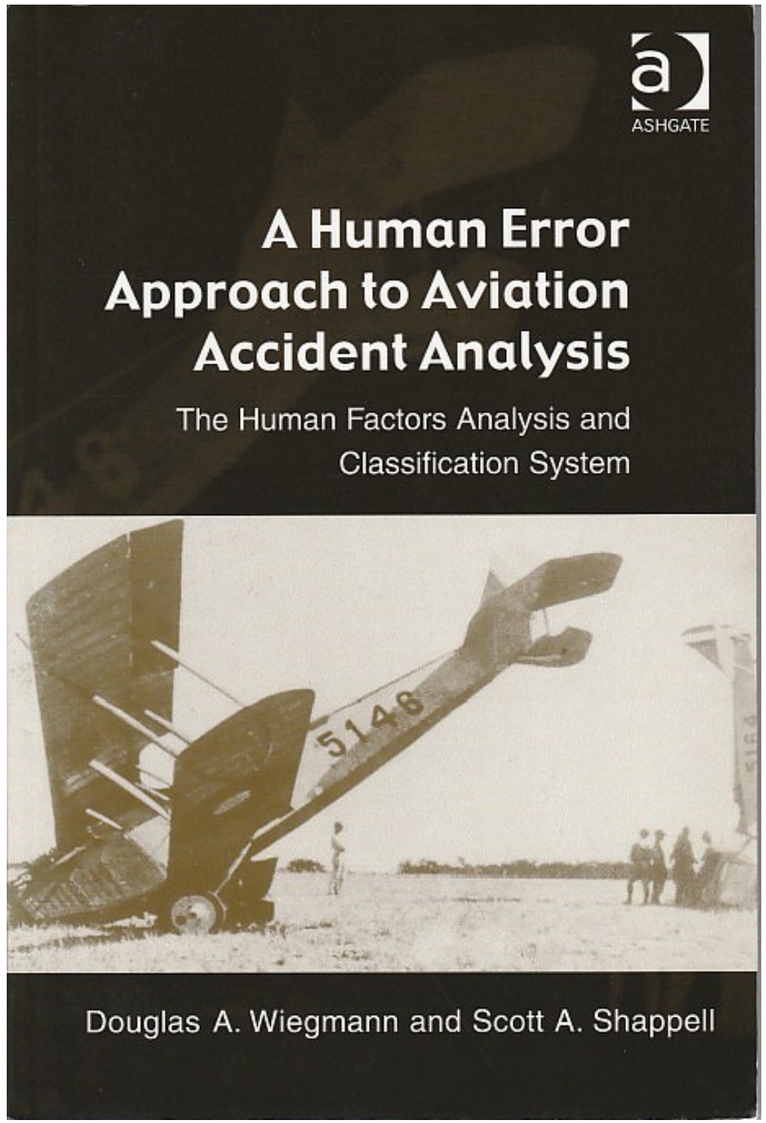
A Swiss-Cheese approach.

The goal is to answer:

Why Did They Do That?



Human Factors Analysis and Classification System



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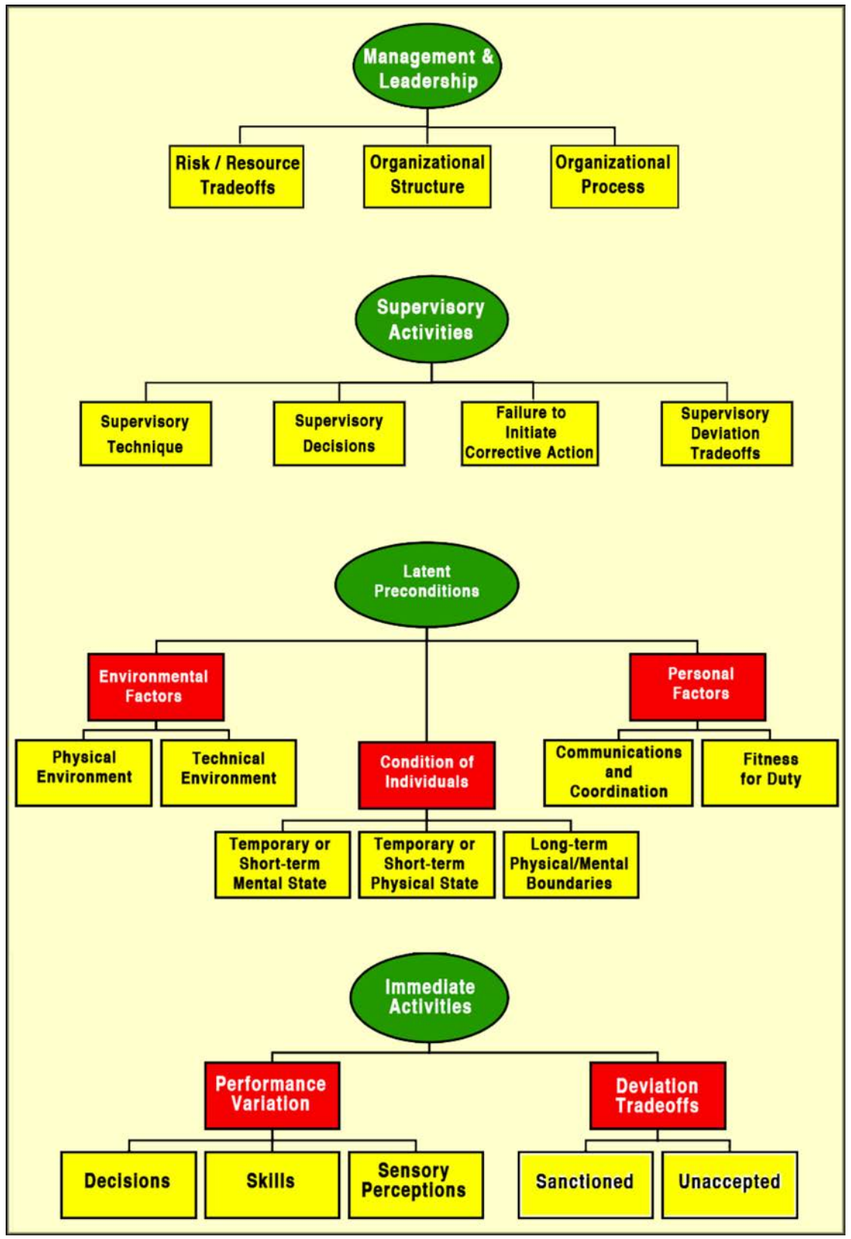
Management & Leadership

Supervisory Activities

Latent Preconditions

Immediate Activities



HFACS — Immediate Activities

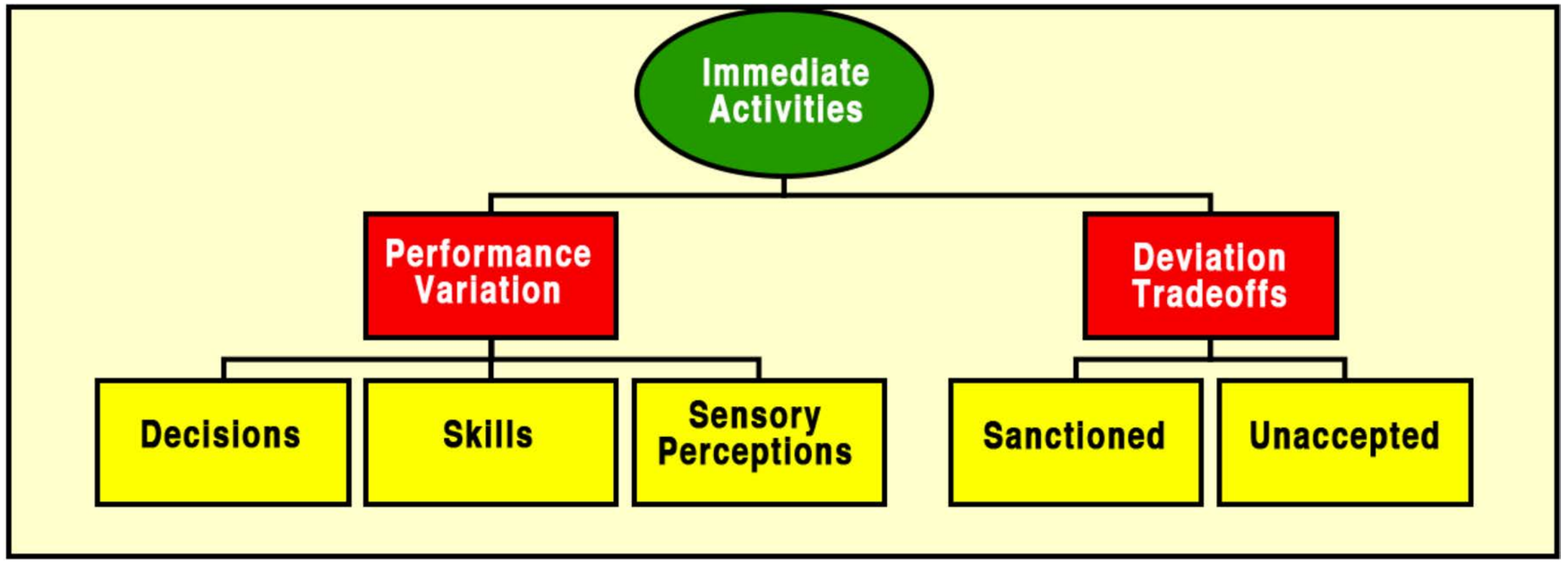
People's activities immediately associated with the incident

Performance Variation

Make sense at the time, within the rules, but fail to achieve their intended outcome

Deviation Tradeoffs

Deliberate deviation from known rules based on a tradeoff judgement

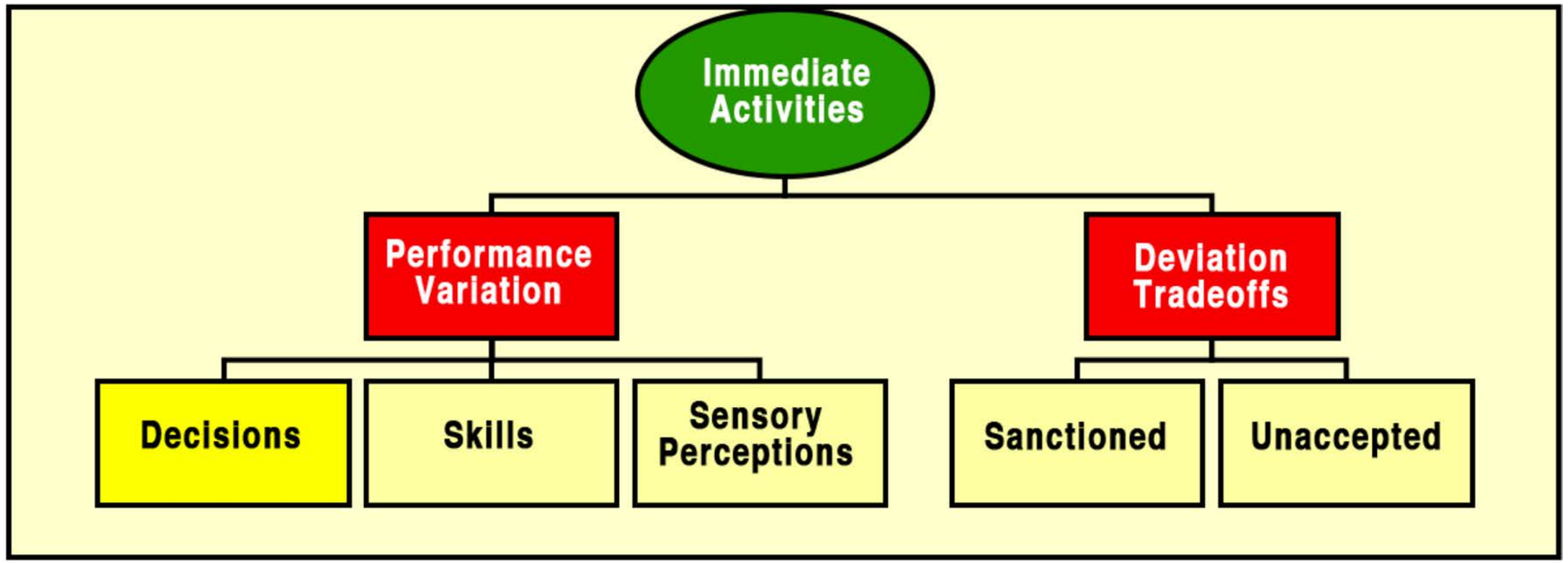


HFACS — Performance Variation

Decisions

Cognitive action, often time-critical, that proves inappropriate or inadequate.

- **Procedural: Procedure known but unintended outcome**
- **Choice: Selected between multiple known response options**
- **Problem-solving: No procedure or known response option; novel solution required**

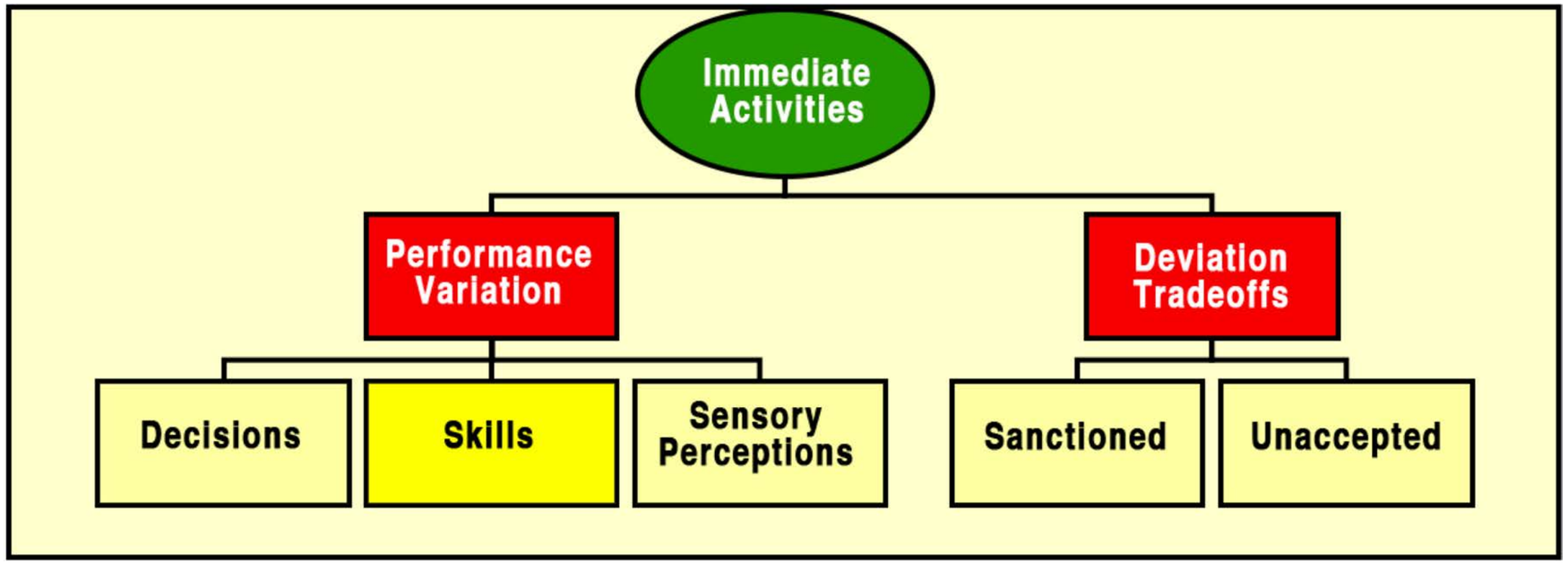


HFACS — Performance Variation

Skills

Routine activity that occurs without significant cognitive analysis.

- **Attention**
- **Memory**
- **Technique**

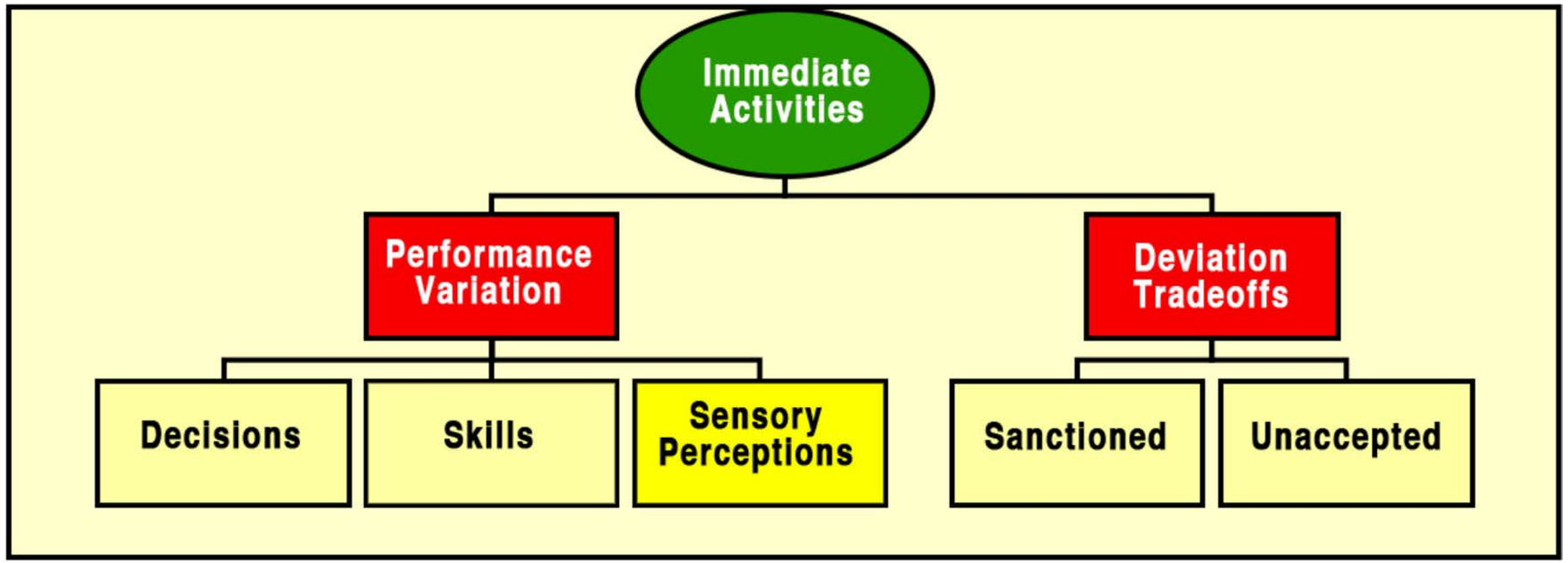


HFACS — Performance Variation

Sensory Perceptions

Sensory input is degraded or unusual.

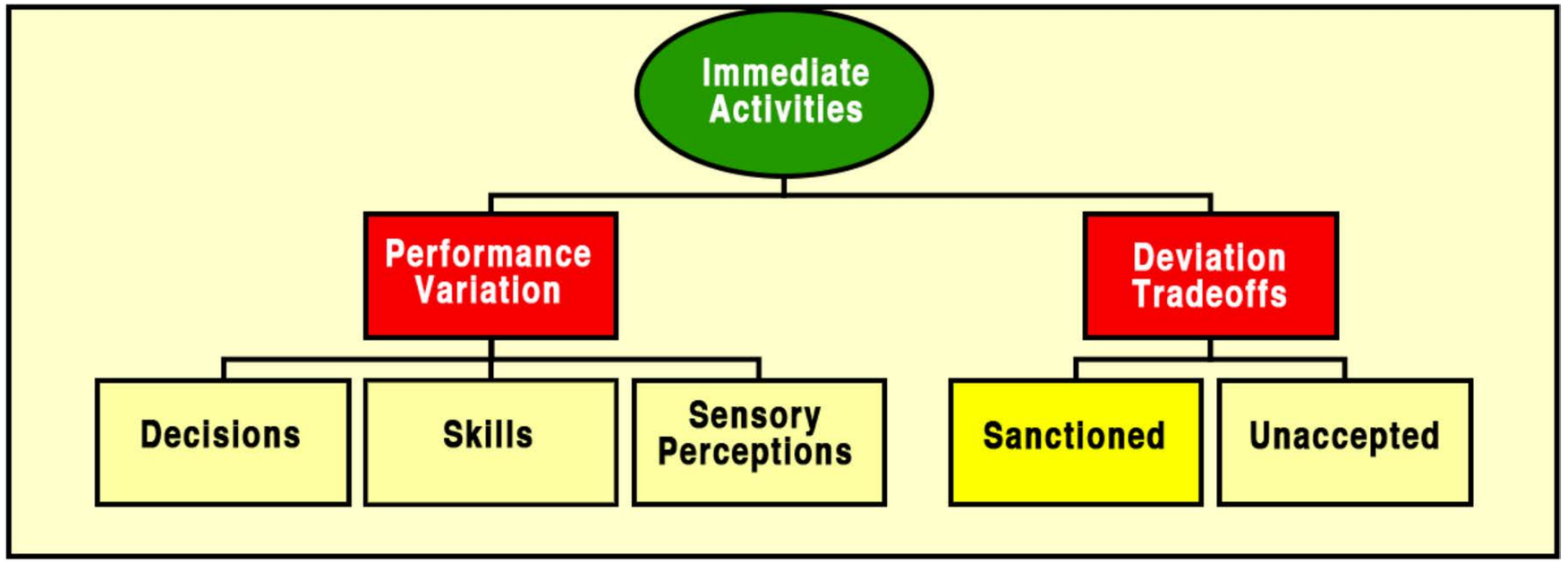
Example results: misjudged speed, height, slipperiness, weight, aural or visual warning



HFACS — Deviation Tradeoffs

Deliberate deviation from known rules based on a tradeoff judgement

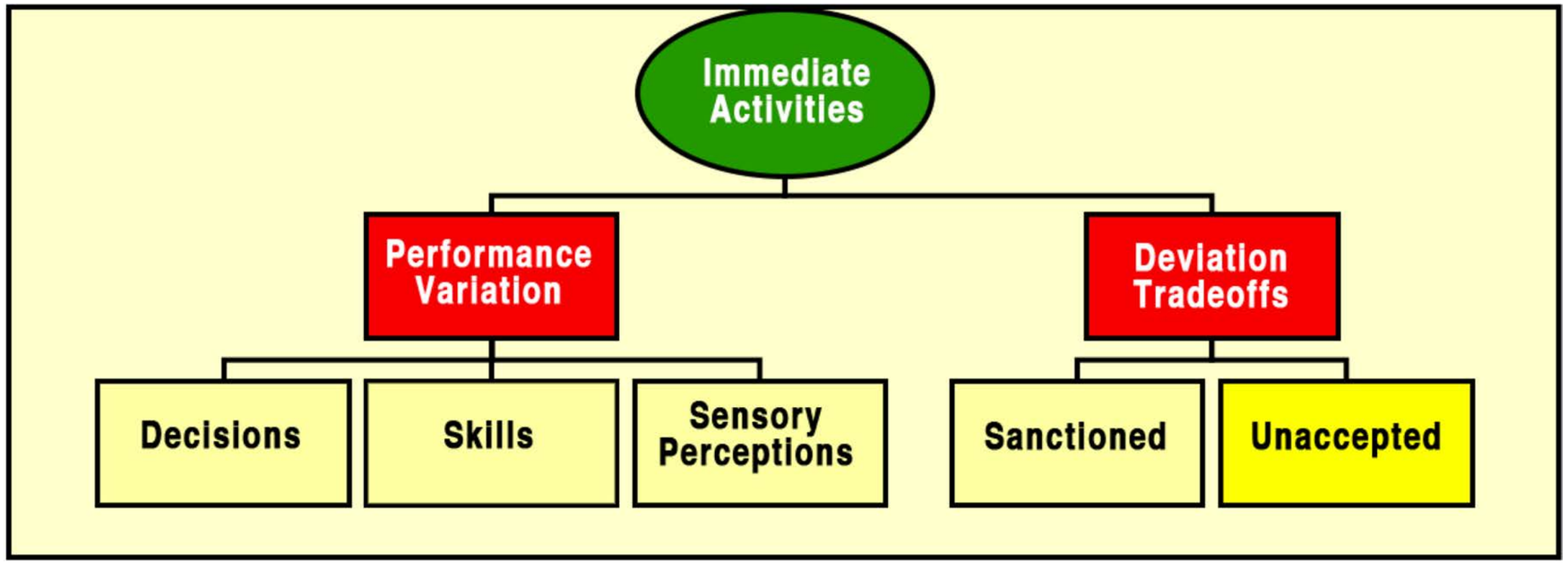
Sanctioned: Habitual and tolerated by authority. “This is how we do this here.”



HFACS — Deviation Tradeoffs

Deliberate deviation from known rules based on a tradeoff judgement

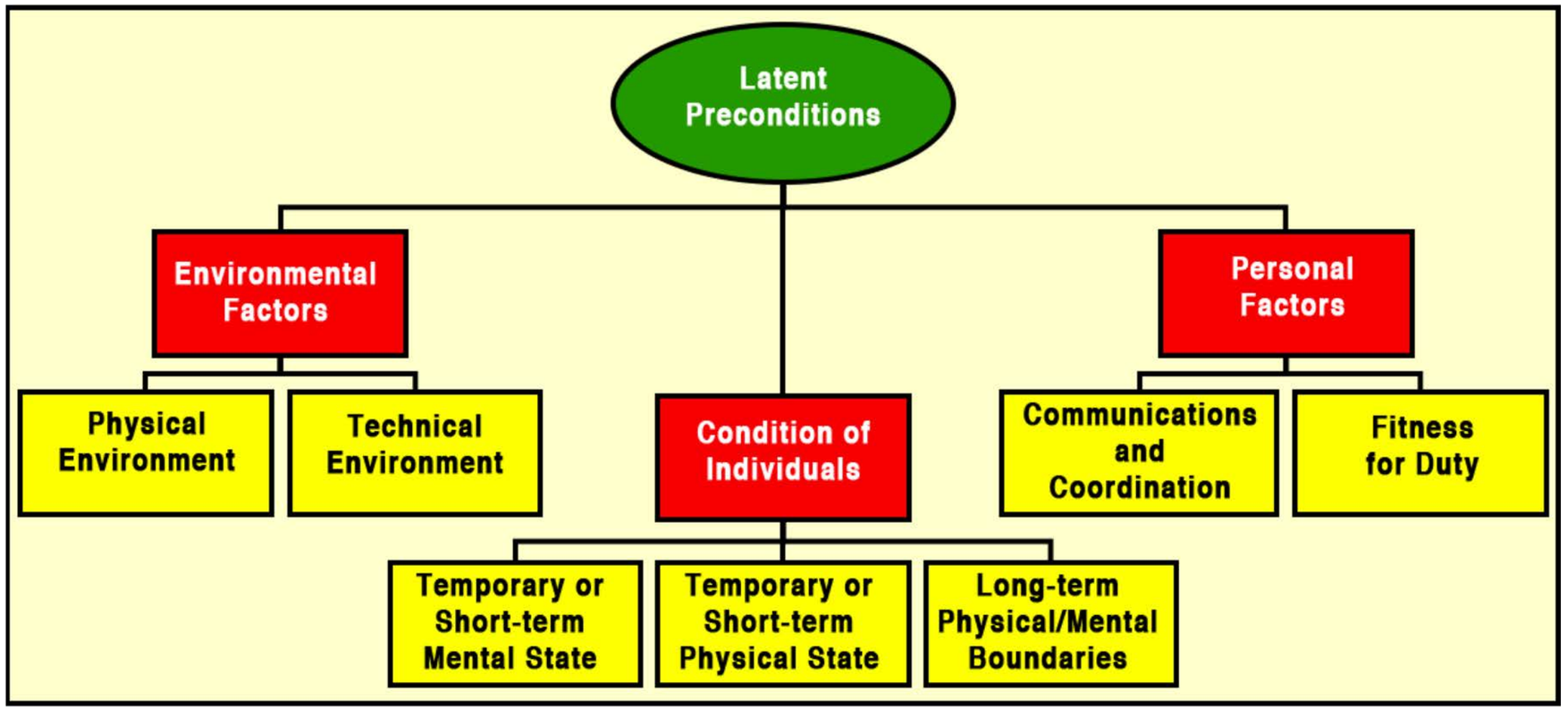
- **Sanctioned: Habitual and tolerated by authority. “This is how we do this here.”**
- **Unaccepted: Isolated and not condoned by authority. Hoping not to get caught.**



HFACS — Latent Preconditions

Pre-existing conditions that reflect as potential underlying causes to Immediate Activities

- **Environmental Factors**
- **Conditions of Individuals**
- **Personal Factors**

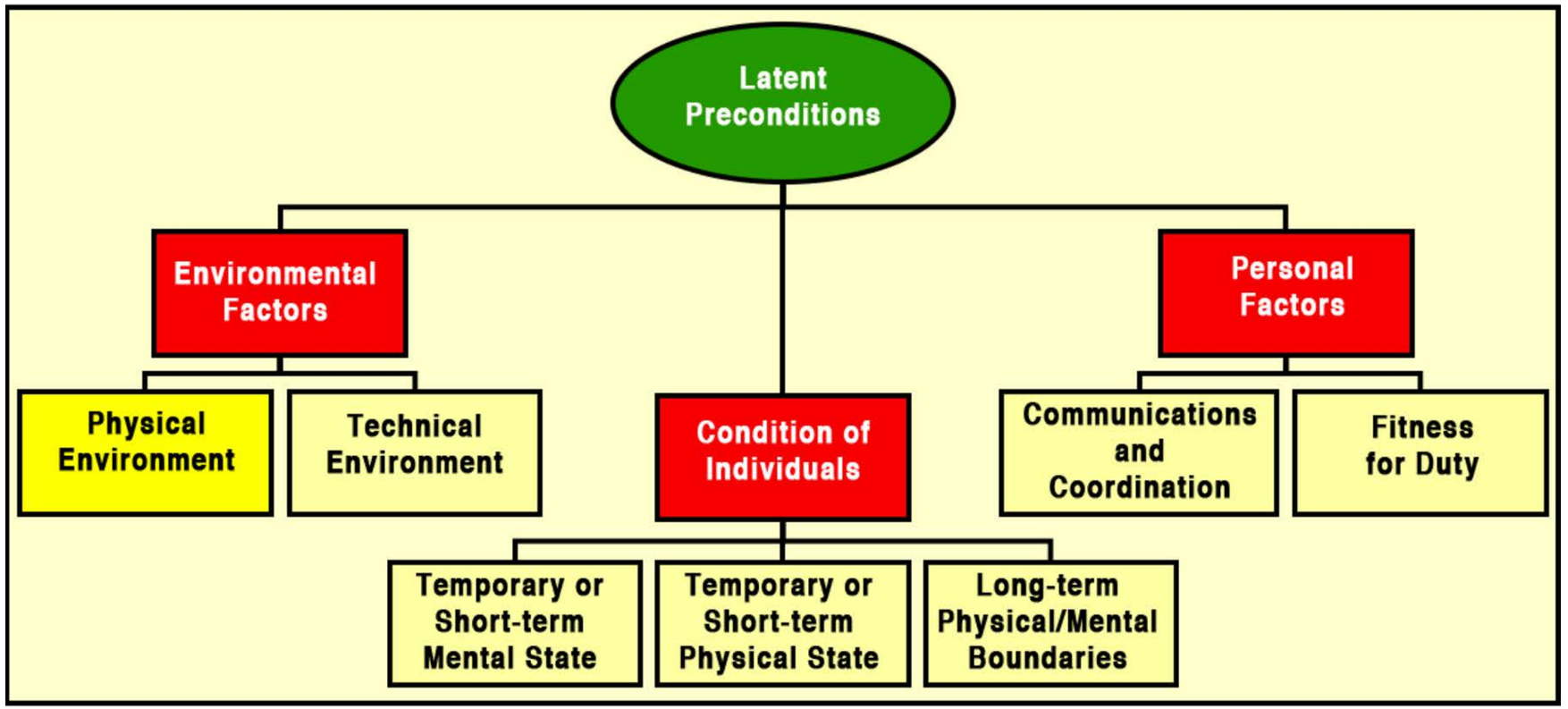


HFACS — Environmental Factors

Physical Environment

Operational Environment: confined space, unprotected height, non-isolated energy.

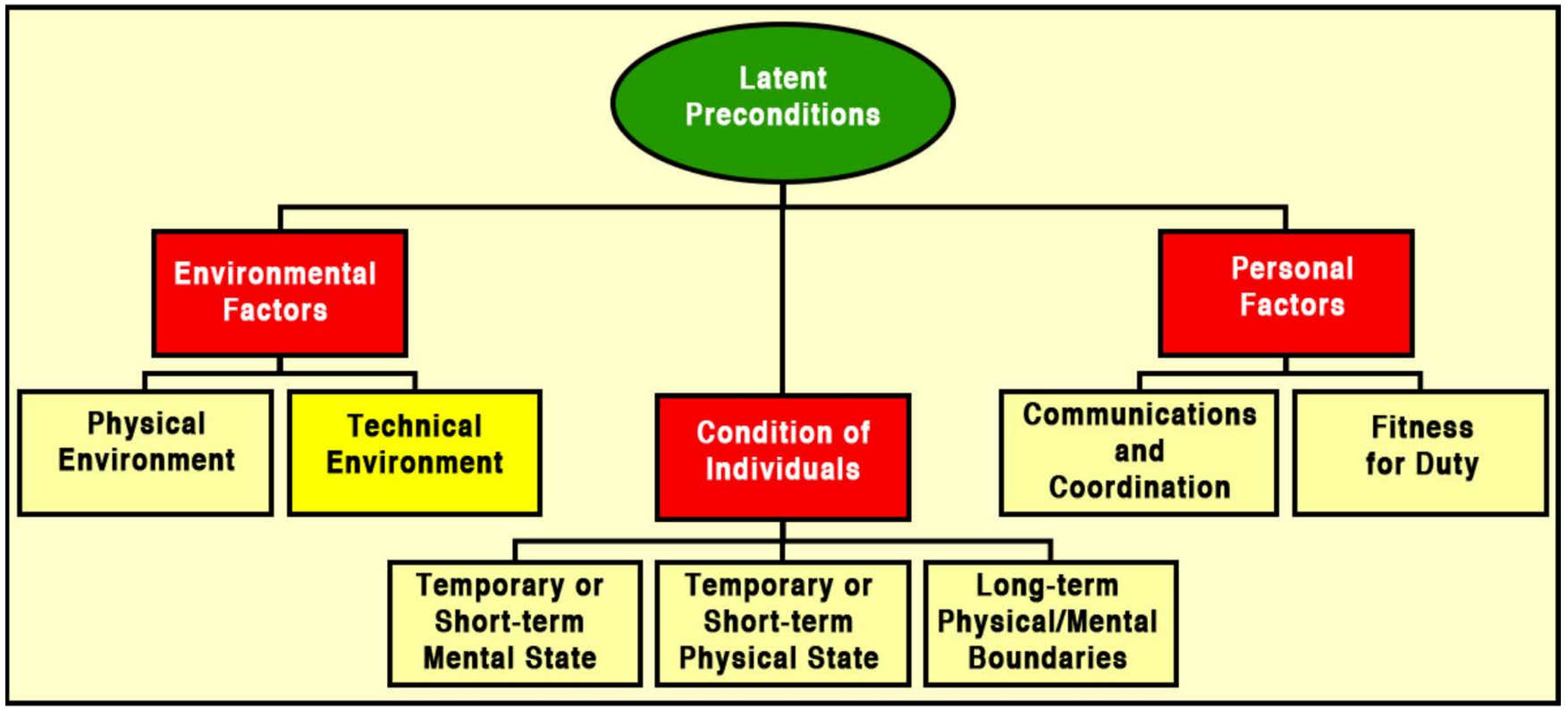
Ambient Environment: weather, lighting, uneven ground



HFACS — Environmental Factors

Technical Environment: e.g., inadequate, confusing, contradictory…

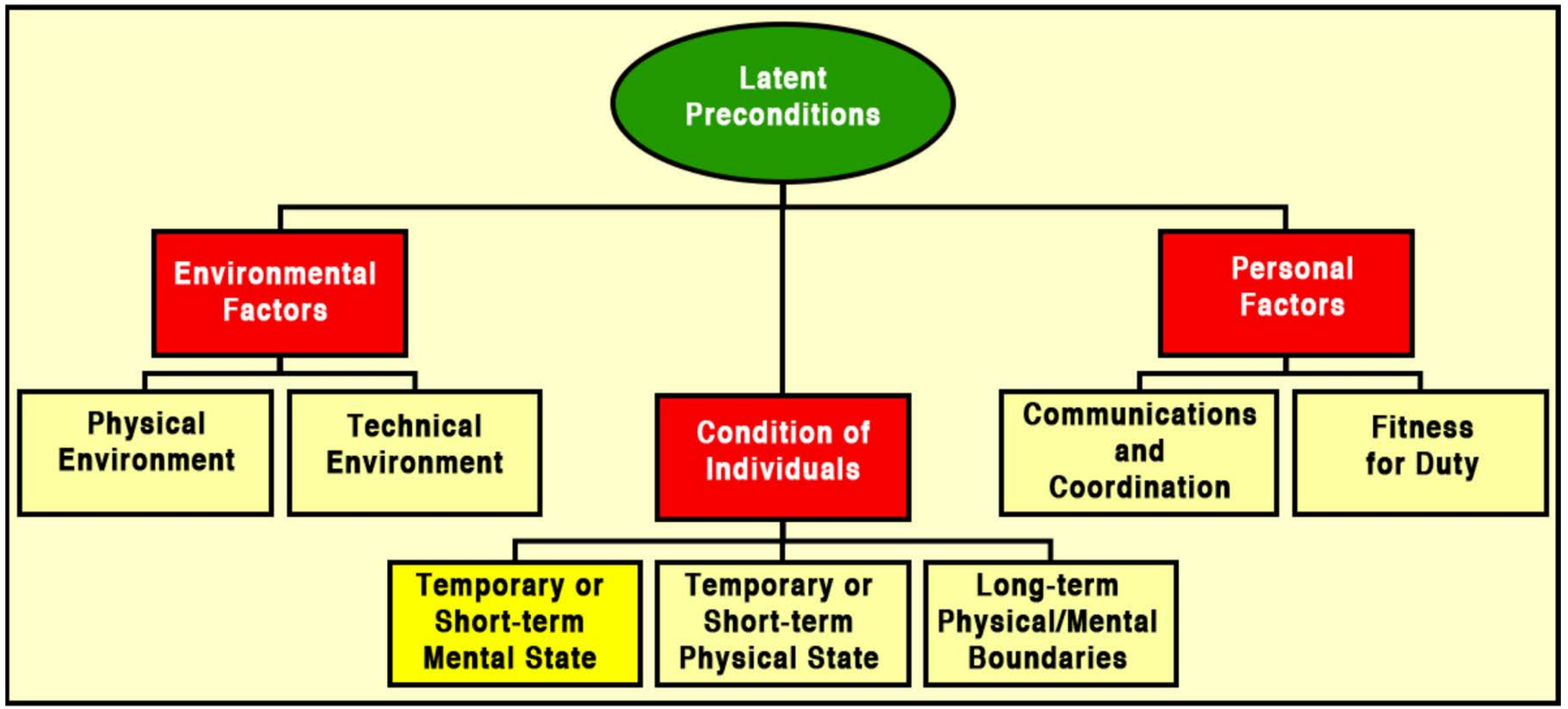
- **Hardware**
- **Rules and Procedures**



HFACS — Condition of Individuals

Temporary or Short-term Mental State

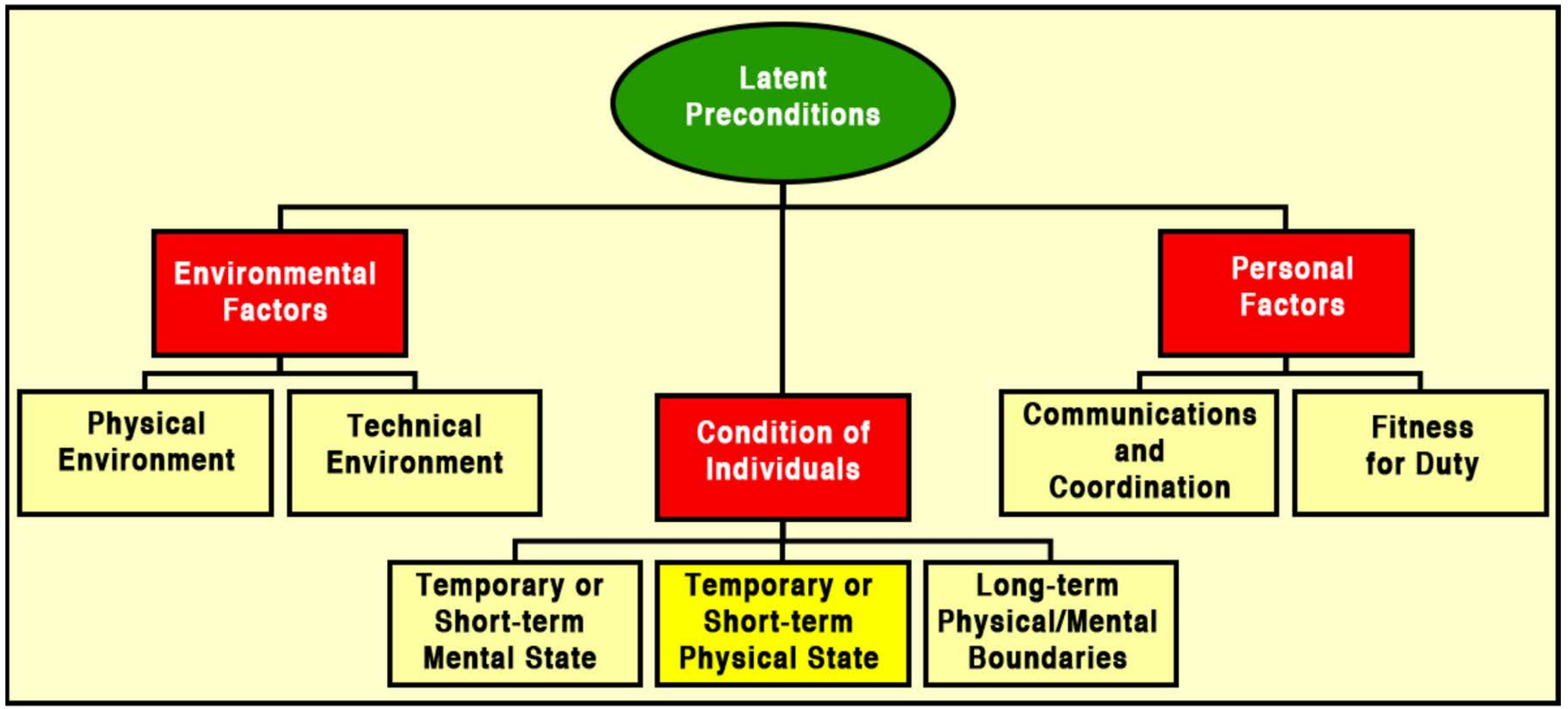
Situational: task fixation, distraction, habitual response
Personality: overconfidence, complacency, misplaced motivation



HFACS — Condition of Individuals

Temporary or Short-term Physical State

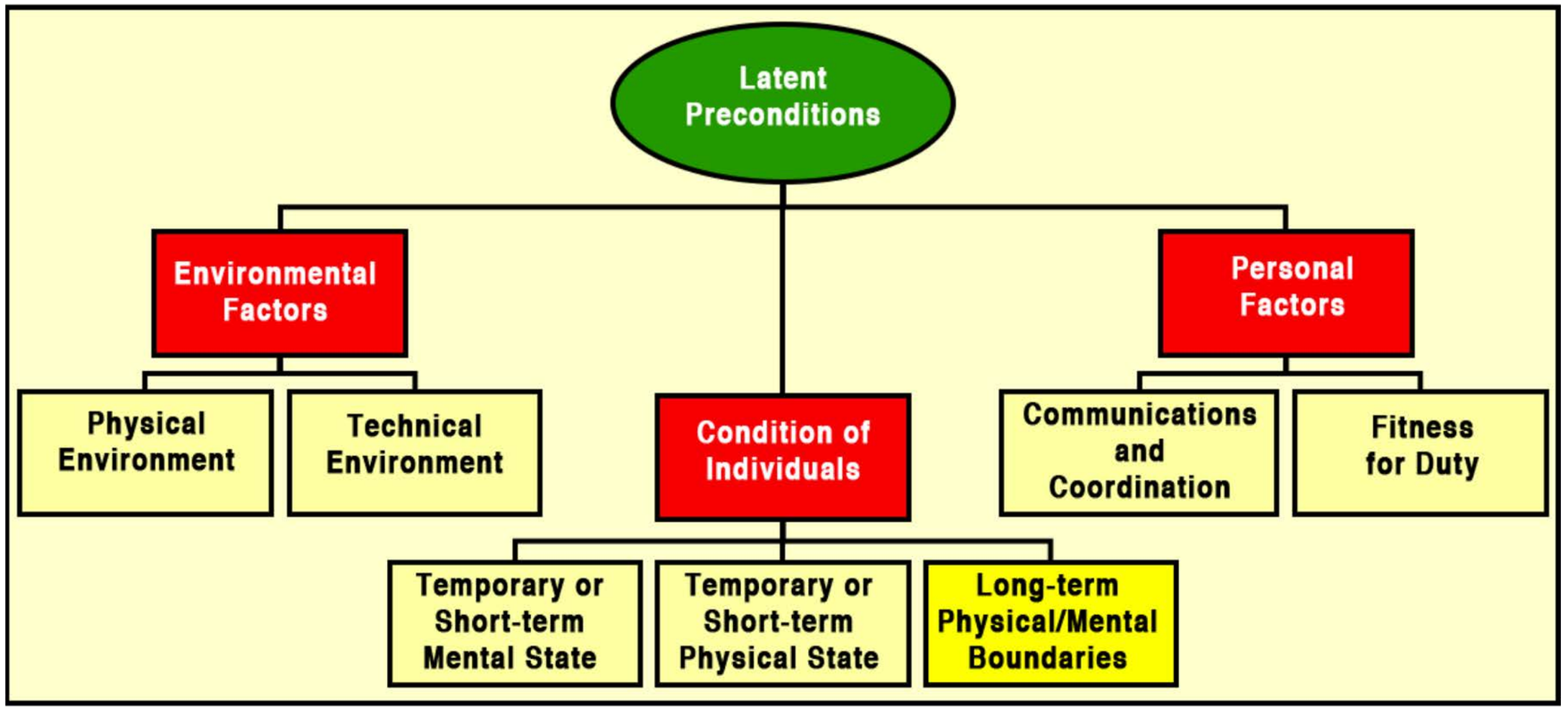
Situational: special disorientation, heat stress, hypoxia
Conditional: fatigue, illness, effect of medications



HFACS — Condition of Individuals

Long-term Physical / Mental Boundaries, e.g.,

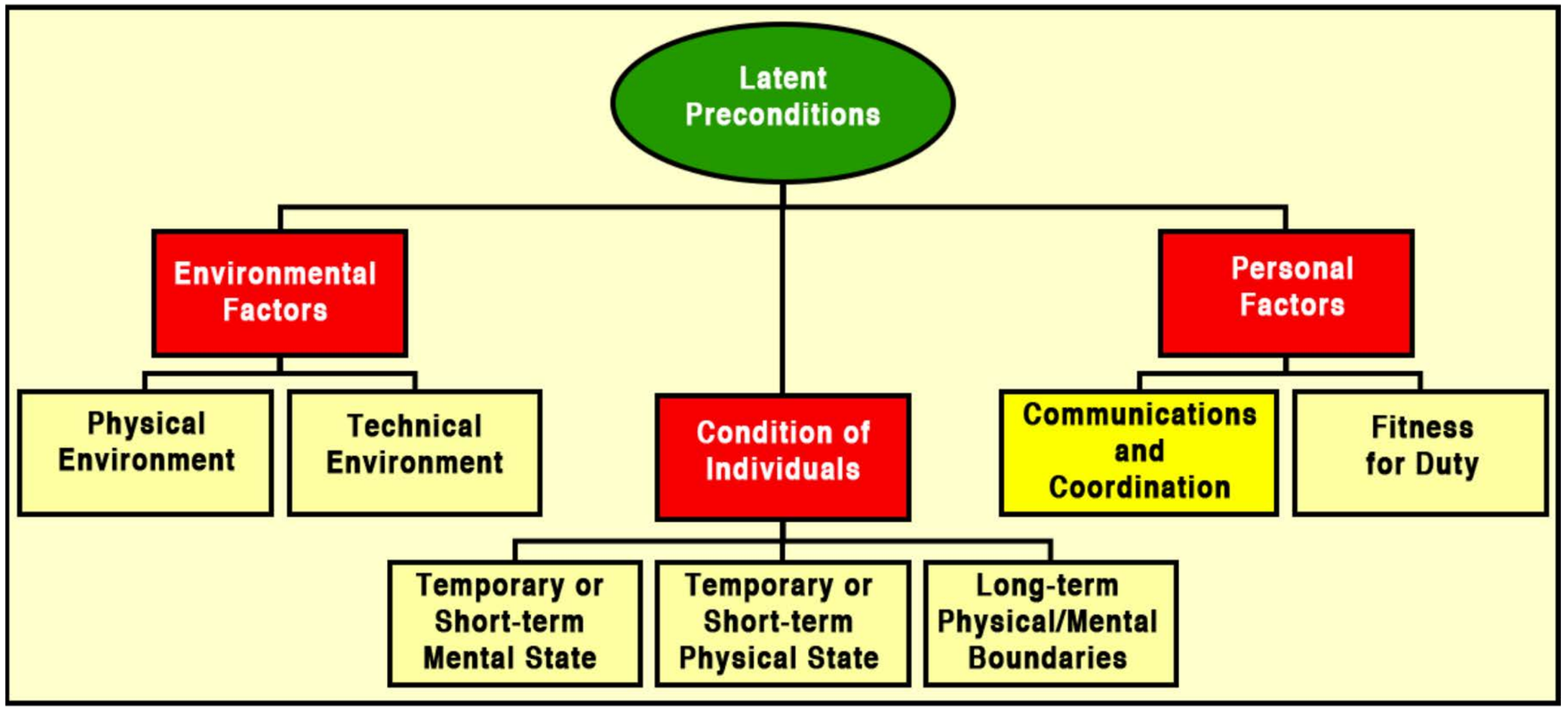
visual deficiency, inexperience, lack of physical capability, out of practice, lack of mental capability



HFACS — Personal Factors

Communication and Coordination, e.g.,

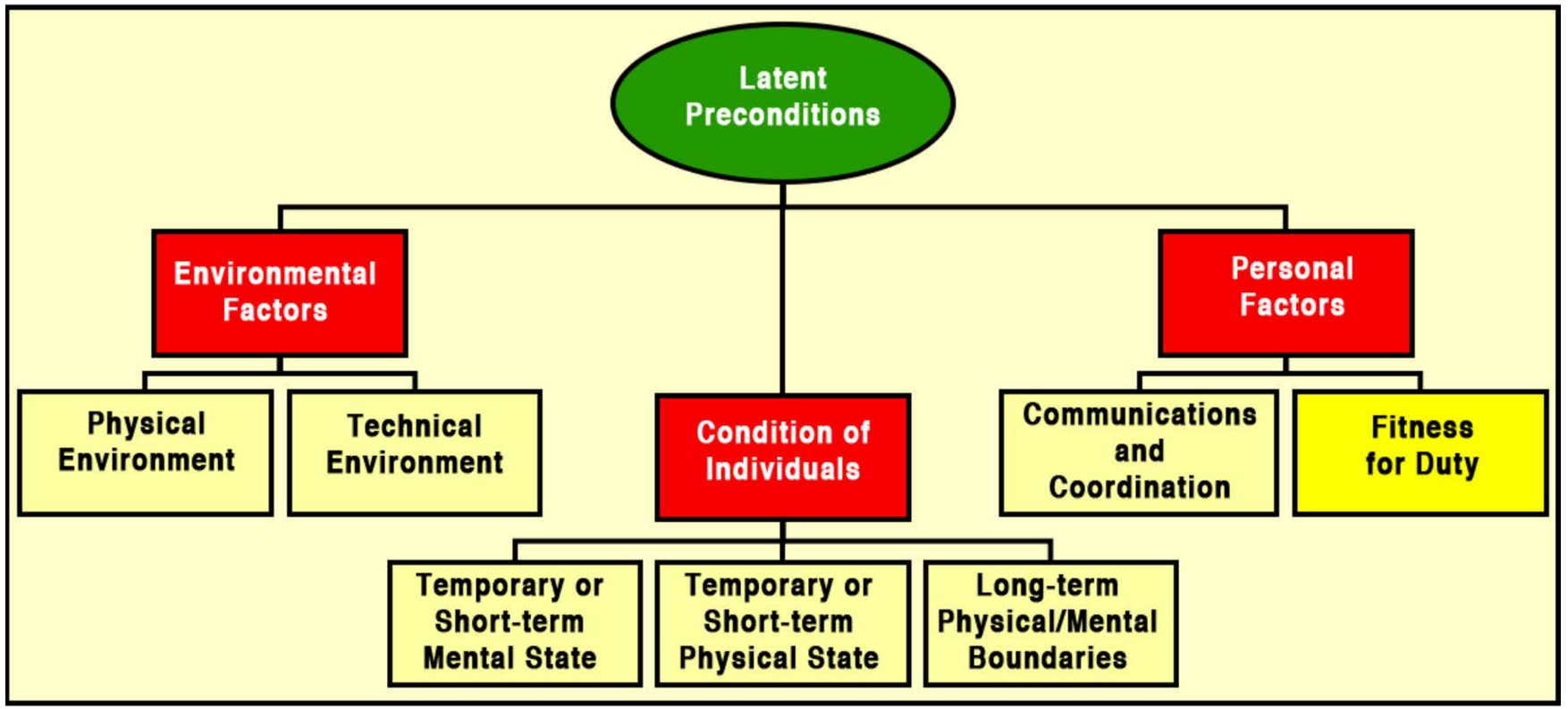
Failure to warn, poor directions, deficient shift turnover, deficient night orders



HFACS — Personal Factors

Fitness for Duty, e.g.,

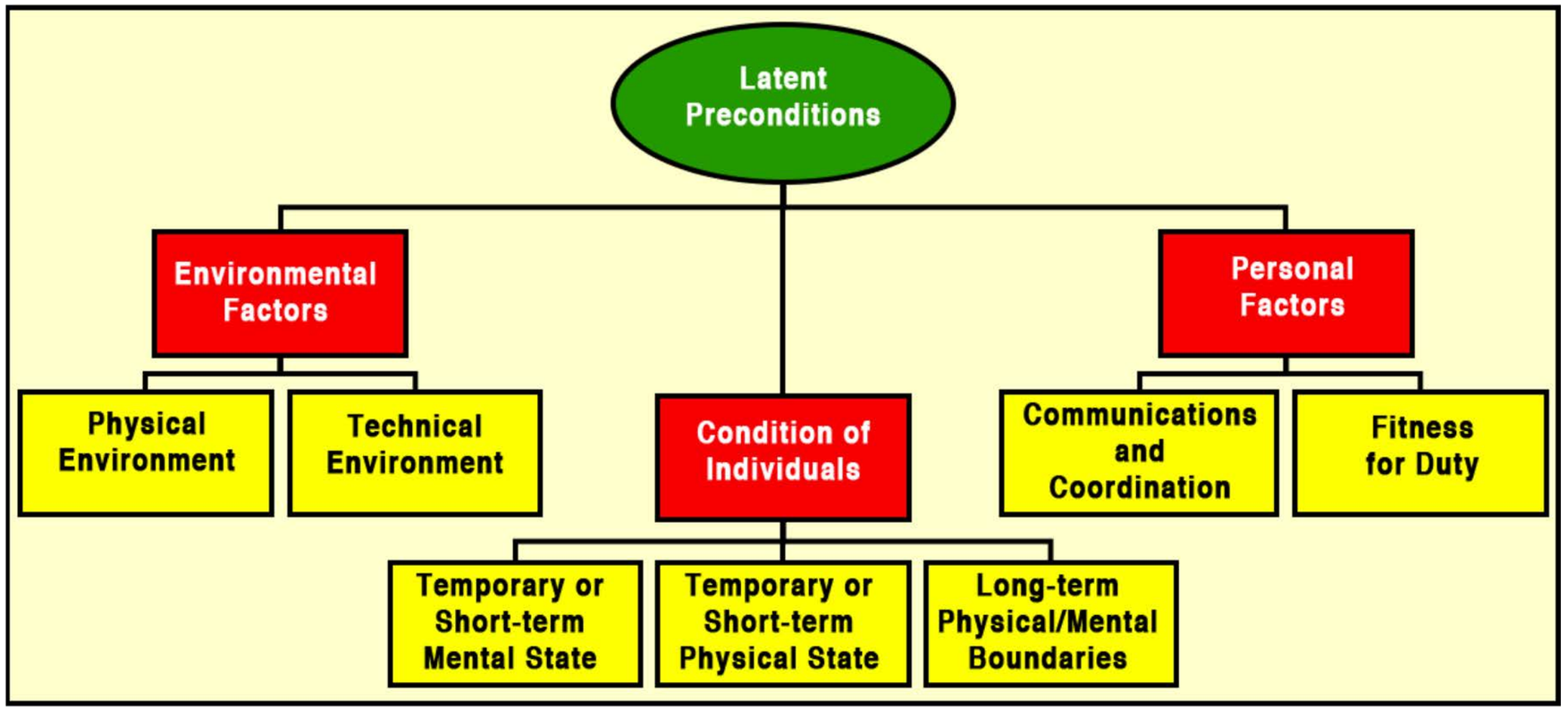
Failure to follow time off requirements, overexertion off-duty, illicit drugs



HFACS — Latent Preconditions

This is where the Human Factors investigation begins, not with Immediate Activities

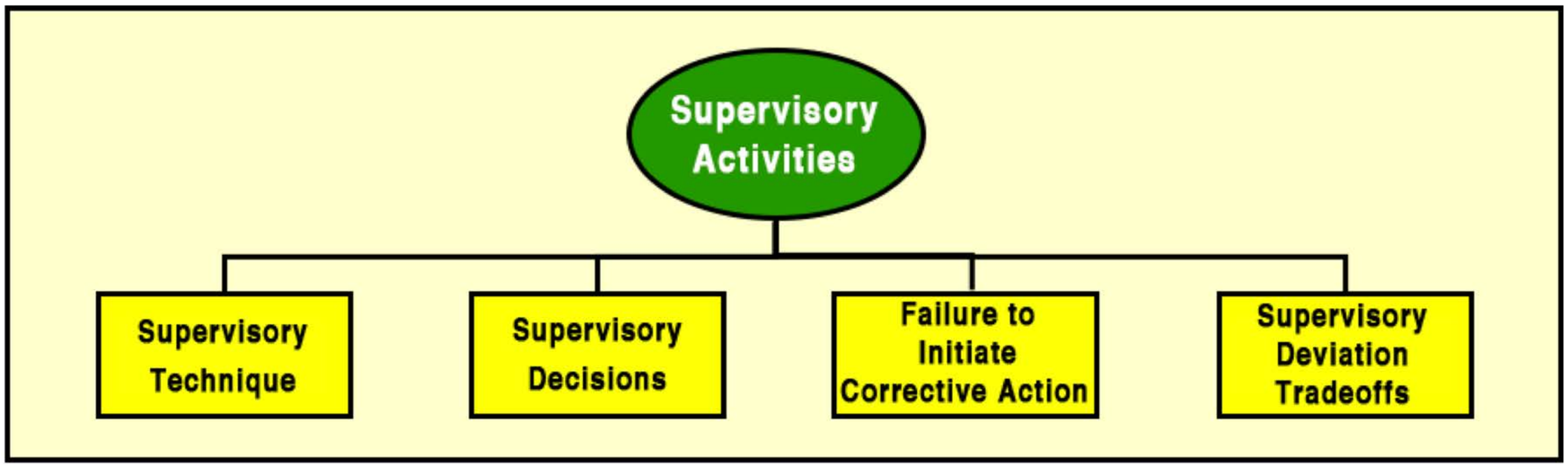
- **It is not “So tell me, what did you do?”**
- **It is gathering historical information. “Tell me about…” “How can you tell…”**



HFACS — Supervisory Activities

Supervisor actions which allow, create, or promote unsafe acts

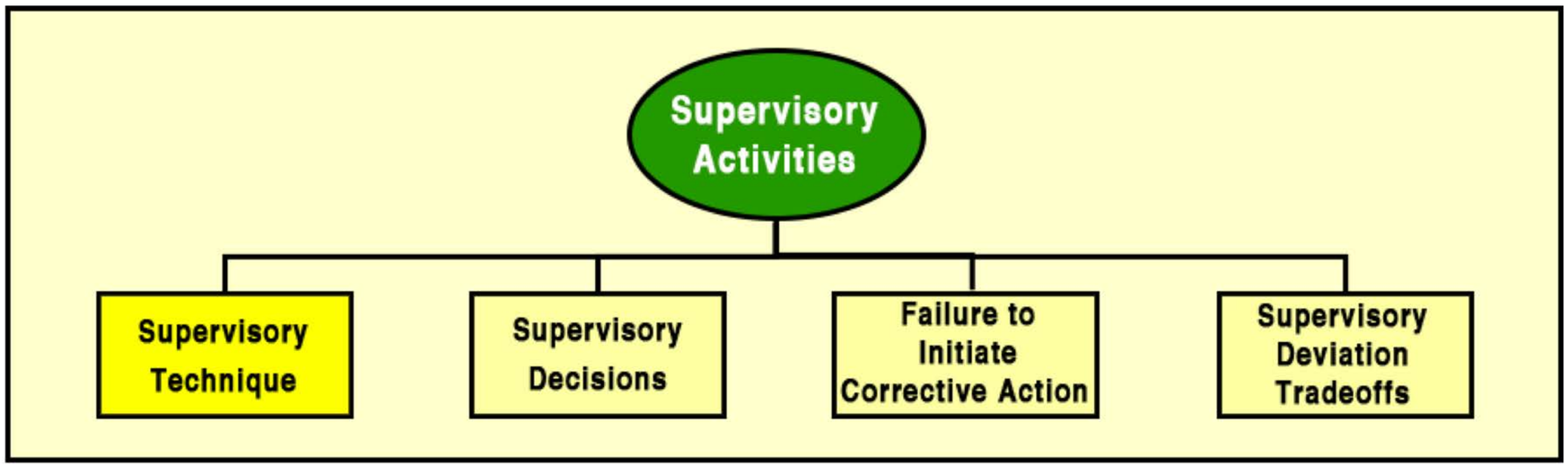
They influence Latent Preconditions and Immediate Activities.



HFACS — Supervisory Technique

Failure to provide the opportunity to succeed, e.g.,

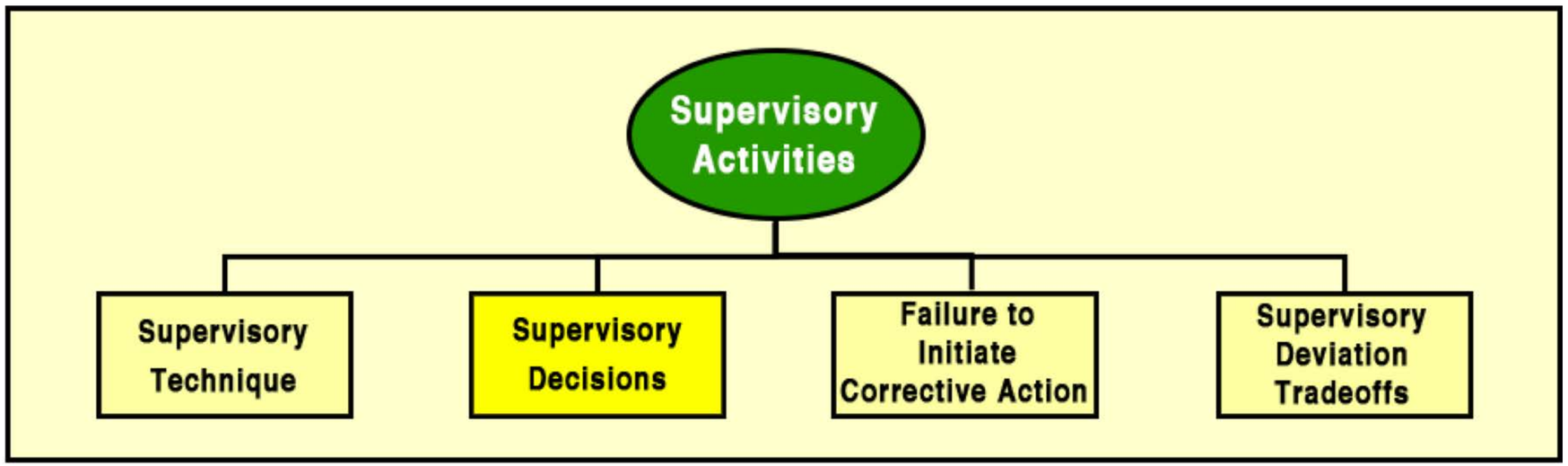
Inadequate guidance or training, poor communications, conflicting directions.



HFACS — Supervisory Decisions

Inappropriate decisions by supervision; they should have known, e.g.,

- **Poor team pairing.**
- **Failure to provide proper time or resources.**

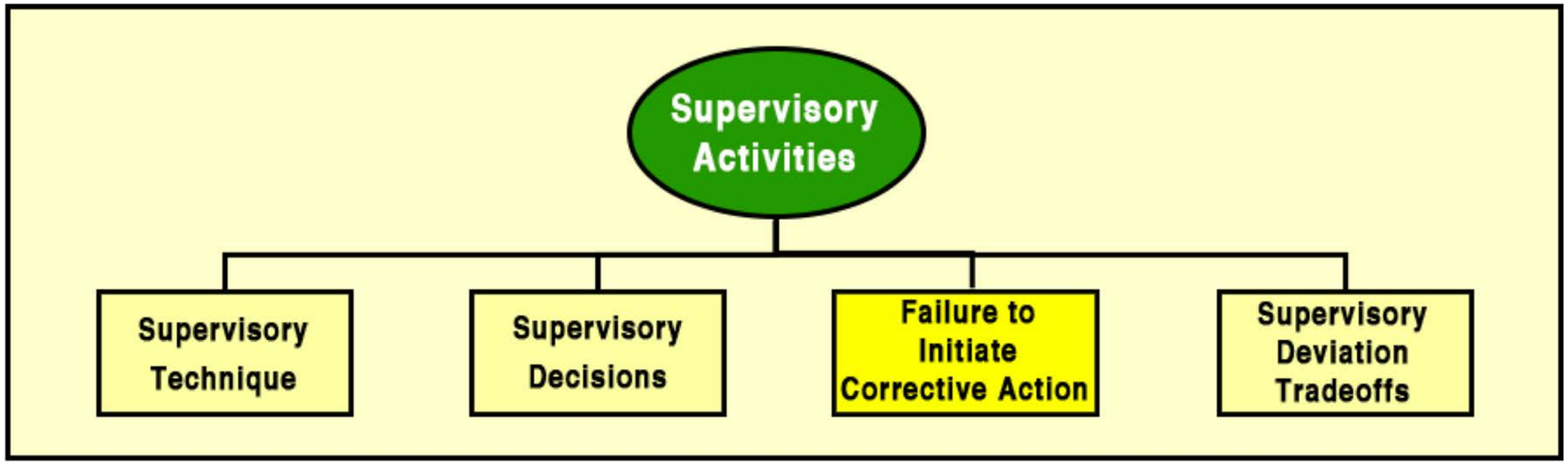


HFACS — Failure to Initiate Corrective Actions

Deficiencies in conditions or behaviors that are allowed to continue, e.g.,

- Tolerating known deficiencies among individuals, equipment, etc.
- Not conducting required testing / verification. Failure to warn.
- Not closing PHA, investigation, and audit action items.

Can lead to implicit sanctioning of Deviation Tradeoffs to procedures and rules.



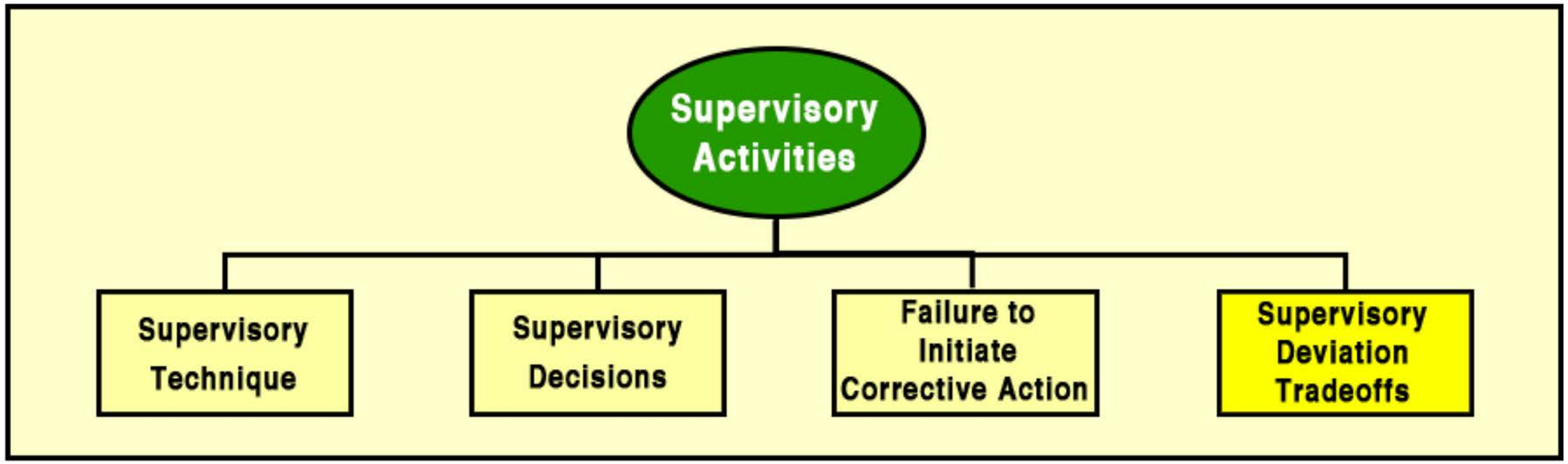
HFACS — Supervisory Deviation Tradeoffs

Willful disregard of, or failure to conform to rules and regulations, e.g.,

Encourage bending the rules, e.g., implied haste, sanctioned shortcuts.

Ignore non-qualifications.

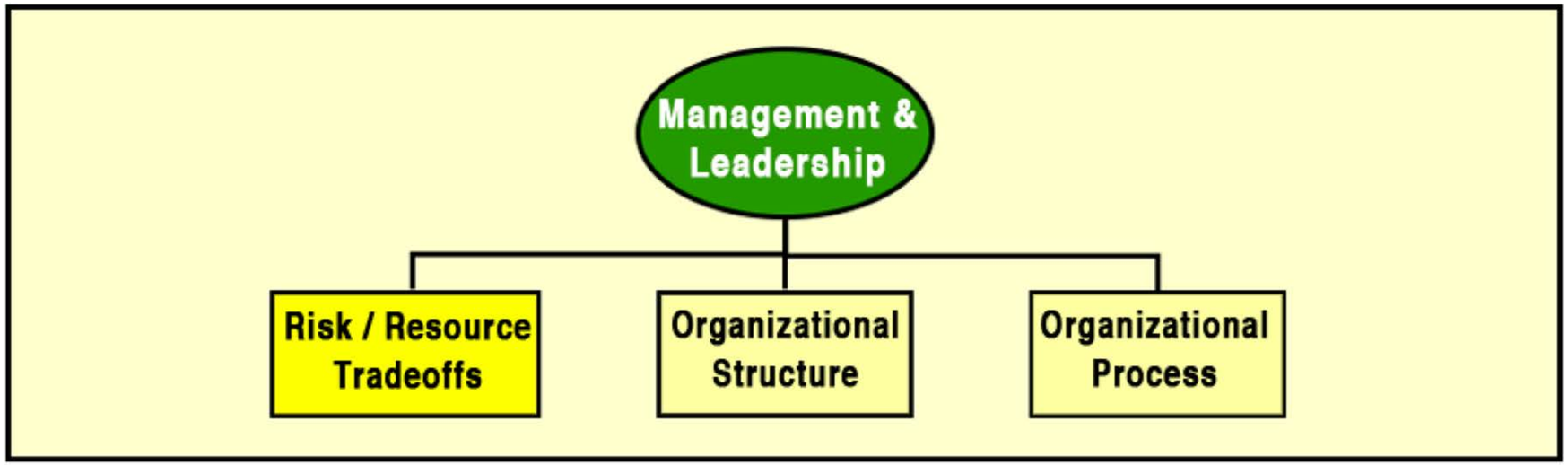
This is explicit sanctioning of Deviation Tradeoffs to procedures and rules.



HFACS — Risk / Reward Tradeoff

Resources balanced inappropriately for reducing risk.

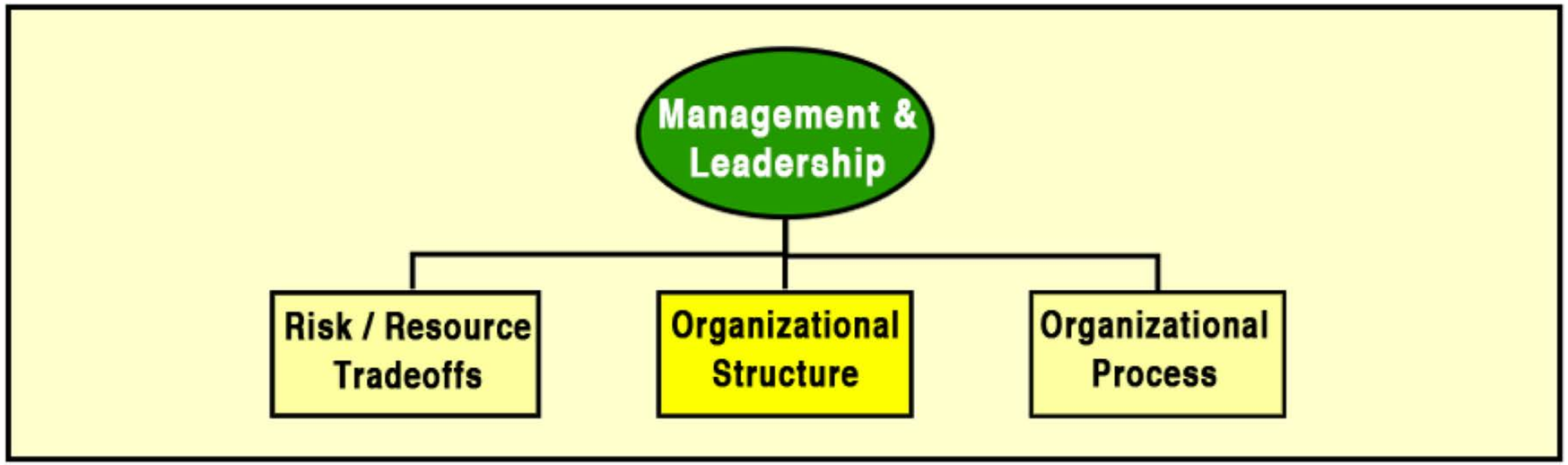
- **Human Resources.**
- **Monetary / Budget Resources.**
- **Equipment / Facility Resources.**



HFACS — Organizational Structure

The organizational working atmosphere and environment.

- **Hierarchy:** chain-of-command, delegation of authority, accessibility, accountability.
- **Policies:** hiring, employee representation, drugs & alcohol.
- **Culture:** The unofficial, unspoken rules, values, beliefs and customs of the organization



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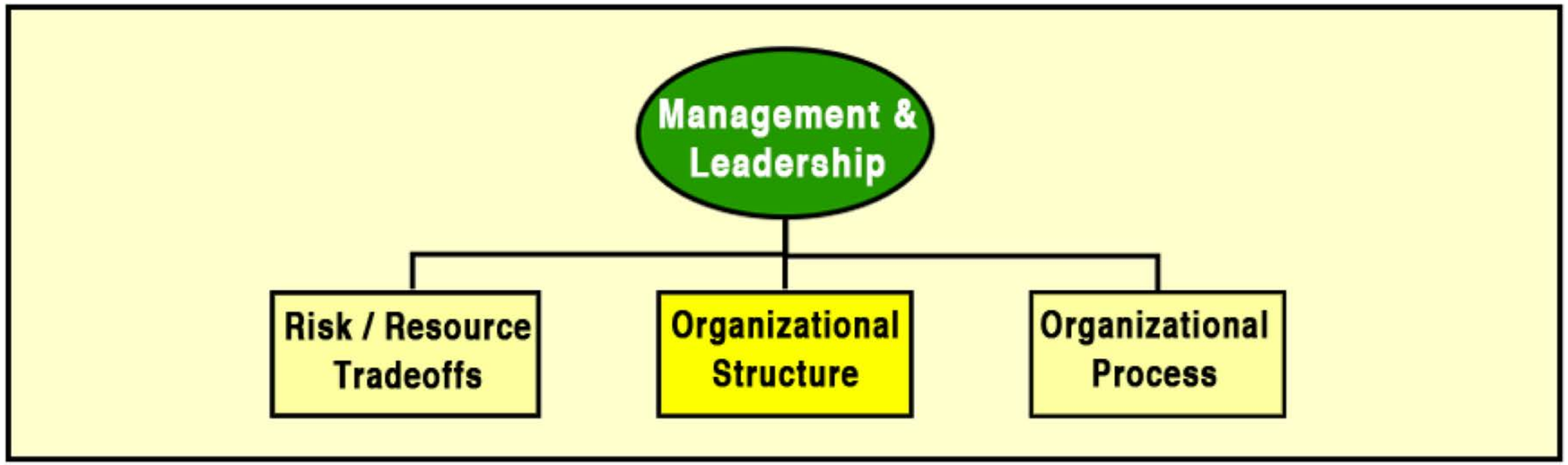
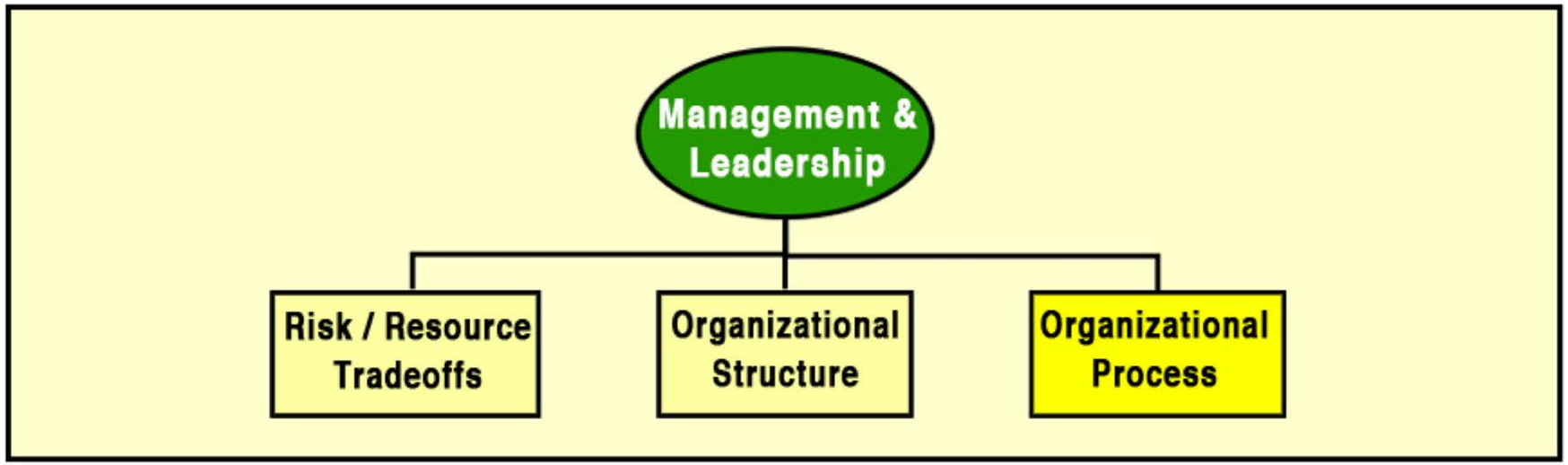


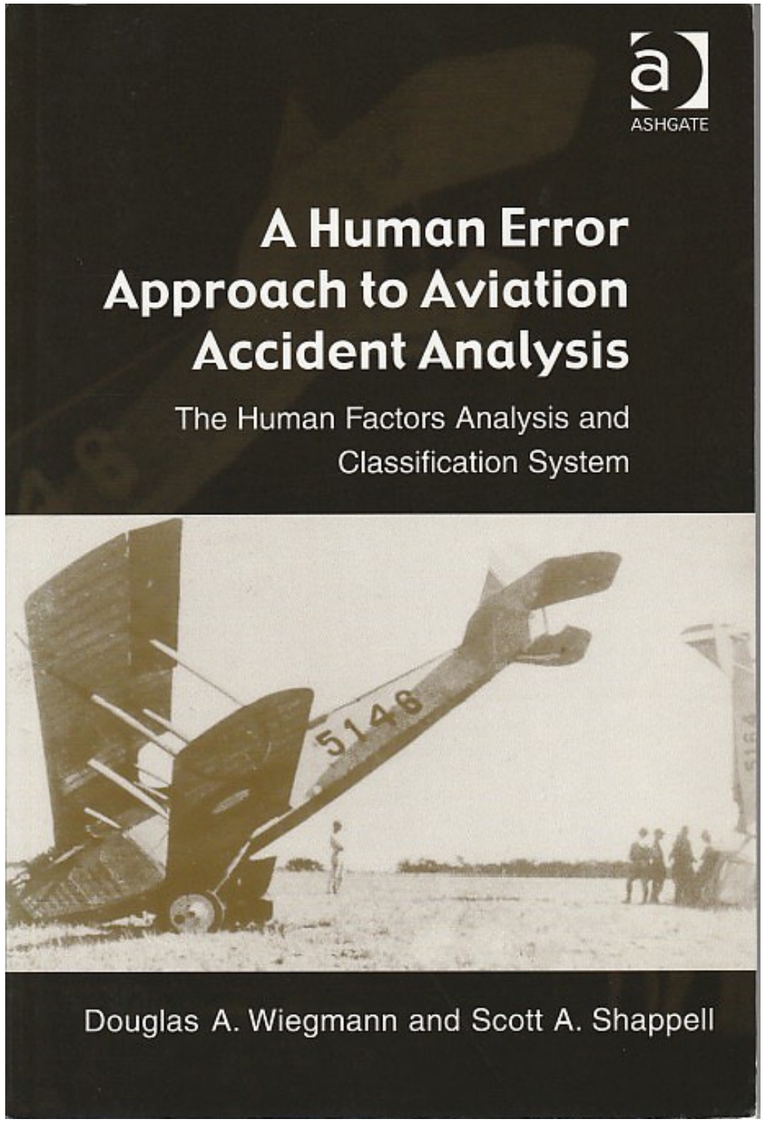
HFACS — Organizational Process

The organizational methods, decisions, and rules that govern activities.

- **Operations: schedules, incentives, tempo**
- **Standards & Procedures: risk tolerance, project management**
- **Oversight: leading and lagging indicators, performance monitoring, corrective action**
- **Legal Obligations**



Human Factors Analysis and Classification System



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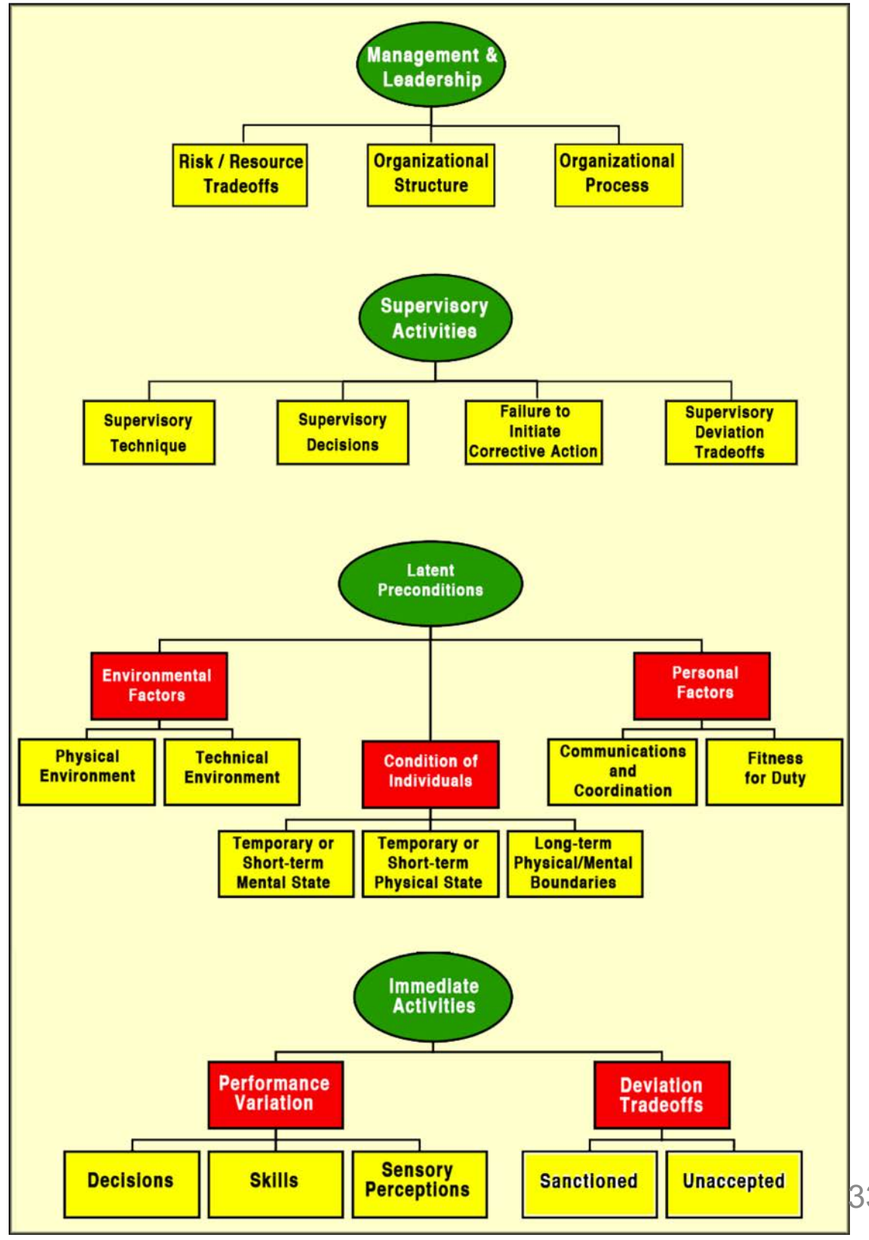

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Incident Investigation – People in the Casual Chain

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Cause and Effect Chart Refresher in Two Slides

Cause and Effect Chart Refresher — Define the Scope

What

- The Primary Effect; what we want to keep from recurring
- Use Noun – Verb: “Arm Broken”, “Chlorine Gas Released”, “Shipment Delayed”

When

- Date and Time
- Can be a Relative Time or Status: “during unit restart” “during shift change”

Where

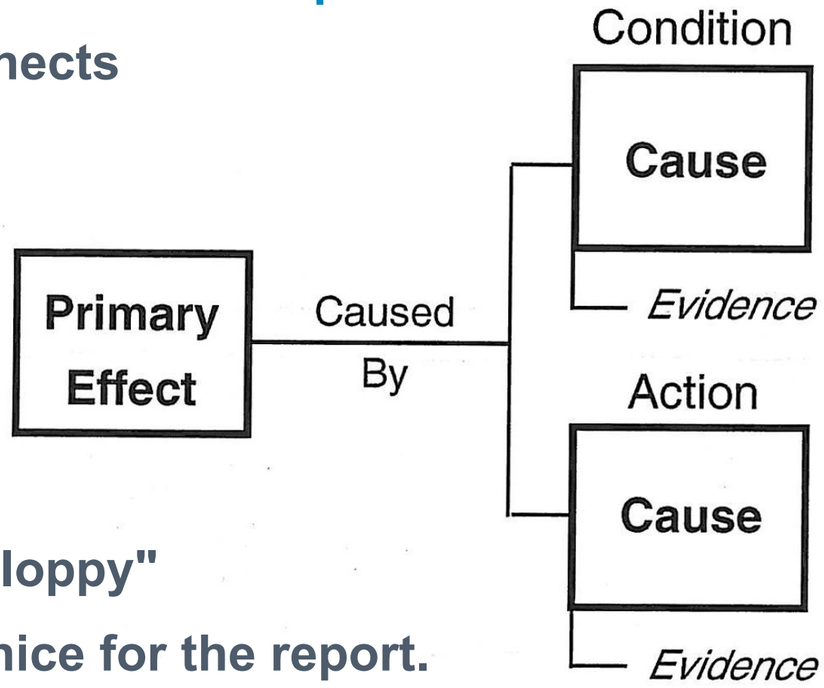
- Facility, System, Component

Significance – Why event is being investigated

- Be specific: “Lost $50,000 of product” instead of “product contamination”
- Be categorical: Safety, Environmental, Production, Cost, Health, Frequency

Cause and Effect Chart Refresher — Work the Chart

1. Ask “why” for each effect; two types of Causes: Conditions and Actions
   - Condition Cause - exists over time, set in motion by action; “procedure exists” “composition is”
   - Action Cause - momentary; “PSV lifted” “vapor cloud ignited” “button pushed”
2. Connect with "caused by” Say it out loud to be sure it connects
3. Support with evidence
   - sensed – sight, sound, taste, touch, smell, data
   - inferred – judgement based on experience
   - intuitive – beliefs, feelings, a hunch; poor evidence
   - emotional – not evidence; can use to create hypotheses
   - "The seal was smoking hot. I bet Joe installed that. He’s sloppy"
4. The chart is a tool, a working document. Make something nice for the report.
   - Track what evidence is in hand and what is needed
   - Show hypotheses



I use SimpleMind cross-platform mind mapping software

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Incident Investigation Interviewing

Investigation Interviews – Introduction

- Interviews are intended to draw out observations, perceptions and assessments.
- Interviews should be composed and cooperative, not confrontational.
- The goal is to define a historical event.

- Pick a definite time and place.
- Conduct eyewitness interviews ASAP: people talk, memories are malleable.
- Plan. Know what needs to be ascertained. Use HFACS categories as a guide.
- Take notes the whole time. This is hard. Notes “sometimes” alerts the interviewee.

- Do you need an open-ended narrative?
- Ask open-ended question, not yes-no. What happened next? What did you notice?
- Don’t interrupt. Pause and quiet are good.
- Don’t insert your information: Let the interviewee provide info and conclusions.

- Consider reviewing some facts for accuracy at the end of the interview.

Investigation Interviews – Have a Plan

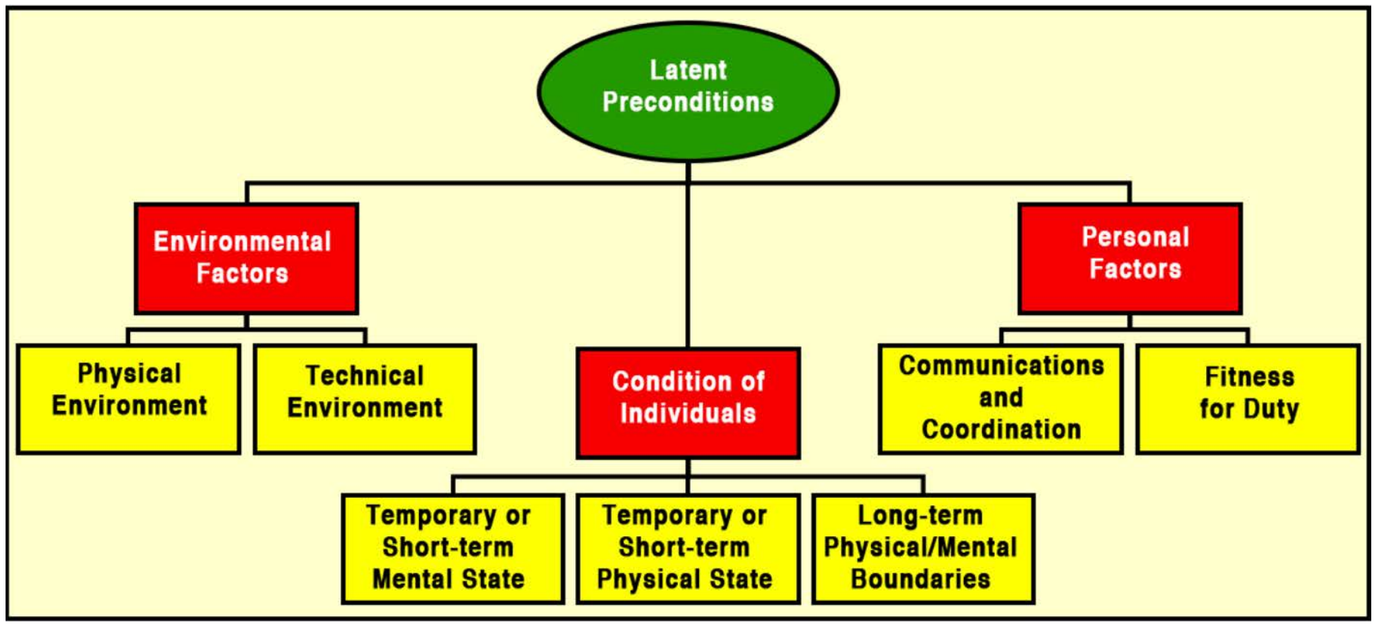
Don’t begin with Immediate Activities

- Probably known from incident report
- Often leads to “Why did you…” and jumps to causes.

Begin at Latent Preconditions

- Determine what is normal; what are expected conditions and situations.
- Then progress to what was different this time.

Answers about Latent Preconditions naturally lead to the other categories.



Investigation Interviews – Dealing with Reluctance

First step: anticipate where this might occur and prepare.

Do you really need the information; for the interviewee to say it?

Is it worth the risk of loss of cooperation from this or future interviewees?

Empathize. “I know this is difficult. I just really need to understand…”

Back off. “OK”, and return later perhaps from another direction.

If you draw a line in the sand, refusal becomes a Big Deal.

Investigation Interviews – Dealing with Suspected Untruth

Again: anticipate where this might occur and prepare.

Establish facts of the topic in Latent Preconditions to prevent excuses.

- **What type of alarms are there? How are you notified? Are they tested?**
- **How do you know how to respond? Do you notify others? When do you shut down?**

Primary Rule: If you know for sure, simply move on.

Consider simply including Recommendations for unacknowledged causal factors.

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Effective Recommendations

Effective Recommendations

Must Prevent Recurrence

- **Prevents or mitigates THIS problem**
- **Prevents similar problems**
- **Does not create new problems**

Consider All Approaches to Potential Solutions

- **Administrative:** Structure, Culture, Oversight, Process
- **Human:** Selection, Training, Motivation, Teamwork
- **Technological:** Data Collection / Assessment, Automation, Tools
- **Task:** Optimization, Formalization, Specialization, Standardization
- **Hazard Intervention:** Removal, Risk Reduction, Risk Acceptance / Coping

Must be within control to implement

- **Effective, Feasible, Acceptable, Economical**

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