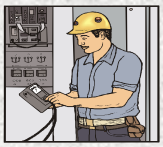


Managing Maintenance Error

Using Human Performance Improvement

Department of Energy
Human Performance Center

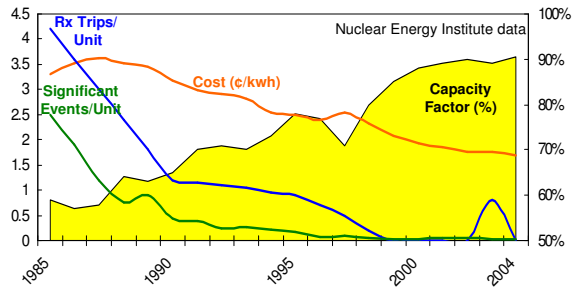
Housekeeping

- Emergency Exits & Assembly
- Start & Stop Times
- Breaks: Frequency & Duration
- Lunch Arrangements
- Restrooms
- Handouts
- Critique Sheets

The application of HPI Principles reduces human error and its consequences

– thus improving safety, quality, and productivity.

US Nuclear Trends



New Terms

- INPO – Institute for Nuclear Power Ops
- Latent Organizational Weakness
- Local Error-Provoking Factors
- Flawed Defenses (Controls)
- Fallibility & Culpability
- Error-Tolerant/Just Culture

Introduce Yourself!

- Your Name
- Your Organization, Group, Position
- Any course expectations

Course Topics

1. Human Performance Problems in Maintenance
2. The Human Risks
3. Fundamentals of Human Behavior
4. Varieties of Error
5. System Failure & A Model of Organizational Accidents
6. Error Provoking Factors & The Workers' Toolbox
7. Workplace Tools & Considerations
8. Leader & Organizational Tools
9. Safety Culture
10. Making It Happen
    – Managing Error Management

Topic-1

Human Performance Problems in Maintenance

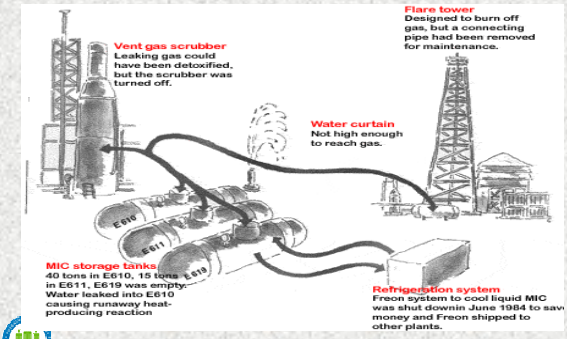
Maintenance Error causes Major Accidents

- **Apollo 13 oxygen tank blow out (1970)**
- **Three Mile Island loss of coolant (1979)**
- **Chicago DC 10 crash at O'Hare (1979)**
- **Bhopal India release of methyl isocyanate gas (1984)**
- **Piper Alpha oil & gas platform explosion North Sea (1988)**
- **Clapham Junction rail collision in England (1988)**
- **Phillips 66 chemical explosion in Texas (1989)**
- **Embraer 120 in-flight structural break in Texas (1991)**
- **Loss of B-757 in Dominican Republic (1996)**
- **DC9 oxygen generator fire over Florida (1996)**
- **Southwest Air landing accident in Chicago (2005)?**

Called the worst industrial accident in history

Bhopal, India Fatal Gas Release

December 2, 1984



Maintenance Error is expensive!

- Maintenance-prolonged outages in US Nuclear Plants priced at $1M/day
- GE reports in-flight engine shutdown (usually caused by maintenance error) costs the airline ~$500,000

Human Error abounds in Maintenance

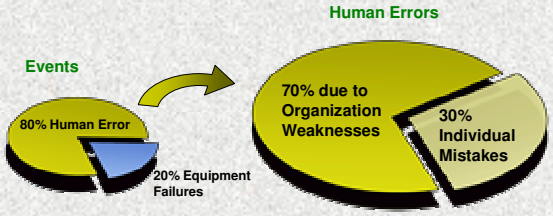
- 42-65 % of Human Performance Problems occur in Maintenance

Data from surveys (3 US & 1 Japanese) associated with nuclear power plant events

Why does maintenance produce an abundance of human error?

- Disassembly & Assembly
- Time pressure (Equipment Off-line)
- Working Conditions (Cramped, poorly lit spaces)
- Turnovers
- Procedures, manuals, & reports
- Inadequate tools & spares

Why a Human Performance Approach?



The Good News is - Maintenance Error can be managed!

- Most maintenance errors fall into systematic and recurring patterns
- Problems are more likely error-inducing situations
- Limited resources can be targeted to achieve maximum remedial effect

Topic-2

The Human Risks

(Human Performance Fundamentals)

A 1999 study estimated 45k-95k people die each year due to human error in medical care!

"Do No Harm"

Dateline - 2003

Significant DOE Events

1995 through 1999 (w/ Potential for Personnel Injury)

Year	Events	HU	%
1995	66	44	67
1996	44	34	77
1997	26	21	81
1998	26	22	85
1999	19	16	84
Totals	**181**	**137**	**76%**

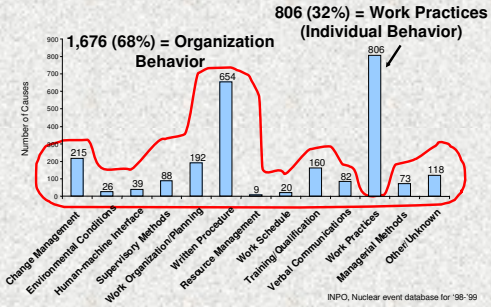
"All systems with people in them suffer human-related disturbances."

Facilitating Safe and Reliable Operations!

Is it due to bad people or error-provoking systems?

Facilitating Safe and Reliable Operations!

Nuclear Industry Events due to Human Performance



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Our Management of Error is prone to error!

- "Normal" Reaction-
  - Focus on individual factors immediately preceding the event
  - Do what seems necessary to prevent recurrence
    - Typically includes disciplinary action, new/revised procedures; blaming, shaming, and retraining

Facilitating Safe and Reliable Operations!

Supervisors and managers should know that people find it difficult to avoid actions that they never intended to commit in the first place!

Facilitating Safe and Reliable Operations!

Human Performance Fundamentals

- Everyone makes errors – **none are intentional**
- Errors are **consequences** – not just causes
- Errors are **inevitable**

Facilitating Safe and Reliable Operations!

A Systems Approach

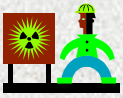
- Events
- The Worker
- Task Factors – the job
- Local Conditions – at the worksite
- Organizational Factors – the system as a whole

Facilitating Safe and Reliable Operations!

HP Formula for Success

Re + Md = Øe

Facilitating Safe and Reliable Operations!



Organizations institute defenses or controls to prevent or mitigate plausible events.

Facilitating Safe and Reliable Operations!

Common Types of Defenses or Controls include:

- Equipment Interlocks
- Safety/Containment Systems
- Personal Protective Equipment
- Surveillances
- Work Authorization
- Training/Qualification/Certification
- Management/Regulatory Oversight
- Self-Assessment

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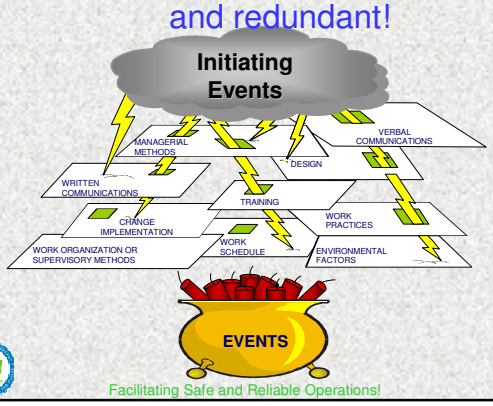
Defense-in-Depth is diverse and redundant!



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What can you do?

Instead of trying to change human nature –

improve the conditions under which people work and anticipate errors!

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Errors are like Mosquitoes

- To get rid of them you must drain the swamps.

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The Principles of Human Performance

- Humans are fallible
- Error is predictable
- Organization influences behavior
- Behaviors are reinforced
- Events are avoidable

Facilitating Safe and Reliable Operations!

Topic-3

The Fundamentals of Human Behavior

"Psychology meets Engineering"

Facilitating Safe and Reliable Operations!

Choose Error?

"People do not operate in a vacuum, where they can decide and act all-powerfully. To err or not to err is not a choice. Instead, people's work is subject to and constrained by multiple factors".

--Sidney Dekker

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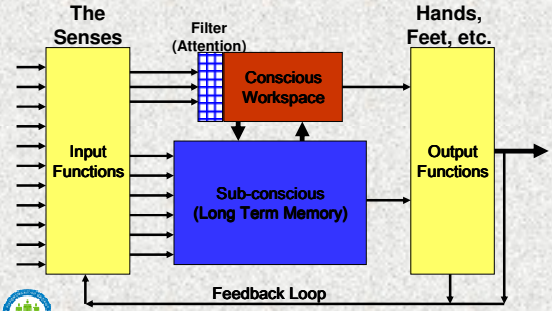
A 'Schematic' of Mental Functioning



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The Human Computer
(Foreground vs. Background)

Conscious Workspace Properties

- A general problem solver
- Limited capacity
- Contents available to consciousness
- Processes information sequentially (1 topic at a time)
- Slow and laborious
- Essential for new tasks

Sub-Conscious Properties

- Vast collection of specialized routines
- No limits yet established, either in terms of size or duration of memories
- Processes (not products) largely unconsciously
- Rapid and effortless
- Handles familiar routines and habits

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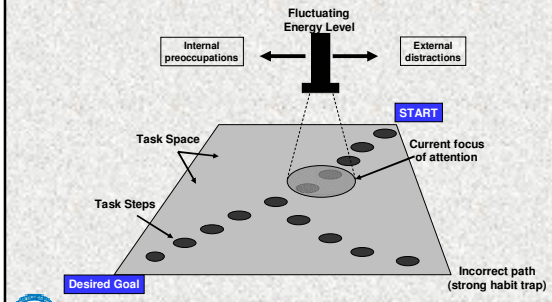
Beam Model of Human Attention



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The Vigilance Decrement – monitoring tasks where 'hits' are relatively few and far between.

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Attention vs. Habit (Skill)

Conscious	Mixed Control Modes	Automatic
•Slow		• Rapid
•Effortful		•Effortless
•Limited		•Unlimited
•Sequential		•Parallel
•Universal		•Specific
•New Tasks		•Skilled Tasks

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Acquiring Skills

Training & Practice

- **Talk yourself through**
- **Respond to signals**
- **Recognize key signals**
- **Economy of effort (timing)**
- **Automatic performance**

Fatigue & Stress

The principal stages in skill acquisition

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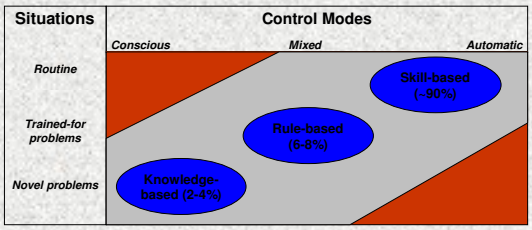
Activity Space



Activity Space definition of Three Performance Modes

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Summary

- Mental Functioning 'Blueprint'
- Acquiring Skills
- Performance Modes

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Topic-4

The Varieties of Error

Define Error -

"An <u>unintended</u> deviation from an expected behavior"

Two Kinds of Error

Active Error
(hands-on)

Latent Error
(leading to underlying conditions)

Error = <u>Unintended</u> Deviation

- The plan is appropriate, but the **actions themselves do not go as planned (active).**
- The actions go as planned, **but the plan is inadequate to achieve desired goals (latent).**

<u>Versus</u>

- Violations – actions **intentionally deviate** from the specified method of working.

Error Type vs. Performance Mode

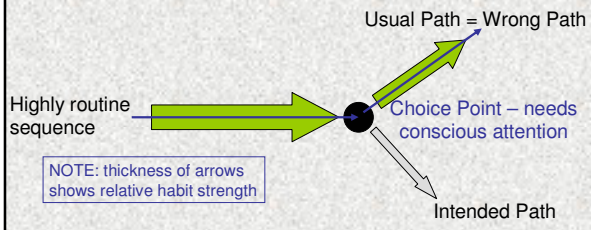
- Skill-based Error (25%)
  - Inattention
  - Err <1:10K (90% of activities)
- Rule-based Errors (60%)
  - Misinterpretation
  - Err ~1:1K (6-8% of activities)
- Knowledge-based Errors (15%)
  - Inaccurate Mental Model
  - Err ~1:2 (2-4% of activities)

Skill-based Errors

"You cannot think and hit at the same time."
- Yogi Berra

- Recognition Failures
- Memory Failures
- Skill-based Slips

A Typical Slip



Rule-based Errors

Misinterpretation:

- **Assumption – misapplying a good rule**
- **Habit – applying a bad rule**

Knowledge-based Error

- **Lack of System Knowledge**
- **Failed problem solving**

"We train our people in theory because you can never postulate every accident that might happen. The only real safety you have is each operator having a theoretical and practical knowledge of the plant so he can react in any emergency."

- Adm Hyman G. Rickover

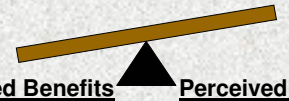
Define Violation -

"<u>Intentional</u> acts to evade a known policy or procedural requirement for personal advantage usually adopted for fun, comfort, expedience, or convenience"

Violation Categories

- **Routine Violations**
- **Thrill-seeking or Optimizing Violations**
- **Situational Violations**

Violation "Balance Sheet"



Perceived Benefits	**Perceived Costs**
• Easier way of working	• Accident
• Saves time	• Injury to self or others
• Gets the job done	• Damage to equipment
• Shows skill	• Costly to repair
• Meets a deadline	• Sanctions/punishment
• More exciting	• Loss of job/promotion
• Looks macho	• Disapproval of friends

Summary

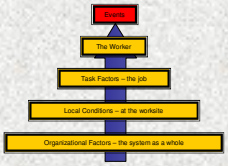
Performance Modes => Error Modes

- Knowledge-based Performance/ Error
- Rule-based Performance/Error
- Skill-based Performance/Error

and

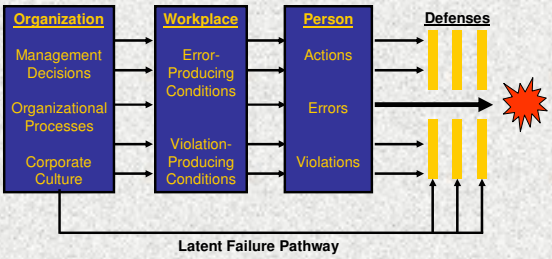
Violations

Topic 5



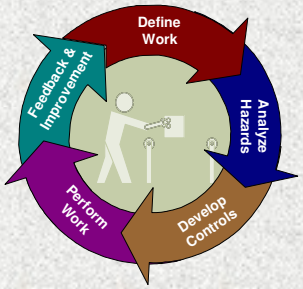
System Failure and A Model of Organizational Accidents

Organizational Accident Model



Sterigenics Explosion August 2004

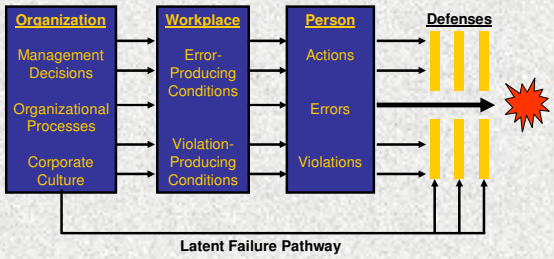
DOE ISM Functions



CSB Recommendations

1. Review and revise the Process **Hazard Analysis** (PHA) program
2. Evaluate current process **controls** and install appropriate safeguards
3. Ensure that all employees with passwords capable of modifying the sterilization cycle sequence have process experience and training that enables them to make safe process decisions.
4. Ensure that the control room, and any other room where employees congregate in dangerous proximity to the sterilization area, is located and/or designed to protect workers from an explosion.
5. **Communicate** the findings and recommendations of this report to all employees, including operators and maintenance staff.

Organizational Accident Model



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Topic 6

Error-Provoking Factors &
The Workers' Toolbox
(T-W-I-N)

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What are Local Error-Provoking Factors?

- Error-producing conditions
- Present in the immediate surrounding

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Error-Provoking Factors

Team beliefs	**Recognition failures**	Inadequate equipment
Time pressure	**Memory lapses**	Sleepiness
Hazard awareness	**Slips**	Circadian low points
Unworkable procedures	**Errors of habit**	Poor Communication
Spares availability	**Mistaken assumptions**	Shift turnovers
'Can-do' attitudes	**Knowledge errors**	Inexperience
Demographics	**Violations**	Task frequency
Documentation		Design deficiencies
Technical support		Housekeeping
Unsuitable tools		Tool control

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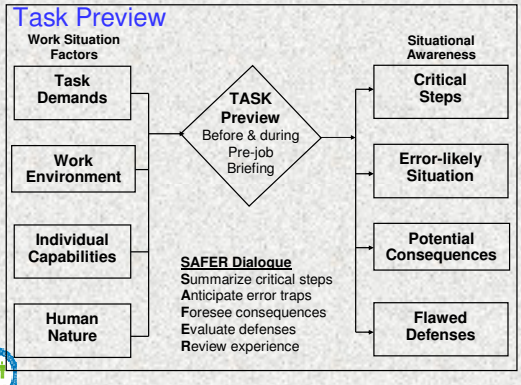
Task Preview



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Error Precursors
Short List

Task Demands	Individual Capabilities
• Time pressure (in a hurry)	• Unfamiliarity w/ task / First time
• High Workload (memory requirements)	• Lack of knowledge (mental model)
• Simultaneous, multiple tasks	• New technique not used before
• Repetitive actions, monotonous	• Imprecise communication habits
• Irrecoverable acts	• Lack of proficiency / Inexperience
• Interpretation requirements	• Indistinct problem-solving skills
• Unclear goals, roles, & responsibilities	• "Hazardous" attitude for critical task
• Lack of or unclear standards	• Illness / Fatigue
Work Environment	**Human Nature**
• Distractions / Interruptions	• Stress (limits attention)
• Changes / Departures from routine	• Habit patterns
• Confusing displays or controls	• Assumptions (inaccurate mental picture)
• Workarounds / OOS instruments	• Complacency / Overconfidence
• Hidden system response	• Mindset ("tuned" to see)
• Unexpected equipment conditions	• Inaccurate risk perception (Pollyanna)
• Lack of alternative indication	• Mental shortcuts (biases)
• Personality conflicts	• Limited short-term memory

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Task Demands: Pressure

Signs of Pressure =>

- "How long is it going to take"?
- Getting angry during a job
- Starting to curse more than usual
- Being anxious to go home

Risk => Temptation to take shortcuts to get a component, system, or facility back into service

Time Pressure

•**Time pressure** was the most reported factor leading to incidents

-survey responses by maintenance personnel

Solution: Be on guard, check yourself, avoid risk-taking and cutting corners

Supervisors – don't add to the problem!

Task Demands: High Workload

Risks of Overload =>

- Ignore selected inputs
- Trade accuracy for speed
- Reduce level of discrimination – accept coarser matches

Solution:

- Postpone things until quieter times
- Redistribute the work
- Abandon the task altogether

Work Environment: Interruptions

Interruptions =>

Increase the chance of Memory Lapse

Risk => Errors of Omission

Solution: Leave behind a clear reminder of exactly where you had to stop (place keeper)

Work Environment: Personality

Is your team compatible?

Unstable

Introverts	Moody Anxious Pessimistic Unsociable Quiet	Touchy Restless Optimistic Aggressive Active
	Passive Careful Thoughtful Controlled Reliable	Sociable Outgoing Lively Carefree Leadership

Extroverts

Stable

Individual Capability: Knowledge & Experience

Risks:

- Tasks requiring knowledge-based problem solving are more error prone than tasks that are well understood
- Experienced craft performing routine tasks can err due to a lack of challenge or stimulation

Solution: Exercise care in assignments and degree of supervision/support

Individual Capability: Lack of proficiency/inexperience

Unfamiliar Jobs =>
Ambiguity - Entering the 'Danger Zone'

Risk => Skills may be 'rusty' or work may be Knowledge-Based

Solution: Call a halt and review the task

Individual Capability: Fatigue

Tiredness =>
Without a good night-time sleep in the last 24 hours, or
Worked for longer than 12 hours

Risk => Increases the chances of making errors

Solution: Make it a priority to get a good nights sleep, avoid unnecessary lengthy overtime work, slow the pace, provide additional checks.

Human Nature: Stress

- **Physical** – heat, humidity, confined spaces, noise, vibration, etc.
- **Pace of Work** – time pressure, interruptions, boredom, fatigue, etc.
- **Social** – disciplinary action, group pressures, incentive schemes, etc.
- **Drugs** – Alcohol, nicotine, medication, etc.
- **Personal Factors** – family/financial worries, aches and pains, colds/flu, etc.

Human Nature: Mindset

- Pride - "Don't insult my intelligence!"
- Heroic - "I'll get it done, hook or by crook!"
- Invulnerable - "That can't happen to me!"
- Fatalistic - "What's the use?"
- Bald Tire - "Got 60K miles and haven't had a flat yet!"
- Summit Fever - "We're almost done!"
- Pollyanna - "Nothing bad can happen."

Human Nature: Risk Perception

Folks are more comfortable when:

- They feel they have control
- Risk provides wanted benefits
- Know about and live with the hazard
- Risks are routine - not new or novel
- Risks come from organizations or people they trust
- Unaware of the hazard(s)

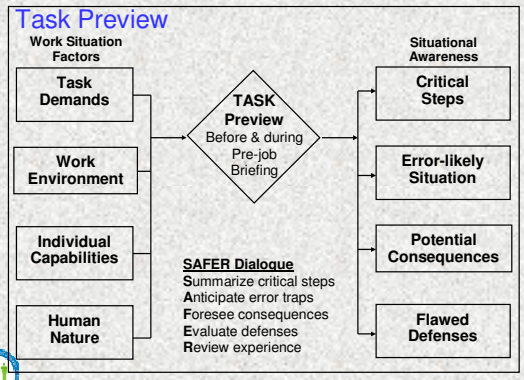
The Purpose of the Workers' Toolbox

Maintain Positive Control =>
what is intended to happen is what happens,
and that is all that happens

What are the Workers' Fundamental Tools?

- Task Preview & Pre-Job Brief
- Situation Awareness
  - Job-Site Review
  - Questioning Attitude
- Stop When Unsure
- Self-Checking
- Procedure Use and Adherence
- Effective Communication
  - Three-Way Communication
  - Phonetic Alphabet
- Place-keeping

Task Preview



What is a Critical Step?

- a procedure step, series of steps, or action that, if performed improperly, will cause irreversible harm to plant equipment, people, or the environment; or significantly impact facility operation.

Task Preview

Commonly Accepted Practice

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 and 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.

Pre-Job Briefing

	Low Risk	High Risk
Simple or Repetitive Activity	Task Preview (including a review of safety hazards and safety requirements)	Tailored Pre-job Briefing (customized briefing checklist)
Complex or Infrequent Activity	Standard Pre-job Briefing (using a standard briefing checklist)	Infrequently Performed Test or Evolution Brief

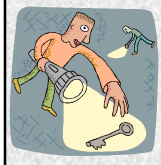
Pre-Job Brief Demo

Pre-Job Brief Demonstration (INPO Video)

Job-Site Review

Commonly Accepted Practice -

"Two-Minute Review" or "Take Two"



» Explore

» Talk

» Eliminate

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Questioning Attitude

Commonly Accepted Practice

- Stop, Look, and Listen
- Ask Questions
- Proceed, if sure – Stop, when unsure

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Stop when unsure!

Commonly Accepted Practice

- Stop!
- Establish a safe condition.
- Notify!

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Self-Checking

Commonly Accepted Practice

1. **S**top
2. **T**hink
3. **A**ct
4. **R**eview

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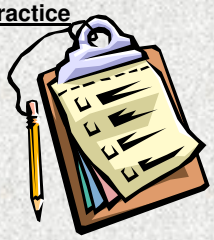
Procedure Use and Adherence

Commonly Accepted Practice

- **Compare** versions
- **Provide** copies
- **Review** steps
- **Use** as specified
- **Follow** as written.
- **Avoid** "N/A"
- **STOP?**
- **Report** problems



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Effective Communication

Commonly Accepted Practice

- Three-Way Communications
- Phonetic Alphabet

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Provoking Omission

Omission likelihood of a task step:

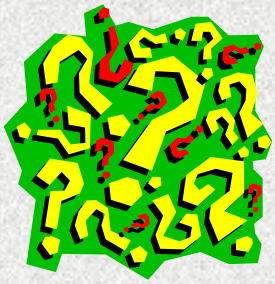
- **Memory Loading**
- **Conspicuity**
- **Position of the Step**
- **Local Cueing**

Use Place-keeping to Avoid Omission!

Commonly Accepted Practices

- ❑ Blackout non-applicable steps
- ❑ Annotate steps started - O ☐
- ❑ Annotate steps completed - ☒ ☑ ⊗ ⦸
- ❑ Use page markers
- ❑ Verify previous steps when interrupted
- ❑ Annotate page completion

Questions about the Worker Tools?



Topic 7

Workplace Tools and Considerations

Workplace or Conditional HP Tools

- Verification Practices
  - Concurrent Verification
  - Independent Verification
  - Peer-Checking
- Flagging
- Reminders/Postings
- Turnover
- Post Job Review
- Pocket Handbooks

Verification Practices

- Peer-Verification
- Independent Verification
- Peer Checking

Flagging

Commonly Accepted Practice

1. **Identify** the component to be flagged
2. **Flag** the designated component
3. **Perform** the work
4. **Remove** flagging device(s)

Reminders & Postings

Criteria for a Good Reminder

- Conspicuous
- Close
- Context
- Content
- Count
- Secondary:
  - Comprehensive
  - Compel
  - Confirm
  - Convenient
  - Conclude

Turnover

Commonly Accepted Practice

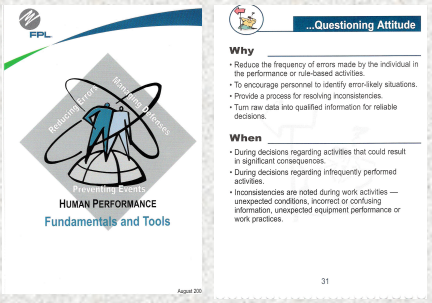
1. Maintain an accurate turnover log
2. Review log/walk down work area
3. Discuss information/ask questions
4. Transfer responsibility

Post Job Review

When to Use the 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 were identified

Pocket Handbooks



Some Other Considerations!

Many maintenance errors have their origins in the workplace environment

- Fatigue
- Task frequency
- Design Issues
- Housekeeping
- Spares, tools and equipment

Workplace Considerations

Fatigue

For maintenance performed outside normal hours, Fatigue Management is one of the most important issues

Fatigue Management:

Shift work

Eight Principles for the Design of Shift Systems

1. No more than 3 weeks of night shifts in succession
2. Avoid permanent night work
3. Rotate shifts forward in time (morning, evening night)
4. Allow at least 2 days off after the last night shift
5. Consecutive work time should not exceed 5-7 days
6. Shifts longer than 8 hours should not permit overtime
7. Allow at least 11 rest hours between shifts
8. Post shift schedules well in advance

Workplace Considerations:

Task Frequency

A 'Bathtub' Effect:

- Knowledge-Based Errors likely for infrequent tasks

But –

- Absent-minded slips are more likely for experienced personnel

Make task assignments carefully!

Workplace Considerations:

Equipment Design

- Design Principles:
  - Easy access to components
  - Functionally related components grouped together
  - Labels clear and informative
  - Minimal need for special tools
  - Delicate adjustments not required in field
  - Design facilitates fault isolation

Workplace Considerations:

Housekeeping

If Poor Housekeeping exists:

1. Management inspects, is aware of problem, does nothing about it – or
2. Management inspects, but fails to identify the problem – or
3. Management doesn't inspect

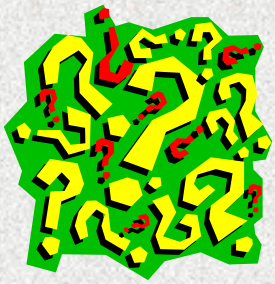
Workplace & Task Measures:

Spares, Tools & Equipment

Key questions regarding tools & equipment:

1. Do workers ever use unapproved tools or equipment?
2. Is unserviceable maintenance equipment left in work areas while awaiting repair?
3. Are commonly used spares or consumables out of stock?
4. If maintenance is around the clock, is technical support available at all hours?
5. Are there systems in place to keep track of tools?
6. Are disassembled components stored and labeled appropriately?
7. Are replacements available when equipment is sent away for servicing or calibration?

Questions about the Workplace Tools?



Facilitating Safe and Reliable Operations!

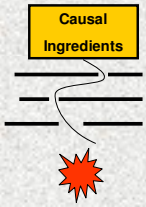
Topic 8

Leader and Organizational Tools

Facilitating Safe and Reliable Operations!

How Accidents Happen!

Event = Unwanted & Unplanned Happening



Causal Ingredients

+ Timing

= Consequences

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Organizational Measures:
Removing Causal Factors

Reactive Outcome Measures –
Applying Lessons Learned from Past Events

Proactive Process Measures –
Assessing 'System Health' and Deploying Targeted Remedial Actions

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Organizational Measures:
Common Factors

Organizational Factors:

- Organizational structure
- People management
- Provision and quality of tools and equipment
- Training and selection
- Commercial and operational pressures
- Planning and scheduling
- Maintenance of buildings and equipment
- Communication
- Knowledge, skills, and experience
- Morale
- Tools, equipment, and parts
- Technical Support
- The environment
- Computers, paperwork, manuals, and procedures

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What you know may only be the 'tip' of the iceberg!

Documented Errors – with Consequences

Undocumented Errors – near misses

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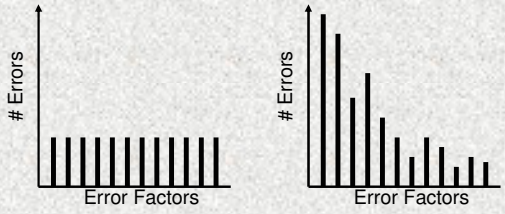
Understanding Error Patterns

Random vs. Systematic



Error Traps – conditions within the system or workplace that produce the same types of errors, regardless of who is doing the job

The Purpose of Proactive Measures

To identify workplace and organizational factors that may later cause an event, and direct remedial efforts at those problems most in need of attention

- Data Gathering
  - Observations, Assessments, Surveys

HP Formula for Success

Re + Md = Øe

Re – Reduce Error

Md – Manage Defenses

Øe – Zero Events

Organizational Measures:
Identifying Gaps-1

Error-Detection Controls:

- Is work self-inspected or inspected by the same work group?
- Are functional checks ever omitted or abbreviated due to time pressure?
- Is insufficient time allowed for the performance of functional checks?
- Are some clearly unnecessary functional checks required?
- Does the climate of the workplace discourage thorough checking of colleagues' work?
- Do some safety-critical tasks lack error-detecting defenses?
- Are functional checks performed predominately at the end of the shift when personnel are likely to be fatigued?
- Have jobs ever been signed-off as completed and satisfactory when later events showed this was not the case?
- Could a system pass a post-maintenance test, but then fail to work when returned to service?

Organizational Measures:
Identifying Gaps-2

Error-Containment Controls:

- If maintenance is being performed on an operating system, is it carried out at a time that will cause the least disruption to other parts of the system?
- Is the work permit system adequate?
- Are strenuous efforts made to avoid the simultaneous disruptions of multiple redundant systems?
- Is staggered maintenance used to avoid disruption by maintenance error?
- After maintenance, is the system operated in a forgiving environment before being returned to full service?
- Are operators or production personnel kept informed of recent maintenance activities?

Organizational Measures:
Proactive + Reactive

Rd + Md = Øe	Reactive Outcome Measures	Proactive Process Measures
Workplace & Organizational Factors	Analysis of many events can reveal recurrent patterns not perceptible in one event	Regular sampling of 'vital signs' reveals those most in need of correction – leads to continuous improvement
Controls, Defenses, Safeguards	Each event shows a penetration of controls/defenses	Regular checks can identify weaknesses prior to failure

Leader & Organizational Toolbox

- Expectations
- Constant Themes
- Observations
- Post-Job Critiques
- Self-Assessment
- Surveys & Questionnaires
- Metrics & Indicators
- Rewards & Recognition
- Operating Experience
- Benchmarking
- Change Management

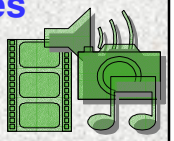
The Office "Coach"

Terry Tate Video

Establish Expectations

- Specific
- Objective
- Doable

Constant Themes



- *"Do the job right the first time!"*
- *"Don't shoot the messenger!"*
- *"Accuracy first, speed will follow!"*
- *"You achieve what you focus on!"*
- *"Preventing problems is always less expensive that solving them!"*
- *Etc.*

Job Observations

Coaching

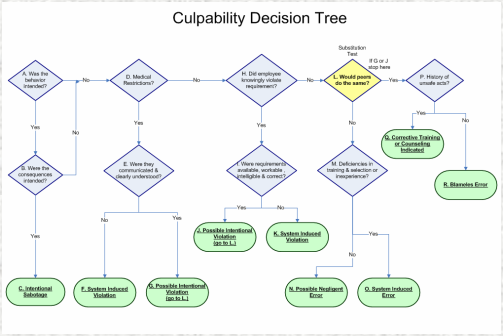
Critiquing

Post-Job Critique

Purpose: Organizational Improvement (OE)

- ❖ Quick and easy
- ❖ Production and Prevention
- ❖ Management acknowledgement
- ❖ Follow-through

Culpability Decision Tree



Adapted from Reason, 1997

→ **Direction of Diminishing Culpability**

Self-Assessment

Finding Problems <u>before</u> They Find You!

Surveys & Questionnaires:
Local Maintenance Survey

- Knowledge, skills, and experience
- Morale
- Tools, equipment, and parts
- Support
- Fatigue
- Pressure
- Personnel safety features
- Time of Day
- Paperwork, manuals, and procedures
- The environment
- Computers
- Inconvenience

Surveys & Questionnaires:
Organizational Survey

- Organizational structure
- People management
- Provision and quality of tools and equipment
- Training and selection
- Commercial and operational pressures
- Planning and scheduling
- Maintenance of buildings and equipment
- Communication

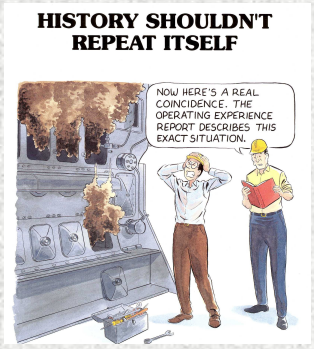
Metrics/Indicators

- Lagging:
  - Injury/Error Rates
  - Rework
  - Rad Exposure
- Leading:
  - Overtime/Absenteeism
  - Backlogs
  - Jobsite Behavior

Rewards & Recognition

Reinforcing <u>Desired</u> Behavior
And
Celebrating Results

Operating Experience



Benchmarking

Benchmarking without making substantive changes in your way of doing business is nothing more than "industrial tourism."

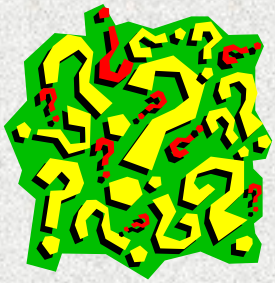
Manage Change

- Identify a champion
- Establish Steering Committee
- Create vision & urgency
- Develop strategy
- Communicate – Communicate
- Empower
- Implement
- Short-Term Successes
- Embed changes

Leader Behaviors Influence Norms and Values

- what managers pay attention to
- reactions to critical incidents
- criteria for allocation of scarce resources
- overt attempts to role model and coach
- criteria for allocation of rewards and status
- criteria for hiring, promotion, retirement, or firing
- stories about important events and people
- formal statements about philosophy and values

Questions about the Leader Tools?



Topic-9

Safety Culture

What is a Safety Culture?

- **What an Organization Is –**
  - the beliefs, attitudes, and values, often unspoken, of an organization's membership regarding the pursuit of safety
- **What an Organization Does –**
  - the structures, practices, controls, and policies that an organization possesses and employs to achieve greater safety

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Safety Culture: Key Attributes

- The engine that drives the organization toward maximum attainable safety
- A 'Collective Mindfulness' of the things that can go wrong
- An Informed Culture – knows where the 'edge' is
- A Learning Culture – open to continuous & wide reaching system improvements

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Safety Culture: Main Components

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Safety Culture: Error Model

- Person Model of Human Error
  - Errors & Violations result from the perversity & unreliability of human nature
- System Model of Human Error
  - Events are caused by the totality of the organization contributing to initiating events & failing to contain the results

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Safety Culture: Can It Be Engineered?

YES!

Changing **Behavior** leads to
Changing **Values, Attitudes, & Beliefs**

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Safety Culture: Creating a Just Culture

Punish the Guilty, but
Protect the Innocent

- A careful balance between dealing with acceptable and unacceptable behavior

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Just Culture:
Variety of Intent

- Radiation Survey:
  - Scenario A – Error
  - Scenario B – Violation by choice
  - Scenario C – Violation with 'good' intention
- The **results** are the same!
- Should the **response** be the same?

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Just Culture:
The Foresight Test

Did the individual who committed the error engage in behavior that an average person would recognize as being likely to increase the probability of making a safety-critical error?

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Just Culture:
The Culpability Test

Culpability is likely if the answer is YES to any of the following:

- **Working under the influence** of a substance that impairs performance
- **Clowning around** while driving potentially damaging equipment (or safety-related activity)
- **Taking unwarranted shortcuts** like signing off jobs prematurely
- **Using** tools, parts or equipment **known to be sub-standard or inappropriate**

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Just Culture:
The Substitution Test

Replace the individual with another of comparable training & experience:

"Given the situation in which the event occurred, could you be sure that they would not have committed the same or a similar type of unsafe act?"

If the answer is '**NO**'--then blame is likely to be inappropriate

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A Just Culture means Getting the Balance Right!

Zero Tolerance
for reckless conduct (**bad acts**)
balanced by
widespread confidence
that the vast majority of unintended unsafe acts will go unpunished (**honest errors)**

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The Challenge of Creating a Reporting Culture

- Natural disinclination to confess – ***"Me?"***
- Suspicion – ***"It will count against us!"***
- Skepticism – ***"Management won't act!"***
- Takes time and effort – ***"Not worth it!"***

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Methods to Overcome the Challenges

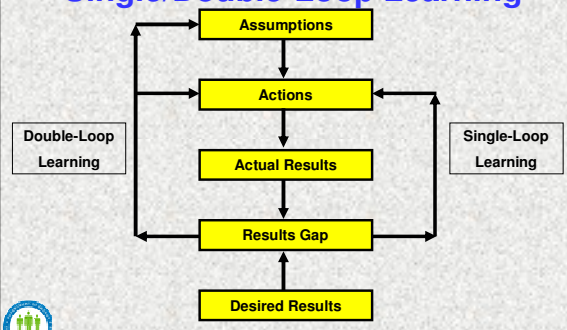
- De-identification
- Protection
- Separation of Functions
- Feedback
- Ease of Making the Report

The next step – Creating a Learning Culture!

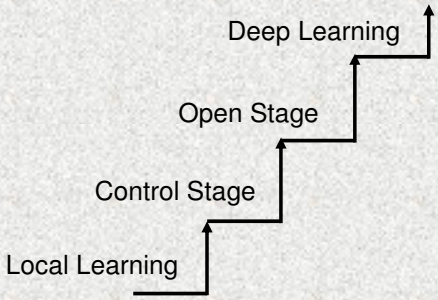
"Without a Reporting Culture, an organization will not possess the ability to collect, analyze, and disseminate the lessons to be learned."

- James Reason

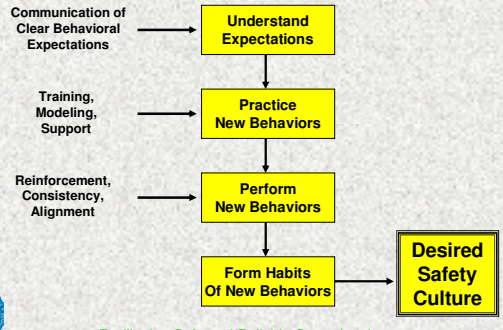
Learning Culture: Single/Double-Loop Learning



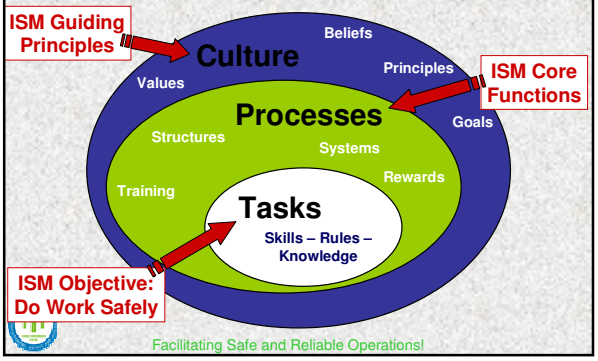
Learning Culture: Stages of Learning



Integrated Safety Mgmt: Changing the Culture



HPI deals with the System



Safety Culture:
The Good – Bad – Average

- **Pathological** –
  - *"Who cares as long as we don't get caught"*
- **Reactive** –
  - *"Safety is important; we do a lot every time we have an accident"*
- **Calculative** –
  - *"We have systems in place to manage all hazards"*
- **Proactive** –
  - *"We work hard on the problems we still find"*
- **Generative** –
  - *"We know that achieving safety is difficult; we keep brainstorming new ways in which the system can fail and have contingencies in place to deal with them"*

Topic 10

Making It Happen

The Management of Error Management

Error Management –
It's not just another program

- Some existing performance improvement programs w/i DOE:
  - Total Quality Management
  - Six Sigma Quality Programs
  - Voluntary Protection Program (VPP)
  - Behavior Based Safety (BBS)
  - Enhanced Work Planning (EWP)
  - Chemical Process Safety Management Systems
  - Conduct of Operations (COO)
  - ISO Standard 9001, Quality Management System
  - ISO Standard 14001, Environmental Management System

ISM Objective –
Do Work Safely!

"The Department and Contractors must systematically integrate safety into management and work practices at all levels so that missions are accomplished while protecting the public, the worker, and the environment. This is to be accomplished through effective integration of safety management into all facets of work planning and execution. In other words, the overall management of safety functions and activities becomes an integral part of mission accomplishment."

- DOE P 450.4 Safety Management System Policy

QA Objective –
Meet or exceed customer expectations

"To ensure that Department of Energy (DOE), including National Nuclear Security Administration (NNSA), products and services meet or exceed customers' expectations."

- DOE O 414.1c Quality Assurance

Common Features of
SMS and QMS

- Assets:
  - Neither safety nor quality can be achieved piecemeal; both need to be planned and managed.
  - Both rely heavily on measurement, monitoring, and documentation.
  - Both involve the whole organization: every function, process, and person.
  - Both strive for continuous improvement.
- Liabilities:
  - Can be paper-intensive systems
  - Form can overwhelm substance – documentation is not reality. Assessments can rely on checklists and miss the real issues.
  - Safety and Quality Systems normally focus on the technical and engineering issues and deal little or not at all with human and organizational problems. The latter issues causing more events than the former.

EM does not supplant quality or safety management, it gives them an important added dimension!

Characteristics of Error Management

- Appropriate mindset more than documentation
- Murphy's Law as a starting point
- Understanding of varieties of human error and conditions likely to promote them
- Needs an 'informed' culture, a 'just' culture, a 'reporting' culture, a 'learning' culture
- Must 'weed and feed' the EM system

Reliability is a "Dynamic Non-Event"

- Dynamic because processes remain under control due to continuous adjustments, adaptations, and compensations.
- Non-Event because 'normal' results receive little or no attention

Reliability = Cognitive Stability + Flexible Activity

Resilience = Resistance to Hazards

# of Events may be a Poor Measure

Organizational Resilience = C^3

Competence- Are your safety and error management tools understood, adequate for the purpose, and properly utilized?

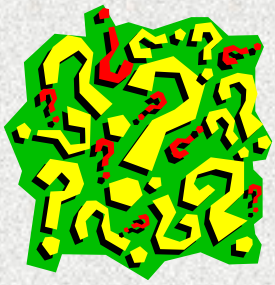
Cognizance- Do your managers understand the nature of the 'safety war' with regard to human and organizational factors?

Commitment- Faced with great pressures, does top management have the will to make error management and safety management work effectively?

- Charles Darwin's Notebook 1837

Summary – EM is evolution not revolution

Questions???



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Task Step Checklist

INSTRUCTIONS: Apply this checklist to all the task steps identified in a procedure or task analysis for tasks that contain omission -prone actions or items, particularly those in which omissions could seriously jeopardize safety. Sum t he scores for each task step and enter into the total column in the scoring grid.

Omission-Prone Feature	Score
1. Has this step ever been omitted in error in the past?	If yes, score 3
2. Does this step form part of an installation or reassembly sequence?	If yes, score 3
3. Does this step involve routine and highly practiced actions?	If yes, score 2
4. Does this step involve consulting written procedures that do not always correspond with local conditions?	If yes, score 2
5. Is this step functionally isolated from the rest of the sequence (i.e., not obviously cued by preceding actions, or stands apart)?	If yes, score 2
6. Does the performance of this step involve a recent change from previous practice in carrying out this task?	If yes, score 2
7. Does this step involve actions or items not required in other very similar tasks?	If yes, score 2
8. If this step were omitted in error, would its absence later be concealed from view?	If yes, score 2
9. Does this step involve the repetition of actions (i.e., recursions) that depend upon some local condition or requirement?	If yes, score 1
10. Does this step involve installing multiple items (bushings, washers, nuts)	If yes, score 1
11. Does this step require cues, or items that are not easily visible, detectable or readily at hand?	If yes, score 1
12. Does this step occur near to the end of the task?	If yes, score 1
13. Does this step occur after the achievement of the task's main goal but before its actual completion?	If yes, score 1
14. Is the performance of this step liable to interruptions or external distractions?	If yes, score 1
15. Is this step likely to be completed by someone who did NOT start the task?	If yes, score 1
16. Is the performance of this step conditional upon some earlier action, condition or state?	If yes, score 1
17. Does this step require remembering detailed instructions?	If yes, score 1
18. Does this step require the removal of tools or unwanted objects from the immediate location of the task?	If yes, score 1
19. Does this step involve the installation and adjustment of multiple fastenings?	If yes, score 1
20. Is this step sometimes not required during the execution of the present task?	If yes, score 1

Task Step Score Sheet for Omission Prone Tasks

Instructions: Place task steps in the numbered spaces provided below. From the ***Task Step Checklist,*** *Assign the appropriate score for each omission prone feature for each step listed on the page. Add up the scores and place totals in the "T" box. The h igher the score, the more omission prone the task step is. Prepare suitable reminders for those steps with the highest scores.*

Task steps /Omission Prone Feature #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1.																					
2.																					
3.																					
4.																					
5.																					
6.																					
7.																					
8.																					
9.																					
10.																					
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12.																					
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16.																					
17.																					

Additional Explanatory Notes

Explanatory Notes for each of the 20 omission-provoking features listed on the *Task Step Checklist*. Each note is related to the same numbered item in the checklist.

1. Previous omissions of this step may or may not have been recorded as quality lapses. It is important to find out from those who regularly perform this task whether there have been unrecorded (or later detected or recovered) instances of this step being omitted.
2. The important distinction here is between disassembly and reassembly. Putting things back is many times more prone to error than taking them apart.
3. Absent-minded omissions are only likely to occur in tasks or sub-tasks that can be run on 'automatic pilot'.
4. Procedures, manuals or work cards in which the test or the diagrams do not match up to the reality as seen by the person doing the job are frequently implicated in erroneous omissions.
5. This is a feature that requires a certain degree of judgment on the part of the analyst. A step is functionally isolated if it stands apart in some way from the rest of the task sequence, and/or if it is not obviously cued by preceding actions.
6. This feature applies when there has been a recent change in carrying out the task. It may have been decided, for example, that an extra inspection or check is now required at a particular stage in the task sequence. Or that some other additional actions are now required. These 'add-ons' are easily forgotten
7. This feature involves negative transfer, or the case where a person moves from one comparable task to another in which there are many similarities but also some important differences.
8. Many omissions, like missing washers, spacers, caps, fasteners and so on, are often concealed from view by subsequent reassembly or installation activity. This makes an omission much harder to detect and recover.
9. Steps involving recursions or the repetition of previous actions in order to satisfy some local condition are especially prone to omission.
10. It is often the case that a step involves the installation of more than one component (for example, three washers, 10 nuts and so on). Some of these items are liable to be left out.
11. A step or an item that is not conspicuous, or readily at hand, is subject to the 'out-of-sight-out-of-mind' principle and liable to be omitted.
12. Steps occurring near to the completion of the task are subject to premature exits in which an individual moves on to the next job without completing the first.
13. Sometimes the main goal of the task is achieved before all the necessary task steps are completed. Later steps in the procedure are vulnerable to omission in conditions of time pressure and high workload.
14. All steps are, in principle, liable to distractions or interruptions, but some are more vulnerable than others. Deciding whether or not this is the case for this step is a matter of judgment and local knowledge.
15. In many maintenance activities, those who begin a job do not always finish it. Where this applies, there is a greater risk of omission.
16. Sometimes the performance of a particular step depends upon some state or condition encountered earlier in the task. These conditional steps are readily forgotten

17. Many steps in maintenance require keeping a large amount of information in memory or having procedures close at hand. Since people rarely 'read and do' at the same time, there is always a strong chance that some of the information required to perform the step correctly will be forgotten and hence omitted.
18. Evidence from quality lapse and error data shows very clearly that the need to remove tools and foreign objects from the job area is frequently forgotten and hence omitted. Again this suffers from occurring late on in the task sequence, but it is still a special and distinct case.l
19. Fasteners, particularly multiple fasteners, are especially prone to omission. Again, they are subject to premature exits.
20. Steps that are required on some occasions but not others are liable to omission, particularly if the need to perform such steps occurs relatively infrequently.

Ten criteria for a good reminder

In order to work effectively, reminders (memory aids to pr event the omission of necessary task steps) should satisfy all of the five conditions described below.

CONSPICUOUS	A good reminder must be able to grab the maintainer's *attention* at the critical time.
CLOSE	A good reminder should be positioned *as closely as possible* in both time and distance to the location of the necessary task step.
CONTEXT	A good reminder should provide sufficient information about *when* and *where* the to-be-remembered task step must be executed.
CONTENT	A good reminder should provide sufficient information to tell the maintainer *what* has to be done.
COUNT	A good reminder should allow the maintainer to *count off* the number of discrete actions or items that need to be included in the correct performance of the task step.
COMPREHENSIVE	A good reminder should work effectively for a *wide range* of to-be-remembered steps.
COMPEL	A good reminder should (when warranted or possible) compe l the technician to carry out a necessary step by *blocking* further progress until it has been completed.
CONFIRM	A good reminder should help the technician to *check* that the necessary steps have been carried out as planned. In other words, it must continue to exist and be visible after the time for the step execution has passed.
CONVENIENT	A good reminder should not cause unwanted or additional *problems*, particularly if these turn out to be worse than the possible omission
CONCLUDE	A good reminder should be *readily removable* once the time for the action and its checking has passed .

NOTE: Reminders have a diminishing impact. The longer the same reminder is left in place, the more likely it is to become just another part of the background scenery. To remain effective, reminders have to be renewed and revitalized

For use with the Task Step Checklist

To identify omission prone steps

Task: Change the oil and replace the oil filter on a Ford F-150 pickup

Conditions: Vehicle stands high enough off the ground that the oil pan drain plug can be accessed without having to raise up the truck. Changing the oil filter, accessed from the engine compartment and located on the driver's side of the engine, requires the use of a step or two to gain closer access and to have the strength to break the filter loose and to securely remove it.

Other Circumstances: Transport of the used oil requires that it be stored in a sealed container

With vehicle in the designated location with the brake on

Task Steps:

1. Assemble oil, filter, rags, filter wrench, 5/8' box end wrench (or crescent wrench or other equivalent) and oil catch container.
2. Unscrew oil pan drain plug and allow oil to flow into catch container
3. When all the oil has drained out, clean around the plug, check the gasket for wear and cracks and replace if necessary.
4. Replace the oil drain plug, start threading with your hand
5. Open the hood and place protective cover over the fender
6. Unscrew, remove and set aside the oil filter
7. Clean surface from which the filter was removed with a soft rag
8. Apply a coating of engine oil over surface of the filter gasket
9. Position the filter to the engine filter bolt and tighten the filter to initial contact with the engine base, then turn filter another 2/3 of a turn (tighten the filter with your hands only)
10. Wipe the filter clean
11. Remove engine oil cap and pour oil into the engine (six quarts)
12. Wipe the oil cap clean and replace it
13. Remove all empty oil containers from the engine compartment and Remove the protective cover from the fender
14. Verify truck is out of gear, brake is on, start engine and let run for 1-2 minutes
15. Inspect the filter and the drain plug to verify there are no oil leaks
16. Check the oil dip stick to verify oil level is correct, add oil if needed.
17. Turn off the engine and close the hood
18. Replace tools, discard rag(s) and dispose of used filter, oil and packaging

For use with the Task Step Checklist

To identify omission prone steps

Task:	Replace an electrical circuit breaker
Conditions:	The panel box located in the garage has a main on/off switch
Other Circumstances:	The existing circuit breaker keeps tripping and a bad breaker is suspected Given a new circuit breaker of the same amperage as the existing breaker
Task Steps:	1. Turn off the main power 2. Take the panel cover off the panel box by unscrewing the face plate. 3. Locate the tripped breaker. Notice the two wires feeding into the side of the breaker. Remember which one is in which position. 4. Loosen the screw holding the white wire first just enough to get the wire out 5. Put a wire nut on the end of the white wire and bend it out of the way 6. Loosen the other screw and do the same thing with the colored wire. 7. Pull the old circuit breaker out and snap a new one into place 8. Replace the wires in the same positions as they were on the old breaker (colored one first, while one second) 9. Tighten the screws holding the wires 10. Replace the face plate 11. Turn the power to the panel on 12. Turn the breaker on

Human Performance Awareness Checklist

The Human Performance Awareness Checklist is designed to elicit views from members of an organization regarding how sensitive their system is to the origins of human performance problems and the methods that are appropriate for dealing with them. The statements provide an idea of the extent of an organization's preparedness for human performance problems and whether or not suitable counter-measures have been put in place.

Respondents are asked to express their beliefs about the extent to which each of the 30 statements on the checklist holds true for their organization. To avoid response bias, approximately half the items are phrased in a positive direction (where agreement is consistent with a resilient organization) and half in a negative direction (where disagreement is consistent with resilience). The scoring direction is shown by a sign (+ or -) in parentheses behind each statement on the master scoring copy. Statements where responses are consistent with organizational resilience score one, a 'don't know' scores zero.

NOTE: resilience refers to those properties of an organization that make it more resistant to its operational hazards. Scores of less than 15 indicate that the organization is vulnerable to losses and disruption due to errors. The maximum organizational resilience score is 30. The checklist and explanation of its use is from James Reason and Alan Hobbs, Managing Maintenance Error: A Practical Guide (pp.166-70).

Human Perfomance Awareness Checklist

Scoring sheet

	YES	Don't Know	NO
Commitment			
1. If something goes wrong, management looks for someone to blame. (-)			
2. Human performance issues are high on management's agenda. (+)			
3. Management is only interest ed in the bottom line. (-)			
4. When there are human performance problems, managers do their best to fix the conditions that promoted them. (+)			
5. Managers believe that the procedures are always correct and applicable. (-)			
6. Managers are genuinely interested in matters relating to human performance. (+)			
7. Managers fail to recognize unsuitable working conditions that produce recurrent human performance problems. (-)			
8. Managers often discuss working conditions and human performanc e problems with people working on the front-line. (+)			
9. Management believes that the threat of disciplinary action is the best way to minimize errors. (-)			
10. Management is willing to act upon good suggestions for improving safety and reliabili ty, even when they come from junior employees. (+)			
Cognizance			
11. Our human performance personnel are well trained and keep up with developments in the human performance community. (+)			
12. Managers believe that only front-line operators, maintenance personnel, and technicians make dangerous errors. (-)			
13. Managers are more interested in quick fixes than system reforms. (-)			
14. Our first-line supervisors are trained to a very high level of competence. (+)			
15. We expect errors to occur and train staff to detect and recover them. (+)			
16. Managers believe that it is cheaper and easier to change people's behavior than the working conditions. (-)			
17. Management does not appreciate that defenses and controls can create problems as well as provide protections (-)			
18. Our managers and supervisors have a good understanding of the workplace factors that are likely to promote errors and violations (+)			
19. Each event in which unsafe acts are implicated is carefully reviewed and the people involved are treated justly. (+)			
20. Management does not appreciate that our existing procedures cannot cover all eventualities. (-)			

	YES	Don't Know	NO
Competence			
21. If we come up with a safer and/or more reliable way of working, we are given credit for it and the information is widely disseminated. (+)			
22. We rarely discuss human performance issues before we start a new job or change working conditions. (-)			
23. We frequently see managers in our work areas. (+)			
24. All personnel receive some basic training in human performance issues. (+)			
25. Employees are reluctant to report errors and near misses because they fear they could be punished. (-)			
26. When someone is uncertain about how to do a job, there is always someone willing and able to advise them. (+)			
27. Employees are actively discouraged from raising issues related to human performance. (-)			
28. When a serious event occurs, management is more interested in discovering how and why the defenses failed than in finding someone to blame. (+)			
29. We do not have an effective incident and error-reporting program. (-)			
30. The same kinds of events keep happening over and over again. (-)			

Checklist for Assessing Institutional Resilience

The Checklist for Assessing Institutional Resilience (CAIR) assesses how safety and error management tools are applied in an organization. The checklist is built on the assumption that organizational resilience is a product of three C's: commitment, competence and cognizance.

- *Commitment.* In the face of ever-increasing budgetary pressures, does top management have the will to make error management and safety management work effectively?

- *Cognizance.* Do your managers understand the nature of the 'safety war'—particularly with regard to human and organizational factors?

- *Competence.* Are your safety and error management tools understood, adequate for the purpose and properly utilized?

CAIR assesses the extent to which attitudes and practices of an organization match up to a 'wish list' of features characterizing a resilient system. It was conceived by asking how the three C's – commitment, cognizance and competence – might be manifested at each of four levels of managerial application: philosophy, policies, procedures and practices.

The question for the respondent is 'Does your organization have the following properties?' Each item is scored one, a half or zero (see top of the form). A score of 16-20 is likely too good to be true. Scores between 8 and 15 indicate a moderate to good level of intrinsic resistance to human and organizational hazards. Any score less than five suggests an unacceptably high degree of vulnerability.

Health Warning: Good scores on CAIR provide no guarantee of immunity from mistakes. Even the 'healthiest' organizations can still have bad events. High reliability requires intelligent wariness and a continuing respect for the many ways in which things can go wrong. Complacency is the worst enemy. Human fallibility and latent system weaknesses will not go away, so there will be no final victories, but error and its consequences can be managed.

CAIR and the explanation of its use is described in Managing Maintenance Error: A Practical Guide by James Reason and Allan Hobbs, 2003.

Checklist for Assessing Institutional Resilience (CAIR)

Complete the checklist as follows:
Yes = this is definitely the case in my organization (score 1)
? = don't know, maybe or it could be partially true (score 0.5)
NO = this is definitely not the case in my organization (score zero)

	Yes	?	No
1. Managers are ever mindful of the human and organizational factors that can endanger their operations.			
2. Managers accept occasional setbacks and nasty surprises as inevitable. They anticipate that staff will make errors and train staff to detect and recover them.			
3. Top managers are genuinely committed to the furtherance of system safety and provide adequate resources to serve this end.			
4. Safety-related issues and human performance problems are considered at high-level meetings on a regular basis, not just after some bad event.			
5. Past events are thoroughly reviewed at top-level meetings and the lessons learned are implemented as global reforms rather than local repairs.			
6. After some bad event, the primary aim of top management is to identify the failed system defenses and improve them, rather than seeking to divert responsibility to particular indi viduals.			
7. Top management adopts a proactive stance towards safety. That is, it does some or all of the following: takes steps to identify recurrent error traps and remove them, strives to eliminate the workplace and organizational factors likely to promote errors, 'brainstorms' new scenarios of failure, and conducts regular 'health checks' on the organizational processes known to contribute to accidents.			
8. Top management recognizes that error-provoking system factors (e.g. under-manning, in adequate equipment, inexperience, patchy training, bad human-machine interfaces and the like) are easier to manage and correct than fleeting psychological states such as distraction, inattention and forgetfulness			
9. It is understood that the effective management of safety, just like any other management process, depends critically on the collection, analysis and dissemination of relevant information			

	Yes	?	No
10. Management recognizes the necessity of combining reactive outcome data (i.e., the near miss and incident reporting system) with proactive process information. The latter entails far more than occasional audits. It involves the regular sampling of a variety of institutional parameters (e.g., scheduling, budgeting, procedures, defenses, training and the like), identifying which of these 'vital signs' is most in need of attention, and then carrying out remedial actions.			
11. Representatives from a wide variety of departments and levels attend safety-related meetings.			
12. Assignment to a safety-related or human performance function is seen as a fast-track appointment, not a dead end. Such functions are accorded appropriate status and salary.			
13. Policies related to near miss and incident reporting systems make clear the organization's stance regarding qualified indemnity against sanctions, confidentiality and the organizational separation of the data-collecting department from those involved in disciplinary proceedings.			
14. Disciplinary policies are predicted on an agr eed (i.e., negotiated) distinction between acceptable and unacceptable behaviour. It is recognized by all staff that a small proportion of unsafe acts are indeed reckless and warrant sanctions, but that the large majority of such acts should not attract punishment.			
15. Line management encourage their staff to acquire the mental as well as the technical skills necessary to achieve safe and effective performance. Mental skills include anticipating possible errors and rehearsing the appropriate recoveries.			
16. The organization has in place rapid, useful and intelligible feedback channels to communicate the lessons learned from both the reactive and the proactive safety information systems. Throughout, the emphasis is upon generalizing these lessons to the system at large rather than merely localizing failures and weaknesses.			
17. The organization has the will and the resources to acknowledge its errors, to apologize for them and to reassure the victims (or their relatives) that the lessons learne d from such accidents will help to prevent their recurrence.			
18. It is appreciated that commercial goals and safety issues can come into conflict and measures are in place to recognize and resolve such conflicts in an effective and transparent manner.			
19. Policies are in place to encourage everyone to raise safety-related issues.			
20. The organization recognizes the critical dependence of effective safety management on the trust of the workforce—particularly in regard to error and incident reporting programs.			

Case Study: Bhopal India Fatal Gas Release Accident

A subsidiary of Union Carbide Corporation built a pesticide and fertilizer production facility near Bhopal in central India in the early 1970s. In 1981 the pesticide production process was improved by adding a plant for the manufacture and storage of a new compound, methyisocyanate (MIC). MIC is used to produce the pesticide Sevin. It is unstable and highly reactive. It reacts violently to water, acids, chlorides and other impurities. The boiling poi nt for MIC is a mere 102 degrees F. MIC was kept at or below 41 degrees with the use of a chiller and a heat exchanger adjacent to the MIC storage tanks. A high temperature alarm would sound if the substance heated above 52 degrees. MIC was stored in 1 of 3 underground 15,000 gallon storage tanks below a 6 inch concrete cap. No more than 9,000 gallons of MIC was ever to be stored in any one tank (60% of tank capacity). Further, one of the three storage tanks was always to be kept empty to allow the transfer of compound to the empty tank in case of an emergency.

The routine transfer of MIC within the piping system caused compound salts to build up in the pipe that could obstruct the transfer of materials. The piping inner walls, therefore, were frequently flushed using fire main water. Since MIC reacts violently with water, before the water flushes, operators initiated exclusionary valve line -ups and installed blank flanges to prevent water contamination in the tanks.

Pressure relief valves on each of the 3 MIC tanks were set at 40 psig. Pressure relief and normal process venting (off gassing from the tanks) was routed through a caustic scrubber to strip toxic components from the vapors. The remaining gaseous byproducts were routed to a ventilation stack, which emptied to the atmosphere 120 ft. above ground. Fire main spray nozzles were located around the plant to raise a water curtain around the facility to help combat and contain a gaseous release in the event of a serious leak.

The MIC facility was supervised and operated by a highly skilled, well -educated staff of East Indians. All the operators were required to have university science degrees. They all were fluent in English. The plant procedures were written in English. Supervisors and operators underwent a thorough training process. When product sales declined, funding became limited; the original staff left the MIC facility for other jobs. By 1984, only a high school degree was required for employment. Training began to deteriorate . Standards waned; operators received only minimal levels of training in their own areas of expertise. Many did not speak English and the procedures remained in English.

With the economic downturn at the plant, production stalled, and corrective and preventative maintenance declined. Many plant components fell into a state if disrepair. Operators lost confidence in the reliability of the instrumentation. To cut costs, refrigerant used to keep the MIC temperature cool was drained from the storage tank chiller to be used at another facility. Temperature in the MIC storage tanks often ranged higher than 77 degrees in hot weather (highest reading on the temperature instrument). The temperature alarm had been either reset or disabled.

On the night of the accident the vent gas scrubber, designed to detoxify leaking gas, was not functioning. The flare tower, designed to burn off gas, was also out of service because of a missing four-foot pipe section. In the weeks prior to December 2, 1984, one of the three MIC storage tanks was allowed to fill to 87% of capacity or 13,000 gallon. (The standard allowable fill was 9,000 gallon or 60% of capacity). An unidentified leak in the nitrogen system was preventing a sufficient pressure buildup to transfer MIC out of the storage tank. Both of the other MIC tanks also contained MIC.

On Sunday evening December 2, at 9:30 p.m. the second shift supervisor directed an operator to begin a routine flush of one section of the transfer piping. Normally, the maintenance supervisor oversaw the piping flushes, but he was not available that night. The operator completed the valve lineup for the flush under the oversight of the shift supervisor, but no slip blinds (blank flanges) were inserted in the piping to ensure total isolation of water from the MIC tanks. There was a shift change an hour later at 10:30 p.m. and the piping flush continued to run. The tank pressure was normal at 2 psig. At 11:00 p.m. the third shift senior control room operator noticed the tank pressure at 10 psig—5 times the normal reading. There was no column on the data record sheets to record tank temperatures. Because of past erratic instrument indications, the shift supervisor believed the reading to be within the range of normalcy.

At 11:30 p.m. operators began to sense the smell and irritation caused by leaking MIC. Upon investigation, a small liquid and gas leak was noted in a pipe run 50 feet up in the superstructure. An operator reported the leak to the MIC shift supervisor at 11:45 p.m. but no investigation was initiated. The shift supervisor later testified that he thought the operator was referring to a water leak. The investigation of the reported leak started at 12:40, nearly an hour later, and after the tea break. Five minutes later the senior control room operator noted tank pressure near the 40 psig relief set-point. He went to the storage tank to investigate. Within seconds the 6-inch concrete cap on tank E-610 began to crack upward as the tank swelled. A gaseous white cloud burst from the 120 foot ventilation stack in a ten foot high plume. In the control room, the pressure gauge was off scale at 55 psig and the tank temperature reading was also exceeding scale.

MIC could not be transferred to the dump tank since it was partially filled and the nitrogen pressurization system for material transfers had not been repaired for the tank—precluding a transfer of material. The Chiller was out of service. Cooling the tank was impossible. The caustic scrubber was not in its prop er configuration after maintenance. And, the flare tower remained out of service and could not be used. The operators stopped the water flushing procedure. Water curtain sprays were initiated to combat the escaping cloud, but the curtain reached a heigh t of only 110 feet. The gas cloud continued to jet out of the ventilation stack to a height of 130 feet or more and slowly drifted in the direction of the community outside the plant.

The plant staff began a disorderly evacuation at about 1:00 a.m. Most workers panicked as the gas escaped, running away to save their own lives and ignored the buses that sat idle on the plant grounds ready to evacuate nearby residents. A large ghetto had been allowed to concentrate outside the fence line of the installat ion. The staff activated a

warning siren to alert the ghetto and the city of 500,000 people of the accident but the siren was the same one frequently used for other communications. After 15 minutes the alarm was turned off in order that it not panic the community. The gas plume spread slowly into the city on a mild breeze coming from the northeast —conditions allowing the cloud to remain concentrated. With the wind direction nearly indistinguishable, many people who had awakened and were fleeing their homes ran downwind into the cloud. Others died in their sleep. Soon hospitals and clinics filled with patients suffering severe skin and eye irritation, respiratory difficulties and severe swelling of the lungs. Thousands of people died. Some independent studies estimated the death toll as high as 10,000 –15,000. Tens of thousands remain permanently injured —mostly lung and eye damage. Since 1984, thousands more have died of cancer and other maladies associated with the Bhopal accident. It has been called the largest industrial accident in history

Rahman Khan, the operator who washed the improperly sealed pipe a few hours before the accident said, "I was trained for a particular job, I don't know about other jobs, During training they just said, 'These are the valves you are supposed to turn, this is the system in which you work, here are the instruments and what they indicate. That's it'".

Another operator said he noticed that the closed valve had not been sealed with a slip blind, a metal disc that is inserted into pipes to make sure that water does not leak through the valve, but he said, "It was not my job to do anything about it".

Primary source: Hop Howlett. The Industrial Operator's Handbook, 1995;

Case Study: Bhopal India Fatal Gas Release Accident

Active Error: Failure to install blank flanges to isolate water from entering the MIC tanks

Latent Errors:

- Failure of supervision to inspect the critical task (an inspection or an independent review would have discovered that flanges were not installed to isolate water from the MIC tanks)
- Failure to maintain adequate surveillance of the flushing process
- Operator who recognized flange was not installed failed to report condition
-Failure to respond to tank pressure reading 5 times greater than normal
- Operator that discovered the leaking MIC failed to effectively communicate the leak to supervision

Local error provoking conditions
Unsafe attitudes
Complacency
Imprecise communications
Lack of knowledge
Unexpected equipment conditions
Confusing displays or controls
Faulty instrumentation
Underutilized procedures in unfamiliar language

Flawed Defenses

Chiller not working, refrigerant used to cool MIC was removed from the system
Alarms unhooked or reset above safe parameters
Nitrogen pressurization system was broken- operators could not transfer material from tanks (some reports said the required empty MIC tank had been filled previously)
Caustic scrubber could not be used
The water curtain was too short at 110 feet; plume escaping at 130 feet
Inadequate warning system to alert the public
Lack of emergency response training and education for the public

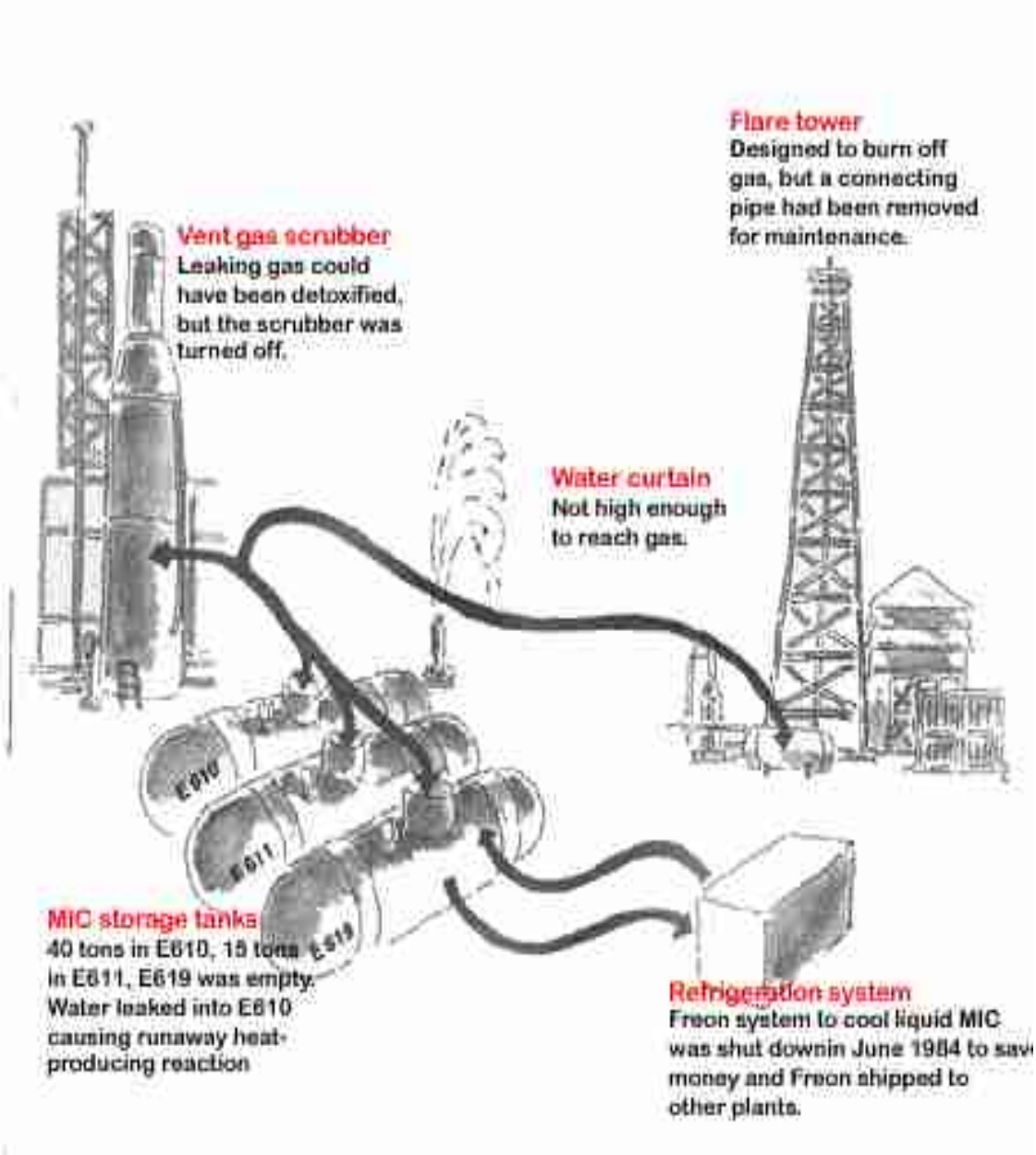
Organizational Weaknesses

-Numerous preventive and regular maintenance irregularities (instrumentation bad, safety systems inoperable or ineffective)
-Poor safety culture-belief that plant was safe because they were not producing product
-Procedures only in English -Indian operators with just a high school education

-Preventative maintenance was allowed to degrade over a long period – instrumentation faulty
-Plant components allowed to lapse into a state of disrepair – defense systems inoperable
-Inadequate training – operators did not understand the system and related safety hazards
-Lack of adequate supervisory staff – Shift supervisor acting for maintenance supervisor
-Poor communication within the organization
-Violated safety parameters

- Failure to operate within safety parameters relative to heat, pressure, amount of MIC in tanks and isolation of one empty tank
  - allowed empty MIC tank to fill so they could not transfer product in an emergency situation
  - Allowed MIC to remain at temperatures beyond the normal parameters.

Bhopal, India Fatal Gas Release Accident: December 2, 1984



Maintenance Climate Assessment Survey

The Maintenance Climate Assessment Survey (MCAS) assesses a maintenance organization's practices from a safety perspective. MCAS is designed to provide managers a means to survey their employees with regard to safety issues and receive feedback on their attitudes and perceptions and issues regarding organizational climate, safety culture, resources availability, workload, and other factors related to safely managing facility maintenance activities. The primary goal o f this survey is to identify and correct latent organizational conditions that may lead to increased operational mishap potential originating from maintenance activities. With the results of the survey, and other indicators, managers are in position to develop and implement strategies to better their organization's performance.

The survey questions have been adopted from the Navy's Maintenance Climate Assessment Survey (MCAS) designed by the Naval Postgraduate School to provide squadron-level commanding officers with a means to survey their maintenance personnel on safety matters. The MCAS process helps squadron commanding officers identify safety concerns (hazards) and highlight areas where they might best focus their efforts (hazard assessment).

1. The organization adequately reviews and updates safety procedures. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
2. The organization monitors maintainer qu alifications and has a program that targets training. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
3. The organization uses safety and medical staff to identify/manage personnel at r isk. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
4. Quality assurance/control inspectors and safety inspectors routinely monitor maintenance evolutions. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
5. Tool control and support equipment licensing are closely monitored. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
6. Signing off personnel qualifications is taken seriously. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
7. Our organizational climate promotes safe maintenan ce. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
8. Supervisors discourage procedure violations and encourage reporting safety concerns. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
9. Peer influence discourages violation of procedures and maintenance standards and individuals feel free to report them. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
10. Violations of procedures are not common in this organization. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know

11. The organization recognizes individual safety achievement through rewards and incentives. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
12. Personnel are comfortable approaching supervisors about personal problems and illnesses. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
13. Safety officer and quality assurance inspector positions are sought after in this organization. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
14. Unprofessional behavior is not tolerated in the organization. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
15. This organization has a reputation for quality maintenance and sets standards to maintain quality control. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
16. QA and Safety are well respected and are seen as essential to mission accomplishment. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
17. QA inspectors sign-off after required actions are complete and are not pressured by supervisors to sign off. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
18. Required publications, tools and equipment are available, current and serviceable, and are used. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
19. QA inspectors are helpful and QA is not 'feared' in my organization. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know

20. Multiple job assignments and collateral duties adversely affect maintenance. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
21. Supervisors recognize unsafe conditions and manage hazards associated with maintenance. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
22. Safety is part of maintenance planning, and additional training and support is provided as needed. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
23. I am provided adequate resources, time, and personnel to accomplish my job. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
24. Personnel turnover does not currently impact the organization's ability to operate safety. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
25. Supervisors are more concerned with safe maintenance than the work schedule, and do not permit cutting corners. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
26. Staffing is sufficient on each shift. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
27. Supervisors shield personnel from outside pressures and are aware of individual workload. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
28. Based on my organization's current assets, manning is not over-committed Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
29. My organization temporarily restricts maintainers who are having problems. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know

30. Safety decisions are made at the proper levels within my organization. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
31. Supervisors communicate the organization's safety goals and are actively engaged in the safety program. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
32. Supervisors set the example for following maintenance standards and ensure compliance. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
33. In my organization, safety is a key part of all maintenance operations and all employees are responsible and accountable for safety. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
34. Safety education and training are comprehensive and effective. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
34. All maintenance evolutions are properly br iefed, supervised and staffed by qualified personnel. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
35. All maintenance activities are properly controlled at appropriate organization al levels. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
36. Effective communication exists up and down the organization. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
37. I get all the information I need to do my job safely. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
38. My organization has effective turnovers between shifts. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know

39. Maintainers are briefed on potential hazards associated with maintenance activities. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
40. Managers resolve conflicts between individuals or among work groups Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
41. The next quality defect will be caused by . . . No comment My response is:	
42. The next quality defect can be prevented by . . . No comment My responseis:	

Organizational Safety Climate Assessment Survey

The Organizational Safety Climate Assessment Survey (OSCAS) assesses an organization's operational practices from a safety perspective. OSCAS is designed to provide managers a means to survey their employees with regard to safety issues and receive feedback on their attitudes and perceptions. Following administration of the survey, managers can receive feedback concerning key issues regarding organizational climate, safety culture, resources availability, workload, and other factors relating to safely managing facility operations. The primary goal of this survey is to identify and correct latent organizational conditions that may lead to increased operational mishap potential. With the results of the survey, and other indicators, managers are in position to develop and implement strategies to better their organization's performance.

The survey questions have been adopted from the Command Safety Climate Assessment Survey (CSCAS) designed by the Naval Postgraduate School to provide squadron-level commanding officers with a means to survey their aircrew and maintenance personnel on safety matters. The CSCAS process helps squadron commanding officers identify safety concerns (hazards) and highlight areas where they might best focus their efforts (hazard assessment). More than 70,000 sailors have participated in the survey.

Organizational Safety Climate Assessment Survey

1. My organization conducts adequate reviews and updates of safety standards and operating procedures Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
2. My organization uses an internal audit and hazard reporting system to catch any problems that may lead to a mishap Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
3. My organization has a defined process to set training goals and to review performance Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
4. My organization closely monitors proficiency and currency standards to ensure workers are qualified Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
5. The leadership in my organization is actively involved in the safety program and management of safety matters Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
6. My organization has a defined process to effectively manage the high -risk operator, maintainer, technician etc. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
7. Management has been successful in identifying individuals who pose a risk to safety Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
8. Individuals in my organization effectively manage human errors and report flaws in defenses Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
9. Managers in my organization work to eliminate latent organization weaknesses that affect human error Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know

10. The leadership in my organization e ncourages reporting safety discrepancies without the fear of negative repercussions. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
11. Individuals in my organization are willing to report safety violations, unsafe behavior hazardous conditions. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
12. In my organization, peer influence is effective in discour aging violations of standard operating procedures. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
13. In my organization, we believe safety is an integral part of all our work. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
14. In my organization, anyone who intentionally violates standards, safety -related procedures, or safety rules, is swiftly corrected. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
15. In my organization, violations of operating procedures and regulations, or general operational standards are rare. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
16. Leaders in my organization encourage every one to be safety conscious and to follow the rules. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
17. In this organization an individual who persistently violates operational standards and rules will seriously jeopardize his/her standing in the organization. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
18. I am not comfortable reporting a safety violation, because people in my organization would react negatively toward me. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
19. My organization has a reputation for high-quality performance. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know

20. My organization sets high quality standards and strives to maintain quality control. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
21. My organization closely monitors quality and corrects any deviations from established quality standards. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
22. Quality standards in my organization are clearly stated in formal publications and procedural guides. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
23. Leaders in my organization permit cutting corners to get a job done. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
24. Lack of experienced personnel has adversely affected my organization's ability to operate safety. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
25. Safety decisions are made at the proper levels by the most qualified people in the organization. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
26. Leaders in my organization consider safety issues during the formation and execution of operational plans. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
27. Leadership in my organization has a clear picture of the risks associated with its operations. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
28. My organization takes the time to identify and assess risks associated with its operations. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know

29. My organization does a good job managing risks associated with its operations. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
30. My organization has increased the chances of a mishap due to inadequate or incorrect risk assessment. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
31. I am provided adequate resources (time, staffing, budget, and equipment) to accomplish my job. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
32. Overtime work is sufficiently controlled to preclude fatigue that could affect safety. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
33. In my organization, pre-job briefings are conducted to review complex or safety-related tasks. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
34. Based on the organization's personnel and other assets, the organization is over committed. StronglyDisagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
35. My organization has incorporated operational risk management processes in decision making at all levels. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
36. My supervisor can be relied on to keep his/her word. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
37. Our leaders and supervisors can be trusted. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
38. My organization's Safety Officer is highly regarded. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know

39. Our Safety Officer is influential in promoting safety. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
40. My organization is genuinely concerned about safety. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
41. Leadership in my organization is successful in communicating its safety goals to unit personnel. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
42. My organization provides a positive climate that promotes safe operations. Strongly Disagree Disagree Neutral Agree Strongly Agree	N/A Don't Know
43. Leadership in my organization is actively involved in the safety program and management safety matters.	N/A Don't Know
44. Leadership sets the example for compliance with facility operating standards.	N/A Don't Know
45. My organization ensures that all unit members are responsible and accountable for safe operations	N/A Don't Know
46. Leadership in my organization willingly assists in providing advice concerning safety matters.	N/A Don't Know
47. Leadership in my organization reacts well to unexpected changes to its plans.	N/A Don't Know
48. My organization does not hesitate to temporarily restrict individuals who are under high personal stress from performing safety-sensitive activities.	N/A Don't Know

49. I am adequately trained to safely conduct the work I do.	N/A Don't Know
50. Morale and motivation are high in my organization.	N/A Don't Know
51. My organization ensures the uniform enforcement of all operating standards among its members	N/A Don't Know
52. My organization provides adequate safety backups to catch possible human errors during high-risk operations.	N/A Don't Know
53. Good communications flow exists both up and down the organization	N/A Don't Know
54. My organization has good two-way communication with other organizations.	N/A Don't Know
55. Safety education and training are adequate in my organization.	N/A Don't Know
56. The Safety Department is a well-respected element of my organization	N/A Don't Know
57. The Safety Officer position is sought after in my organization.	N/A Don't Know
58. My organization's Safety Department keeps me well informed regarding important safety information	N/A Don't Know

59. The most hazardous activity I perform is:	
60. The most significant actions my unit can take to improve safety is/are:	