BDB received 11/12/04

From: <David_M_Collins@dom.com>
To: <nrcrep@nrc.gov>
Date: Fri, Nov 12, 2004 11:39 AM
Subject: Public Comments - RIS on SCWE

10/14/04
69FR61049

(1)

Mr. Lesar

Attached find comments on:

Draft Regulatory Issue Summary 2004-xx Establishing and Maintaining a SCWE

(See attached file: Comment on NRC SCWE RIS Nov 04.doc)(See attached file: Sen Voinovich Scolds NRC.doc)(See attached file: Davis-Besse workers' repair job hardest yet .doc)

(See attached file: Ensuring Safe Cultures Draft 11-11-2004.ppt)

David M. Collins
Engineering Analyst
Millstone Power Station
Dominion Nuclear Connecticut
Phone 1-800-269-9994 x3710
Fax 860-437-5916

CC: <LLJ@nrc.gov>, <William_J_Hayes@dom.com>

E-RIDS=ADM-03
Add = A. Markley (ANM)
L. Jarriel (LLJ)

Template=ADM-013

Mail Envelope Properties (4194E732.CA2 : 5 : 31906)

Subject:	Public Comments - RIS on SCWE
Creation Date:	Fri, Nov 12, 2004 11:36 AM
From:	<David_M_Collins@dom.com>
Created By:	David_M_Collins@dom.com

Recipients
nrc.gov
twf2_po.TWFN_DO
NRCREP

nrc.gov
owf4_po.OWFN_DO
LLJ CC (Lisamarie Jarriel)

dom.com
William_J_Hayes CC

Post Office	Route
twf2_po.TWFN_DO	nrc.gov
owf4_po.OWFN_DO	nrc.gov
	dom.com

Files	Size	Date & Time
MESSAGE	490	Friday, November 12, 2004 11:36 AM
Comment on NRC SCWE RIS Nov 04.doc		39936
Sen Voinovich Scolds NRC.doc		27136
Davis-Besse workers' repair job hardest yet .doc		26112
Ensuring Safe Cultures Draft 11-11-2004.ppt		714240
Mime.822	1107712	

Options

Expiration Date:	None
Priority:	Standard
Reply Requested:	No
Return Notification:	None
Concealed Subject:	No
Security:	Standard

David M. Collins
6 Katherine Rd,
Old Lyme, CT 06371

November 11, 2004

Michael T. Lesar,
Chief, Rules and Directives Branch,
Office of Administration,
NRC

Public Comments:

Proposed Generic Communication (RIS) Establishing and Maintaining a Safety Conscious Work Environment

Dear Mr. Lesar,

Congratulations on your hard work, I think this new guidance is a great improvement and will be very helpful. I do have some suggestions.

The RIS summary says:

> *In March 2003 the Commission directed the staff to develop further guidance that identified best practices to encourage a SCWE. The guidance is based on the existing guidance provided in a 1996 policy statement.*

I make my comments based on an assumption that the new guidance is being proposed to replace the 1996 guidance, as the 1996 guidance did not appear to adequately ensure the development of an acceptably healthy SCWE at Davis Besse, and presumably at an unknown number of other U.S. plants.

ATTACHMENT 1
I believe since Davis Besse the NRC has assumed a more hands on proactive role. I would like to see an updated, more detailed description here of the NRC's current approach to SCWE, the actions the NRC takes to ensuring adequate safety cultures and SCWEs in the industry.

INTRODUCTION
Suggest you reword "implementation of this guidance may not improve a SCWE without additional efforts by site management". Makes the RID seem ineffective.
Say something like " implementation of the guidance in the RIS is expected to help foster a more healthy organizational SCWE."

ELEMENTS OF A SCWE

SCWE Policy

Schein says: "Leaders Create Culture" INPO says (human performance fundamentals course) "Safety Culture Is The Central Role Of Leadership"

The maintenance of the cultural environment (SCWE) should be identified as the responsibility of the leadership (management) team

SCWE Training

Excellent IMO that your recommendations for training include expectations for management behavior. This is key.

I suggest you reference INSAG 15 and two of the INPO Human Performance Fundamentals training chapter 2 job site and the individual and chapter 4 leadership as these documents provide a lot of specific guidance for managers (and workers) on culture positive from which this training can be developed.

SCWE Incentive

Suggest you break the last paragraph in this section into a separate topic called "Maintaining a Blame Free Environment" and put it under training.

A blame environment is a major enemy of SCWE and a healthy reporting culture. Davis Besse's inability to eliminate the environment of blame (in fact it increased after the event) in my view is the major factor that keeps the SCWE there from improving.

Millstone was the opposite – it was shoot the messenger. Blame Environment sends a message "if I find out you screw up, I will kill you." Shoot The Messenger sends a message "if you point out that I screwed up, I will kill you." Both destroy the potential for a healthy reporting culture. I think most plants are educated enough to at least avoid the appearance of STM but many (like Davis Besse) feel they need to prove to the NRC that they are tough on safety by blaming, reassigning and terminating staff. This was a huge HU / SCWE mistake that continued at Davis Besse through recovery right under the nose of the NRC.

Avoiding a blame cycle is a huge SCWE management issue that needs to be much better understood, so I recommend you steal the "blame cycle" graphic and text from INPO HU Fundamentals chapter 4 leadership and add it to your RIS.

Tools to Assess the SCWE

Survey and Interview Tools

A survey of manager behaviors encouraging the workforce to raise concerns should be viewed as a primary SCWE management tool. Very good that it is included, but it should be a separate item, and highlighted as a primary tool.

Below is Leon Olivier's simple leadership team safety culture formula that developed robust worker/manager trust relationships and SCWE during recovery and beyond.

1. Care about quality
2. Care about workers

Olivier required that all leaders continually show care and respect for all individuals, and continual care and concern not just for safety issues, but for all quality issues. Almost every culture and SCWE problem at Millstone, Davis Besse and elsewhere, can be traced back to these two issues – a lack of concern for people, and a lack of concern for quality.

Olivier demanded these qualities from every member of his leadership team. The qualities were monitored by leadership surveys, and leaders who proved unable to exhibit these qualities were replaced. This drove the safety culture and SCWE to a very high level, which many people felt was at that time the healthiest safety culture and SCWE they had ever observed in the industry.

After restart the surveys, group administering the surveys, and the pressure on managers were all considered extraordinary measures and were discontinued. Once the SCWE reached an apparently healthy level, the NRC did not require continuation of these measures. I discussed this with then Millstone senior NRC resident Dave Beaulieu. We both agreed that after recovery, there was nothing in place to prevent what occurred there from occurring again.

Had the relatively simple measures used at Millstone to manage the quality of the SCWE been institutionalized and across the industry, my belief is that the BAC event at Davis Besse would very likely have been avoided. Since 1996 I have been trying in various forums to get people to better understand the connections between leadership behavior, safety culture and SCWE performance, and encourage the NRC to become more proactive. Recently I have been communicating with Senator Voinovich's aide Brian Mormino on this issue.

Based on my Millstone observations, short of a regulatory requirement I doubt many managers (probably no managers) will voluntarily implement the surveys recommended in the RIS. Have you ever voluntarily asking the passengers in your car to criticize the safety of your driving? It is not human nature to do this - don't expect many managers to do these surveys.

Elihu Goldraitt, author of the hugely popular business book *The Goal*, says in his book *The Theory of Constraints*:

> *..but there is one thing we absolutely cannot tolerate – constructive criticism.*

That being said, to manage safety culture quality as it truly needs to be managed, there is no question that industry managers must learn to tolerate constructive criticism from workers, to listen with care and concern to the workforce human issues, and by way of accomplishing this to embrace these sort of leadership culture surveys.

To this end there needs to be more understanding, training, and guidance in this area. To be implemented on the scale needed, this will ultimately have to come in the form of a Reg Guide or a NUREG that all the plants commit to. This will need to be implemented coincident with the addition of the topic of safety culture to all of the licensee QA Program Topical Reports.

First there is a tremendous amount of awareness that needs to be raised. Safety culture is a human performance safety system strongly related to safety of operations, and something that very much requires quality assurance. When I present my views on what is needed to manage safety culture quality, human performance professionals in the audience nod enthusiastic agreement, and from the remainder of the audience I get mostly blank stares.

Only the HU professionals can see clearly where we need to go. Also, almost all the people who were at Millstone through recovery see it, and those people I have met who are currently fixing cultures at FENOC and PSEG plants see the need for this, but the great majority of the industry as yet does not.

To summarize my main point, the NRC needs to develop safety culture quality regulations. A major barrier to such development is the current position of the NRC, which seems to be that any such regulation would somehow:

1. Cross "the line" and get the NRC into managing the plants
2. Be necessarily subjective.

My observation is that effective objective safety culture regulation will be simple and straightforward, will not require significant plant resources, will not require any additional NRC resources, and will not involve the NRC managing the plants beyond what the current scope of the ROP already provides.

That the NRC cannot see how simple, objective, and non-resource intensive safety culture regulation can be is only because the NRC has not yet studied safety culture adequately.

Here is a quote from a December 2002 Plain Dealer article from ACRS member Dr. Apostolakis, then ACRS Chairman:

> *"For the last 20 to 25 years," he said, "this agency has started research projects on organizational-managerial issues that were abruptly and rudely stopped because, if you do that, the argument goes, regulations follow. So we don't understand these issues because we never really studied them."*

I would be happy to work with the NRC on developing safety culture / SCWE quality regulations. For my ideas on safety culture management, you are welcome to review the attached powerpoint presentation titled:

Ensuring Safe Cultures in High Hazard Ventures, an Integrative Approach

So far I have discussed my concept of objective safety culture regulation only with Dr. Apostolakis, but I hope to add this to my presentation in the future. I hope to also include a discussion of regulation in the article I am currently writing for the Elsevier journal *Reliability and System Safety* at the suggestion of editor Apostolakis.

Again, congratulations on your hard work, I think this new guidance will be very helpful for improving the management of SCWE in the industry.

Sincerely,

David Collins
Millstone
1-800-269-9994 x3710
david_m_collins@dom.com

c:

Lisamarie Jarriel,
Agency Allegations Advisor, Office of Enforcement, NRC

Sen. George Voinovich scolds the government's nuclear watchdog agency

Friday, May 21, 2004

Tom Diemer

Plain Dealer Bureau

Washington- Sen. George Voinovich scolded the government's nuclear watchdog agency Thursday, telling its leaders they should more closely police safety activities of workers inside nuclear plants, like Ohio's Davis-Besse.

"I want to know if you are dedicated to making sure it doesn't happen again," he said, referring to the pineapple-size hole discovered in the Davis-Besse reactor lid in early 2002.

"We are going to talk about safety standards," he lectured the Nuclear Regulatory Commission. "If you won't do it, I'll pass legislation to get it done."

Voinovich got the commissioners' attention at a hearing of his Environment and Public Works subcommittee. But they resisted his demand for a new regulation, imposing a "safety culture" standard on nuclear plants to allow inspectors to measure whether workers and management are putting safety first.

"We're not in the business of managing utilities," said Nils Diaz, chairman of the commission. A rule tracking the interaction of managers and workers on safety issues "could be very, very subjective," added Commissioner Edward McGaffigan.

Voinovich, whose subcommittee has jurisdiction over the NRC, called the hearing in part to examine a highly critical General Accounting Office report which said the nuclear commission should have spotted the corrosion in the Davis-Besse reactor lid before it became a risk to the public.

Diaz said the NRC has reviewed its oversight at Davis-Besse and has implemented 16 recommendations, including an upgrade in training of inspectors. There were 51 recommendations. The commission had two inspectors at Davis-Besse during the more than four years it took for the rust hole to develop. Recent testing by the NRC showed the lid was as close as two months to bursting when the company stumbled on the hole in March 2002.

The GAO said in its report the nuclear regulatory body miscalculated the risk of suspected reactor leaks at Davis-Besse in November of 2001, leaving the plant on line and running. The commission had other long-standing shortcomings in its oversight of America's 103 nuclear plants, the report said.

Diaz conceded the NRC dropped the ball on communication and technical know-how at the FirstEnergy Corp. plant in Oak Harbor, just east of Toledo.

"Clearly, Davis-Besse was our worst hour," said McGaffigan. "One of the major lessons learned - and we should have already learned it - is we have to have excellent people everywhere."

The NRC has ordered Akron-based FirstEnergy to assess the safety culture at Davis-Besse annually for five years and report its findings to the government. But other nuclear plants do not face that requirement.

Voinovich was not satisfied. After the rust hole was disclosed in 2002, he said he got nervous phone calls. "George, what is going on? I thought things were fine," he said he was asked.

"People ought not to go to bed worrying about the safety of our nuclear power plants," he told Diaz.

Diaz said he disagreed with some of the criticism by the GAO, the investigative arm of Congress, because the observations were outdated and had already been addressed. He said the commission has stepped up recruitment efforts as its work force ages.

The chairman of the full committee, James Inhofe of Oklahoma, said that although "recent events have tested the NRC, he was "generally pleased with how the commission has responded."

Rather than harp on the accident-waiting-to-happen at Davis-Besse, Inhofe said he was disappointed the NRC is not more optimistic about the future of nuclear power. Diaz had said he doubted that nuclear energy could increase its 20 percent share of the nation's electricity output over the next 15 years.

But David Lochbaum, a nuclear engineer testifying for the Union of Concerned Scientists, was even gloomier about the future.

"The NRC's regulatory impairments make nuclear power's cost and risk higher than is necessary," Lochbaum testified. "Left unchecked, the only question is whether economics or disaster will bring down the curtain on nuclear power in America."

To reach this Plain Dealer reporter:

tdiemer@plaind.com, 216-999-4212

Sunday, December 29, 2002

Davis-Besse workers' repair job hardest yet

Employees must fix plant's damaged attitude on safety

THE PLAIN DEALER, Cleveland, OH
By John Mangels and John Funk

FIRSTENERGY CORP. Randy Fast, Davis-Besse plant manager, holds a "town meeting" with employees at the reactor complex Dec. 19 to discuss issues related to the plant's restart, including the need for a safety-minded culture. FIRSTENERGY CORP. Randy Fast, Davis-Besse plant manager, holds a "town meeting" with employees at the reactor complex Dec. 19 to discuss issues related to the plant's restart, including the need for a safety-minded culture.

For more than two years, the radiation detectors at the Davis- Besse nuclear power plant insistently signaled that something was wrong inside the hulking gray bunker that houses the reactor. The plant's response to those repeated warnings signaled something as well.

The twin monitors constantly sniff the muggy air inside the containment building, searching for signs that the reactor's vital coolant might be leaking. And from 1999 to 2001, the detectors' air filters - which normally require monthly changing - were clogging as often as every day with a fine yellow-brown dust. Consultants identified it as coolant residue and rusting metal, likely carried aloft by steam.

Although they suspected a coolant leak somewhere, Davis-Besse personnel couldn't find one. Instead of pursuing its cause, they moved the monitors' intakes to a different spot. They even bypassed one of the devices' three sensors because it kept triggering alarms.

To experts like Mario Bonaca, a top adviser to the Nuclear Regulatory Commission, the Davis-Besse detectors weren't just registering a leaking, rusting reactor lid, but a corroded attitude toward safety, too. "Those were almost daily events," the nuclear industry veteran fumed at a recent meeting. "Didn't somebody scratch their head and say, 'Why are we overriding these indications?' "

No one did, not the FirstEnergy Corp. managers of the Toledo- area reactor, not the NRC inspectors who were based there, not the analysts for the nuclear industry who gave the plant a clean bill of health. Despite years of obvious signs, the widespread breakdown at Davis-Besse of the "nuclear safety culture" escaped everyone's notice.

"There clearly were some issues with safety culture at that plant that had not been recognized by us, and not recognized by the top- most management of FirstEnergy," said NRC Chairman Richard Meserve. As he told an industry group in November, "the Davis-Besse episode presents the fundamental question as to whether the NRC's approach to assuring an adequate safety culture is sufficient."

Until now, the agency's inspections and rules have focused on hardware and procedures. The NRC has shied away from directly regulating the fuzzier concept of an appropriate safety mindset at the nation's 103 commercial nuclear plants - influenced, in part, by the industry's position that such attention would be meddling in management affairs.

But the shock waves from Davis-Besse have given new urgency to the safety culture debate inside White Flint, the NRC's fortress- like Rockville, Md., headquarters. Some members of the Advisory Committee on Reactor Safeguards, an influential panel of scientists and engineers that counsels Meserve and the four other NRC commissioners, have recently voiced concerns about a possible gap in safety culture regulation. The group will make recommendations this spring.

Meanwhile, the NRC must tackle the more immediate problem of making certain that something it does not yet know how to measure has been restored at Davis-Besse - before the idled plant is allowed to restart.

High stakes

Plumbing an organization's culture sounds better suited for a Harvard MBA thesis than for America's nuclear overseers. But the relative priority that workers and managers give to safety-mindedness is perhaps nowhere more important than at a nuclear plant, where an accident can affect millions of people.

"If it's an industry with catastrophic potential, any lapses are magnified," said Yale University sociologist Charles Perrow, author of "Normal Accidents," a book examining technological risk. With their immense complexity and domino-chain processes, nuclear plants have a built-in propensity for accidents, Perrow argues.

So the organizational sins that might only result in a bad burger or a burned finger at McDonald's - sloppy work, poor supervision, ignored warnings, unnecessary risk-taking - have profoundly greater consequences at a place like Davis-Besse.

The nuclear industry's opposition to formal regulation of the safety culture doesn't mean it thinks the concept is unimportant - quite the opposite. A confidential report in September by the industry's research arm, the Institute for Nuclear Power Operations, analyzed the 20 most significant "near misses" in American nuclear history. (Davis-Besse made the list twice, for its reactor lid hole in 2002 and a 1985 incident in which coolant pump failures brought the reactor's radioactive fuel rods to within two hours of melting.)

The study found that the most commonly reported cause - named in 14 of the 20 mishaps - was plant personnel lacking "an appreciation of the risks associated with their actions" and taking "a non- conservative approach toward reactor safety."

The term nuclear safety culture was introduced after the Chernobyl disaster in 1986. Pinning down exactly what it means has proved elusive.
"I think if you were to talk with five different people about what safety culture is, you'd probably get five different answers," Meserve said in a recent interview with The Plain Dealer.

George Apostolakis, a respected Massachusetts Institute of Technology nuclear engineering professor who chairs the NRC's safety advisory panel, goes further.
"We really don't understand what an adequate safety culture is and how to measure it," Apostolakis said. "Some of my colleagues with long experience at nuclear plants tell me they walk into a facility, and 10 minutes later they know whether they have a good safety culture. But they can't tell me why."

Safety before profit

The general consensus is that the safety culture is a blend of attitude, behavior and values: a commitment to excellence; a questioning outlook; personal accountability; a willingness to raise or listen to safety concerns and fix them; a belief from the boardroom down to the broom-pushers that safety comes before everything, including profits.

David Collins, an engineering analyst at Connecticut's Millstone nuclear power station who studies safety culture, likens it to the moral and ethical code that guides doctors: "An attitude that ensures the [nuclear] technology first does no harm." How do you measure an attitude, though?

The NRC historically has avoided much work in the area, to the great frustration of people like Apostolakis, the agency's top safety adviser.

"For the last 20 to 25 years," he said, "this agency has started research projects on organizational-managerial issues that were abruptly and rudely stopped because, if you do that, the argument goes, regulations follow. So we don't understand these issues because we never really studied them."

Instead, the agency has staked its confidence on the ability of its routine equipment inspections and program reviews to act as an indirect barometer of safety culture. If its inspectors find a backlog of maintenance work, the NRC's thinking goes, or repeated failures by engineers to get to the bottom of a stuck valve, that should trigger alarms about an appropriate safety attitude and prompt greater agency scrutiny.

Going any further to impose specific safety culture requirements, the nuclear industry has argued, would force a cookie-cutter approach on plants that are as different as the Southerners or Rust Belt natives who populate them, robbing managers of the flexibility to achieve safety in the way that works best for their employees. A government regulation might also undercut the notion that nuclear plants themselves have the primary responsibility for safety.

Troubling events at the Millstone plant in the 1990s raised questions about utilities' commitment to safety culture and the NRC's capacity to catch its decline. Amidst equipment failures, internal warnings of a "cultural problem" and several dozen claims that workers were penalized for bringing up safety issues, the three- reactor complex landed on the NRC's "watch list" of problem plants in 1996.

The plant's owner, Northeast Utilities, shut it down for repairs and other operations. After Time Magazine exposed Millstone's flaws, the agency ordered Northeast to prove it had a comprehensive plan to ensure that workers who aired safety concerns wouldn't face retaliation before it could restart the reactors. In essence, the NRC demanded that Millstone establish an aspect of safety culture, without saying how to do it.

"Fortunately, Millstone was able to get the right people in there and work with management, with all the consultants we had, to come up with some kind of definition of safety culture," said Paul Blanch, an engineer and former Northeast whistleblower who was brought back to help address the problems.

The two-year effort required replacing about 40 managers and developing programs to re-educate those who remained on how to handle safety complaints and employee concerns. Workers and bosses had to learn to communicate and rebuild shattered trust.

"There were dramatic examples of people changing," but progress was halting and fragile, said MIT management professor John Carroll, who has studied the Millstone case. The lengthy shutdown cost Northeast more than $1 billion; in 1998 the utility decided for economic reasons that only two of Millstone's three reactors would return to service.

The Davis-Besse shock

The Millstone debacle was supposed to have heightened the nuclear industry's awareness of the safety culture issue.

The NRC also believed that its new approach to monitoring the nuclear fleet, launched in 2000, would be a more sensitive, less subjective indicator of how well reactors were operating. While the revamped Reactor Oversight Program still didn't directly rate plants' safety culture - or workers' ability to report safety concerns - the refocused inspections were supposed to be able to detect problems in those areas in plenty of time to avert a crisis.

Which is why Davis-Besse came as such a shock to regulators and the industry: Until the day the hole in the reactor lid was found in March, the plant got uniformly high marks from the NRC's inspections and, reportedly, the confidential ones done by the Institute for Nuclear Power Operations that deal even more directly with safety culture.
"It's a major failure of the system, in my view," Apostolakis said.

Even before the Davis-Besse event, the NRC was warming to the idea of requiring that all reactor operators put in place safety- conscious work environment programs to ensure employees' freedom to raise concerns. Senior agency officials have recommended such a rule, and the commissioners will take up the matter soon.

But a broader regulation mandating that plants have - and that the NRC verify - an adequate safety culture is much less likely any time soon. NRC rulemaking is typically a years-long process.

And the Nuclear Energy Institute, the industry's powerful lobbying arm, would oppose safety culture-related regulations because it believes that current rules are adequate, that new ones would be subjective and that Davis-Besse was a unique event, not a fleetwide problem.

"The NRC is excellent at regulating hardware. It's very difficult to regulate mindset," said Ellen Ginsberg," the industry group's deputy general counsel.

While that may be true, Meserve insists that the NRC is "not taking anything off the table" in its consideration of safety culture options.
"I can't tell you that we should change the way we do things," he said. "If we were to find tools" to measure a plant's culture objectively, "I think a lot of concerns of regulation in that area would diminish."

Do they care?
One such tool may spring from the advice that a legendary football coach offers leaders. Lou Holtz suggests that whether a business succeeds depends on how the boss measures up to these employee questions: "Can I trust you? Do you care about me? Are you committed to excellence?"

Collins, the Millstone analyst, realized from his experiences during the plant's recovery that workers' feelings about managers are a strong meter of the organization's culture. With input from MIT's Carroll, he fashioned a survey based on those themes. He and others believe that it can pinpoint trouble spots where leadership - and by extension, safety culture - have slipped.

Collins, who already has done a test run of the survey at Millstone, suggests that the survey could be done at least yearly, with the NRC reviewing summary results. If employee confidence fell below a certain level, the agency and utility could discuss remedies, with a time period for improvement before the NRC stepped up enforcement. In short, a measuring tool.

Davis-Besse has undertaken its own employee surveys since the shutdown. Though not based on Collins' model, they are one of the indicators that the NRC panel overseeing the plant's rehabilitation will use to judge its readiness to resume operating. Most are based on how well workers and managers perform while under the NRC's magnifying glass.

"That's the only way the NRC can make a (safety culture) determination - looking at decisions and whether they're made conservatively," said Andrew Kadak, an MIT nuclear engineering professor and former nuclear CEO.

"I don't know how to measure safety culture," said the NRC panel's chair, Jack Grobe, who's been through several restarts of troubled plants. Nonetheless, he is confident there are reliable proxies. An important one is the reports that workers file alerting their bosses to equipment problems or conditions needing attention.

"That's the guy in the field, having an itch," Grobe said. "How he writes it down, how the company responds to that, how they identify corrective actions and follow through - that is one key indicator."

Davis-Besse's response to the discovery several months ago of evidence that the bottom of the reactor - in addition to the lid - might also be leaking is another telling sign, Grobe said. Chemical tests of rust on the vessel's base couldn't rule out that it came from bottom leaks rather than from running down from the lid. Instead of waiting for the NRC to tell it what to do, FirstEnergy on its own proposed a much more extensive test.

To Grobe, that was a watershed of sorts, a hint that Davis- Besse's wilted safety culture might be reviving. "It's very clear to me that the people in the plant (now) feel very comfortable raising difficult issues, in a very direct way."

But the recovery, which has already cost FirstEnergy nearly $400 million, will be long and difficult, warns Millstone veteran Blanch. "We really objectively did not observe significant improvement for more than two years," he said. "And it was a monumental effort."

For complete Davis-Besse coverage, go to www.cleveland.com/ davisbesse/
To reach these Plain Dealer reporters:

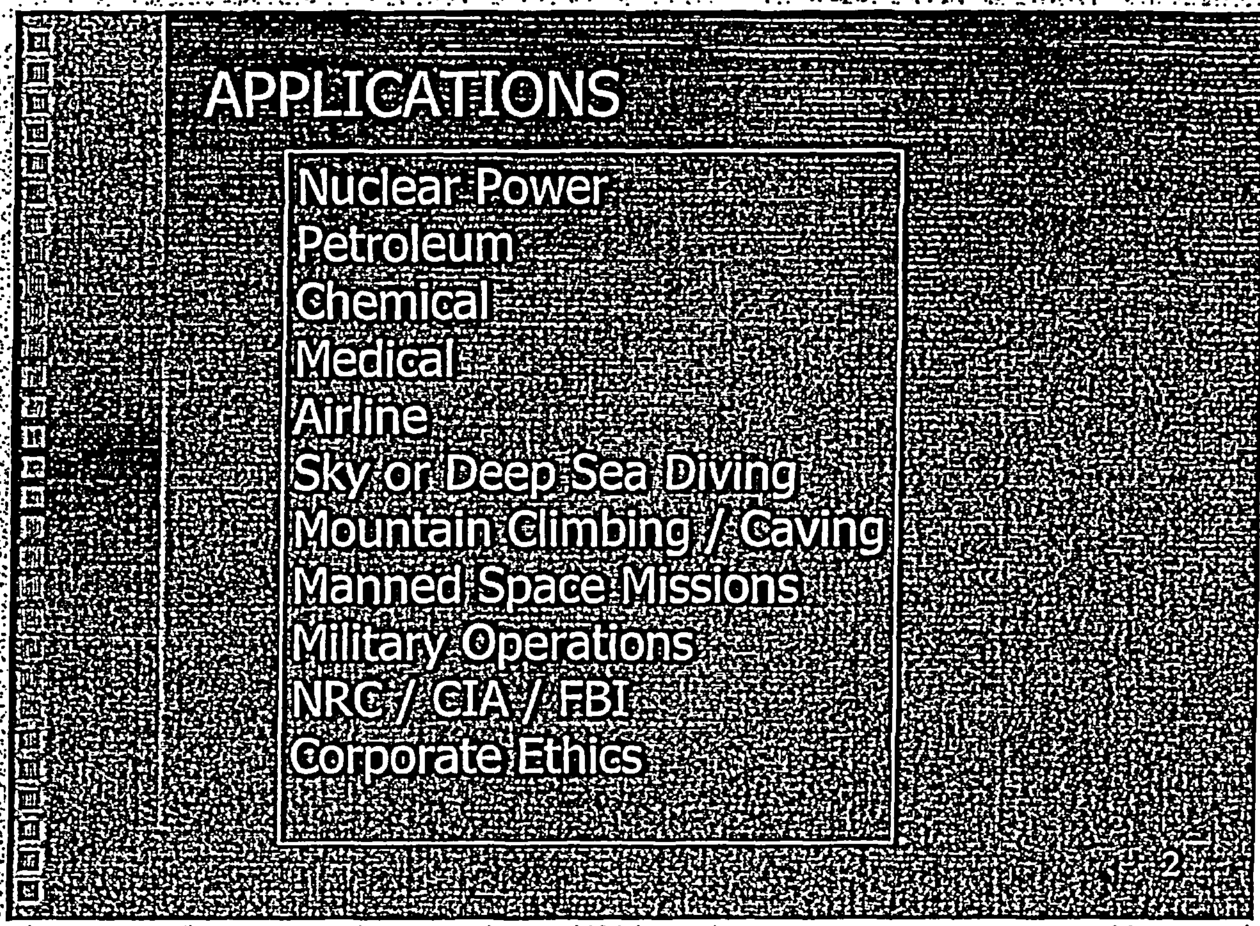
jmangels@plaind.com, 216-999-4842
jfunk@plaind.com, 216-999-4138

Ensuring Safe Cultures in High Hazard Ventures - an Integrative Approach

(DRAFT NOV, 04)

david_m_collins@dom.com 1-800-269-9994 x3710

1


APPLICATIONS
Nuclear Power
Petroleum
Chemical
Medical
Airline
Sky or Deep Sea Diving
Mountain Climbing / Caving
Manned Space Missions
Military Operations
NRC / CIA / FBI
Corporate Ethics
2

DEFINITIONS

Arrogance
Showing proud self-importance and disregard for others. A type of unethical behavior.

Ethical Attitude
Care and concern for the impact of one's behavior on the lives and welfare of others.

High Hazard Venture
An activity that requires the management of risk to human life or the environment.

HHV Safety Culture
The ethical attitude within a high hazard venture organization, instilled and maintained by the managing leadership, which ensures a hazardous activity first does no harm to people or the environment.

DEFINITIONS

HHV Safety Culture
The type of safety culture within an organization that controls the SOE risk introduced by human performance. A quality HHV safety culture maintains the human performance element of SOE risk ALARA: *As Low As Reasonably Achievable.*

Safety Culture
A type of ethical business or organization culture that proactively manages activities such that people are protected from physical harm.

Safety Culture
A human performance safety system that requires regular assessments and maintenance like any safety system.

SOE
Significant Operating Event. An unexpected and undesired operating event, with minor to major safety consequences.

DEFINITIONS

Management

The act of handling or controlling something successfully.

Negative, Weak, Toxic, Low Performance, or Low Quality Culture

A condition of organization culture where behavior does align with or support espoused values.

Positive, Strong, Healthy, High Performance, or Quality Culture

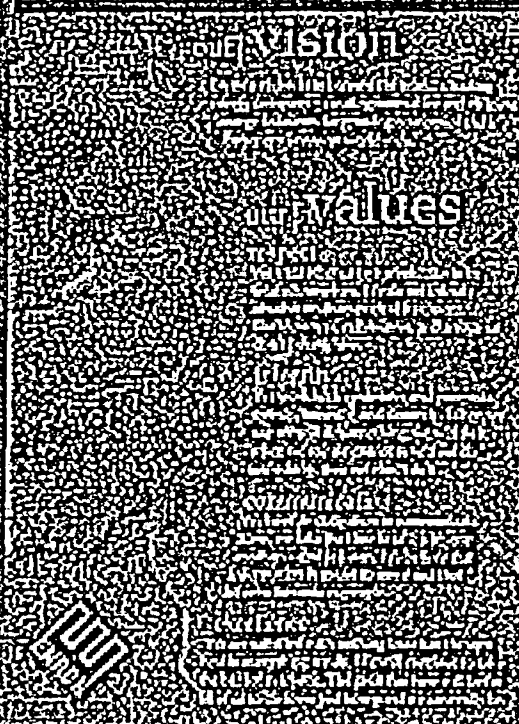
A condition of organization culture where behavior aligns with and supports stated, espoused values.

BACKGROUND

An Organization's Behavior
does not always align with it's stated (espoused) values.

A Weak, or Low Quality Culture
is the condition where an organization's behavior does not align with it's stated, espoused values.

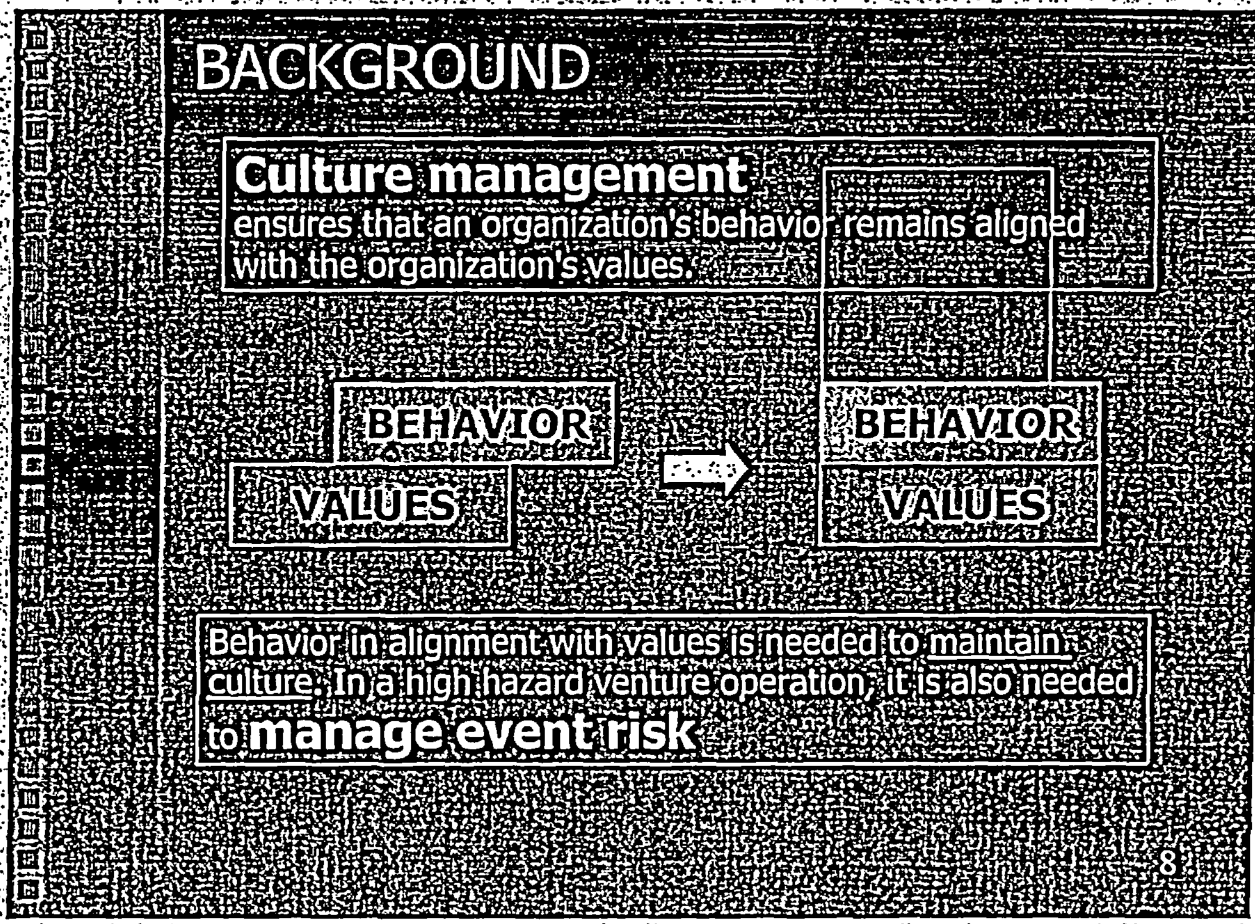
BACKGROUND



ENRON Value Statements:

Respect
We treat others as we would like to be treated ourselves. Ruthlessness, callousness, and arrogance don't belong here.

Integrity
We work with customers and prospects openly, honestly and sincerely. When we say we will do something, we will do it.


BACKGROUND
Culture management
ensures that an organization's behavior remains aligned with the organization's values.
BEHAVIOR
VALUES
BEHAVIOR
VALUES
Behavior in alignment with values is needed to maintain culture. In a high hazard venture operation, it is also needed to manage event risk
8

TOPIC

Basis of Method	Industry Objective	Plant Objective
Role of Leadership	Use of OE	Clear Definition
Effective Assessments	Permanent Improvement	Roadmap to Understanding

Basis of Method

BBS: Behavior Based Safety Studies

Safety Culture = Process + Values

Behavior Based Safety Dr. Scott Geller	Behavior Based Safety Dr. T. McSween	Behavior Based Safety Dr. T. Krause

Basis of Method

Safety Culture = Process + Values

Non-compliance with an <u>established</u> process

If a process is established (proven effective and well understood) and compliance problems exist, the <u>values</u> part of the culture equation needs to be better instilled and maintained by the managing leadership through more effective and more frequent:

- **communication**
- **training**
- **assessment**

Basis of Method

Example 1:
Teenagers instructed to keep their room clean
- some will
- some won't
- some say they do but don't

As teenagers they have successfully cleaned their room many times before. The process is therefore an established one, and not at the root of the compliance problem.

The solution is to improve the instillation and reinforcement of <u>values</u> through more effective and more frequent:

- communication
- training
- assessment

Basis of Method

Example 2:

Nuclear Plant 10CFR50 Appendix B Compliance

- some will
- some won't
- some say they do but don't

Appendix B requirements have not changed for many years. The process is therefore an established one, and not at the root of the compliance problem.

The solution is to improve the instillation and reinforcement of values through more effective and more frequent:

- communication
- training
- assessment

Basis of Method

QMT - Quality Management Theory
Effective Management Formula:
Define, Measure, Manage

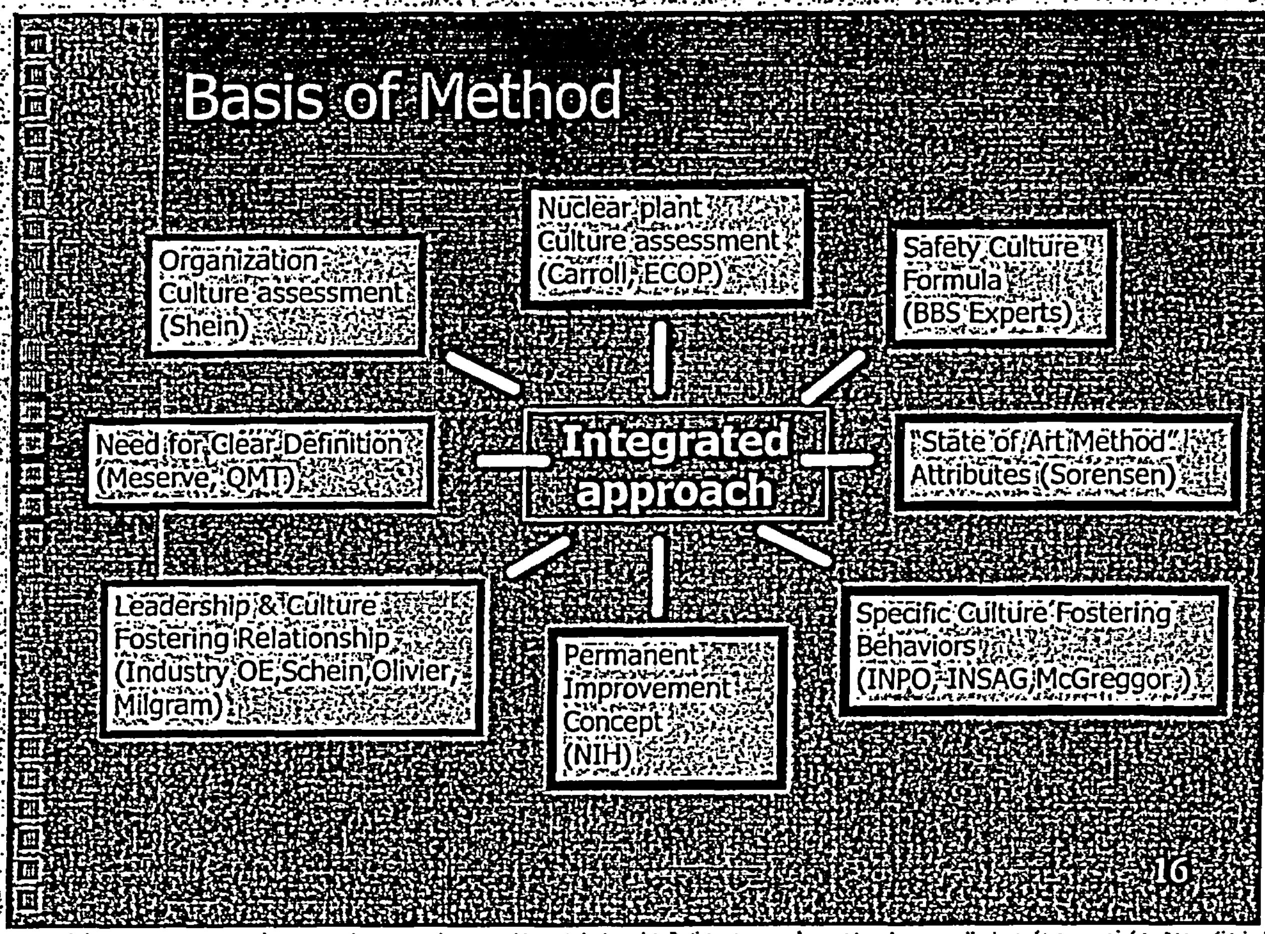
To manage anything effectively
You need to be able to measure it accurately

To measure anything accurately
You need to be able to define it clearly

Basis of Method

NRC Chairman
Dr. Richard Meserve
November 2002
INPO CEO Conference:

"The concept of safety culture is <u>not crisply defined</u> it is (therefore) not surprising that the NRC and other organizations have not found an unambiguous way to measure it."


Basis of Method
Organization Culture assessment (Shein)
Nuclear plant Culture assessment (Carroll, ECOP)
Safety Culture Formula (BBS Experts)
Need for Clear Definition (Meserve, QMT)
Integrated approach
"State of Art Method" Attributes (Sorensen)
Leadership & Culture Fostering Relationship (Industry OE,Schein,Olivier, Milgram)
Permanent Improvement Concept (NIH)
Specific Culture Fostering Behaviors (INPO, INSAG,McGreggor)
16

TOPIC

Basis of Method	Industry Objective	Plant Objective
Role of Leadership	Use of OE	Clear Definition
Effective Assessments	Permanent Improvement	Roadmap to Understanding

Industry Objective

Initial Industry Action

The Industry must acknowledge that the quality of the safety culture affects the safety of operations.

To reduce safety culture as an SOE causal factor, the Industry must begin to maintain the quality of safety cultures above minimal acceptable levels.

The first step in managing the quality of safety cultures is to add safety culture to the QA Topical Report of all licensees.

Industry Objective
Plant QAP (Typical)

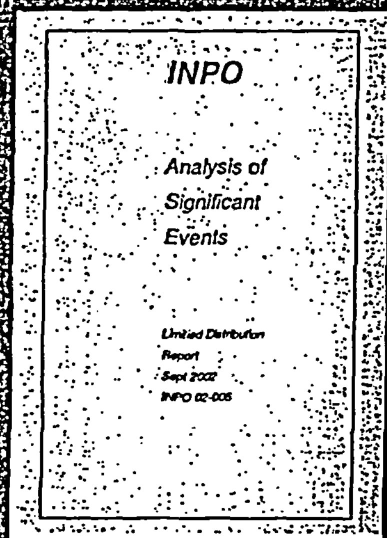
QUALITY ASSURANCE PROGRAM (QAP)
TOPICAL REPORT – NUCLEAR POWER STATION

Policy Statement: this Quality Assurance Program (QAP) Topical Report has been developed to achieve quality assurance in all activities affecting safe operations.

- QAP 1.0 Organization
- QAP 2.0 Program
- QAP 3.0 Design Control
- QAP 4.0 Procurement
- QAP 5.0 Procedures
- QAP 6.0 Documents
- QAP 7.0 Materials and Services
- QAP 8.0 Parts and Components
- QAP 9.0 Special Processes
- QAP 10.0 Inspection
- QAP 11.0 Testing
- QAP 12.0 Test Equipment
- QAP 13.0 Handling Shipping
- QAP 14.0 Inspection Testing
- QAP 15.0 Non Conf Materials
- QAP 16.0 Corrective Actions
- QAP 17.0 QA Records
- QAP 18.0 Audits
- QAP 19.0 Safety Culture

Industry Objective

Safety Culture as a Causal Factor


INPO

Analysis of Significant Events

Limited Distribution Report
Sept 2002
INPO 02-005

According to a 2002 INPO Study of SOEs

No SOE causal factor is more frequent than a weak Safety Culture

Industry Objective

Safety Culture as a Causal Factor

Identified as Causal Factors in 70% of the most Serious SOEs:

- lack of appreciation of risks
- lack of questioning attitude
- non-conservative approach

All are directly related to The Quality of the Safety Culture

Industry Objective

GOAL

The Industry should establish a goal of cutting safety culture <u>in half</u> as a causal factor of SOEs

This means going forward safety culture would be identified as a causal factor in less than 35% of future SOEs

Industry Objective

More Effective Culture Metrics are Needed

Every plant will argue that their safety culture is strong, but many plants have weak safety cultures.

A weak safety culture like a weak immune system in the human body, fails to protect a plant from significant operating events.

Better metrics are needed capable of alerting a plant to weak safety culture conditions.

Evidence of this is that currently the first indication of a weak safety culture is often a significant operating event.

Industry Objective

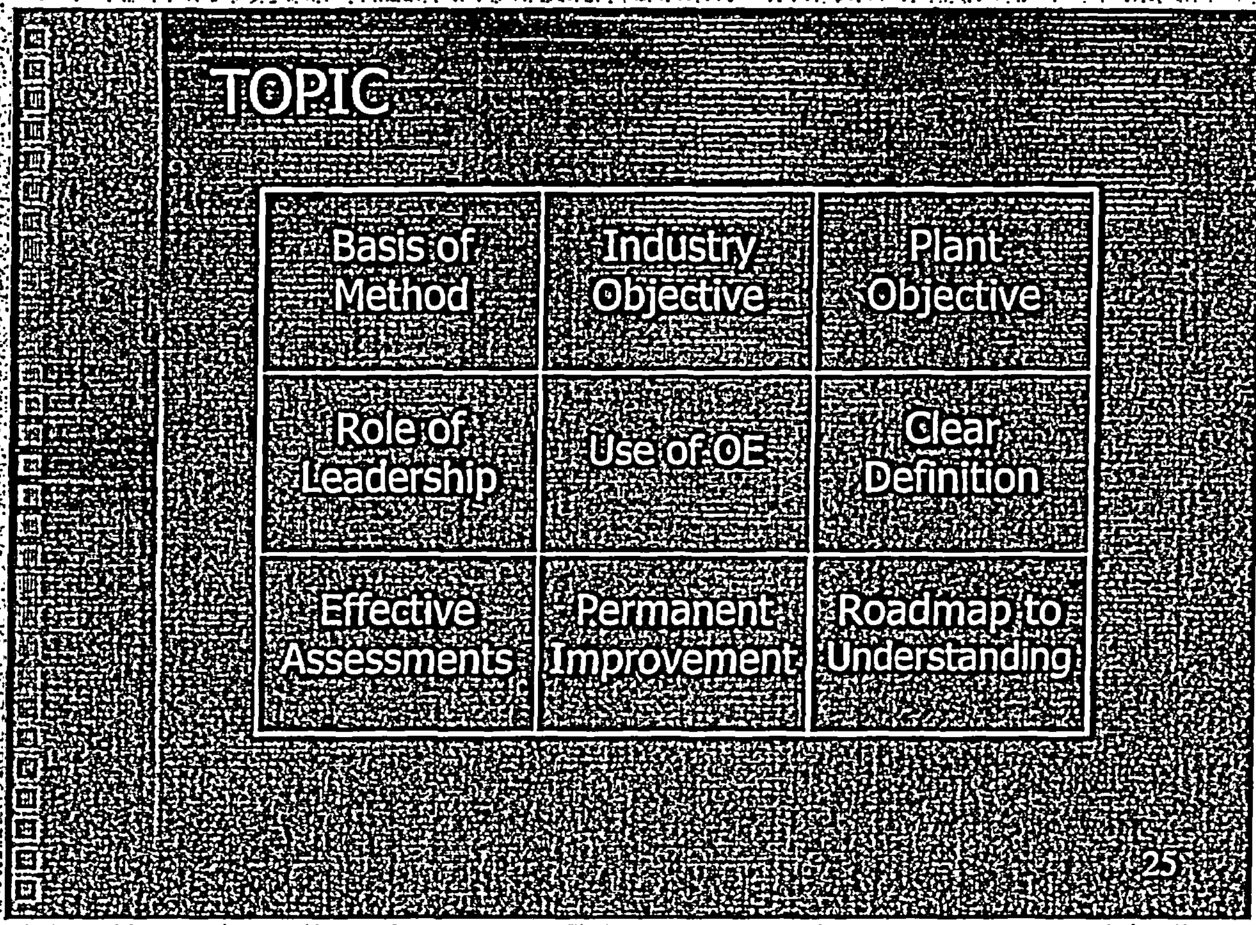
Additional Evidence that More Effective Culture Metrics are Needed

Before 2001 there were never more than two US fuel failure events in any one year, in 2001 there were eight. **In 2002** there were twelve.

In 2003 there were 1262 SOEs, the most ever in one year.

Due to economic pressure to continually reduce outage durations, INPO anticipates that SOEs during refuelings will increase in frequency and severity.

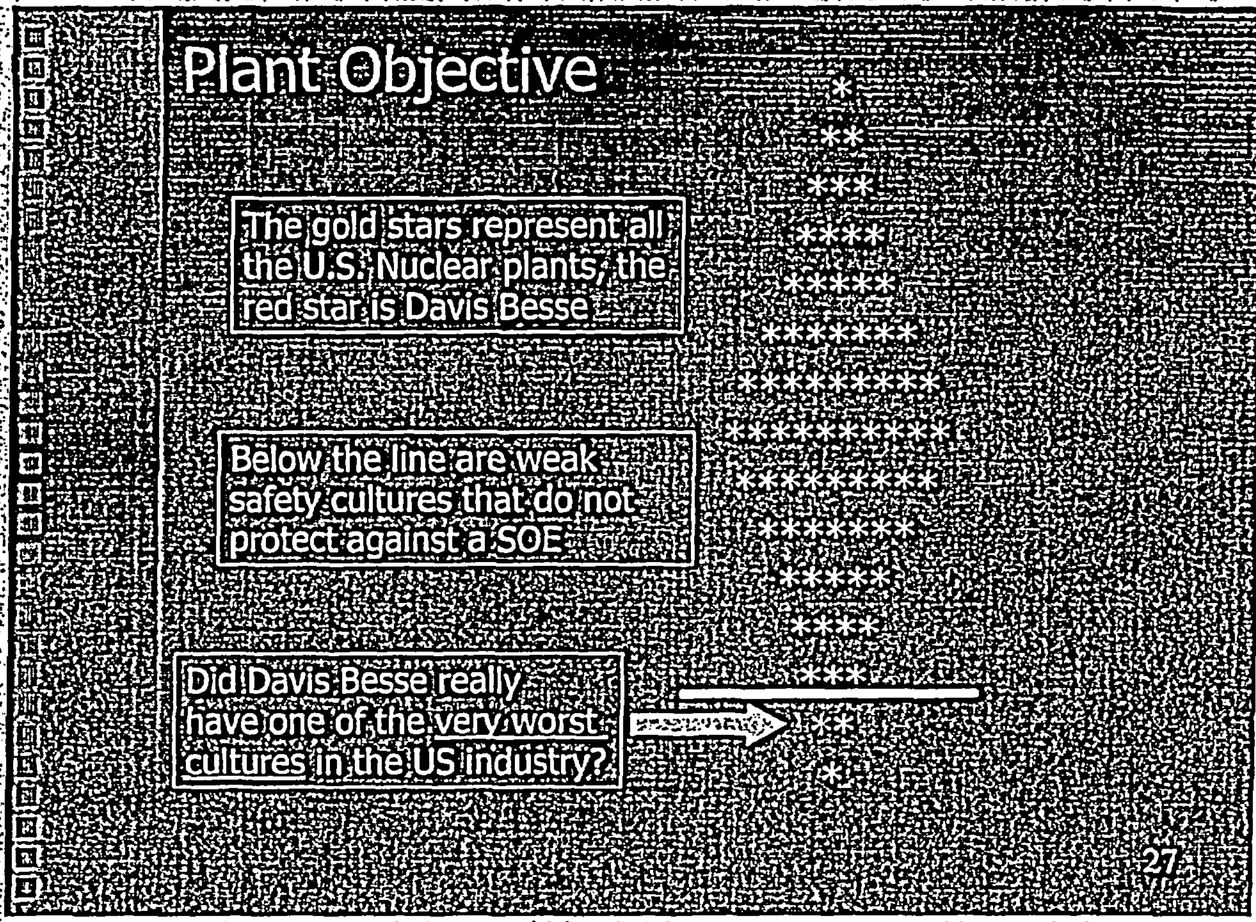
Pressure to continue operating was not observed to be a SOE causal factor prior to deregulation, but since has been identifed in approximately half of the most serious SOEs. INPO expects this may increase.


TOPIC
Basis of Method
Industry Objective
Plant Objective
Role of Leadership
Use of OE
Clear Definition
Effective Assessments
Permanent Improvement
Roadmap to Understanding
25

Plant Objective

How healthy are the safety cultures of individual plants?

What should individual plants be doing?


Plant Objective
The gold stars represent all the U.S. Nuclear plants, the red star is Davis Besse
Below the line are weak safety cultures that do not protect against a SOE
Did Davis Besse really have one of the very worst cultures in the US industry?
27

Plant Objective

Was the Davis Besse Culture really that bad?

- Pre-event NRC inspection reports said the DB safety culture was "green" or "good"
- The NRC says long production runs correlate with safe plants, and DB was having long runs.
- INPO picked up on some culture issues, but didn't flag any major ones
- According to the DB PM, DB was in one of the best condition of any FENOC plant, and had one of the lowest operator error rates in the US

Plant Objective

Why do we think the Davis Besse culture was very different from the average US plant?

What if the Davis Besse culture actually belonged about here, not the best, not strong enough to protect against a SOE, but still far from the worst in the industry?

```
    *
    **
   ***
   ****
  *****
 *******
*********
**********
*********
 *******
  *****
   ****
   ***
    **
    *
```

Plant Objective

The NRC acknowledges they are not able to assess licensee safety culture effectively. Also, most plants have not institutionalized effective safety culture management.

What if this is a more reasonable graphic of where the US Industry is today, many plants with cultures much like Davis Besse had, unable to protect the plant against a serious event.

```
*
**
***
****
*****
*******
*********
**********
*********
-------------
*******
*****
****
***
**
```

Plant Objective

What should individual plants be doing?

Individual plants should be institutionalizing effective safety culture management.

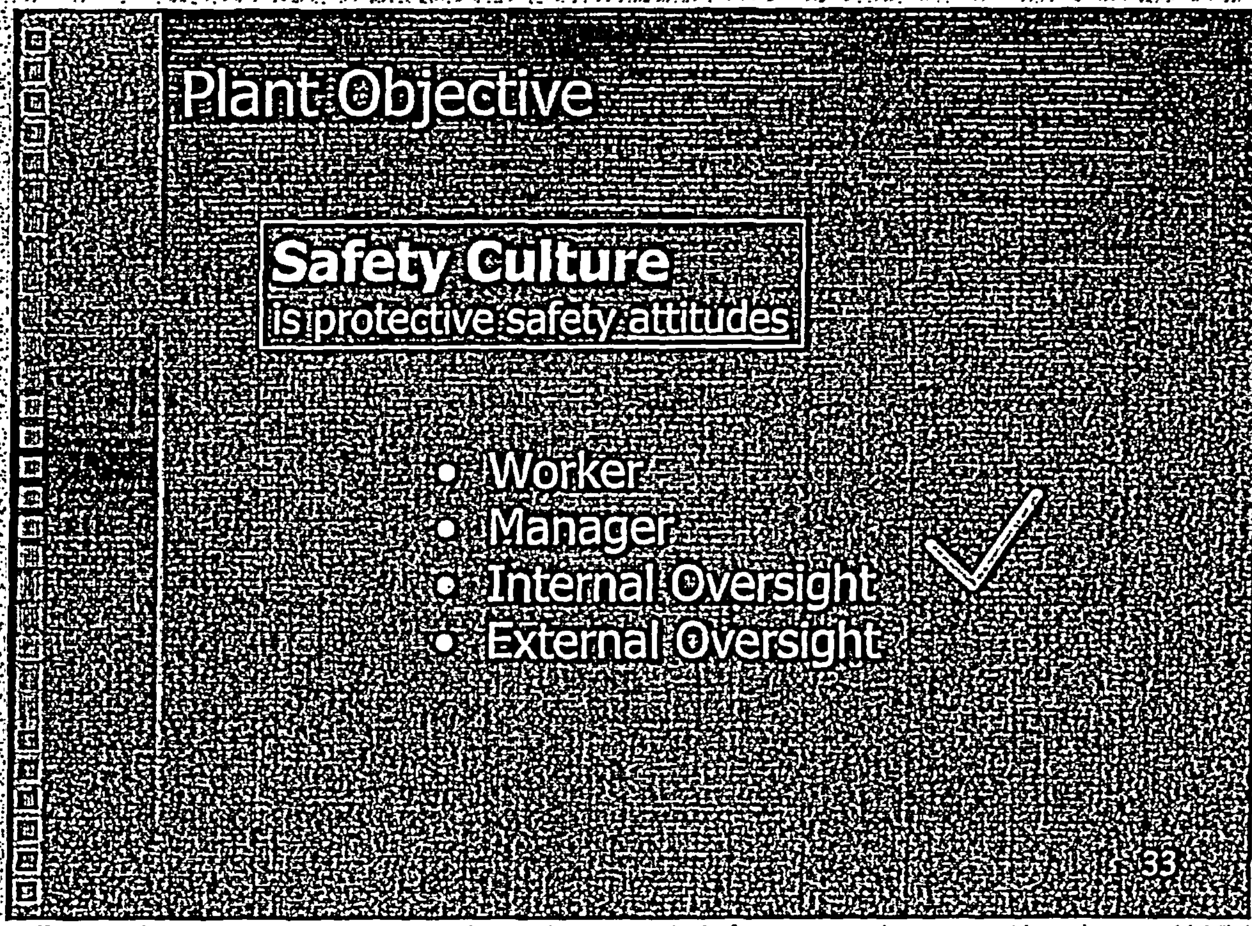
This begins with training such as:
What is Safety Culture?

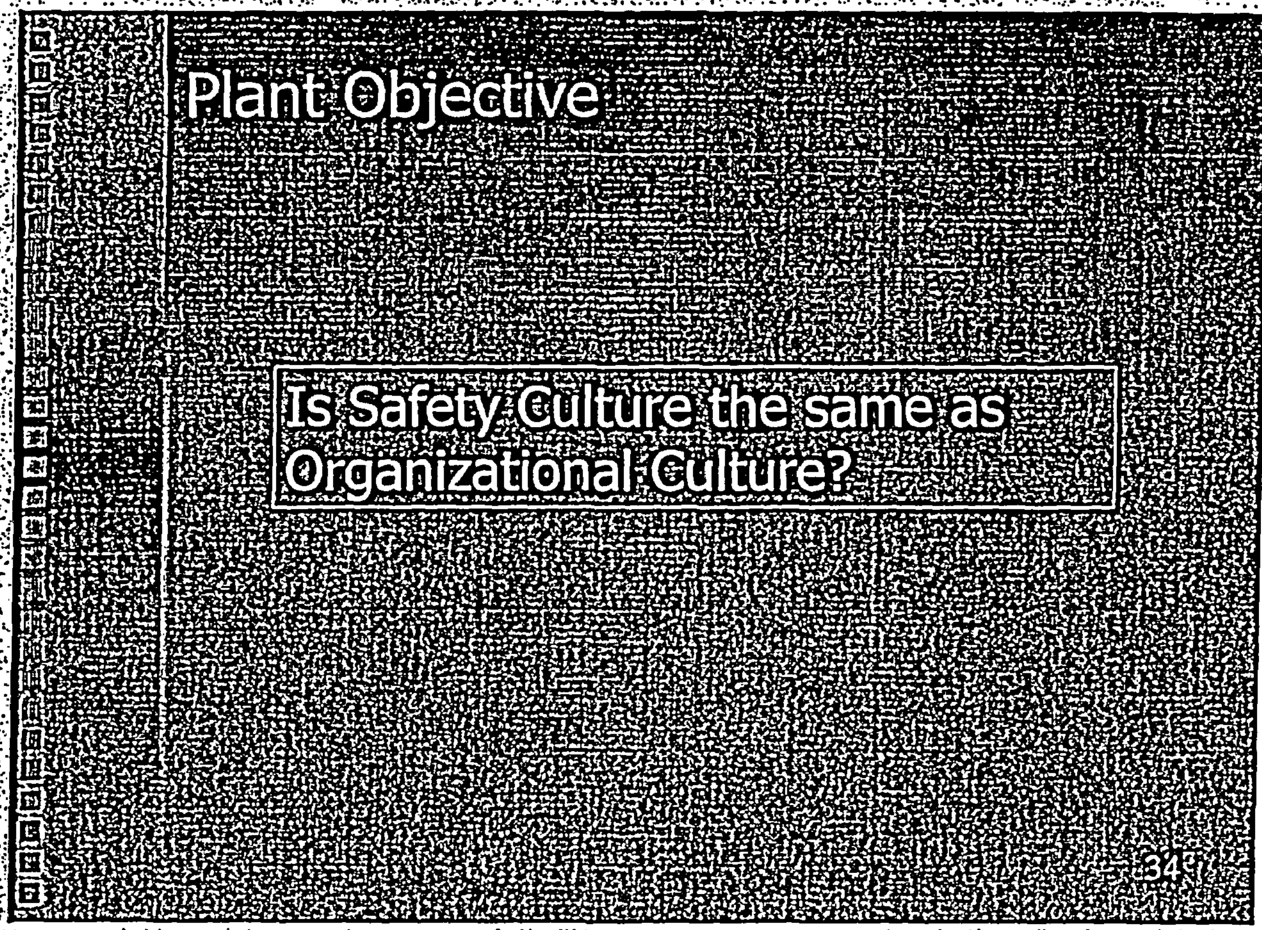
Plant Objective

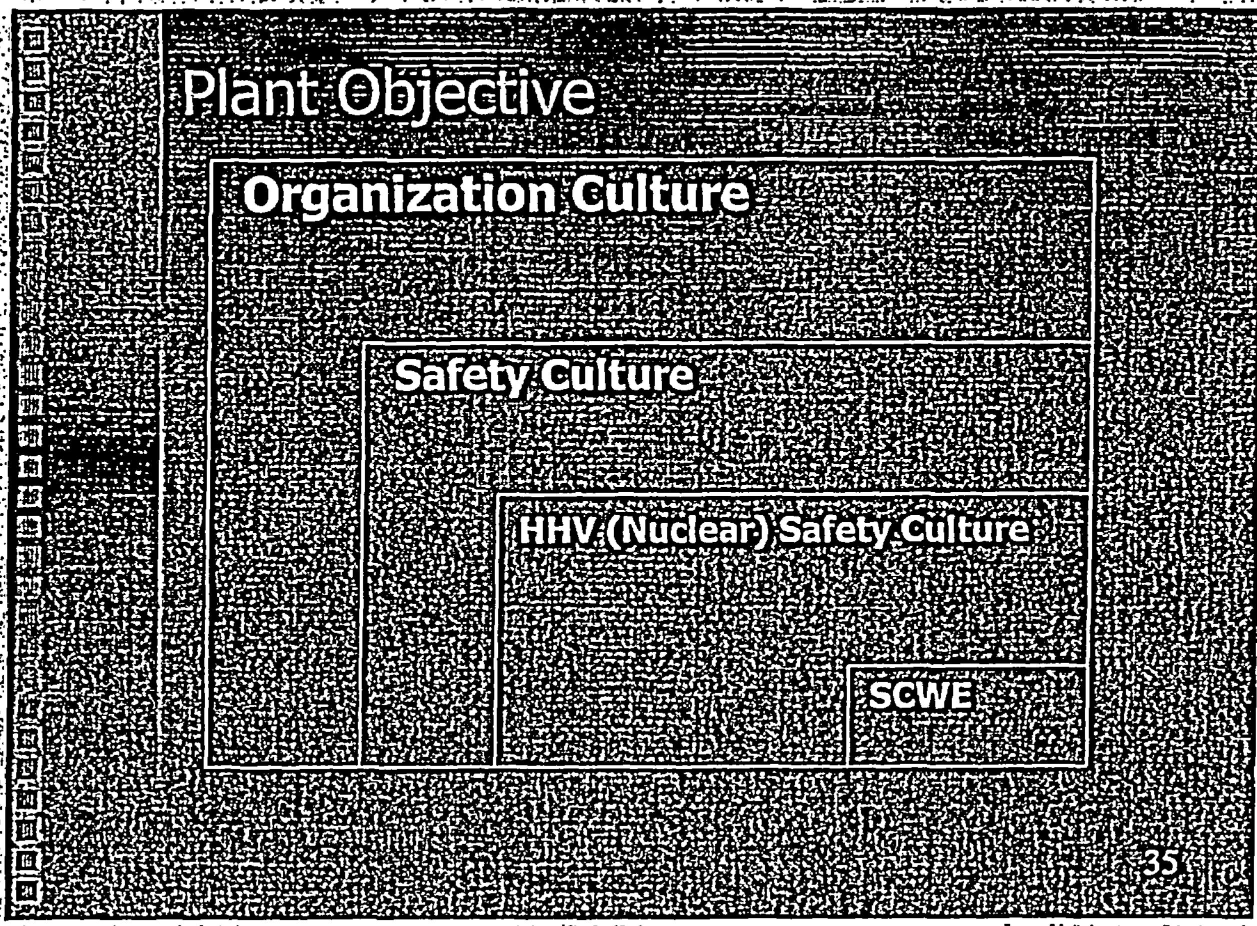
What is Safety Culture?

Safety Culture <u>is not</u> the performance of protective boundaries or equipment

- Fuel cladding
- RCS
- Containment


Plant Objective
Safety Culture
is protective safety attitudes
• Worker
• Manager
• Internal Oversight
• External Oversight
33


Plant Objective
Is Safety Culture the same as
Organizational Culture?
34


Plant Objective
Organization Culture
Safety Culture
HHV (Nuclear) Safety Culture
SCWE
35

Plant Objective

Organization Culture
Safety, Management, Operations, Engineering, Outage Planning, HR, Training

Safety Culture
HHV, Hardhat/OSHA, Electrical, Fire, Security, Medical

HHV (Nuclear) Safety Culture
SCWE, Questioning Attitude, Appreciation of Risk, Conservative Decision-making, Appendix B Compliance, Procedural Compliance, Engineering Reviews, Human Performance, Training, Learning Organization

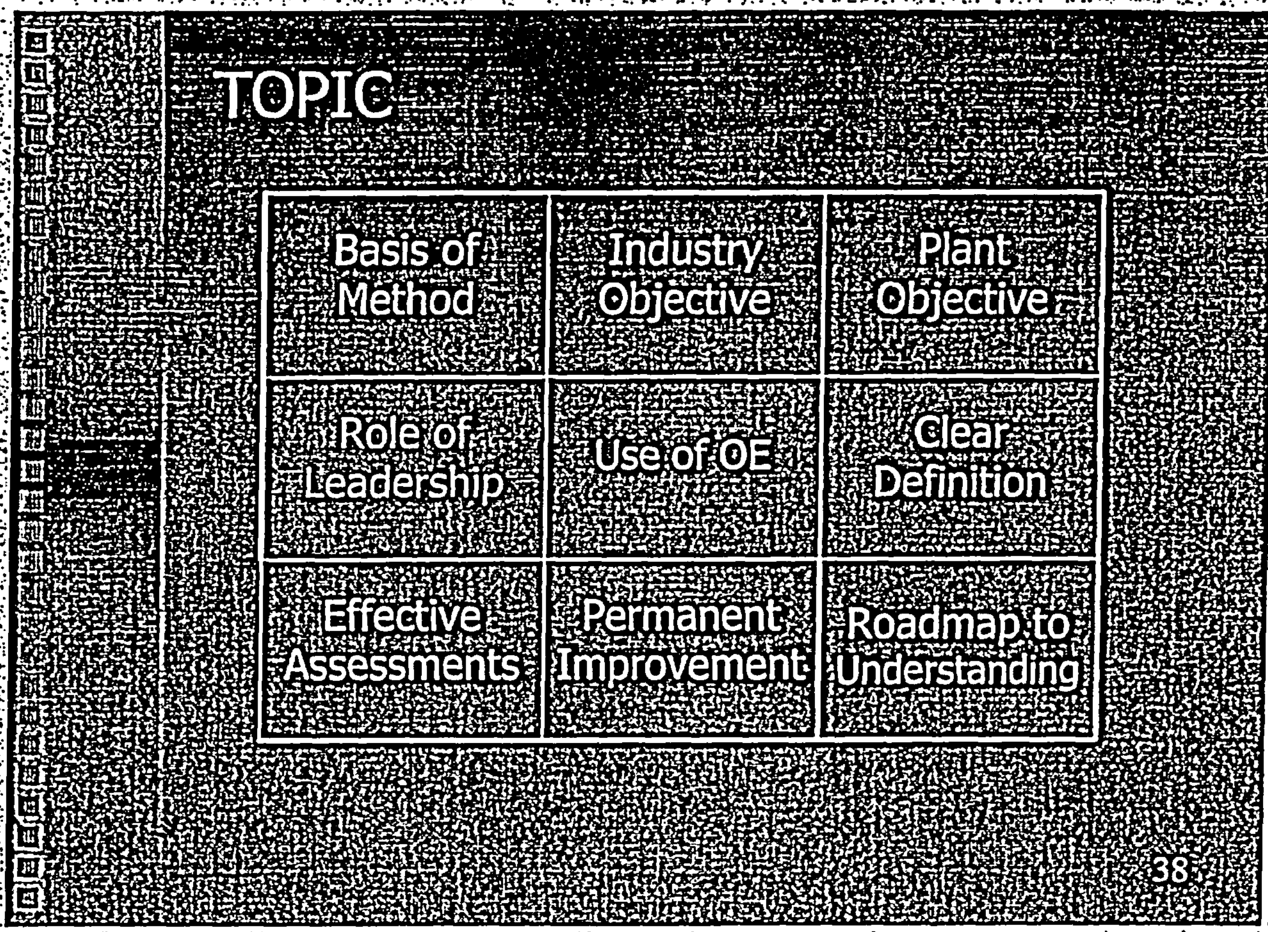
SCWE Understanding Impact of actions on others, Communication Skills, "Crucial Conversations"

SOE

Plant Objective

Safety Culture

Is a human performance safety system that requires regular assessments and maintenance just like a mechanical safety system.


TOPIC
Basis of Method
Industry Objective
Plant Objective
Role of Leadership
Use of OE
Clear Definition
Effective Assessments
Permanent Improvement
Roadmap to Understanding
38

Role of Leadership

Stanley Milgram's Obedience Experiments

At Nuremberg, justification for genocide by those accused was frequently based on "obedience" obeying orders under the authority of their superiors.

To test obedience to authority, Milgram had subjects administer shocks to another "subject" (an actor) behind a wall supposedly wired to electrodes who would react in "pain" when a "shock" was administered.

Role of Leadership

What Happened?

Psychiatrists, behavioral science faculty, adults and students predicted only 4 % would reach 300 volts, and only a pathological fringe would administer the highest shock on the board.

To everyone's surprise, what happened was that no subject male or female stopped before reaching 300 volts (100% of subjects vs. the 4% predicted).

Also to everyone's surprise, 65% obeyed orders to the very end of the 450-volt scale.

Role of Leadership

Chief Finding: Extreme willingness to obey

The chief finding of the Millgram study is the extreme willingness of adults to go to almost any lengths on the command of authority.

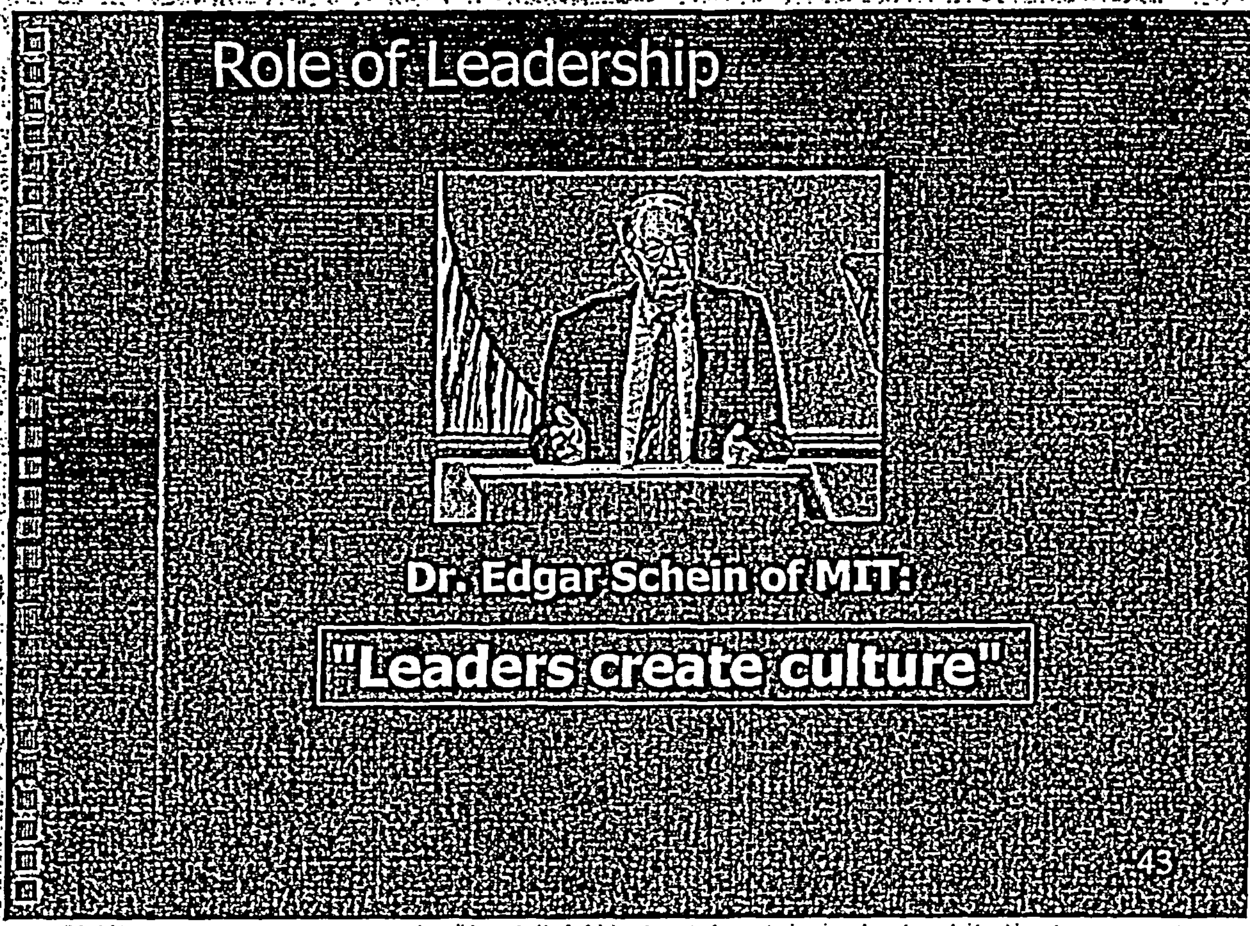
In a variation of the experiment, the subject assisted an actor who was administering the shocks. When assisting, 37 of 40 subjects continued on to the end, or 92%.

Role of Leadership

Implications for HHV safety culture:

The 92% value in the variation may be representative of a case where a manager of a group implements an unethical directive from above, and the members of the group perceive their actions as assisting the manager.

Milgram's experiments indicate the ability of authority to create cultures, including negative, unsafe or unethical cultures, with <u>surprisingly little objection or resistance</u>.


Role of Leadership
Dr. Edgar Schein of MIT:
"Leaders create culture"
43

Role of Leadership

INPO®
Institute of Nuclear Power Operations
on for excellence in safety and performance

"Safety culture is the central role of leadership"

- INPO Human Performance Fundamentals Training

Role of Leadership

"Safety culture flows down from the actions of senior management."

-INSAG

Role of Leadership

The cornerstone concept:

Leadership Behavior Creates Org Culture

Role of Leadership

Douglas McGregor
theory x / theory y
management behavior

Role of Leadership

Theory x

- The average person dislikes work and will avoid it he/she can.
- Therefore most people must be forced with the threat of punishment to work towards organizational objectives.
- The average person prefers to be directed; to avoid responsibility; is relatively unambitious.

Role of Leadership

Theory y

- People will apply self-control and self-direction in the pursuit of organizational objectives.
- People will do this without external control or the threat of punishment.
- Commitment to objectives is a function of rewards associated with their achievement.
- People usually accept and often seek responsibility.

Role of Leadership

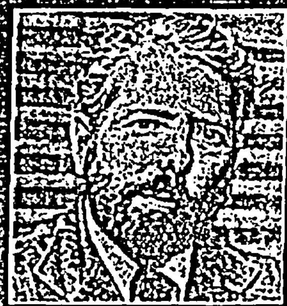
Theory y behavior
aligns with Industry Guidance for Fostering Positive Safety Cultures

INPO®
Institute of Nuclear Power Operations
...on for excellence in safety and performance

IAEA

Theory x behavior
does not

Role of Leadership



Stanley Milgram 1974

"The mutual support provided by men for each other is the strongest bulwark we have against the excesses of authority."

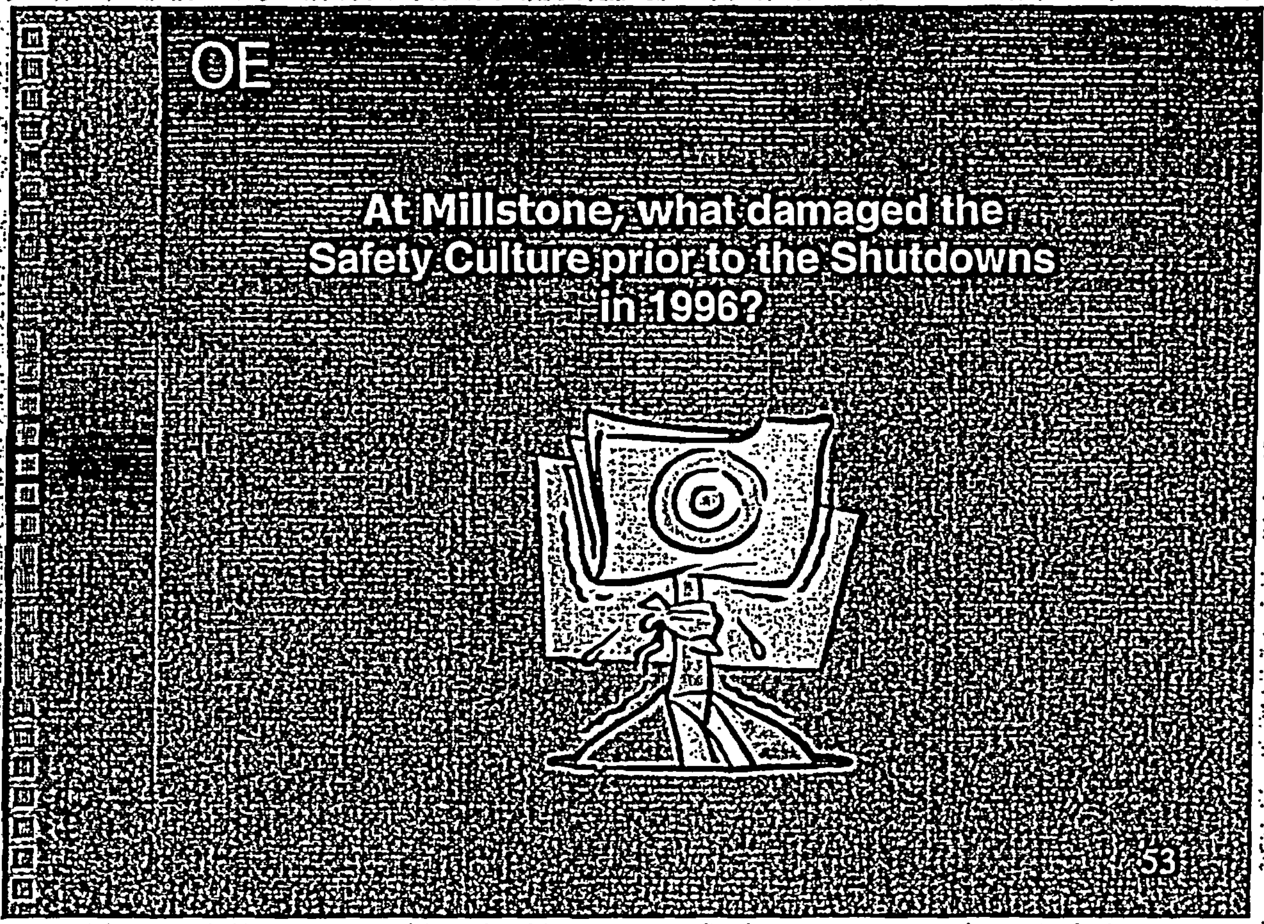
Dr. Roger Dean Duncan:

"Managers with poor cultures should not be allowed to hide out in organizations"

TOPIC

Basis of Method	Industry Objective	Plant Objective
Role of Leadership	Use of OE	Clear Definition
Effective Assessments	Permanent Improvement	Roadmap to Understanding

52


OE
At Millstone, what damaged the Safety Culture prior to the Shutdowns in 1996?
53

Use of OE

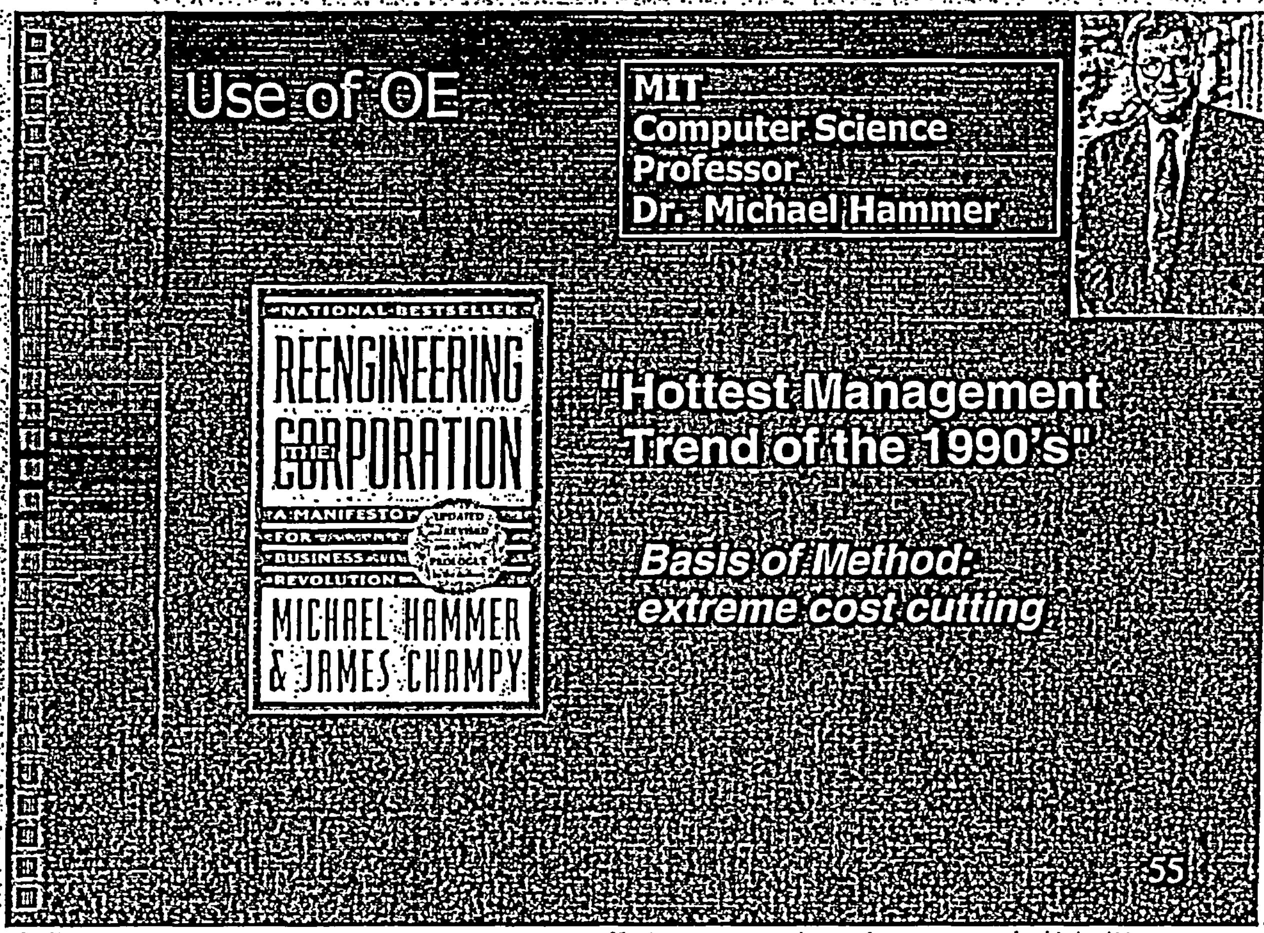
Millstone Senior Leadership enacts Philosophy of Extreme Cost Cutting

"We can no longer afford to be a Cadillac"

"If something is not necessary to do, it is necessary not to do"

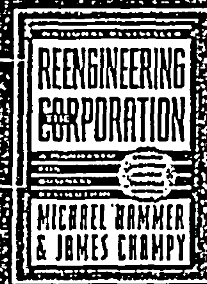
"If you don't like how we must now operate, there are people willing to take your place"

Improvement suggestions (workers and NRC) ignored
Many reports and evidence of "shoot the messenger"
Workers afraid to raise concerns
Loss of trust that the plant is operating safely


Use of OE
MIT
Computer Science
Professor
Dr. Michael Hammer
NATIONAL BESTSELLER
REENGINEERING
THE CORPORATION
A MANIFESTO
FOR
BUSINESS
REVOLUTION
MICHAEL HAMMER
& JAMES CHAMPY
"Hottest Management Trend of the 1990's"
Basis of Method:
extreme cost cutting
55

Use of OE

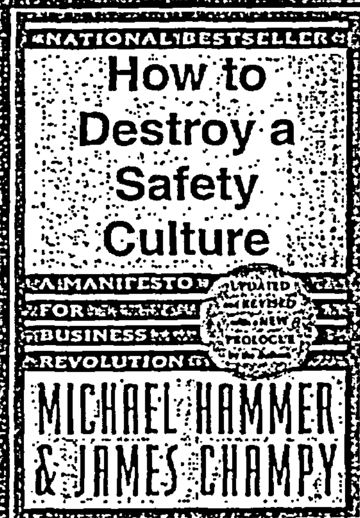
Since the 1990's
> 70% failure rate



Dr. Michael Hammer today on Reengineering failures:

"I forgot about people, I learned people are essential"

Use of OE



The book might just as well have been titled:

"How to destroy a safety culture"

Use of OE

John Beck's Final Message to Millstone Leadership:

John Beck

"Never forget that previous management failed so miserably, not because they were not intelligent, not because they did not understand clearly what successful economics looked like in a competitive environment...

...they failed because they were arrogant, dismissive, and refused to listen to the issues and concerns of the people who make this place run.

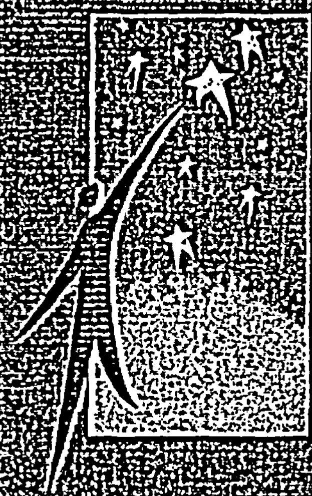
Use of OE

In other words, they failed because they forgot about people.

Use of OE

The new Millstone senior managers said the most difficult part of recovery was restoring the manager / worker trust relationship

Use of OE



How do you restore a Safety Culture from one of the worst

to one of the very best in the industry?

Millstone OE

Lee Olivier, CNO Millstone Recovery

Millstone OE

"Show people that you care about excellence and that you care about them,

and when you do these things you build trust coupled with higher expectations"

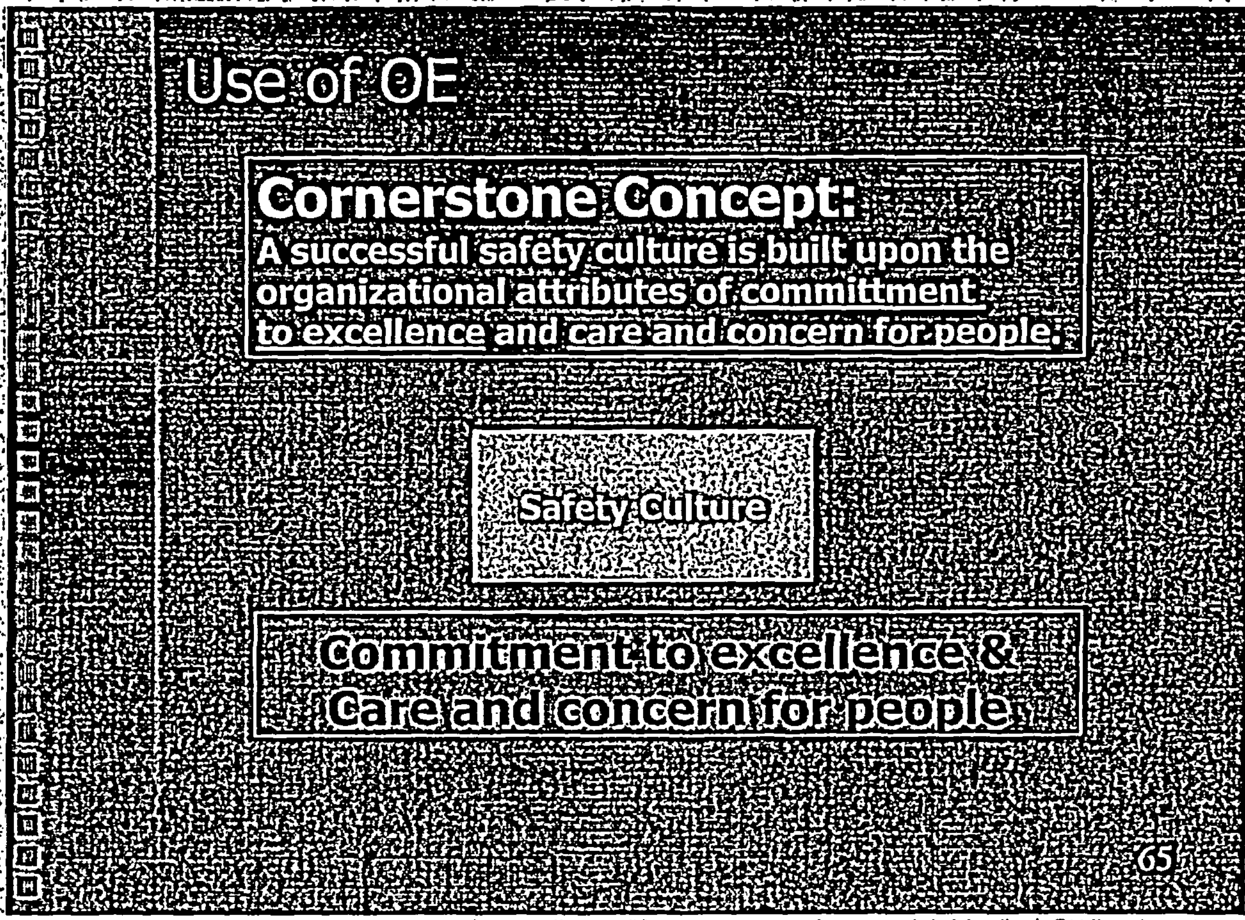
Millstone OE

Fundamental attributes of safety culture

The essence of safety is a high level of care and concern for people. The fundamental attributes of a safety culture are:

- Commitment to excellence
- Care and concern for people

This is the main OE lesson of Millstone Recovery.


Use of OE
Cornerstone Concept:
A successful safety culture is built upon the organizational attributes of committment to excellence and care and concern for people.
Safety Culture
Commitment to excellence &
Care and concern for people
65

Use of OE

Quality Management Theory: Building Trust

Dr. S. Tom Foster, professor, author, consultant in quality management.

"The number one thing a leader does that builds trust is to support worker quality improvement efforts"

Use of OE

Strategic Management Theory: Adaptive Cultures

Thompson & Strickland

Deregulation has created a need for adaptive cultures across the US energy industry. All nuclear plants must adapt to lower costs while maintaining a strong safety focus.

According to SMT, in an adaptive culture it is most important that top management demonstrate genuine care and concern for all stakeholders.

Use of OE

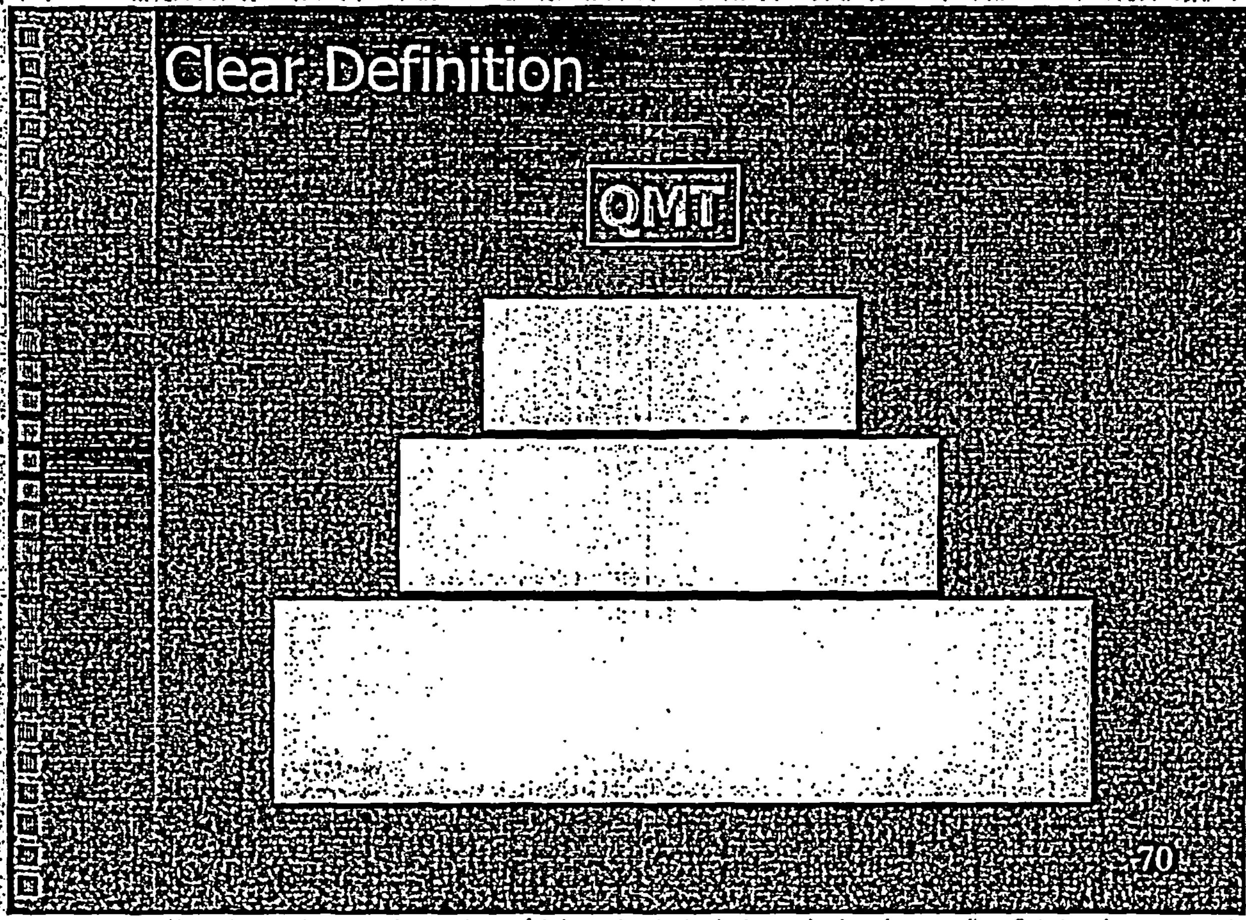
Cornerstone Concept:
Commitment to excellence and care and concern for people are the fundamental attributes needed for a successful HHV culture in a competitive environment.

Safety Culture
Quality Culture
Adaptive Culture

Commitment to excellence &
Care and concern for people

TOPIC

Basis of Method	Industry Objective	Plant Objective
Role of Leadership	Use of OE	Clear Definition
Effective Assessments	Permanent Improvement	Roadmap to Understanding

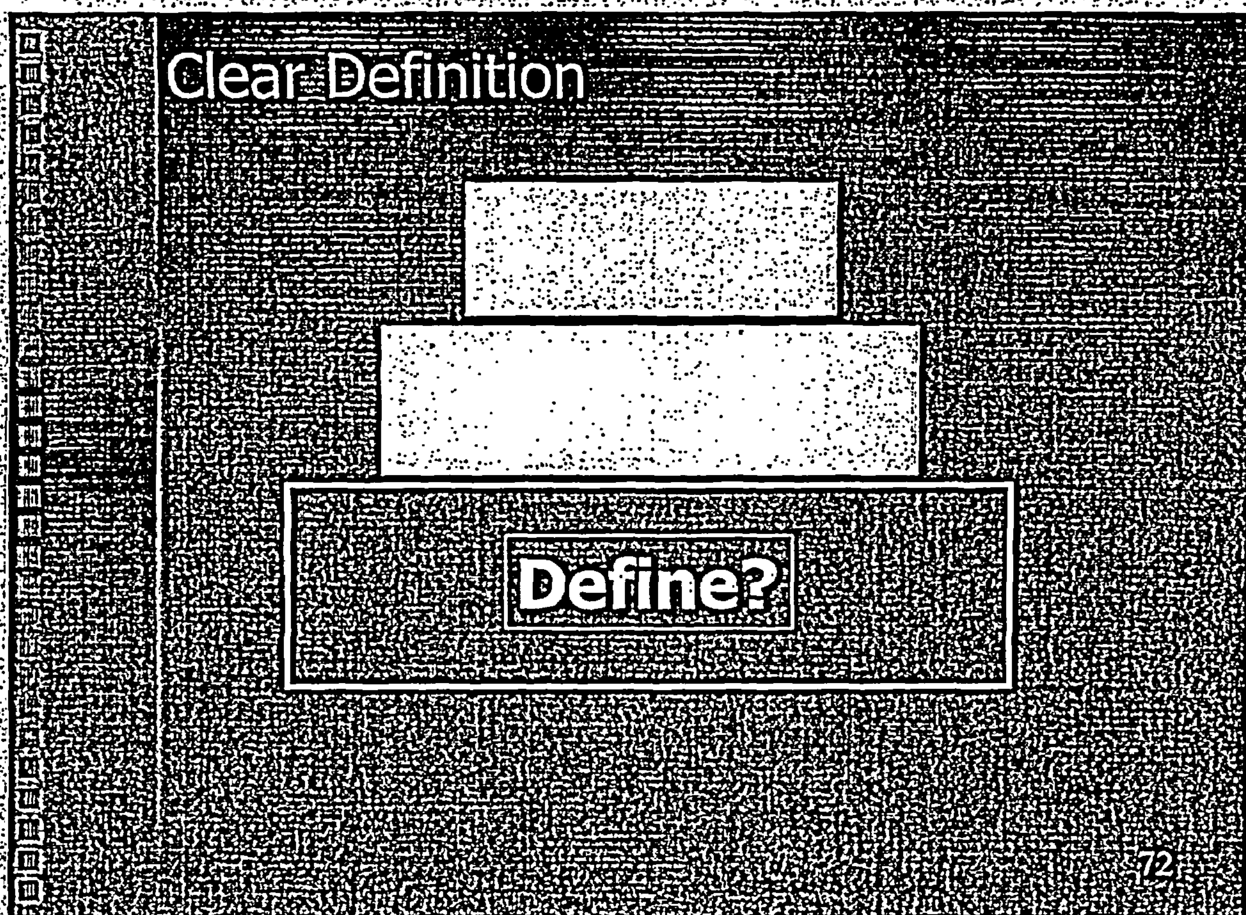

Clear Definition
QMT
70

Clear Definition

NRC Chairman
Dr. Richard Meserve
November 2002 INPO Conference:

"The concept of safety culture is not crisply defined...

...it is not surprising that the NRC and other organizations have not found an unambiguous way to measure it."


Clear Definition
Define?
72

Clear Definition

Proposed Clear Definition for HHV Safety Culture:

An ethical attitude within a high hazard venture organization, instilled and maintained by the managing leadership, which ensures the activity being managed first does no harm to people or the environment.

TOPIC

Basis of Method	Industry Objective	Plant Objective
Role of Leadership	Use of OE	Clear Definition
Effective Assessments	Permanent Improvement	Roadmap to Understanding

Effective Assessments – What Works?

Organizational Culture Expert

MIT Professor Edgar Schein on culture assessment:

Observe the artifacts of the culture: what do you see, hear and feel while hanging around?

Do the shared tacit assumptions (the real culture) align with the espoused values (the stated culture)?

Effective Assessments - What Works?

Does the walk match the talk?

Culture is assessed by reviewing the observed behavior (artifacts) and evaluating whether the observed behavior aligns with the stated (espoused) values, or if there are other beliefs for how people should behave in the organization (shared tacit assumptions).

Do the artifacts indicate this:	Or this:
BEHAVIOR	BEHAVIOR
VALUES	VALUES

Effective Assessments – What Works?

Schein on Culture Surveys:

Surveys (alone) <u>don't work</u>. Surveys can only flag (in a general way) whether the espoused values are being met or not.

A focus group is needed to identify the true culture, the "shared tacit assumptions".

Effective Assessments - What Works?

Organizational Safety Culture Expert

MIT Professor John Carroll

The (culture) survey data is almost irrelevant, it's the conversations around the survey and the actions based on those conversations that are important.

Effective Assessments – What Works?

Surveys

In a large organization such as a nuclear plant, it is not practical to regularly form focus groups with all workers, so culture surveys are necessary.

The survey should not attempt to solicit answers to every conceivable (hundreds of) culture questions, because it is not possible to discern the true culture in this manner.

The survey should ask general questions and flag general areas where the culture is suspect. The true culture (the shared tacit assumptions) is then determined from a focus group discussion.

Effective Assessments – What Works?

Test of Method at Millstone

Effective Assessments - What Works?

Field Test

The proposed method was field tested at Millstone in the fall of 2000

Survey

Simple, quick surveys on leaders were filled out by staff, answers are binned simply as "good", "neutral", or "needs more focus"

Reports

Leaders received individual reports on their culture as perceived by their staff

Follow-up

When a significant portion (a third or more) of the staff reported more focus needed, need for a focus group was indicated

Effective Assessments – What Works?

Survey example

DEMONSTRATION OF TRUST

GOOD	NEUTRAL, DON'T KNOW	MORE FOCUS NEEDED
4	1, 2	3

- "do the right thing" attitude
2. safety priority over production
3. commitments honored
4. open, honest communications

Effective Assessments – What Works?

Survey example

DEMONSTRATION OF CARE

GOOD	NEUTRAL DONT KNOW	MORE FOCUS NEEDED
6, 7, 8		5

- shows care and respect, does not blame individuals

6. encourages questions, listens well, not defensive
7. holds regular meetings, requests and uses feedback
8. ensures appropriate training, workload, and schedules

Effective Assessments - What Works?

Survey example

DEMONSTRATION OF EXCELLENCE

GOOD	NEUTRAL DON'T KNOW	MORE FOCUS NEEDED
10, 11	12	9

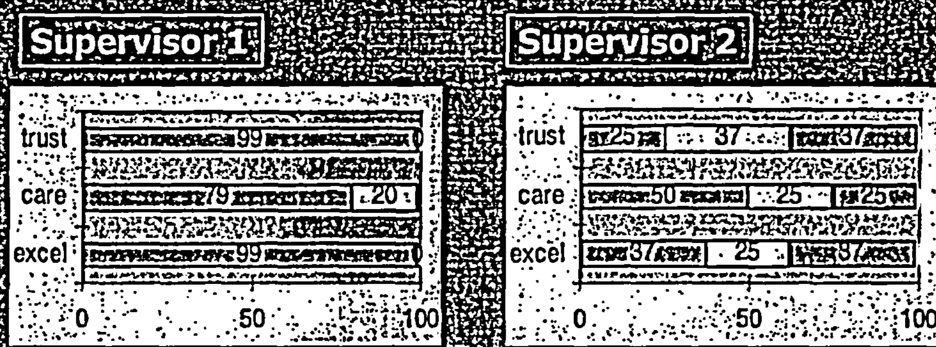
- values errors as learning opportunities

10. ensures process is properly implemented
11. use of OE, industry guidance, lessons learned
12. supports quality improvement efforts

Effective Assessments - What Works?

Results example

Bars:
green - good
white - neutral
red - focus needed

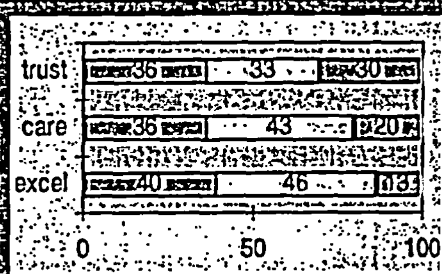


Effective Assessments - What Works?

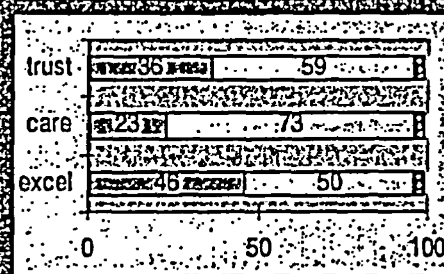
Results example

Bars:
green - good
white - neutral
red - focus needed

Department Manager



Plant Manager



Effective Assessments -- What Works?

Best Method

Why this method may prove to be a "best method"

- Integration of expert information
- Proper focus (leadership behavior)
- Suitable metrics
- Complete conceptual framework
- Many endorsements from leading experts

Effective Assessments - What Works?

Study of Safety Culture Assessment Methods

John Sorensen NRC ACRS

Senior NRC ACRS Fellow John Sorensen Study: "Safety Culture - A Survey of the State of the Art"

- Identified criteria, block diagram "roadmap" of elements necessary for effective assessment
- Reviewed a variety of methodologies against the criteria, including the ubiquitous INSAG approach, and including the organization process approach applied at Davis Besse during recovery and elsewhere.

Effective Assessments - What Works?

John Sorensen NRC ACRS

Results:

- None of the methods studied met Sorensen's criteria for an effective assessment.
- None followed the conceptual framework outlined in the paper.
- All were empirical attempts that were unsystematic and underspecified
- None developed attributes and indicators that clearly linked safety culture to safety of operations.

Effective Assessments – What Works?

Sorensen's comments on the method in this presentation:

John Sorensen
NRC ACRS

- The idea of using leadership culture as a surrogate for safety culture is a good one.
- The conceptual framework looks relatively complete
- The importance of suitable metrics shouldn't be underestimated.
- There is a reasonable chance that management could accept this kind of measurement.
- A very promising approach, one that has a good chance of advancing the "state-of-the-art."

Effective Assessments - What Works?

John Beck
lead culture assessor for Millstone and Davis Besse recovery

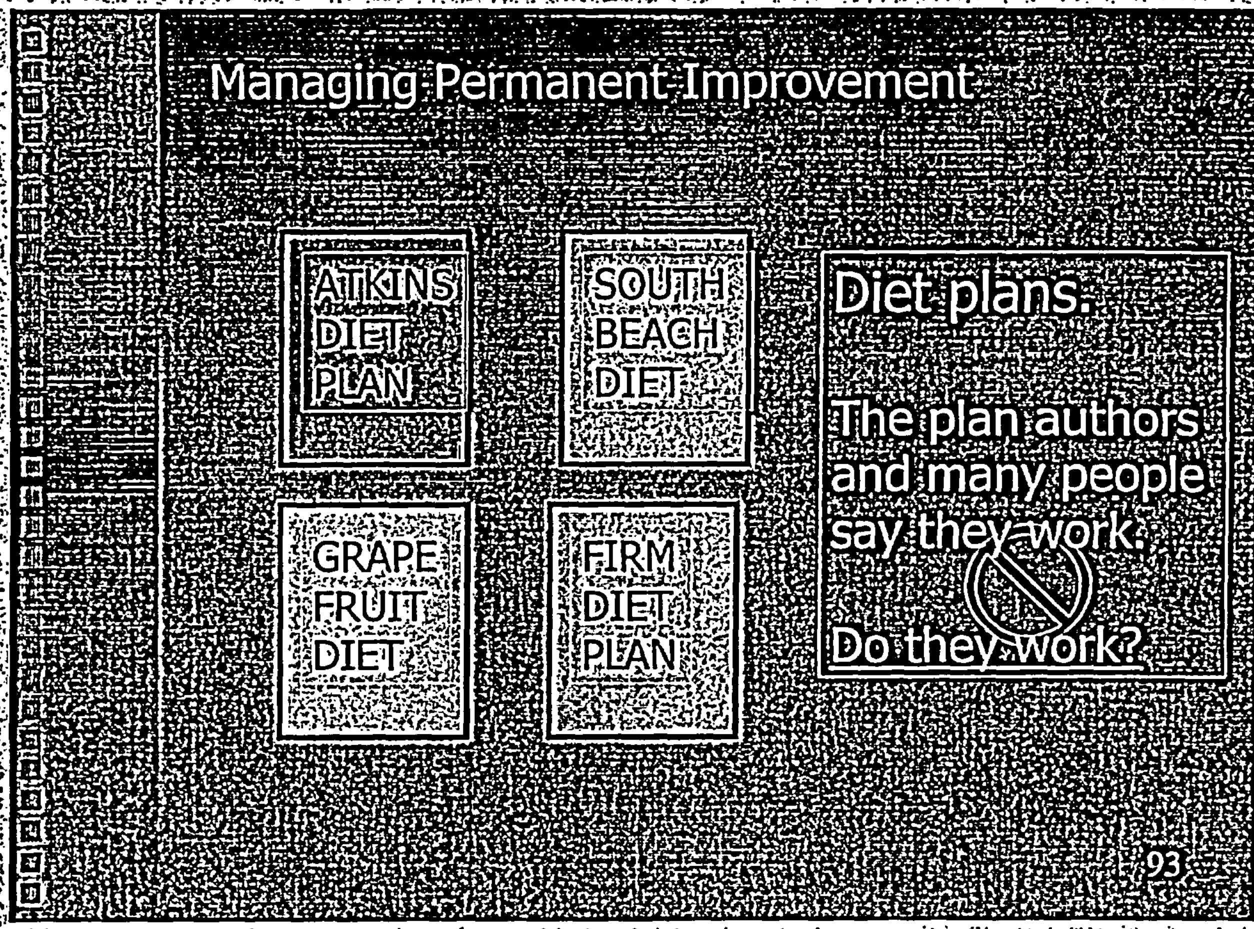
Comments on the method in this presenation:

John Beck

"Very good stuff. This tool, used intelligently, could be of benefit to management if they chose to take advantage of it..."

TOPIC

Basis of Method	Industry Objective	Plant Objective
Role of Leadership	Use of OE	Clear Definition
Effective Assessments	Permanent Improvement	Roadmap to Understanding


Managing Permanent Improvement
ATKINS DIET PLAN
SOUTH BEACH DIET
GRAPE FRUIT DIET
FIRM DIET PLAN
Diet plans.
The plan authors and many people say they work.
Do they work?
93

Managing Permanent Improvement

Diet Plans - Do they work?

National Institutes of Health on dieting:

Within five years 95-98% of people who lose weight gain it back, and 90% gain back more weight than they lost.

Only 2-5% succeed. The failure of weight loss programs is so great that a leading researcher has said:

"Dieting is the leading cause of obesity in the US."

Managing Permanent Improvement

INPO HU FUNDA MENTALS

DAVIS BESSE SOER

INPO New 8 PRINC IPLES!

INSAG 15 How to...

Culture plans.

The plan authors and many people say they work.

Do they work?

Managing Permanent Improvement

Culture plans - Do they work?

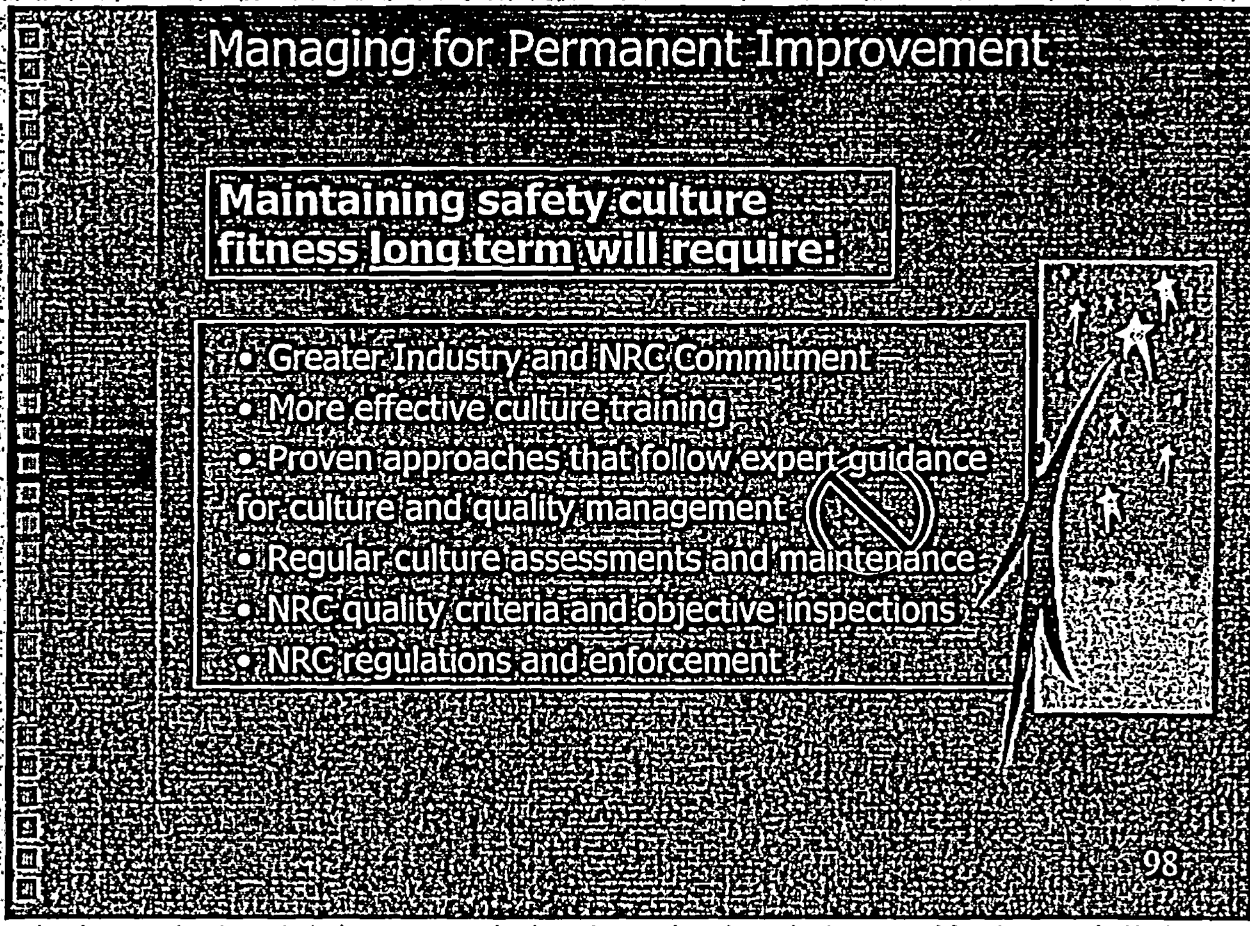
Considerable evidence suggests that few of the culture assessment and management methods currently used in the industry are effective. This is suggested by:

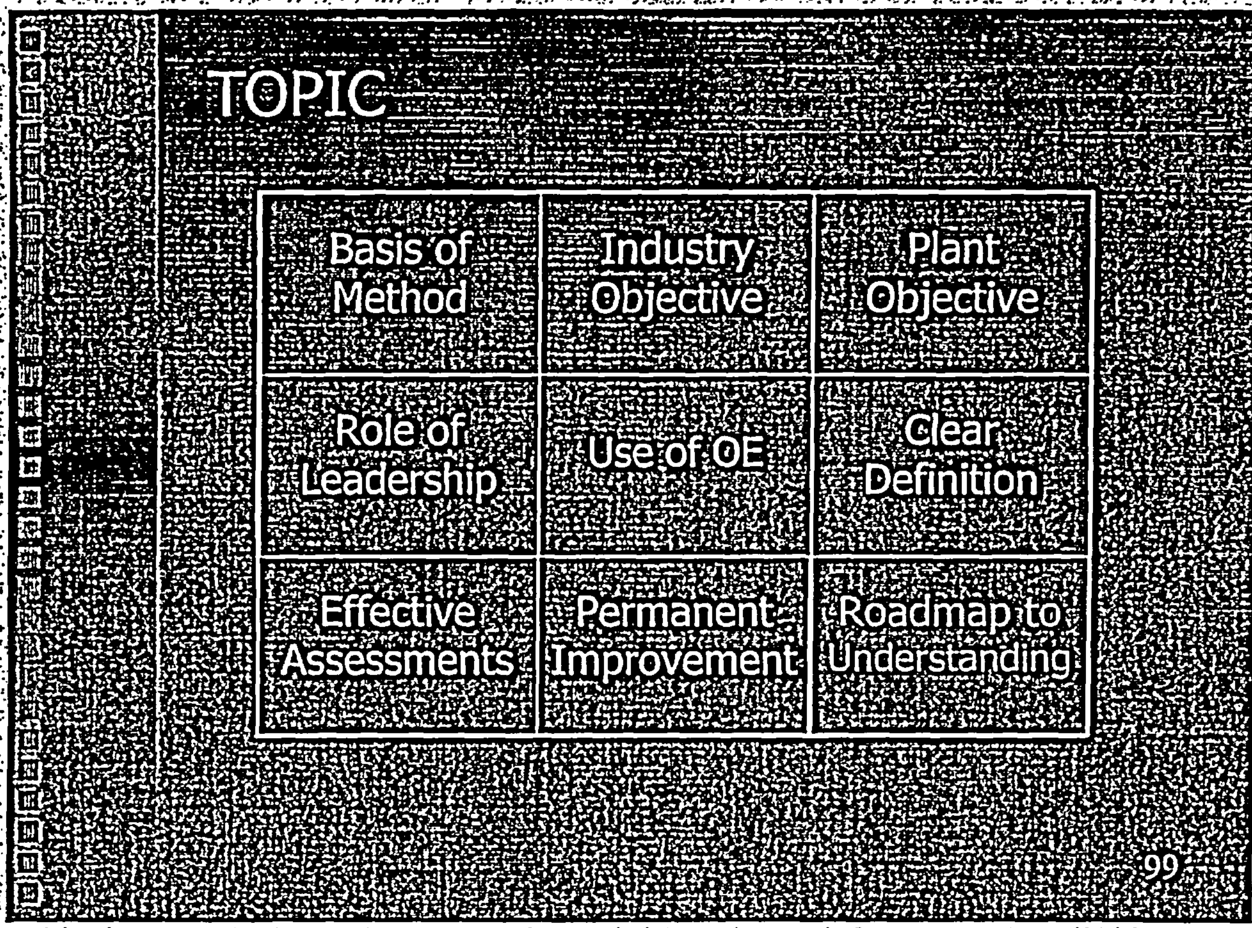
- Lack of integration with studies by culture experts Sorensen, Schein, Carroll et. al.
- Inability of methods to establish attributes and criteria
- Violation of quality assessment principles
- Ineffectiveness of the INSAG methods
- The inability of NRC and INPO inspections to flag culture problems pre-event at Davis Besse.
- The failure of Davis Besse to establish a strong, unambiguously positive culture prior to restart.

Managing Permanent Improvement

Why don't the existing methods work?

Current industry approaches either do not follow expert culture assessment guidance, or violate the fundamentals of quality management theory or apply unproven "brainchild" methods


Managing for Permanent Improvement
Maintaining safety culture fitness long term will require:
• Greater Industry and NRC Commitment
• More effective culture training
• Proven approaches that follow expert guidance for culture and quality management
• Regular culture assessments and maintenance
• NRC quality criteria and objective inspections
• NRC regulations and enforcement
98


TOPIC
Basis of Method
Industry Objective
Plant Objective
Role of Leadership
Use of OE
Clear Definition
Effective Assessments
Permanent Improvement
Roadmap to Understanding
99

Roadmap to Understanding

- Nuclear is Different
- Most Frequent Causal Factor
- Human Performance Safety System
- Defense-in-depth Ethical Attitude
- Central Role of Leadership
- Clear Definition
- Methodology Development
- Integrated Approach

Roadmap to Understanding

Nuclear is Different

Nuclear is Different

The nuclear energy industry needs to understand that high hazard venture or "nuclear" safety culture differs from OSHA safety culture. It is not the hardhat safety culture but the nuclear safety culture that protects a plant from significant operating events.

Roadmap to Understanding

Most Frequent Causal Factor

Most Frequent Causal Factor

The nuclear energy industry needs to understand that a weak nuclear safety culture is the most frequently identified SOE causal factor. The industry needs to set a goal of cutting the frequency of safety culture as a SOE causal factor in half.

Roadmap to Understanding

Human Performance QA Safety System

Human Performance QA Safety System

The industry needs to manage safety culture as a human performance safety system that requires regular assessment, maintenance and regulation just like a mechanical or electrical safety system. The first step toward managing the quality of safety cultures will be to add safety culture to QA Programs across the industry.

13

Roadmap to Understanding

Defense-in-depth Ethical Attitude

Defense-in-depth Ethical Attitude

The industry needs to understand safety culture as an ethical attitude, a defense-in-depth attitude of workers, managers, internal oversight, and external oversight. An ethical attitude that ensures the hazardous activity being managed and operated does not harm people or the environment.

Roadmap to Understanding

Central Role of Leadership

The industry needs to understand that safety culture is, as INPO says, the "central role of leadership", and manage safety culture by assessing how well leadership performs this role.

Central Role of Leadership

Roadmap to Understanding

Clear Definition

The industry needs to understand the management-measurement-definition relationship requires the development of a clear definition from which the fundamental attributes of safety culture can be clearly and unambiguously identified.

Clear Definition

Roadmap to Understanding

Methodology Development

Once a clear definition has been established, and the attributes clearly identified, an optimal assessment, management and regulatory approach needs to be developed.

Methodology Development

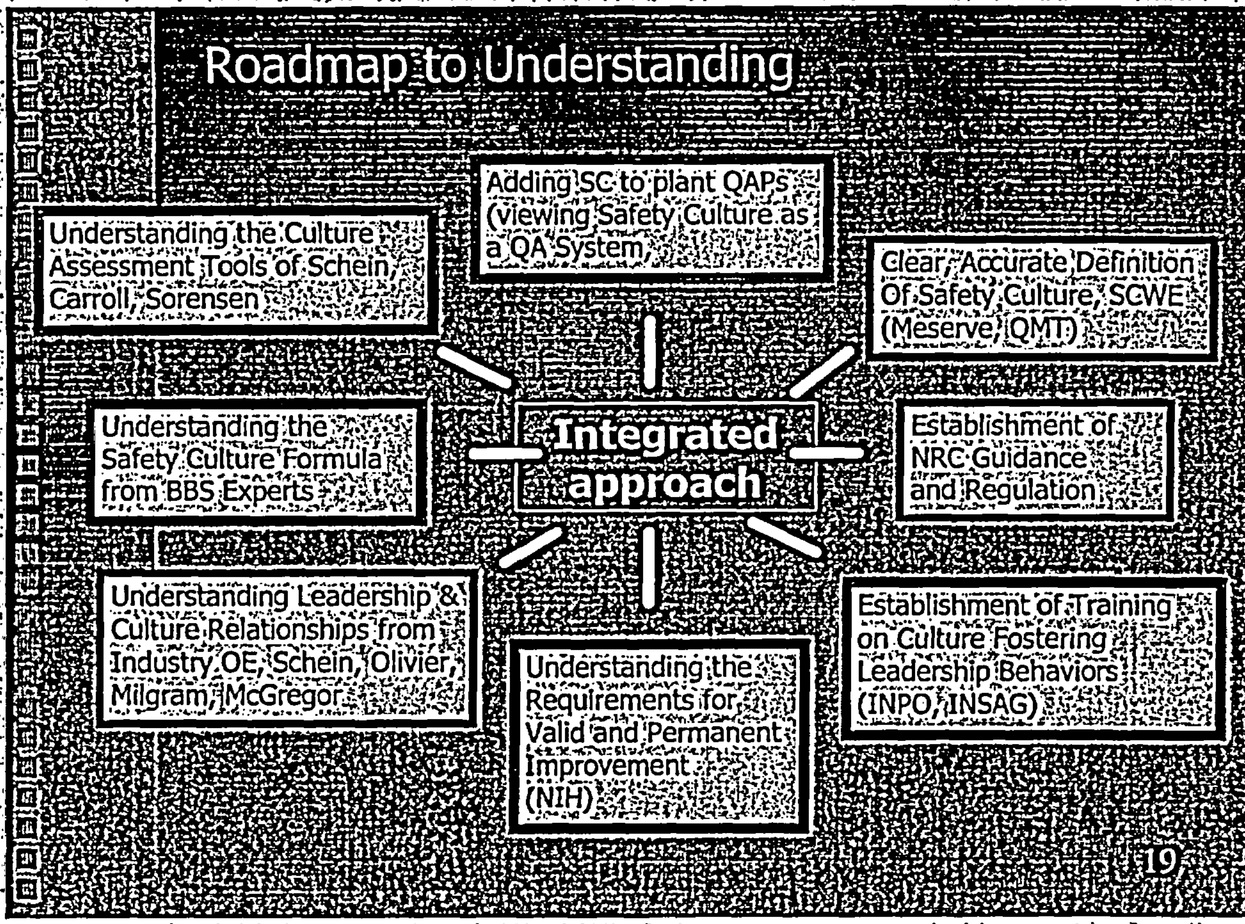
Roadmap to Understanding

Integrated Approach

Development of an optimal method requires an integrated approach with input from all of the following sources:

- culture experts
- industry OE
- proven management approaches
- proven regulatory approaches

Integrated Approach


Roadmap to Understanding
Adding SC to plant QAPs (viewing Safety Culture as a QA System)
Understanding the Culture Assessment Tools of Schein, Carroll, Sorensen
Clear, Accurate Definition Of Safety Culture, SCWE (Meserve, QMT)
Integrated approach
Understanding the Safety Culture Formula from BBS Experts
Establishment of NRC Guidance and Regulation
Understanding Leadership & Culture Relationships from Industry OE, Schein, Olivier, Milgram, McGregor
Understanding the Requirements for Valid and Permanent Improvement (NIH)
Establishment of Training on Culture Fostering Leadership Behaviors (INPO, INSAG)
19

Conclusion

Safety culture is a safety related human performance system.

It is the responsibility of the licensees to establish and maintain healthy safety cultures.

It is the responsibility of the NRC to establish regulatory guidance that objectively assures that quality and safety is maintained above a minimal required level for safety related systems, including safety culture.

The NRC has not yet developed the necessary guidance, and licensees have not yet taken the necessary actions to assure that the contribution of safety culture as a causal factor of SOEs is maintained ALARA.

RDB received 11/12/04

10/14/04

69FR61049

(2)

From: <David_M_Collins@dom.com>
To: <nrcrep@nrc.gov>
Date: Fri, Nov 12, 2004 1:56 PM
Subject: Additional information

(See attached file: D.Collins Bio.doc)(See attached file: INPO HU Jobsite and Individual chapter2.pdf)(See attached file: INPO HU Leadership chapter4.pdf)

David M. Collins
Engineering Analyst
Millstone Power Station
Dominion Nuclear Connecticut
Phone 1-800-269-9994 x3710
Fax 860-437-5916

CC: <LLJ@nrc.gov>

E-RIDS=ADM-03
Call = A. Markley (ADM)
L. Jarrick (H-5)

Template=ADM-013

Mail Envelope Properties (4195074F.D7D : 20 : 36221)

Subject: Additional information
Creation Date: 11/12/04 1:52PM
From: <David_M_Collins@dom.com>

Created By: David_M_Collins@dom.com

Recipients
nrc.gov
twf2_po.TWFN_DO
NRCREP

nrc.gov
owf4_po.OWFN_DO
LLJ CC (Lisamarie Jarriel)

Post Office	Route
twf2_po.TWFN_DO	nrc.gov
owf4_po.OWFN_DO	nrc.gov

Files	Size	Date & Time
MESSAGE	290	11/12/04 01:52PM
D.Collins Bio.doc	652800	
INPO HU Jobsite and Individual chapter2.pdf		2052319
INPO HU Leadership chapter4.pdf		1825037
Mime.822	6201404	

Options

Expiration Date:	None
Priority:	Standard
Reply Requested:	No
Return Notification:	None
Concealed Subject:	No
Security:	Standard

David M. Collins Bio

I have a masters degree in Executive Engineering Management from the University of New Haven.

Since the events that unfolded at Millstone from 1996-1998 I have been studying the management of safety culture.

Since 1998 I have discussed the subject of safety culture management with many PhDs and Industry experts, written papers (including a thesis paper) on the subject, been quoted in a number newspaper articles (mostly related to Davis Besse), and presented to various Industry groups.

Presentations:

1. June 2003 ACRS Safety Culture Workshop
2. June 2003 9th Annual HPRCT Workshop
3. December 2003 University of New Haven (Thesis Defense)
4. May 2004 Spring INPO Human Performance Conference
5. June/July 2004 Millstone Employee Concerns Program Peer Group
6. August 2004 ANS Utility Working Conference

I am currently preparing an article on Safety Culture Management for *Reliability Engineering and System Safety Journal* at the suggestion of the editor, NRC ACRS member and MIT Engineering Professor Dr. George Apostolakis.

I live with my wife Kathy in Old Lyme, Connecticut where the Connecticut River meets Long Island Sound.

CHAPTER 2

THE JOB SITE AND THE INDIVIDUAL

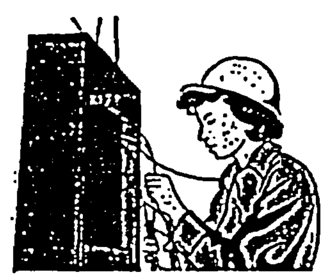
HUMAN FALLIBILITY AND VULNERABILITY

Humans possess an *innate characteristic* to be imprecise—human nature. Human nature comprises all mental, emotional, social, physical, and biological characteristics that define human tendencies, abilities, and limitations. For instance, humans tend to perform poorly under high stress and undue time pressure. Because of human variability, the best any human being can be is 99.99+ percent reliable. The adage, "To err is human..." reminds us that error is always to be anticipated. Because of 'fallibility,' human beings are vulnerable to *external* conditions that exceed the limitations of human nature. Vulnerability to such conditions makes people susceptible to error. This is especially true when people work within complex systems (hardware or administrative) that have concealed weaknesses—latent conditions that either provoke error or weaken defenses against the consequences of error.

> *The ability to detect error-likely situations to head off preventable events depends largely on how well these factors are understood regarding their role in human error.*
>
> -Dr. James Reason
> *Human Error*

The job site is any location where either the physical or paper plant can be changed. The physical plant comprises the systems, structures, and components that function to support the production of electricity or to protect the reactor core. The "paper" plant consists of the design bases and other documentation needed to help control the configuration of the physical plant. Flaws in the paper plant can lie dormant and can lead to undesirable outcomes in the physical plant or even personal injury. Front-line workers 'touch' the physical plant as they perform their assigned tasks. Supervisors observe, direct, and coach workers. Engineers and other technical staff perform activities that alter the 'paper' plant or modify processes and procedures that direct the activities of workers in the physical plant. Managers influence worker and staff behavior by their verbal or written directives and personal example. All this activity requires "control," since all human activity involves the risk of error.

Common Traps of Human Nature



There is always a chance of error. Because consequential error is a rare occurrence, people tend to overestimate their ability to maintain control during task performance. There is a general lack of appreciation of the limits of human capabilities. Whenever the limits of human capabilities are exceeded, the likelihood of error increases. The following characteristics of human nature, among others, are commonly encountered whenever performing activities in a complex work environment.

Stress. Stress is the body's mental and physical response to a perceived threat(s) in the environment. The important word is *perceived*; the perception one has about his or her ability to cope with the threat. Stress increases as familiarity with a situation decreases. It can result in panic, inhibiting the ability to effectively sense, perceive, recall, think, or act. Anxiety and fear usually follow when an individual feels unable to respond successfully. Along with anxiety and fear, memory lapses are among the first symptoms to appear. The inability to think critically or to perform physical acts with accuracy soon follows. Effective strategies for reducing the effects of stress and improving performance include good health, skills training, procedure adherence, and teamwork.

Mental Strain Avoidance. Humans are naturally reluctant to engage in concentrated thinking as it requires high levels of attention for extended periods. Thinking is a slow, laborious process that requires great effort.[1] Consequently, people tend to look for familiar patterns and apply well-tried solutions to a problem. They are tempted to settle for satisfactory rather than the best solutions. Mental biases, or shortcuts, used to reduce mental effort include:

- assumptions – a condition taken for granted or accepted as true without verification of the facts
- habit – an unconscious pattern of behavior acquired through frequent repetition
- confirmation bias – the reluctance to abandon a current solution—to change one's mind—in light of conflicting information due to the investment of time and effort in current solution. This bias orients the mind to 'see' evidence that supports the original supposition and to ignore or rationalize away conflicting data.[2]
- similarity bias – the tendency to recall solutions from situations that appear similar to those that have proved useful from past experience
- frequency bias – a gamble that a frequently used solution will work; giving greater weight to information that occurs more frequently or is more recent
- availability bias – the tendency to settle on solutions or courses of action that readily come to mind and appear satisfactory; more weight is placed on information that is available (even though it could be wrong).[3,4] This is related to a tendency to assign a cause-effect relationship between two events because they occur almost at the same time.[5]

Inaccurate Mental Models. Humans remember information in terms of key words, phrases, and pictures. All details typically cannot be remembered. Because human beings tend to minimize mental strain, representations or simple pictures of system statuses are inherently flawed since they do not contain all information. This is due in part to a limited working memory.

Limited Working Memory. The mind's "workbench" for problem-solving and decision-making is very forgetful. This temporary, attention-demanding storeroom is used to *remember* new information and is actively involved during learning, storing, and recalling information.[6] Most people can reliably remember three or four items at a time while the upper limit is five to seven items. Using placekeeping techniques while using complex procedures accommodates this limitation.

> *Machines are fast, accurate, and dumb. Humans are slow, sloppy, and brilliant.*
>
> *-unknown submariner*

Limited Attention Resources. The limited ability to concentrate on two or more activities challenges the ability to process information to solve problems. Studies have shown that the mind can *concentrate* on, at most, two or three things simultaneously.[7] Stress usually leads to the "tunneling" or "vagabonding" effects in the ability to accurately focus on available and relevant information. Tunneling occurs when an individual focuses on only one source of information to the exclusion of others. Vagabonding occurs when a person looks at everything without really understanding its meaning. Important information may be ignored or overlooked. Attention can be improved by experience, training, procedures and teamwork.[8]

Mind-Set. People tend to focus more on what they want to accomplish (goal) and less on what needs to be avoided because human beings are primarily goal-oriented by nature. As such, people tend to "see" only what the mind expects, or wants, to see.[9] The human mind seeks order, and, once established, it ignores anything outside that mental model. Information that does not fit a mind-set may not be noticed and vice versa, missing that which is not expected or seeing something that is not really present.[10] Prejob briefings, if done mindfully, help people recognize what needs to be avoided (noticed) as well as what needs to be accomplished.

Difficulty Seeing One's Own Error. Individuals, especially when working alone, are particularly susceptible to omissions. People who are too close to a task, or are preoccupied with other tasks, may fail to detect abnormalities. People are encouraged to "focus on the task at hand." However, this is a two-edged sword. Because of our tendency for mind-set and our limited perspective, something may be missed. Peer-checking, concurrent and independent verification techniques help detect errors that an individual can miss.

> *...the mind cannot really notice all there is to notice.*
>
> *-Dr. Edward de Bono*
> *Practical Thinking*

Limited Perspective. Humans cannot see all there is to see. The inability of the human mind to perceive all facts pertinent to a decision challenges problem solving. This is similar to attempting to see all the objects in a locked room through the door's keyhole. It is technically known as "bounded rationality."[11] Only parts of a problem receive one's attention while other parts remain hidden to the individual. This limitation causes an inaccurate mental picture, or model, of a problem and to underestimate the risk.[12] A well-practiced problem-solving methodology is a key element to effective control room team performance during plant upsets as well as for the management team during meetings to address the problems of operating and maintaining the plant.

Susceptibility To Emotional/Social Factors. Anger and embarrassment adversely influence team and individual performance. Problem-solving ability especially in a group may be weakened by emotional obstacles. Pride, embarrassment, and the need to belong to the group may inhibit critical evaluation of proposed solutions, possibly resulting in team errors. (See Team Errors at the conclusion of this chapter.)

Motivated Toward Goal Accomplishment. People want to succeed. They are naturally motivated to adopt behaviors that result in achievement, comfort, convenience, efficiency, and even fun. However, a focus on goal tends to conceal hazards, leading to inaccurate perception of risks. Errors, hazards, and consequences usually result from either incomplete information or assumptions. Also, humans are naturally drawn toward positive experiences and avoid negative consequences, especially if these are immediate and certain. If error-free performance (active errors) is not held up as an important value, or is not established as the standard for performance, then at-risk behavior in the pursuit of job accomplishment can actually be encouraged.

Fatigue. People get tired. Physical, emotional, and mental fatigue can lead to error and poor judgment. Fatigue is affected by both on-the-job demands (production pressures, environment, and reduced staffing) *and* off-duty life style (diet and sleep habits).[13] Human beings possess biological clocks, referred to as circadian rhythms, which have periods of about 24 hours. Fatigue leads to impaired reasoning and decision making, impaired vigilance and attention, slowed mental functioning and reaction time, loss of situation awareness, and adoption of shortcuts.

Unsafe Attitudes

Attitudes can be hazardous to your health—and to the plant. Anyone can possess an unsafe attitude. Although influenced by many factors, *attitudes are chosen.*[14] Unsafe attitudes are derived from beliefs and assumptions about workplace hazards. Hazards are threats of harm. Harm includes physical damage to equipment, personal injury, and even simple human error. Unsafe attitudes blind people to the precursors to harm (exposure to danger). Notice that hazards are not confined to the physical plant; they exist in the office environment as well. The unsafe attitudes that are described below are detrimental to excellent human performance and to the physical plant and are usually driven by one's perception of risk.

Risk Perception. Human beings judge risk poorly, typically underestimating it. Why is this so? Subconsciously, each of us "decides" what to be afraid of and how afraid we should be. Most people think of risk in terms of probability, or likelihood, without adequately considering the possible consequences or severity of the outcome. Our "risk perception" tends to be guided more by our heart than our head. As human beings we consider the factors listed below in varying degrees in assessing the risk of a situation.[15] People are <u>less afraid</u> of risks or situations:

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

What 'feels' safe may, in fact, be dangerous. The following unsafe attitudes create danger in the work place.

Pride. An excessively high opinion of one's ability; arrogance. Being self-focused, pride tends to blind us to the value of what others can provide, hindering teamwork. People with foolish pride think their competence is being called into question when they are corrected about not adhering to expectations. The issue is human fallibility, not their competence. This attitude is evident when someone responds, "Don't tell me what to do!" Because of the limitations of human nature, error-prevention methods are used to control error. As it says in the *Holy Bible*, "Pride goes before destruction." (Psalms 18:16).

Heroic. An exaggerated sense of courage and boldness; the Admiral Farragut syndrome: "Damn the torpedoes, full speed ahead." Usually, reaction is impulsive, thinking something has to be done fast, or all is lost. This perspective is characterized by an extreme focus on goal without consideration of hazards to avoid.

Fatalistic. A defeatist belief that all events are predetermined and inevitable, and nothing can be done to avert fate; "que será, será," (what will be will be) or "Let the chips fall as they may."

Summit Fever. The zeal to finish the closer one gets to a goal. Nearness to goal accomplishment can cause individuals to disregard or not see conditions or factors important to safety; for example, an automobile driver running a red light at a busy intersection.[16]

> *When people hang around a grizzly long enough, eventually she's going to catch somebody doing something stupid.*
>
> *-Tom Murphy photographer, Yellowstone National Park*

Invulnerability. A sense of immunity to error, failure, or injury. Most people do not believe they will err in the next few moments; "That can't happen to me." Error is always a surprise when it happens. This is an outcome of the human limitation to accurately estimate risk. As one person put it, humans are simply "accidents waiting to happen," an expression that reflects Principle No. 1 (see Chapter 1).

Pollyanna. People tend to presume that all is normal and perfect in their immediate surroundings.[17] Humans seek order in their environment, not disorder, to fill in gaps in perception and to see wholes instead of portions.[18] Consequently, people unconsciously believe that everything will go as planned. This is particularly true when people perform 'routine' activities, unconsciously thinking nothing will go wrong. This belief is characterized with quotes such as "What can go wrong", or "It's routine." This attitude promotes an inaccurate perception of risk and can lead individuals to ignore unusual situations or hazards, potentially causing them to react either too late or not at all (related to complacency).[19]

Bald Tire. A belief that past performance is justification for not changing (improving) existing practices or conditions: "I've got 60,000 miles on this set of tires and haven't had a flat yet." A history of success can promote complacency. Evidence of this attitude is characterized with quotes such as, "We haven't had any problems in the past," or "We've always done it this way." Station managers can be tempted to ignore the need to benchmark their processes and practices with other organizations or to reject recommendations for improvement if results have been good.

Awareness of such attitudes among the workforce is a first step toward actions to improve work planning, procedure development, and application of error-prevention methods.

Uneasiness and Intolerance

> *I am always scared. Imagination and fear are among the best engineering tools for preventing tragedy.*
>
> *-Dr. Henry Petroski To Engineer is Human*

Understanding fallibility encourages a proactive perspective toward work. Because of human fallibility, it is easy to err, and a person may not even know it. In light of the limitations of human nature, people in any function should possess a keen sense of uneasiness toward any activity, whether it involves managing, operating, maintaining, or engineering.[20] A nagging doubt that the current job situation may be hiding something endures.[21] Uneasiness prompts a person to "expect success but anticipate failure." A sense of uneasiness will foster intolerance for error traps. Eventually, people become intolerant of working conditions that could provoke error or increase the risk to the plant. Recognizing error-likely situations and degraded or missing defenses forms a strategic foundation for improving human and plant performance.

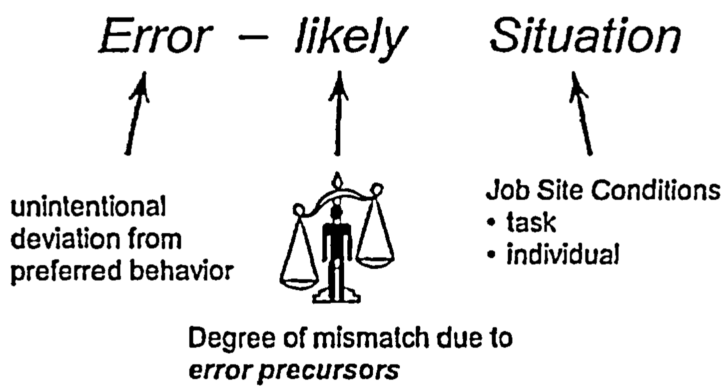
Job-Site Vulnerabilities

The job site is that location where people can "touch" physical plant equipment or alter the "paper" plant. Vulnerability becomes relevant at the job site from two perspectives. First, the physical plant is vulnerable to the mistakes and at-risk behaviors of station personnel, especially front-line workers. *The risk (to the plant) is in people.*[22] Second, people are vulnerable to conditions in the work place that can provoke error. External conditions that can provoke error at the job site are of key concern for management. Such job-site conditions are known as error-likely situations.

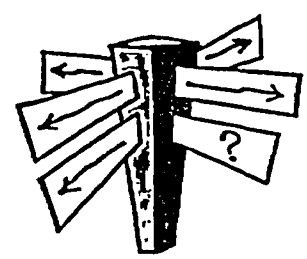
ERROR-LIKELY SITUATION

> *A work situation in which there is greater chance for error when performing a specific action or task in the presence of error precursors.*[23]

An *error-likely situation*—an error about to happen—typically exists when task-related factors exceed the capabilities of the individual (a mismatch) at the point of "touching" either the physical or paper plant.[24] Notice the words *action or task* in the definition. The simple presence of adverse conditions cannot be error-likely unless a specific action is to occur within that set of adverse conditions. A person cannot fall off a bicycle unless he or she rides the bicycle. Darkness is not a factor for performance until an instrument technician attempts to read a label on an instrument. Error-likely situations are also referred to as error traps.



Error Precursors



Unfavorable conditions embedded in the job site that create mismatches between a task and the individual are known as error **precursors**. Error precursors interfere with successful performance, and increase the probability for error.[25] Undesirable job-site conditions can be categorized into one or more of the following four categories:[26]

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

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

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

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

Error precursors are, by definition, prerequisite conditions for error and, therefore, exist *before* the error occurs. If discovered, job-site conditions can be changed to minimize the chance for error. This is more likely if people possess an intolerance for error traps. For example, knowing that drugs and drinking impair one's ability to drive an automobile safely, an individual can choose not to drive, and not to drink or take drugs, even prescription drugs. Such conditions are controllable before performing the task.

Challenge. When a mismatch is reduced by addressing the relevant error precursors, the risk for error is minimized, but a chance for error remains because of human nature. Contamination in radiologically controlled areas is controlled to minimize the risk of being contaminated. Similar to the ALARA (as low as reasonably achievable) concept, error precursors can be minimized to reduce the chances of error. Most error precursors are outcomes of latent organizational weaknesses (see *Anatomy of an Event* in Chapter 1) and can be corrected by addressing the respective processes, programs, values, etc. As such conditions are minimized, the error rate should drop, resulting in a lower frequency of events. Robust multiple defenses protect the plant from isolated, trivial errors.

Common Error Precursors

Conditions at the job site that can provoke error are not mysterious and obscure. Often, they are obvious. They are *noticeable*, if people look for them. The error precursors listed below (in order of impact) were compiled from a study of INPO's event database as well as reputable sources on human performance, ergonomics, and human factors:

Task Demands	Individual Capabilities
1. Time Pressure (in a hurry)	1. Unfamiliarity with task / First time
2. High workload (large memory	2. Lack of knowledge (faulty mental model)
3. Simultaneous, multiple actions	3. New techniques not used before
4. Repetitive actions / Monotony	4. Imprecise communication habits
5. Irreversible actions[α]	5. Lack of proficiency / Inexperience
6. Interpretation requirements	6. Indistinct problem-solving skills
7. Unclear goals, roles, or responsibilities	7. Unsafe attitudes
8. Lack of or unclear standards	8. Illness or fatigue; general poor health
Work Environment	**Human Nature**
1. Distractions / Interruptions	1. Stress
2. Changes / Departure from routine	2. Habit patterns
3. Confusing displays or controls	3. Assumptions
4. Work-arounds / OOS[β] instrumentation	4. Complacency / Overconfidence
5. Hidden system / equipment response	5. Mind set (intentions)
6. Unexpected equipment conditions	6. Inaccurate risk perception
7. Lack of alternative indication	7. Mental shortcuts or biases
8. Personality conflict	8. Limited short-term memory

[α]Irreversible actions are not necessarily precursors to error, but are often overlooked, leading to preventable events. It is included in this list because of its importance.
[β]OOS - out of service

Although many conditions can provoke error, the error precursors listed in the above table appear to be the more common conditions associated with events triggered by human error. Descriptions of the above error precursors (Common Error Precursor Descriptions), and a more extensive list of error precursors (Error Precursors) are provided at the end of this chapter. Each station is encouraged to adapt the list to more closely reflect the conditions experienced by specific work groups. These conditions should be reviewed periodically to ensure they accurately reflect prevailing working conditions.

TWIN Analysis. Understanding error precursors provides insight into the potential for error for a specific task. TWIN is a memory aid that stands for Task demands, Work environment, Individual capabilities, and human Nature. Several stations use "Always WITH It" (Work environment, Individual capabilities, Task Demands, and Human Nature) to aid personnel with the preparation of work to head off potential error-likely situations.[27] Remember, by themselves, error precursors do not define an error-likely situation. A human act or task must be either planned or occurring concurrent with error precursors to be considered error-likely. Several examples are provided below. For each example, notice the underlined action. TWIN analysis is ineffective without consideration of the specific action, which is usually a step in the specified procedure or work package. Recall that error is an unintended action.

1. <u>Writing</u> the wrong year on personal checks at the beginning of a new year

Error Precursors:

- *Change* - new year
- *Repetitive task* - write several checks
- *Habit* - written previous year numerous times during the previous year

2. <u>Turning</u> the charging pump switch instead of the dilution valve switch

Error Precursors:

- *Identical switches* - both pistol-grip style
- *Adjacent* - within an inch apart
- *Interruption* - verifying the status of several annunciator alarms just at the moment to start dilution
- *Repetitive task* - done several times during shift while performing a plant startup

3. <u>Isolating</u> the wrong flow transmitter during a calibration of several instruments while one is in test

Error Precursors:

- *Poor lighting* - incandescent lights casting shadows
- *Repetitive task* - several transmitters calibrated previously
- *Random placement of transmitters* - procedurally directed to calibrate in numerical sequence by component nomenclature
- *Small lettering (black-on-gray)* - difficult to read unless person is positioned directly in front of label plate

PERFORMANCE MODES

Information Processing

> *Mistakes arise directly from the way the mind handles information, not through stupidity or carelessness.*
>
> *-Dr. Edward de Bono*
> *Practical Thinking*

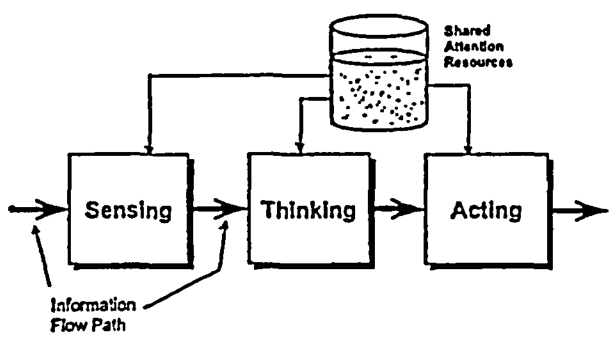
To better anticipate and prevent error, one should understand how people process information, as illustrated below. The brain is designed for information transfer, but sometimes it fails.[28] Error is a function of how the brain processes information related to the performance of an activity. When people err, there is typically a fault with one or more of the stages of information processing, not so much a function of one's motivation, as is the case in violations. However, be cautious not to base the causes of an event on internal mental structures; it leaves managers guessing as to what to do about it. What people were thinking at the time of an event is mostly the outcome of their tools, assigned tasks, and operational and organizational environments (see Chapter 6 on Root Cause Analysis).[29]

Sensing. Visual, audible, and other means to perceive information in one's immediate vicinity (displays, signals, spoken word, or cues from the immediate environment). Recognition of information is critical to error-free performance.

Thinking. Mental activities involving decisions on what to do with information. This stage of information processing involves interaction between one's working memory and long-term memory (capabilities, knowledge, experiences, opinions, attitudes).

Acting. Physical human action (know how) to change the state of a component using controls, tools, and computers; includes verbal statements to inform or direct others.[30]

Shared Attention Resources. A pool of mental resources that enables the mind to attend to information while performing one or more tasks (such as driving a car and talking on a cellular telephone at the same time).[31] How much attention is required to perform satisfactorily defines the mental workload for an individual, as some tasks require more attention than others.[32] Knowledge, skill, and experience with a task decrease the demand for attention.



Attention

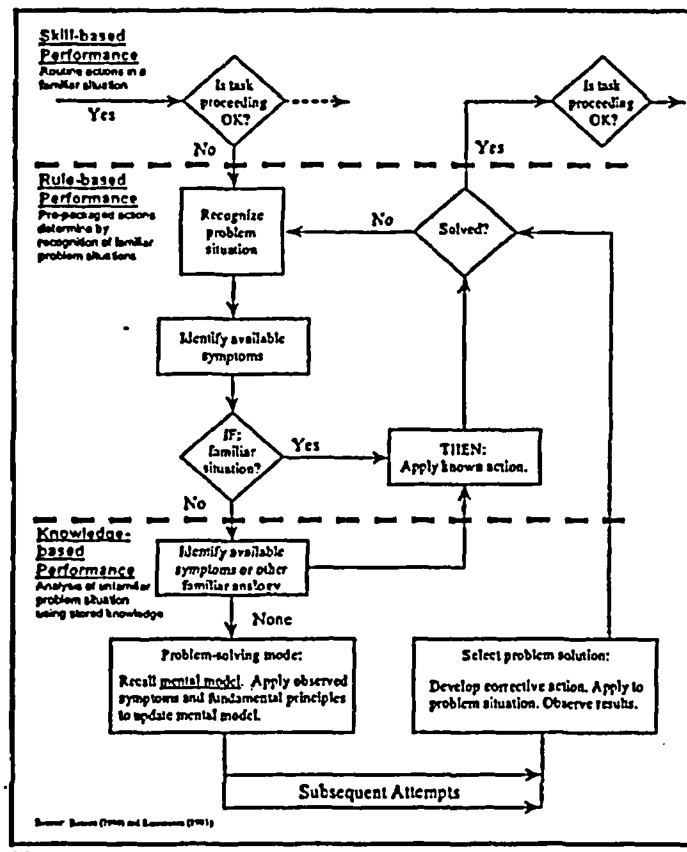
Inattention to Detail. This is a commonly cited cause of human performance problems. Attention can be focused, divided, or selective. If attention is focused, something has to be ignored. By focusing on one thing, other items cannot be perceived. *Divided attention* involves paying attention to two or more sources of information on a time-share basis, similar to using a flashlight in a dark room trying to see two different items, moving the flashlight back and forth. Divided attention can be dangerous; for example, a driver's attention is significantly distracted while using a cell phone. Studies show that drivers are four times more likely to be in an accident if using a cell phone, even "hands-free" styles. *Selective attention* means an individual gives preference to distinct information such as one's name in a noisy meeting room. Humans cannot pay attention to everything all the time, which leads to the occasional error.[33] Managers demand that workers "focus on the task at hand," and then post signs that say, "Think Safety."

Does this make sense? The likelihood of error is enhanced when someone attempts to do more than one activity in one stage of information processing, such as listening to the radio and a passenger simultaneously while driving an automobile. Trained, experienced operators can consciously attend to a maximum of two or three channels of information (such as flow, temperature, pressure) and still be effective.[34] Beyond that, error is likely.

"Gut Feeling." It is common to be aware of something without being conscious of it. The subconscious level of attention continually receives information from the immediate environment. A "gut feeling" that something is not right is a signal that the subconscious has detected something that is inconsistent with the present situation, goals, or intent. For instance, one can walk to the car in the morning to go to work without a wallet and feel something has been forgotten. This feeling is an opportunity![35] Do not ignore it. Pursue what is causing the feeling. The subconscious level of attention is notifying the person that something is not quite right. Questioning attitude and situation awareness are enhanced by paying attention to these feelings.

Generic Error Modeling System (GEMS)

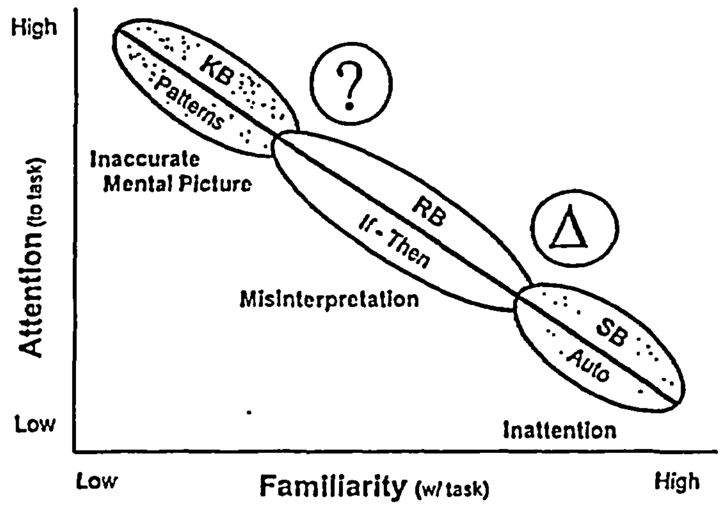
This model (flow chart) shows how humans select the level of information processing for a particular performance situation, work or play. Depending on the situation as perceived by the individual, he or she will chose a processing mode—that is, performance mode—that seems adequate to control the situation. As described later, the GEMS model helps explain the three modes of error. Awareness of the "performance mode" chosen for a specific task will help a person anticipate the kind of errors one can make and which error prevention techniques would be more effective.



Information processing (sensing-thinking-acting) operates in one or more of three modes: skill-based (SB), rule-based (RB), and knowledge-based (KB). The performance mode is usually a function of the familiarity an individual has with a specific task and the level of attention (information processing) a person applies to the activity. The chart illustrates the distinctions between the three modes of performance.[36] Uncertainty declines as knowledge about a situation improves (learning and practice). Consequently, familiarity (knowledge, skill, and experience) with a task will establish the level of attention or mental functions the individual chooses to perform an activity. As uncertainty increases, people tend to focus their attention to better detect critical information needed for the situation. People want to boost their understanding of a situation in order to respond correctly.[37] But, people tend to default to the lowest level of mental effort they perceive necessary to adequately accomplish the task (avoidance of mental strain). As a result, information important for the situation may be missed.

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

Skill-Based Performance



Skill-based performance involves highly practiced actions in very familiar situations. They are usually executed from memory without significant conscious thought or attention (see illustration above). Behavior is governed by preprogrammed instructions developed by either training or experience and is less dependent upon external conditions.[38] Many actions in a typical day are controlled unconsciously by human instinct, such as writing one's signature, *a classic example of skill-based* performance. Also, performing a very familiar procedure is typically performed at the skill-based level.

Examples. Skill-based activities involve those that can be done very reliably without much conscious thought. Common examples of skill-based activities include:

- manipulating valves and switches
- taking logs
- using a hammer or other hand tool
- controlling various processes manually (such as pressure and level)
- hanging a tag
- swapping strainers
- analyzing chemical composition of a sample
- performing repetitive calculations
- moving control rods
- using measure and test equipment
- attaching test jumpers
- operating a circuit breaker
- walking through a door or opening a cabinet door

- performing a commonly used procedure
- replacing parts during maintenance

> *You cannot think and hit at the same time.*
>
> *-Yogi Berra*
> *Former Manager, New York Yankees*

Error Mode. The error mode for skill-based performance is *inattention*. Skill-based errors are primarily execution errors, involving slips and lapses in attention or concentration. Errors involve inadvertent slips and unintentional omissions triggered by simple human variability or by not recognizing changes (note the Δ symbol on above chart) in task requirements, system response, or plant conditions related to the task. Under ideal conditions the chance for error is less than 1 in 10,000.[39] People most often possess an accurate understanding of the task and have correct intentions. Roughly 90 percent of a person's daily activities are spent in the skill-based performance mode.[40] However, only 25 percent of all errors are attributable to skill-based errors.[41] Potentially, a person can be so focused on a task that important information in the work place is not detected.[42] Another concern for skill-based tasks is that people *are* familiar with the task. The greater the familiarity the less likely perceived risk will match actual risk. People become comfortable with risk and eventually grow insensitive to hazards.[43]

Rule-Based Performance

Rule-based behavior is based on the selection of stored rules derived from one's recognition of a work situation; it follows an *IF* (symptom X), *THEN* (situation Y) logic. The situation, although possibly familiar, is usually unanticipated. Problems discovered during a task usually require a different skill than originally planned to accomplish the task successfully.[44] Many events have occurred because people did not recognize that the original task had changed, such as the transition from preventive maintenance to troubleshooting. The work situation has changed such that the previous activity (skill) no longer applies. Therefore, the big picture in rule-based performance is to improve one's interpretation of the work situation so that the appropriate response is selected and used.[45] This is why procedures are prepared for situations that can be anticipated. Using the GEMS model, procedures are pre-determined solutions to possible work situations that require specific responses. Rules are necessary for those less familiar, less practiced work activities for which a particular person or group is not highly skilled. For instance, if the "Reactor Scram" annunciator alarms, the operator then performs the pre-determined immediate actions for a reactor scram and follows the appropriate emergency procedures to guide plant stabilization and recovery. Most rules are documented in procedures or recalled from previous training, but many rules are developed from experience (thumbrules) or accepted group practices.

> *Errors made performing routine, familiar tasks are not unlike accidents that occur in the home. Just as we generally assume that our homes are the safest places imaginable, we tend to disregard the possibility of errors in the performance of routine tasks. The truth is, we relax our vigilance performing familiar activities and fail to pay close attention [to hazards] when an activity is routine.*
>
> *-Gerard Nierenberg*
> *Do It Right the First Time*

Not all activities guided by a procedure are necessarily rule-based performance. In normal work situations, such activities are commonly skill-based for the experienced user.

Examples. Rule-based activities involve decisions based on an "if-then" logic. Examples includes the following:

- deciding whether to replace a ball bearing inspected during preventive maintenance

- responding to a control board annunciator
- estimating the change in tank level based on a temperature change (thumbrules)
- feeling equipment on operator rounds
- performing radiological surveys
- facilitating a training seminar (choosing response to participant statements)
- using emergency operating procedures
- developing work packages and procedures

Error Mode. Since rule-based activities require interpretation using an if-then logic, the prevalent error mode is *misinterpretation.* People may not fully understand or detect the equipment or plant conditions calling for a particular response. Errors involve deviating from an approved procedure, applying the wrong response to a work situation, or applying the correct procedure to the wrong situation.[46] For example, blocking automatic actuation of safety injection used to be an accepted rule whenever a reactor operator perceived a reactor scram as "uncomplicated," when, in fact, the scram was not. The chance for error increases when people make choices or decisions, especially in the field. Rule-based and knowledge-based performance modes involve making choices. With less familiarity for the activity, the chance for error increases to roughly 1 in 1,000.[47] In terms of reliability, this is still very good (99.9 percent). In the nuclear industry, studies have shown that roughly 60 percent of all errors are rule-based.[48]

Knowledge-Based Performance

> *Humans are notorious pattern matchers.*
>
> *-Dr. James Reason*
> *Human Error*

Knowledge-based behavior is a response to a totally unfamiliar situation (no skill or rule recognizable to the individual). The person must rely on his or her understanding and knowledge of the system, the system's present state, and the scientific principles and fundamental theory related to the system.[49] People enter a knowledge-based situation when they realize they are uncertain (see the ? symbol on previous chart) about what to do. If uncertainty is high, then the need for information becomes paramount.[50] To effectively gain information about what we are doing or about to do, our attention must become more focused.[51]

Not all hazards, dangers, and possible scenarios can be anticipated in order to develop appropriate procedures. Even training is unable to anticipate all possible situations that can be encountered. There are some situations in which no procedure guidance exists and no skill applies. Knowledge-based situations are puzzling and unusual to the individual. Knowledge of plant systems and fundamental sciences must be used to effectively tackle the problem-solving situation. In many cases, information sources contain conflicting data, too much data, or not enough data, amplifying the difficulty of problem-solving. Because uncertainty is high, knowledge-based tasks are usually stressful situations.

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

- troubleshooting

- *performing an engineering evaluation*
- reviewing a procedure for 'intent of change'
- resolving conflicting control board indications
- responding to an unknown plant transient
- meetings to address problems
- resolving human performance problems
- planning business strategies, goals, and objectives
- performing root cause analysis of events
- conducting trend analyses
- designing equipment modifications
- allocating resources
- changing policies and expectations

Error mode. Knowledge-based activities require diagnosis and problem-solving. Decision-making is erroneous if problem-solving is based on inaccurate information. Most decisions are made with limited information and assumptions. Consequently, the prevalent error mode is an *inaccurate mental model* of the system, process, or of plant status. The mental picture people use to solve a problem may be based on insufficient information. Under such circumstances, the chance for error is particularly high, approximately one in two (50 percent).[52] In the nuclear industry, studies have shown that roughly 15 percent of all errors are knowledge-based.[53]

Front-line workers (operators and technicians) spend most of their working hours in the skill-based and rule-based performance modes because of the prescriptive nature of their jobs. On the other hand, managers, supervisors, engineers, and other "knowledge" workers spend most of their time in rule-based and knowledge-based performance modes because of the discretionary character of their jobs. Knowledge workers spend a great deal of time solving problems and making judgments and decisions. Obviously, people in these positions need to apply error-prevention techniques to their jobs just as those who manipulate plant equipment.

Mental models. A mental model is the structured understanding of knowledge (facts or assumptions) a person has in his or her mind about how something works or operates (for example, plant systems).[54, 55] Mental models are used in all performance modes. In fact, mental models give humans the ability to detect skill-based slips and lapses. They aid in detecting deviations between desired and undesired system states, such as manually controlling tank water level.[56] Fundamentally, a mental model is an internalized picture or map of a system or situation that organizes knowledge about:

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

But, as a general rule mental models are inaccurate because of the limitations of human nature. It is important to remember that knowledge-based performance involves problem-solving, and mental models should be considered explicitly, when a team works on a problem.[57] Team members should agree with the model they intend to use to diagnose and solve a problem.

Otherwise, misunderstandings and assumptions may occur. Frequent timeouts can help teams keep mental models up-to-date.

A person handles a complex situation by simplifying the real system into a mental image (simple one-line drawing) they can remember. An individual's mental model may reflect 1) the true state of the system, 2) a perceived state of the system, or 3) the expected state of the system, and is developed through training and experience with the system and recent interactions with the system. Be forewarned, all mental models are inaccurate in some way.[58]

> *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*
> *US Navy (deceased)*

High-Risk Performance. Knowledge-based performance is the riskiest performance mode when it comes to expected error rate.[59] When encountering an unfamiliar situation, people may make erroneous assumptions to ease their mental workload. Consequently, they tend to generate solutions using rules similar to the present situation. Such solutions are often based on insufficient information. As time to respond to a situation decreases, the chance for error increases. The chance for error is highest when an unfamiliar situation (especially involving physical danger) strikes suddenly and requires quick reaction.[60] Because of the limitations of human nature and an incomplete knowledge of the situation, error is almost inevitable. Therefore, all attempts should be made to change the work situation so that the individual (or team) can perform in either the rule-based or skill-based performance modes.

Assumptions. Knowledge-based situations can be stressful, anxious situations. Assumptions reduce the strain on the mind allowing it to think without excessive effort. Consequently, assumptions tend to occur more often, leading to trial-and-error problem-solving approaches. Assumptions also occur as an outgrowth of unsafe attitudes and inaccurate mental models. Statements such as "I think ...," "We've always done it this way," or "I believe ..." are hints that an assumption has been or is being made. Inaccurate mental models, in turn, can promote erroneous assumptions that may lead to errors. All too often, assumptions are treated as fact. Challenging assumptions is important in improving mental models, solving problems, and optimizing team performance. Assigning a "Devil's advocate" in a critical problem-solving situation may be worthwhile toward achieving a better solution.

Assumptions must be challenged to detect unsafe attitudes and inaccurate mental models. Assumptions can be challenged using the following process:[61]

1. Identify *conclusion*(s) being made by another person or yourself.
2. Ask for or identify the *data* that leads to the conclusion(s). "How did you get that data?" "What is the source of your concern?"
3. Ask for the *reasoning* (mental model) that connects data with conclusion. "Do you mean...?" "Can you clarify that...?" "Why do you feel that way?"
4. Infer possible beliefs or *assumptions*.
5. Test the assumption with the other person. "What I hear you saying is..."

Shortcuts. Mental biases are unconscious methods to reduce mental strain, reducing the need to acquire and process more information.[62] Humans tend to seek order in an ambiguous situation and to seek patterns they recognize. Personnel should be aware of the potential for error this creates during problem-solving and decision-making such as troubleshooting and diagnostics during emergency operation. In some form or another, all humans use mental biases. Biases were discussed earlier in this chapter with respect to the limitations of human nature.

ERROR PREVENTION

Errors can be prevented, caught, or mitigated. Some techniques listed below are designed to catch and recover from error, but most are designed to *prevent error.* This course reference refers to these as error-*prevention* techniques.

The fundamental aim of these techniques is to help the individual maintain "positive control" of a task situation. Positive control means that 'what is intended to happen is what happens, and that is all that happens.' Every task is different. *Consequently, the techniques described below must be adapted to the specific work situations encountered.* Do not simply direct people to self-check. Aggressively managing job-site conditions and adapting error-prevention techniques and other defenses to counter specific error traps and other risks is a chief concern for event-free plant performance. But, be forewarned. Despite how rigorous people use error-prevention tools and techniques, people will still err. All that can be hoped for is to minimize the error rate, which tends to reduce the frequency of events the station suffers.

Avenues of Error Prevention

Errors can be prevented or caught by machines, other people, and the individual, as described below. Engineered, administrative, and cultural controls provide opportunities for error prevention. An explanation of at-risk practices and basic error-prevention techniques follows.

Machines. Equipment can be ergonomically designed to catch anticipated errors. For instance, computer software can be designed to ask if the user really wants to delete an electronic file after it has been selected for deletion. This challenge gives the user an opportunity to think again if that is the right thing to do. Engineered controls, such as forcing functions, can be designed into equipment to physically block inappropriate human action, such as interlocks. For example, try inserting a 3½ inch diskette into a computer disk drive in any way other than the correct way. It will not work. The machine jogs one's attention by asking a question or creating an interlock.

Other People. Co-workers and supervisors are willing resources to help prevent or catch errors especially if the workforce understands the limitations of human nature. Administrative controls, such as peer-checking, challenge, concurrent verification, and independent verification, require other people. However, just because two people are used to prevent errors, it will not be successful every time. People are fallible. *Team errors* can occur. An open environment in which peers feel comfortable to correct or coach each other is an important success factor for effective teamwork. To facilitate this, people should take initiative and ask others to check them. More detail on team errors is provided at the end of this chapter.

Individuals. Lastly, the individual can catch his or her own error before or after it occurs. Other administrative controls, such as self-checking techniques and use of quality procedures, help individuals reduce errors. However, operating experience shows that procedure use and adherence is still people-dependent, and mistakes still happen. Since preventing and catching errors depends solely on the individual, it is the least reliable of the three ways of catching errors, because humans are fallible. Therefore, do not routinely rely on the individual as the only approach to reducing the number of plant events. To improve the rigor with which people use error-prevention techniques, cultural controls should be explicitly considered. People must believe they can err, they must value error-free work, and they must have a sense of uneasiness and a questioning attitude as they perform their activities. Such a culture evolves through an aggressive leadership that understands the values, beliefs, and attitudes they want.

At-Risk Practices

At-risk behaviors are actions that involve shortcuts, violations of error-prevention expectations, or simple actions intended to improve efficient performance of a task, usually at some expense of safety. At-risk practices involve a move from safety toward danger. These acts have a higher probability, or potential, of a bad outcome. This does not mean such actions are "dangerous," or that they should not ever be performed. However, the worker and management should be aware of at-risk practices that occur, under what circumstances, and on which systems. At-risk behavior usually involves taking the path of least effort and is rarely penalized with a plant event, a personal injury, or even correction from peers or a supervisor. Instead it is consistently reinforced with convenience, comfort, time savings, and, in rare cases, with fun.[63] Some examples of at-risk behaviors are:

- performing two-handed control board manipulations
- performing a task using two or more procedures
- hurrying through an activity
- following procedures cookbook-style (blind compliance)
- removing several danger tags quickly without annotating removal on the clearance sheet when removed
- reading an unrelated document while controlling an unstable system in manual
- having one person perform actions at critical steps without peer checking or performing concurrent verification
- not following a procedure as required when a task is perceived to be "routine"
- attempting to lift too much weight to reduce the number of trips
- trying to listen to someone on the telephone and someone else standing nearby (multitasking)
- signing off several steps of a procedure before performing the actions
- working in an adverse physical environment without adequate protection (such as working on energized equipment near standing water—progress would be slowed to cleanup the water or to get a rubber floor mat).

Single-error vulnerability is an important element when considering at-risk actions in a task. Single-error vulnerabilities exist when one mistake or slip will lead to personal injury or damage to equipment. People and equipment are at risk, when only one mistake leads to injury or damage. For instance, if one should trip or slip while walking near the edge of a cliff, a fall is certain. If walking several feet from the edge, a trip or slip is not fatal. Similarly, if a technician is using an uninsulated screwdriver while making adjustments on an instrument in tight quarters, grounding the device is a certainty with a slip of the hand. At-risk actions should **NOT** be permitted when single-error vulnerabilities exist.

Persistent use of at-risk behaviors builds over-confidence and trust in personal skills and ability. This is dangerous, since people foolishly presume they will not err. Without correction, at-risk behaviors can become automatic (skill-based), such as rolling through stop signs at residential intersections. Over the long-term, people will begin to under-estimate the risk of hazards and the possibility of error at the job site and will consider danger (or error) more remote.[64] People will become so use to the practice that, under the right circumstances, an event occurs. Managers and supervisors must provide specific feedback when at-risk behavior is observed. People are more likely to avoid at-risk behavior if they know it is unacceptable. Also, peer coaching is becoming a more popular expectation for the workforce at excellent performing stations. Preferably, peers correct peers. Otherwise, without coaching and correction, uneasiness toward equipment manipulations or intolerance of error traps will wane.

High quality procedures minimize at-risk behavior. Poorly conceived written procedures, including work packages, prompt users to be creative in accomplishing the intent of the procedure.[65] When weak work planning and scheduling exists, workers are tempted to adopt at-risk behaviors to get the job done. Problems such as poor access to the work site and insufficient or inadequate tools or equipment may provoke at-risk actions or even violations (See *Job Site Conditions* and *Organization Defined* sections in Chapter 3.).

Error-Prevention Techniques (and Their Bases)

Error-prevention techniques are defensive measures aimed at preventing and catching active errors. *These functions are implied in the Anatomy of an Event as the causal link between* "flawed defenses" and the "initiating action." To optimize their effectiveness at preventing, catching, or mitigating error, error-prevention techniques should be adapted to the specific job or task. These are commonly referred to as human performance "expectations." Error-prevention expectations and their standards should be consistently documented, interpreted, and applied across the station.

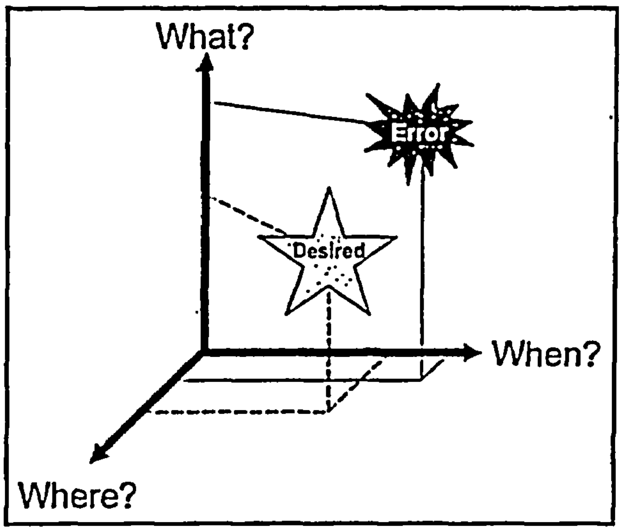
A survey of all plants in the U.S. commercial nuclear industry was conducted (fall 2002) asking each plant what practices defined their principal set of error-prevention tools: Of 65 operating stations,[1] the following top eight techniques, in order of popularity (number of plants using the technique), were identified:

- Self-checking (63)
- Peer-checking (60)
- Three-point communication (54)
- Procedure Use and Adherence (50)
- Pre-job Briefings (39)
- Stop when Unsure (37)
- Questioning Attitude (37)
- Placekeeping (27)

A variety of techniques were identified. Techniques, such as independent verification and concurrent verification, are so common, and in many cases proceduralized, that many stations did not identify them as a core error-prevention technique. The top eight techniques listed above, along with several others that are popularly used and known to be effective, are described below. The basic technique along with its bases in human nature are included in the description.

[1] Salem and Hope Creek are considered as one station.

Self-Checking. Attention varies. In most activities, some steps are more important than others. This technique boosts attention at important points in an activity before a specific act is executed. Important steps involve touching plant equipment to change its status or may simply involve revising a document important for plant safety and reliability, such as technical procedures and critical drawings. In some plants these steps are determined by the component involved, which can initiate a plant transient or activate an engineered safety system if handled incorrectly. Such components are known as "critical components" or "vital points." In such cases, self-checking is expected. Once attention is focused, the individual takes a moment to think about the intended action and its expected outcome. If visual or physical contact is broken, then self-checking should occur again.



Flaws with self-checking include situations the user may not recognize *when* to use the technique, *what* to pay attention to, or even *where* to pay attention (See illustration at right.). A worker once stated, "We are so good at self-checking, we can do it in our sleep." The physical act does not necessarily mean the mind is attending to the task. If attention is not correctly focused, error is likely. During a game of baseball, an infielder's attention can vary dramatically between pitches. However, attention becomes focused at the beginning of the pitcher's windup (when), toward the opposing batter (where), and finally, on the ball (what). Some stations have specified situations that require self-checking. But self-checking can be used any time when the performer recognizes the importance of the act about to be performed. Workers should be *specific* with self-checking practices. Know the more important actions—that is, the critical steps—in a task before performing it. An effective prejob briefing that highlights critical steps of an activity aids such preparation. Error is always a specific action, not a generality. Therefore, self-checking must be specifically applied. Since, error involves an unintentional breakdown of information processing, improving attention at the critical junctions will help prevent or catch an error. Therefore, the self-checking technique, or any error-prevention practice for that matter, should be *precise* in its application.

Peer Checking. Peer-checking allows another individual to observe or check the work of a performer to ensure correct performance of a specific manipulation or set of actions. Peer-checking involves having a second knowledgeable individual verify that the action planned by the performer is appropriate before execution and occurs according to plan. The purpose of peer-checking is to *prevent* error. Peer-checking is merely two persons (performer and checker) self-checking in parallel on the same action. This technique takes advantage of a fresh *set of eyes* not trapped by the performer's task-related mind-set. The checker may "see" hazards or potential consequences the performer does not see. Peer-checking augments self-checking, but does not replace it for the performer. Peer-checking is not intended to oversee an entire activity or job.

> *It's our (my) responsibility to catch, examine, and prevent not only our own errors but those that others make too.*
>
> *-Gerard Nierenberg*
> *Do It Right the First Time*

In most cases, workers ask for a peer-check. In other cases, a peer-check can occur without being requested. This is becoming known as a "challenge." If a person detects that an action by another person may be unsafe, or at risk, especially if a safety system is being bypassed, he or she may question the performer to verify the intent and desired outcome before the action is taken. Scuba divers call this the "buddy system." The opportunity to challenge is enhanced if performers verbalize their actions in advance. The challenge is a teamwork technique and should not be interpreted as mistrust of one's competence or qualification. Finally, in a high-reliability organization, workers and supervisors request peer checks when they feel the potential consequences warrant it. Special cases of peer-checking can be designed for specific activities. For instance, another qualified individual can be assigned to verify an action does not produce a plant transient and confirms or verifies that the equipment is left in the required position.

Usually, peer-checking is reserved for selected, important, or nonreversible actions on equipment deem 'risk-significant' with respect to plant safety or reliability, personal safety, or radiological safety. But peer-checking can be over-used. Using peer-checking too often can diminish the perceived need for self-checking, a principal error-prevention tool. Peer-checking 'all' actions may result in an increase in errors, because peer-checking may become rote (engaged physically, absent mentally). It becomes an inefficient use of a worker's time, when applied to simple, low-risk activities. Finally, asking for a peer-check during extremely busy periods can distract the peer, who may be preoccupied with an equally important task. Asking for a peer-check during emergency or off-normal situations may make matters worse. In these cases, self-checking is the technique of choice. The following example was observed during a recent plant evaluation:

> *The reactor operator (RO) potentially distracted the balance-of-plant reactor operator (BOP). The RO asked for a peer check on starting the heater drain pump, while the BOP was manually controlling feedwater. The BOP had to stop and divert his attention from an important task. Rather than decline the request and ask someone else to help, the BOP maintained his hands on the feedwater station controls, while he confirmed the selection of the RO, and he did not adjust feedwater when the peer check was performed.*

Although peer-checking is usually more reliable than self-checking, there are exceptions to every rule. The practice adopted for such situations is obviously management's prerogative, but the potential of creating other error traps should be considered when setting such an expectation.

Peer-checking and concurrent verification should not be used interchangeably. Although the physical act of verification is the same, concurrent verification is a documented, formal, rigorous check of another's action and is usually directed by a procedure. A potential hazard associated with either method is that the peer may not be fully aware of the context of the action. The selected method may be successful for the action, but the action may not be correct for the plant or equipment situation.

Peer-checking is performed by two individuals. One acts as the performer, and the second person, peer, acts as the checker. Peer-checking is performed as follows:

Three-Part Communication Practices. The aim of communication is to exchange information, achieving mutual understanding between two or more individuals. Verbal communication involving speaking and listening can occur face-to-face, by telephone, portable radio, or public address systems. Written communication occurs by procedures, labels, signs, logs, pass-down/turnover logs, e-mail messages, personal notes, and so on. The face-to-face exchange of information is the most frequently used form of communication. It is usually not recorded, and possesses the greatest risk of misunderstanding. Information related to plant status is of primary importance for plant safety and reliability. Routinely, *areas for improvement* involving communication weaknesses are identified during INPO evaluations of operator performance during shift activities and simulator training. However, hallway conversations can be just as risky in that both individuals are often in a hurry on their way to an appointment.

To ensure understanding of near-term changes of physical plant equipment during critical activities, face-to-face, telephone, or radio communication requires at least three verbal transmissions. Mutual understanding is the goal. The person responsible for the communication is the originator, or sender, verifying the receiver understands the message as intended. The sender gets the attention of the intended receiver and speaks the message, the receiver repeats the message in a paraphrased form, and the sender acknowledges the receiver understands the message. Appropriate feedback is used to verify understanding of each transmission. This is commonly referred to as "three-part communication." For instance, the following standard practice could be used:

Face-to-Face Technique	Explanatory Comments
1. Sender states the message.	➢ Sender position himself or herself in front of the intended receiver. ➢ The first name of receiver is used to get his or her attention. ➢ **Caution:** Three-way communication does not start with a question; it always starts with a direction.
2. Receiver acknowledges sender.	➢ Receiver paraphrases the message in his or her own words. ➢ The receiver asks questions to verify his or her understanding of the message.
3. Sender acknowledges the receiver's response.	➢ If receiver understands the sender correctly, then the sender responds with "That is correct." ➢ If the receiver does not understand the message as intended, the sender responds with "That is wrong," (or words to that effect) and restates the original message.
4. If corrected, the receiver acknowledges the corrected message paraphrasing the message in his or her own words.	

When the only distinguishing difference between two component designators is a single letter, then the **phonetic alphabet** form of the letter should be substituted for the distinguishing character. The table below lists substitute words. For example, 2UL-18L and UV-18F would be stated "two U L eighteen LIMA" and "two U L eighteen FOXTROT."

Letter	Word	Letter	Word	Letter	Word	Letter	Word
A	Alpha	H	Hotel	O	Oscar	V	Victor
B	Bravo	I	India	P	Papa	W	Whiskey
C	Charlie	J	Juliet	Q	Quebec	X	X-ray
D	Delta	K	Kilo	R	Romeo	Y	Yankee
E	Echo	L	Lima	S	Sierra	Z	Zulu
F	Foxtrot	M	Mike	T	Tango		
G	Gulf	N	November	U	Uniform		

Some key words can be used to convey specific meanings, when communicating operational information critical to plant or personnel safety. For instance, "STOP" should be used to immediately terminate any action or activity before harm is realized. "CORRECT" means sender has confirmed understanding of the receiver. "WRONG" conveys clearly a lack of understanding of the meaning of the intended message. Other words can be reserved for special meanings related to the organization's activities. However, all personnel must be trained in the meaning and use of such operational words.

Verbal communication can either be effective or efficient. Efficient communication is more concerned with the speed of transmission of the message and less with understanding. *However, effective communication requires verification that all parties understand the message.* Errors can occur with either the sender or the receiver. Sending errors include:

- Wrong message is sent or message is unclear.
- Message is inconsistent with other information; creates confusion. Content may conflict with non-verbal cues of the sender or with the context of the activity. For example, specific values are stated when operators report the state of critical parameters during off-normal plant situations.
- *Message is unsuitable for the receiver. Sender fails to consider the receiver's work* situation, role, knowledge, or terminology (such as an operator talking to an engineer).
- Message is not transmitted adequately (such as not loudly enough or by imprecise enunciation of words).
- Message is not sent.
- Message is transmitted to the wrong person or place. This error is more prevalent when the communication is not face-to-face, such as telephone, e-mail, or radio.
- Message is transmitted at the wrong time, either too early or too late to be useful to the receiver.
- Sender fails to verify receiver accepted and understood the message.

Just as the customer is responsible for verifying the accuracy of a pizza delivery order over the telephone, so is the sender responsible for the accuracy and understanding of the message received by the receiver. Errors by the receiver include:

- Message (written) is not found or used. This is similar to the first error. Also, the message may be disregarded.
- Message is not sought. Receiver does not seek information necessary to perform a task.
- Message is misunderstood.
- Receiver does not check with sender to verify understanding.

The **will to communicate** is an attitude, a conviction. In all disasters around the world that were analyzed, information was available before or during the tragedy that could have prevented the outcome. In every case, either the information was not acted on, or it was not sought out, or it was not passed on, or it did not get through.[66] Communication is, perhaps, the most effective defense in the prevention of errors and events. The *will* to communicate and the means to communicate must prevail in the organization. People must believe communication of either facts or feelings is a desirable behavior and will be reinforced. Assertive communication is essential to effective execution of some error-prevention methods (such as peer-checking, concurrent verification, teamwork, problem-solving, conservative decision-making), feedback, self-assessments, coaching, prejob briefings, etc. In today's society, it's easy to keep quiet, not wanting to draw attention to oneself. However, when the safety of the plant or people are at risk, speak up! Excessive professional courtesy for one's superior can lead to team errors (see Team Errors at the end of this chapter.).

Any level or function of an organization can impede the flow of information. Obstacles to communication, whether formal or informal, must be rooted out to maintain all communication channels open, up, down, or across the organization. Consequently, every individual of the organization is responsible to request needed information, verify he or she accurately understand it, pass it on to those who need or could use the information, or act on it.

Procedure Use and Adherence. The need to use and adhere to procedures is well understood and accepted in the nuclear industry. Effective procedure performance is fundamental to safe operation of the plant. Procedures are used to ensure activities are performed correctly, safely, consistently, and in accordance with licensing requirements. However, lack of clear direction from management often leads to errors by the worker and is frequently identified as a cause of plant events or equipment problems. Technical procedures are written to direct desired behavior for the various complex and technical work that is performed in the station. Procedures incorporate the policies, operating experience, effective practices, and management decisions about how a task is to be performed. Procedures are intended to direct people's behavior in a proper sequence and to minimize the choices users have to make. Experience has shown that procedures may not contain sufficient information for the user. With turnover of the workforce, younger workers take the place of more experienced personnel. When workers are forced to interpret a procedure's use and applicability, the chance for error is increased. The quality of the procedure is paramount, especially if the task involves risk-significant systems or components.

Expectations for procedure *use* specify the minimum required reference to the procedure during the performance of a task, such as continuous use (in-hand), reference use, and information use. Procedure *adherence* means following the intent and direction provided in the procedure regardless of the level of use. Some procedures are used so often, that the individual becomes skilled with the procedure. These are no longer rule-based tasks, but skilled tasks. One's proficiency with a procedure (frequency of use and how recently it has been used), and the risk associated with the task are the primary factors used to determine the level of use.

Three levels of procedure use frequently encountered in the industry are defined as follows:

- Continuous Use. The procedure is in hand and followed step-by-step; each step is completed prior to commencing following step. The expected response(s) of an action is understood before the action is taken, and responses to actions are verified before proceeding with the next step. In most cases the activity will have an immediate, adverse impact on plant or personnel safety if performed incorrectly—that is, an error is not recoverable before suffering undesirable consequences. Also, "Continuous Use" should be required if the activity is either complex (beyond "skill-of-the-craft") or infrequently performed by the person assigned.
- Reference Use. Segments of the procedure can be carried out by memory and does not necessarily have to be in hand, but is followed step-by-step. "Reference Use" is appropriate if incorrect performance will NOT have an immediate adverse impact on plant or personnel safety, being recoverable. The procedure or work package is reviewed periodically during performance of the task to verify all steps are being completed as written, and all segments have been performed. Also, "Reference Use" is allowable if the task is relatively simple (within skill of the craft) or is performed frequently enough by the person assigned such that proficiency has been maintained. "Reference Use" procedures should be available to users at the job site.
- Information Use. The procedure can be carried out by memory, section-by-section, allowing resequencing of steps within the section; also known as "periodic" use. Incorrect performance has no impact on plant or personnel safety. Such tasks are simple to carry out regardless of the person assigned. Administrative procedures usually are designated "Information Use."

Working copies of procedures are used in the field when record keeping is required at multiple or remote work locations. These procedures should be stamped "Working Copy" to distinguish them from other copies. Reference copies of procedures require no recording of data, signatures, or initials. Typically, reference copies are used, while another individual completes a working copy in the field based on first-hand knowledge of the outcome of each step. First-hand knowledge exists when one observes or performs an action, or one receives a direct report from an individual who performed the action. If working copies of procedures are contaminated, a photocopy may be made, or data, signatures, and initials can be transferred to another copy of the procedure. A photocopy is preferable, since it is less likely to involve errors.

Occasionally, procedure non-use becomes the accepted norm, especially if management has tacitly accepted the practice. Procedure quality suffers if adherence is not held to high standards. Over time the station workforce experiences turnover, and plant equipment is modified. If procedures are unused, or used in a casual manner, needed changes to the procedure may not be identified. Worse, an inexperienced user may follow an outdated procedure verbatim and trigger an event. Obviously, formal policies and resulting expectations on the use and adherence of procedures should be established.

Certain words have special meanings in procedures and should be defined clearly. Typically, "shall" denotes a requirement, usually a regulatory requirement or commitment. The words "will" and "must" should be interpreted as "shall." "Should" denotes a management expectation with no link to regulatory requirements; the individual is to perform the action unless there is a good reason not to. "May" implies an allowable or permissible action (not a requirement or recommendation), if conditions warrant it; "shall" and "should" do not apply. "Ensure" or "verify" direct the user to establish the stated condition or status if not already established. "Check" directs the user to determine the status or existing condition, but does not allow changing that status or condition without explicit approval from responsible authority.

Procedures are developed with two assumptions: all required equipment is operating correctly, and the necessary plant conditions have been established. Consequently, a given procedure may not work every time. Users must be alert to plant situations to identify when procedures cannot be performed as written for the plant conditions. Not only should procedures match plant conditions, but procedures also should be developed to match the skills and knowledge of the people who will use them. Processes related to procedure development and revision can encourage use and adherence by the following:[67]

- Clearly delineating key decision points or critical steps in a procedure
- Keeping procedures simple at a level of detail that matches user knowledge and ability
- Minimizing mental and physical workload (burden)) as well as personal risk of injury to the user
- Reducing in-field interpretations or decision-making not guided by the procedure
- Using a language and terminology that is clear to the user
- Eliminating inconsistencies internal to the procedure and between procedures (such as mutually exclusive actions and actions incompatible with equipment or plant state)
- Improving familiarity with key procedures by training individuals to a skill-based level
- Enhancing usability by adhering to established human factors principles in both procedures and work instructions (such as salience of information, referencing, branching, graphics, tables, organization, and presentation style)
- Eliminating drawing and technical errors

Individuals can improve their personal effectiveness using procedures by:

- Improving their knowledge of procedure bases
- Verifying the procedure to be used in the field is the most up-to-date version of the document by checking its revision number and date against an authorized list of effective procedures
- Rereading the previous two or three steps of a procedure before proceeding with a task after being distracted, interrupted, or delayed
- Practicing transitions between procedures
- Using placekeeping methods rigorously

Procedures are not perfect. All will have some flaws. Some flaws can possibly impact plant and person. "Thinking compliance" must be used—a questioning attitude while using a procedure. If a procedure cannot be performed as directed by the approved document, then:

- Stop the job.
- Place the system, equipment, and components in a safe condition.
- Contact the supervisor and recommend corrective action, if able.
- Resolve the problem.

Various guidelines regarding procedure development are not included in this document, since many other useful references have been published on this important topic. However, the reader is encouraged to refer to EPRI technical reports or to benchmark this issue at other organizations. EPRI's Procedure Usability Measurement Process (PUMP) can be used to determine a procedure's usability.[68]

Stop When Unsure. When confronted with a situation that creates a question, a person is in uncharted (unfamiliar) territory—a knowledge-based performance situation. Given the chances for error are particularly high in a knowledge-based situation (1 in 2 to 1 in 10), the best course of action, when unsure, is to stop and get another 'mind' on the problem (also known as "timeout"). For collaboration to occur, people must recognize when they are in knowledge-based situations. Whenever a question is encountered and what to do about it is uncertain, stop and get help. Get help from those who possess the expertise, not necessarily from those of higher rank.[69] One plant instituted a policy that "You cannot answer your own question."[70] The aim is to make the best decision by promoting collaboration and group problem-solving.

Also, when that "gut feeling" is telling you that something is not right, stop. This also applies when one experiences, "What am I doing here?" or "I'm here, but can't remember what I am supposed to do." Don't be embarrassed, stop and collaborate!

Prejob Briefing. There are two primary purposes of the prejob briefing: 1) to prepare workers for what is to be *accomplished,* and 2) to sensitize them to what is to be *avoided.* Most prejob briefings do not adequately address what to *avoid.* Error prevention is not adequately addressed, even when the first-line supervisor reminds the work crew, "Make sure you self-check!"

A task preview should occur before the prejob briefing. This involves giving the worker time to review the task before participating in the prejob briefing. This provides the individual with a concept of the task, what the task is trying to accomplish, and what to avoid, especially if the task was addressed during work planning or the walkdown. See *SAFER* in Chapter 5 for a description of a task preview technique.

Knowing the critical steps before conducting an activity can save the plant from unnecessary trips and transients. Workers are forewarned when their attention must be piqued, and they will more readily recognize where and what to self-check. Self-checking is more effective when a good pre-job briefing has taken place.

Prejob briefings should be a *dialogue* among the participants, rather than a monologue by the first-line supervisor or a lead technician. A genuine dialogue will uncover subtle conditions that could lead to error. Intelligent conversations between the team members will help recognize assumptions, error traps, and misunderstandings that could lead to an event.

Prejob briefings should be conducted for routine as well as infrequently performed or complex tasks. Routine tasks are usually simple and/or repetitive. Experience shows that many events occur during 'routine' activities. Given human nature, there really is no such thing as "routine."

Questioning Attitude. A questioning attitude encourages foresight to precede actions, to make sure planning, judgment, and decision-making are appropriate for the situation. A questioning attitude fosters awareness of uncertainty and hazards. Recognizing hazards or error-likely situations while on the job is greatly dependent on this attitude. It is similar to defensive driving. *Uneasiness* toward human fallibility, especially when performing physical work on plant equipment, is important to a healthy questioning attitude. Also, *intolerance* for uncertainty, error traps, and degraded defenses is effective only with a questioning attitude. A reluctance to fear the worst is aggravated by human nature, since humans tend to accentuate the positive. A healthy questioning attitude must overcome the temptation to rationalize away "gut feelings" of something not right.

Foresight is the level of attention given to understanding the significance and nature of near-term actions before proceeding with an action.[71] In other words, the individual looks ahead for the presence of hazards before changing the state of equipment. Each individual should think not only about "my actions," but also about "equipment response." If one is conscious of only a given action and not to the plant or system at large, the individual is mindlessly following the procedure, which is known as "cookbooking." Similarly, use of "thumb rules" leads to the application of familiar solutions to familiar problems. The routine use of thumb rules can promote an 'unthinking' response to perceived "simple" problems.

A questioning attitude is enhanced by a good prejob briefing that explicitly includes a dialogue on hazards, critical parameters, and error traps and their potential consequences. Using an "If—Then" logic or "What if...," questions can help improve people's foresight and situation awareness. A questioning attitude should also lead to the practice of using multiple, alternative indications (facts). Indications of critical parameters are verified against independent, alternative indications to improve comprehension of the actual state of equipment. Knowing the critical parameters that readily indicate the effect of an action aids in responding to offnormal situations correctly. Therefore, agreement on critical parameters important for plant safety or job success should be reached before an activity is begun.

Placekeeping. Placekeeping involves reliably marking steps in a procedure that have been completed or that are not applicable (skipped). Placekeeping is particularly important for plant status and configuration control as well as reassembly of equipment after maintenance, or any situation when the consequences of skipping, repeating, or partially completing a step would result in adverse consequences. The method should help the user maintain positive control of steps completed and those yet to be performed. .It is especially useful if the user is interrupted or delayed, such as at turnover and shift change, allowing the user to go to the last step performed. The technique may differ for each procedure depending on factors such as the layout and logic of the procedure and the importance of the task with respect to safety and reliability.[72]

Navigating a procedure, especially a detailed one involving branching and multiple decision points, can place the physical plant in jeopardy if steps are omitted or performed in an incorrect sequence. As workers perform a task, their attention constantly shifts from the procedure to the controls, to indicators, to physical equipment, to other people, and so on. Therefore, placekeeping becomes an important error-prevention technique.

The following practices are examples from the industry that enhance placekeeping:

- Performing page checks to verify no pages are missing prior to use
- Blacking out procedure steps that are "not applicable"
- Rereading the previous two or three steps performed after being distracted
- Proceduralizing peer checks for the risk-significant steps
- Providing sign-offs for each step (signatures or initials), documenting completion
- Circling a step denoting "in progress" and slashing through the circle to indicate completion of the step
- Annotating completion of a page in the bottom margin of the procedure
- Identifying which page is the last in a procedure by printing "LAST PAGE."

Procedure steps are usually signed off as completed by the person performing the step. In some cases a second person is allowed to sign off a step as completed only when in direct contact with the performer. When a second person is required, the second individual should sign "for" the performer, such as "JCS for TMM."

Some placekeeping/signoff practices should **NOT** be used such as the following:

- Using check marks instead of initials or signatures for continuous use procedures, unless the procedure specifically allows it
- Ditto marks (")
- One set of initials followed with a line through remaining signoff blanks
- Signing off a step as completed before it is

Several other error-prevention practices are used across the industry. Other techniques that could be used include the following:

Concurrent Verification. Concurrent verification (CV) (also known as 'double' verification) is the act of having a second qualified individual verify the correctness of an action and the expected result before and during the action. CV aims to prevent errors. It is used when an action or manipulation, if performed in error, could result in an immediate threat to safe and reliable plant operation (for example, throttling a valve, installing a jumper, lifting an electrical lead, or operating a switch or breaker), personal safety, or result in a significant transient. This error-prevention technique is usually reserved for predetermined actions of a critical nature that are usually directed by a procedure. It is important to identify those situations that could result in an immediate threat to safe and reliable plant operation and designate the use of CV for such actions. Individuals performing a CV review intended actions and expected responses before the act is performed. CV is generally documented formally. The operations perspective of the process is described in detail in section VI of INPO 01-002, *Guidelines for the Conduct of Operations at Nuclear Power Stations* (Component Configuration Control).

Persons performing a CV should be qualified with the CV technique, and qualified technically for the job.

A supervisors can decide to use CV, if the nature of the work warrants it based on the following conditions:

- Complexity of the action(s)
- Chance of missing the step / section exists due to excessive redundancy
- Human factors or ergonomic constraints such as difficult access, poor labeling, limited visibility, etc.
- Limited ability to test or verify status before restoration or repositioning
- Limited experience or proficiency of individual involved

Self-checking is always performed during CV, but CV can be confused with other two-person techniques. Peer-checking accomplishes the same function as CV, but peer-checking can be requested by anyone at any time for any action for which a greater degree of human reliability is desired. Also, keep in mind that CV is not independent verification. Whenever the principal individual performs an action in the physical presence of the checker, the acts are not independent. People in the presence of others are always influenced despite their best efforts.

However, two objective self-checks should occur, one by each person, while minimizing the influence (leading) of the performer on the checker.

Independent Verification. Independent verification (IV) is an additional verification of product quality or system state by a second qualified individual, operating independently after the original performance, to verify a specified condition exists. Peer-checking and concurrent verification are designed to catch errors before they are made. IV on the other hand, catches errors *after* they have been made. Consequently, IV is used when an immediate consequence to the plant or equipment is unlikely should an action be performed incorrectly. It is an act of checking a component's or document's status independent of the actions that established the existing state. Qualified has the same meaning as explained earlier for CV. The operations perspective of the process is described in detail in section VI INPO 01-002, *Guidelines for the Conduct of Operations at Nuclear Power Stations* (Component Configuration Control).

Independence requires *separation in time and space* between the individuals involved to ensure freedom of thought. True independence cannot be established if one individual is looking over the shoulder of the other, even from a distance. An advantage of rigorous independent verification is higher assurance of actual component condition. A disadvantage is the additional time, exposure, and costs necessary to maintain rigorous independence of verifications.

Important management aspects of the technique include identifying which components require verification, defining situations that require independent verification, defining methods for performing the independent verification, and training personnel in the use and bases of the methods. Methods must ensure that all personnel perform IV in the same fundamental manner. Methods will likely vary depending on the type of component, such as air-operated valves, manual-locked valves, fuses, circuit breakers, and others. Not all components require verification, because the possibility of error may be remote or the effect of an error may not be significant to safe and reliable plant operation. In some cases, it would be unreasonable to use IV if it would require undoing what the first person did, such as for work on locked valves and installation of fuses. Such situations may actually require concurrent verification. Therefore, it is important to designate systems and components to be verified and the appropriate verification method for the situation.

Problem-Solving. Problem-solving is a classic indication that the individual or group is in a knowledge-based situation. There is unfamiliarity with the issue, it has been characterized as a problem that must be solved, and individuals dealing with the issue may lack fundamental knowledge of the situation. Everyone eventually experiences situations that do not match what is desired, and the path to achieve the desired goal is vague or unknown. Consequently, the chance for error increases dramatically in a knowledge-based work situation. Without guidance, human beings do not usually solve problems rigorously, methodically, or painstakingly. People need a disciplined approach to problem-solving and become so well practiced with the approach that they will maintain it during stressful situations. Without practice, people will default to what they are comfortable with—that is, trial-and-error.

This is commonly the case during problem-solving meetings. Frequently, meetings are conducted to solve problems that cannot be handled as well individually. Errors can be made during meetings, mostly because of inaccurate mental models and misinterpretation of information. Open communication is key to overcoming these hindrances. The accuracy of various mental models being used to deal with problems must be verified by those participating. This is particularly difficult, since most mental models are tacit, existing below the level of awareness. This could lead to more assumptions being made, especially if factual information is not readily available.[73]

Any obstacle that can hinder the free flow of communication must be identified before the problem-solving task is performed. Inaccurate mental models will persist if a dialogue of factual information is inhibited. In addition to the problem-solving task, participants must be keenly aware of ongoing group processes, such as conflict resolution, brainstorming, social loafing, groupthink, personality conflicts, and so on (See Team Errors near the conclusion of this chapter.). Groupthink, in particular, must be guarded against, because it can result in poor decisions with disastrous outcomes. Individuals may censor themselves to maintain cohesiveness with the group. Consequently, the group may possess inaccurate perceptions about hazards, pitfalls, and even error-likely situations.

A fundamental problem-solving technique includes many or all of the following elements:[74]

- Define the problem—that is, the gap between actual and desired conditions.
- State the goal(s) clearly. Prioritize them if more than one.
- Establish an accurate mental model of the system. Gather as much information relevant to the problem as time permits (Some data may be missed.).
- Identify alternatives that could accomplish the goal(s).
- Decide on a course of action that achieves goal(s), considering risks and costs. Consider guidelines for conservative decision-making.
- Plan by considering several solutions or courses of action.
- Predict potential outcomes and side effects ("what if?").
- Execute the plan.
- Review the outcomes and adapt (any of above steps).

Sometimes problem-solving occurs during stressful situations. To be better prepared for such situations, consider the following suggestions to improve problem-solving performance:

- Start problem-solving meetings with a review of the agenda, critical decisions to be made, the potential consequences of a bad decision and how a bad decision can be avoided.
- Use data, not assumptions, as facts.
- Assign the role of *devil's advocate* to someone to challenge assumptions, decisions, and so on, using direct questions (See the technique for challenging assumptions described in *Knowledge-Based Performance* of this chapter). Beware leaps in logic. Encourage people to identify facts that support their assertions. This encourages reflection and deeper reasoning.
- Strengthen people's ability to work cooperatively with others. Practice using team conflict management and communication skills. Do not let personality conflicts or emotions influence decisions. Frustration should be recognized as a cue to ask more questions.
- Be cautious of problem-solving dominated by one individual. It is difficult to see your own mistakes, and others may not be given the opportunity to share their ideas or challenge that person's reasoning.
- Enhance people's fundamental knowledge of scientific principles and mental models of the plant hardware and human systems. Use system/component knowledge and

fundamental principles of physical sciences associated with plant systems and components in unfamiliar situations.

- Adopt a methodical problem-solving technique such that people do not default to trial-and-error methods during stressful circumstances.
- Practice using the methodical diagnostic and problem-solving techniques with simulated, unfamiliar situations under various levels of time pressure. Develop and practice lateral thinking skills—that is, solving problems with no explicit directions on how to proceed.
- Buy time by delaying the deadline to respond. This reduces time pressure, allowing the thinking process to proceed more slowly, improving the chances for success.
- Promote generation of ideas using group techniques such as brainstorming and the *nominal group technique.*

Conservative Decision-Making. Conservative decision-making is a rule-based and knowledge-based performance strategy that places the safety needs of the physical plant, in particular the reactor core, above the near-term production goals of the organization. Most often, these choices are rule-based in that the decision to make is usually clear. However, choices may not always be absolutely clear, as is in situations one is uncertain what to do. The conservative decision will remain illusive until the operational problem has been deliberately and methodically thought out. Even then, the decision must be considered suspect. If an individual recognizes a manipulation error, he or she must "think" before reacting. Simply reversing an act that was done in error, for instance, reconnecting a terminal lead after it has been removed, may do more damage than good.

Short-term decisions are those made without a formal engineering analysis. In these situations, the following guidance can be used:

- Stay within a safe operating envelope.
- Use all available information.
- Avoid hasty decisions or hurried actions.
- Use all available people who can provide additional insight. At a minimum, the control room team should be used for operational decisions.
- Develop contingency actions if time allows.
- Minimize uncertainty, and do not proceed when uncertain.
- Do not allow economics to preempt safety (production).

Long-term decisions enjoy the luxury of time allowing the support of formal analysis. Such decisions should be guided by the following principles:

- Use all available information.
- Use all available qualified personnel including offsite support if necessary.
- Maintain plant parameters within a safe operating envelop.
- Minimize as much uncertainty as possible. Rely on data, and challenge assumptions.
- Verify changes to safe operating parameters are fixed, understood, and trusted by the worker.

- Develop contingency actions to place plant structures, systems, or components in safe conditions if limits are exceeded.
- Involve upper management in the decision-making, taking advantage of worker input.
- Consider the cumulative risk of all decisions made (for situations involving more than one decision).
- Consider long-term consequences of minimizing loss of revenue (trust of regulator, public, and staff).

Decisions are reviewed after the fact to publicly reinforce conservative decisions, privately coach or counsel personnel who make non-conservative decisions, and incorporate lessons learned.

As the industry becomes more competitive, operators must not let pressure to keep the plant running affect conservative decisions needed to operate the plant safely, particularly regarding the reactor core. A corollary of this is that operators must not feel a sense of haste. Haste can lead to nonconservative action. Conservative acts demand support and positive recognition by managers and should not be criticized. Regrets about conservative decisions should not be made public. Individuals, despite their positions, should not criticize team decisions to be conservative. Incentive programs and reinforcement must be consistent with this policy.

Additional information on conservative decision-making can be found in *Operational Decision Making* (a Professionalism series document); Significant Operating Experience Report (SOER) 94-01, "Nonconservative Decisions and Equipment Performance Problems Result in a Reactor Scram, Two Safety Injections, and Water-Solid Conditions"; SOER 96-01, "Control Room Supervision, Operational Decision-Making, and Teamwork"; and INPO 01-002, *Guidelines for the Conduct of Operations of Nuclear Power Stations.*

Flagging. Several events have been attributed to an individual starting an activity on one component, taking a break or otherwise distracted from the component, and performing manipulations on the wrong component. Wrong unit, wrong train events were at one time a frequent occurrence. These kinds of errors have decreased dramatically with improved labeling, color-coding, and procedures to guide the user. However, to further enhance the probability of working only on the correct equipment, some stations have implemented "flagging" that either denotes the correct component to work on or highlights those "not" to touch during an activity. Exelon stations developed this technique and have a great deal of experience and success using the practice.

Operating Experience. A key to effectively using operating experience is for the right information to be communicated to the right people in time to make a difference. It is unreasonable to expect workers to recall lessons learned from training that was provided months or, perhaps, years earlier. Hence, the station should make effective use of the operating experience information tools (for example, Nuclear Network® and the INPO Website) and have a systematic way of providing "just-in-time" relevant operating experience information to workers. The "Prevent Events" section in INPO operating experience documents provides insight that may be pertinent to a person's role and the technical elements of the task. Operating experience that is properly reflected in procedures should lessen the severity and number of recurring problems. Other documents such as standing orders, lesson plans, and the work planning process may also be used to incorporate operating experience information.

People have an innate or natural tendency to think "it can't happen here," or "that won't happen to me." Humans underestimate risk and overestimate their ability to maintain control. None of us think we will make a mistake. This sense of invulnerability is a *unsafe attitude*. Do not underestimate the difficulty of using and internalizing operating experience. Prudent use of operating experience must be a relentless pursuit of leadership. Lessons learned can be reinforced during various training forums and through day-to-day activities such as, prejob briefing, job-site coaching and reinforcement by supervisors, and engineering decisions. What expectations have been established for the routine use of operating experience information? Do managers and supervisors use operating experience as an input for their own field monitoring activities? Is access to operating experience information in support of work preparations and prejob briefings convenient ("just-in-time)? Is appropriate operating experience used to highlight potential consequences of an evolution or task? How are post-job reviews used to capture lessons learned from in-house experience? Questions such as these provide insight into the effective dissemination of operating experience information.

Supervisory Monitoring. Supervisory presence in the work place can be an effective defense against error. Errors are less likely when supervisors are in the field. Supervising field activities provides the technician or operator another set of eyes to detect and recover from error, as well as "see" conditions that could provoke error. Through work preparation, pre-job briefings, field observations, coaching, reinforcing, and counseling, worker performance is enhanced, and the physical plant is challenged less from error, at-risk practices, and violations.

Supervisors should, and are expected to, exercise their authority to protect the plant and personnel. Maintaining high standards of performance minimizes complacency, and focusing on professional, caring relationships with individual workers promotes healthy communication about work-place conditions that pose obstacles to error-free performance. Knowledge of critical tasks, critical parameters, critical steps, and vital points will aid their oversight. Because of their unique, uninvolved role, they are typically able to see potential barriers to completing assigned tasks and can take appropriate measures to remove them from the activity. Supervisors, when they detect at-risk practices or behaviors that do not satisfy expectations and standards of performance, can take the opportunity to coach, reinforce, and counsel as needed. In the field supervisors can solicit feedback. Communications with subordinates should promote a spirit of cooperation, mutual respect, honesty, and fairness. This environment encourages workers to willingly bring up issues and share what is hindering their ability to accomplish assigned tasks.

Entergy Operations established a utility-wide standard for "contact time" for in-field monitoring. Contact Time is defined as "the cumulative amount of time spent in the company of employees, observing and coaching their behaviors."[75] Internal studies revealed that each station's error rates dropped with a corresponding increase in contact time.

TEAM ERRORS

Why do events happen when there are two or more people working on a task? Doesn't a second set of eyes provide an additional defense against error? How can anything go wrong? Just because two or more people are performing a task does not ensure that it will be done correctly. In team situations, workers may not be fully attentive to the task, or may be otherwise influenced co-workers. Several socially related factors influence the dynamics among individuals on a team. Team errors are shortcomings in performance that can be triggered by the social interaction among group members. For instance, data at one nuclear station shows that operations' configuration control issues, which usually involve concurrent or independent verification, are particularly subject to the dangers of "social loafing."[76]

Social Loafing.[77] Because individuals are usually not held personally accountable for a group's performance, some individuals in a group may not actively participate. As the saying goes, "there is safety in numbers." People refrain from becoming involved believing that they can avoid accountability, or "loaf," in team, or "social," activities.

Team errors are stimulated by, but are not limited to, one or more of the following situations:

- *Halo Effect* – This results from blind trust in the competence of specific individuals because of their experience or position in an organization. Consequently, other personnel drop their guard against error by the competent individual, and vigilance to check the respected person's actions weakens or ceases altogether.
- *Pilot/Co-pilot* – A subordinate person (co-pilot) is reluctant to challenge the opinions, decisions, or actions of a senior person (pilot). Subordinates may express "excessive professional courtesy" when interacting with senior managers, unwittingly accepting something the boss says without critically thinking about it or challenging the person's actions or conclusions.[78]
- *Free Riding* – If one person takes the lead in a group activity, others may tend to 'tag along' without actively scrutinizing the intent and actions of the person doing the work. "The other person is 'thinking' about the task." Or, they may feel, "it's not my job."
- *Groupthink* – This is a reluctance to share contradictory information about a problem for the sake of maintaining the harmony of the work group. This is detrimental to critical problem-solving. Highly cohesive, tight-nit groups are particularly susceptible to this kind of team error. Usually, this is worsened by one or more dominant team members who possess considerable influence on the group's thinking (pilot/co-pilot or halo effect). Consequently, critical information known within the group may remain hidden from other team members. Groupthink can also result from too much "professional courtesy"—subordinates passing on only "good news" or "sugar-coating" bad news so as to not displease their bosses or higher level managers.
- *Risky Shift* – There is tendency to gamble with decisions more as a group than if each group member was making the decision individually.[79] Accountability is diffused in a group. If two or more people agree together that they know a "better way" to do something, they will likely take the risk and disregard established procedure or policy. This has been referred to as a "herd mentality." In the worst case, this is how riots get started.

Competence vs. Control.[80] Humans are fallible, and even the best people can make the worst mistakes.[81] Regardless of who a person is and what position he or she holds in an organization, that person can err. Therefore, controls (defenses and error-prevention techniques) are adopted to prevent, catch, or mitigate the outcomes of error. The purpose of these controls is to make the process (or task) go smoothly, properly, and according to high standards.[82] Remember, positive control means that 'what is intended to happen is what happens, and that is all that happens.' Some people may be insulted when others check their work. When people are directed to check or review another person's performance, the competence of the performer is not being called into question as some may think. Controls are necessary because of human fallibility, not incompetence. The fact that a person is assigned a task means he or she is considered competent, or qualified, to perform the activity. Human nature is the problem, and "controls" are needed to reduce the chances for error.

Antidotes to Team Errors. The following strategies can be used to reduce the occurrence of team errors:

- Train on team errors and their causes.
- Practice questioning attitude/situation awareness.
- Designate a devil's advocate.
- Maintain independence in thought from other team members.
- Challenge actions and decisions of others.
- Call "time outs" to help the team achieve a shared understanding of plant or product status.
- Perform a thorough and independent task preview. (See Chapter 5 for a description of task preview.)
- Participate in formal team development training

ERROR PRECURSORS (long list)

The conditions listed below were derived from an in-depth study of INPO's event data base and several highly regarded technical references on the topic of error. Many references refer to error precursors as *behavior-shaping factors* or *performance-shaping factors.* The bolded error precursors are more prevalent and are listed in order of impact. Other error precursors are not listed in any particular order.

Task Demands

- **Time pressure (in a hurry)**
- **High workload (memory requirements)**
- **Simultaneous, multiple tasks**
- **Repetitive actions / Monotony**
- **Irreversible acts**[a]
- **Interpretation requirements**
- **Unclear goals, roles, or responsibilities**
- **Lack of or unclear standards**
- Confusing procedure / Vague guidance
- Excessive communication requirements
- Delays; idle time
- Complexity / High information flow
- Long-term monitoring
- Excessive time on task

Individual Capabilities

- **Unfamiliarity with task / First time**
- **Lack of knowledge (faulty mental model)**
- **New technique not used before**
- **Imprecise communication habits**
- **Lack of proficiency / Inexperience**
- **Indistinct problem-solving skills**
- **'Unsafe' attitudes for critical task**
- **Illness / fatigue (general health)**
- Unawareness of critical parameters
- Inappropriate values
- Major life event: medical financial, and emotional
- Poor manual dexterity
- Low self-esteem; moody
- Questionable ethics (bends the rules)
- Sense of control / Learned helplessness
- Personality type

Work Environment

- **Distractions / Interruptions**
- **Changes / Departure from routine**
- **Confusing displays / controls**
- **Work-arounds / OSS**[b] **instrumentation**
- **Hidden system response**
- **Unexpected equipment conditions**
- **Lack of alternative indication**
- **Personality conflicts**
- Back shift or recent shift change
- Excessive group cohesiveness / peer pressure
- Production overemphasis
- Adverse physical climate (habitability)
- No accounting of performance.
- Conflicting conventions; stereotypes
- Poor equipment layout; poor access
- Fear of consequences of error
- Mistrust among work groups
- Meaningless rules
- Nuisance alarms
- Unavailable parts or tools

Human Nature

- **Stress (limits attention)**
- **Habit patterns**
- **Assumptions (inaccurate mental picture)**
- **Complacency / Overconfidence**
- **Mind-set**
- **Inaccurate risk perception (Pollyanna)**
- **Mental shortcuts (biases)**
- **Limited short-term memory**
- Pollyanna effect
- Limited perspective (bounded rationality)
- Avoidance of mental strain
- First day back from vacation / days off
- Sugar cycle (after a meal)
- Fatigue (sleep deprivation and biorhythms)
- Tunnel vision (lack of big picture)
- "Something is not right" (gut feeling)
- Pattern-matching bias
- Social deference (excessive professional courtesy
- Easily bored
- Close-in-time cause-effect correlation

- Acceptability of "cookbooking" practices
- "Rule book" culture
- Equipment sensitivity (inadvertent actions)
- Lack of clear strategic vision or goals
- Identical and adjacent displays or controls
- Out-of-service warning systems
- Lack of procedure place-keeping
-
- Difficulty seeing own errors
- Frequency and similarity biases
- Availability bias
- Imprecise physical actions
- Limited attention span
- Spatial disorientation
- Physical reflex
- Anxiety (involving uncertainty)

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

[b] OOS - out of service

COMMON ERROR PRECURSOR DESCRIPTIONS

The first eight error precursors from the table on the previous pages are described below. These tend to be the more commonly encountered conditions that provoke errors. The error precursors for each category are arranged in order of influence.

Task Demands	Description
Time pressure (in a hurry)	Urgency or excessive pace required to perform action or task Manifested by shortcuts, being in a hurry, and an unwillingness to accept additional work or to help others No spare time
High workload (high memory requirements)	Mental demands on individual to maintain high levels of concentration; for example, scanning, interpreting, deciding, while requiring recall of excessive amounts of information (either from training or earlier in the task)
Simultaneous, multiple tasks	Performance of two or more activities, either mentally or physically, that may result in divided attention, mental overload, or reduced vigilance on one or the other task
Repetitive actions / Monotony	Inadequate level of mental activity resulting from performance of repeated actions; boring Insufficient information exchange at the job site to help individual reach and maintain an acceptable level of alertness
Irrecoverable acts	Action that, once taken, cannot be recovered without some significant delay No obvious means of reversing an action
Interpretation requirements	Situations requiring "in-field" diagnosis, potentially leading to misunderstanding or application of wrong rule or procedure
Unclear goals, roles, & responsibilities	Unclear work objectives or expectations Uncertainty about the duties an individual is responsible for in a task that involve other individuals Duties that are incompatible with other individuals
Lack of or unclear standards	Ambiguity or misunderstanding about acceptable behaviors or results; if unspecified, standards default to those of the front-line worker (good or bad)

Work Environment	Description
Distractions / Interruptions	Conditions of either the task or work environment requiring the individual to stop and restart a task sequence, diverting attention to and from the task at hand
Changes / Departure from routine	Departure from a well-established routine Unfamiliar or unforeseen task or job site conditions that potentially disturb an individual's understanding of a task or equipment status
Confusing displays / controls	Characteristics of installed displays and controls that could possibly confuse or exceed working memory capability of an individual Examples: • missing or vague content (insufficient or irrelevant) • lack of indication of specific process parameter • illogical organization and/or layout • insufficient identification of displayed process information • controls placed close together without obvious ways to discriminate conflicts between indications
Work-arounds / Out-of-Service instrumentation	Uncorrected equipment deficiency or programmatic defect requiring compensatory or non-standard action to comply with a requirement; long-term materiel condition problems that place a burden on the individual
Hidden system response	System response invisible to individual after manipulation Lack of information conveyed to individual that previous action had any influence on the equipment or system
Unexpected equipment condition	System or equipment status not normally encountered creating an unfamiliar situation for the individual
Lack of alternative indication	Inability to compare or confirm information about system or equipment state because of the absence of instrumentation
Personality conflict	Incompatibility between two or more individuals working together on a task causing a distraction from the task because of preoccupation with personal differences

Individual Capabilities	Description
Unfamiliarity with task / First time	Unawareness of task expectations or performance standards First time to perform a task (not performed previously; a significant procedure change)
Lack of knowledge (mental model)	Unawareness of factual information necessary for successful completion of task; lack of practical knowledge about the performance of a task
New technique not used before	Lack of knowledge or skill with a specific work method required to perform a task
Imprecise communication habits	Communication habits or means that do not enhance accurate understanding by all members involved in an exchange of information
Lack of proficiency / Inexperience	Degradation of knowledge or skill with a task because of infrequent performance of the activity
Indistinct problem-solving skills	Unsystematic response to unfamiliar situations; inability to develop strategies to resolve problem scenarios without excessive use of trial-and-error or reliance on previously successful solutions Unable to cope with changing plant conditions
"Unsafe" attitude for critical tasks	Personal belief in prevailing importance of accomplishing the task (production) without consciously considering associated hazards Perception of invulnerability while performing a particular task Pride; heroic; fatalistic; summit fever; Pollyanna; bald tire
Illness / Fatigue	Degradation of a person's physical or mental abilities caused by a sickness, disease, or debilitating injury Lack of adequate physical rest to support acceptable mental alertness and function

Human Nature	Description
Stress	Mind's response to the perception of a threat to one's health, safety, self-esteem, or livelihood if task is not performed to standard Responses may involve anxiety, degradation in attention, reduction in working memory, poor decision-making, transition from accurate to fast Degree of stress reaction dependent on individual's experience with task
Habit patterns	Ingrained or automated pattern of actions attributable to repetitive nature of a well-practiced task Inclination formed for particular train/unit because of similarity to past situations or recent work experience
Assumptions	Suppositions made without verification of facts, usually based on perception of recent experience; provoked by inaccurate mental model *Believed to be fact* Stimulated by inability of human mind to perceive all facts pertinent to a decision
Complacency / Overconfidence	A "Pollyanna" effect leading to a presumption that all is well in the world and that everything is ordered as expected Self-satisfaction or overconfidence, with a situation unaware of actual hazards or dangers; particularly evident after 7-9 years on the job Underestimating the difficulty or complexity of a task based upon past experiences
Mind-set	Tendency to "see" only what the mind is *tuned* to see (intention); preconceived idea Information that does fit a mind-set may not be noticed and vice versa; may miss information that is not expected or may see something that is not really there; contributes to difficulty in detecting one's own error (s)
Inaccurate risk perception	Personal appraisal of hazards and uncertainty based on either incomplete information or assumptions Unrecognized or inaccurate understanding of a potential consequence or danger Degree of risk-taking behavior based on individual's perception of possibility of error and understanding of consequences; more prevalent in males

Human Nature	Description
Mental shortcuts (biases)	Tendency to look for or see patterns in unfamiliar situations; application of thumbrules or "habits of mind" (heuristics) to explain unfamiliar situations: • confirmation bias • frequency bias • similarity bias • availability bias
Limited short-term memory	Forgetfulness; inability to accurately attend to more than 2 or 3 channels of information (or 5 to 9 bits of data) simultaneously The mind's "workbench" for problem-solving and decision-making; the temporary, attention-demanding storeroom we use to remember new information

REFERENCES

[1] Dorner. *The Logic of Failure.* 1996; pp.185-186.

[2] Senders & Moray. *Human Error Cause, Prediction, and Reduction.* 1991; pp.44, 67.

[3] Reason. *Human Error.* 1990; pp.38-39.

[4] Wickens. *Engineering Psychology and Human Performance.* 1992; pp.277-281.

[5] Swain & Guttman. *Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications* (NUREG/CR-1278). 1983.

[6] Wickens. *Engineering Psychology and Human Performance.* 1992; pp.211-222.

[7] Spettell & Liebert. "Training for Safety in Automated Person-machine Systems," American Psychologist. May 1996.

[8] Wickens. *Engineering Psychology and Human Performance.* 1992; pp.20-21.

[9] Weick and Sutcliffe. *Managing the Unexpected.* 2001; pp.33-41.

[10] Russel. *The Brain Book.* 1979; pp.211-215.

[11] Reason. *Human Error.* 1990; pp.38-39.

[12] Turner and Pidgeon. *Man-Made Disasters.* 1997; pp.109-115.

[13] Hursh. "Fatigue and Alertness Management using *FAST™*." Presentation at nuclear industry annual workshop on *Human Performance/Root Cause/Trending* in Baltimore, MD, June 6, 2001. Dr. Steven Hursh is a professor at Johns Hopkins University School of Medicine. *FAST™* (Fatigue Avoidance Scheduling Tool) is a software program aimed at minimizing personnel fatigue.

[14] Keller. *Attitude is Everything.* 1999; pp.14-16.

[15] Ropeik and Gray. *Risk: A Practical Guide for Deciding What's Really Safe and What's Really Dangerous in the World Around You.* 2002; pp.15-18.

[16] Krakauer, *Into Thin Air*, 1997. This is the story of how 12 climbers died during an ascent of Mount Everest in 1996.

[17] Yates. *Risk-Taking Behavior.* 1992; p.52.

[18] Dorner. *The Logic of Failure.* 1996; p.109.

[19] Turner and Pidgeon. *Man-Made Disasters.* 1997; p.34.

[20] Yates. *Risk-Taking Behavior.* 1995; p.52.

[21] Weick and Sutcliffe. *Managing the Unexpected.* 2001; p.94.

[22] INPO. "In-Reactor Fuel-damaging Events, A Chronology (INPO 91-008)." 1991.

[23] Swain and Guttman. *Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Application, Final Report* (NUREG/CR-1278). 1983.

[24] Center for Chemical Process Safety. *Guidelines for Preventing Human Error in Process Safety,* American Institute of Chemical Engineers. 1994; pp.12-15.

[25] Health and Safety Commission. "Advisory Committee on the Safety of Nuclear Installations Study Group on Human Factors, Second Report: Human Reliability Assessment - A Critical Overview." Her Majesty's Stationery Office. 1991; p.33.

[26] Gilbert. *Human Competence, Engineering Worthy Performance.* 1996; pp.82-89.

[27] Limerick Generating Station, 2000.

[28] Restak. *Brainscapes.* 1995; p.60.

[29] Dekker. *The Field Guide to Human Error Investigations.* 2002; pp.47-50.

[30] Wickens. *Engineering Psychology and Human Performance.* 1992; pp.17-20.

[31] Marrietta Daily Journal. "Scientists: People cannot drive safely, talk at same time." July 30, 2001.

[32] Wickens. *Engineering Psychology and Human Performance.* 1992; p.69.

[33] Wickens. *Engineering Psychology and Human Performance.* 1992; pp.386-391.

[34] Spettell & Liebert. "Training for Safety in Automated Person-machine Systems," American Psychologist. May 1996.

[35] Weick and Sutcliffe. *Managing the Unexpected.* 2001; p.41.

[36] Reason. *Managing the Risks of Organizational Accidents.* 1998; pp.68-70.

[37] Turner and Pidgeon. *Man-Made Disasters.* 1997; pp.124-126.

[38] Reason. *Human Error.* 1990; p.56.

[39] Health and Safety Commission. "Advisory Committee on the Safety of Nuclear Installations Study Group on Human Factors, Second Report: Human Reliability Assessment - A Critical Overview." Her Majesty's Stationery Office. 1991; p.9.

[40] Catoe, J. "Hypnotherapy." Atlanta Journal and Constitution. November 22, 1998.

[41] Performance Improvement International. An internal study of errors across the nuclear industry revealed that 25 percent of errors were skill-based, 60 percent were rule-based, and 15 percent were knowledge-based. 2000.

[42] Health and Safety Commission. Advisory Committee on the Safety of Nuclear Installations Study Group on Human Factors, Second Report: Human Reliability Assessment – A Critical Overview. Her Majesty's Stationery Office. 1991; p.7.

[43] Geller. *The Psychology of Safety.* 1998; p.61.

[44] Center for Chemical Process Safety. *Guidelines for Preventing Human Error in Process Safety,* American Institute of Chemical Engineers. 1994; pp.78-80.

[45] Reason. *Managing the Risks of Organizational Accidents.* 1998; p.70.

[46] Reason. *Human Error.* 1990; pp.74-86.

[47] Swain & Guttman. *Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications* (NUREG/CR-1278). 1983.

[48] Performance Improvement International. An internal study of errors across the nuclear industry revealed that 25 percent of errors were skill-based, 60 percent were rule-based, and 15 percent were knowledge-based. 2000.

[49] Reason. *Human Error.* 1990; pp.53-55.

[50] Turner and Pidgeon. *Man-Made Disasters.* 1997; pp.124-126.

[51] Wickens. *Engineering Psychology and Human Performance.* 1992; p.20.

[52] According to a conversation with Dr. James Reason, professor of psychology at the University of Manchester in the United Kingdom, the chances for error in a knowledge-based situation are roughly a toss-up, "If you're good." Otherwise, the chances for success get worse. February 1997.

[53] Performance Improvement International. An internal study of errors across the nuclear industry revealed that 25 percent of errors were skill-based, 60 percent were rule-based, and 15 percent were knowledge-based. 2000.

[54] Dorner. *The Logic of Failure*. 1996; pp.71-79.

[55] Reason. *Human Error*. 1990; pp.61-66, 86-89.

[56] Howlett. *The Industrial Operator's Handbook*. 1995; p.45.

[57] Dorner. *The Logic of Failure*. 1996; p.42.

[58] Baxter, G. & Bass, E. "Human Error Revisited: Some Lessons for Situational Awareness." Fourth Symposium On Human Interaction with Complex Systems. March 22-24, 1998; pp.81-87.

[59] Swain & Guttman. *Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications* (NUREG/CR-1278). 1983.

[60] Turner and Pidgeon. *Man-Made Disasters*. 1997; pp.33-34.

[61] Senge. *The Fifth Discipline Fieldbook*. 1994; pp.245-246

[62] Senge. *The Fifth Discipline Fieldbook*. 1994; pp.86-95.

[63] Geller. *The Psychology of Safety*. 1998; pp.41-43.

[64] Turner & Pidgeon. *Man-Made Disasters*. 1997; p.34.

[65] Reason. *Managing the Risks of Organizational Accidents*. 1998; pp.49-51.

[66] Allison. *Global Disasters*. 1990; p.40-45.

[67] EPRI. *Phase 2 Development of Procedure Usability Measurement Process (PUMP) Method," Report (TR-110175)*. 1998; pp.7-8.

[68] EPRI, "Phase 2 Development of Procedure Usability Measurement Process (PUMP) Method," Report TR-110175. 1998.

[69] Weick and Sutcliffe. *Managing the Unexpected*. 2001; p.109.

[70] Duane Arnold, 2000.

[71] Turner & Pidgeon, *Man-Made Disasters*. 1997; pp.85-89.

[72] EPRI, "Phase 2 Development of Procedure Usability Measurement Process (PUMP) Method," Report TR-110175. 1998.

[73] Senge, P. *The Fifth Discipline Fieldbook*. 1994; p.245

[74] Dorner, *The Logic of Failure*. 1996; pp.43-47.

[75] Entergy. "Human Performance Program" (PL-162), Nuclear Management Manual. 2002.

[76] Coovert & Smit, "Are Two Heads Better Than One?" Braidwood Nuclear Station. 1999.

[77] Latane, "Many heads make light the work: The causes and consequences of social loafing." Journal of Personality and Social Psychology. 1979.

[78] Hopkins. *Preventing Human Error, A Practical Guide to Quality - Safety - Effectiveness*. 2000; p. 44-45.

[79] Yates. *Risk-Taking Behavior*. 1992; pp.168-173.

[80] Hollnagel. *Cognitive Reliability and Error Analysis Method*. 1998; pp. 154-155.

[81] INPO. *Excellence in Human Performance*. 1997; p.3.

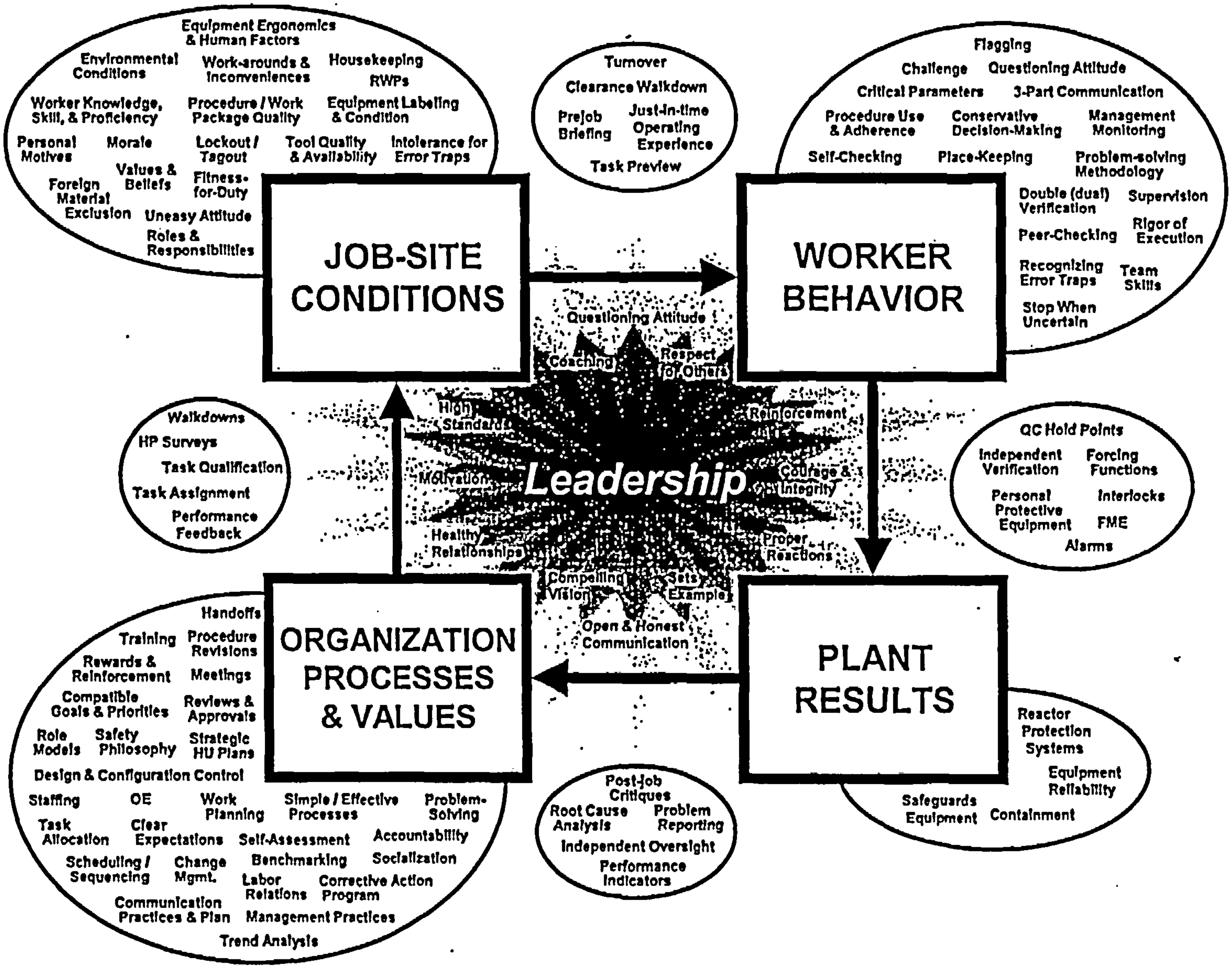
[82] Drucker. *Management: Tasks, Responsibilities, Practices*. 1974; p.218.

CHAPTER 4

LEADERSHIP

Excellence in Human Performance

The Performance Model (with example defenses)



LEADER DEFINED

Management systems and engineered controls are not fully effective on their own to ensure safety. A *culture* must exist in which hazards, error-likely situations and flawed defenses are readily recognized, communicated, and resolved before work proceeds. Fostering the will to communicate at all levels of the organization despite personal fears is one of the most challenging tasks of station management. Consequently, leadership is the management activity that will most likely move a station to the *next level* of human performance.[1]

> *With every problem, someone somewhere sees it coming. But those people tend to be low rank, invisible, unauthorized, reluctant to speak up, and may not even know they know something that is consequential.*
>
> *-Weick and Sutcliffe*
> *Managing the Unexpected*

A leader is *any individual* who takes personal responsibility for his or her performance as well as the plant's performance *and* attempts to influence the improvement of organizational processes and values. Improving human performance demands that people value prevention (safety) and perceive it as crucial to the long-term success of both the station and themselves. Workers, supervisors, and managers must believe they can prevent human error and its consequences. Values, beliefs, and corresponding practices—the culture—reaches into all parts of the organization. The values and beliefs people possess are strong factors in the choices they make when they encounter unanticipated situations or when direction is vague or absent. Influencing these factors such that people possess the will to communicate despite personal consequences is the central theme of leadership in human performance improvement.

To promote effective communication, healthy relationships among plant personnel are imperative. Fundamentally, such relationships are characterized by respect, honesty, and fairness. Also, if workers are to make safe choices in the field, they must have a clear vision of the station's values with respect to safety. Is the business case for human performance improvement clear? Do production pressures preempt safe work practices? Do people value the prevention of errors? Are error-prevention behaviors reinforced? Are the recognition plan and accountability policy consistent with safety and prevention values? Is feedback to management important to eliminate process deficiencies? By establishing and maintaining healthy, as well as professional, relationships with individual workers, managers can stay aware of the values, beliefs, and practices of the organization. *Focusing on the station's shared values, beliefs, and practices—culture—is the most effective way to maximize the organization's resistance to events.*[2]

LEADER'S ALIGNMENT ROLE

Human performance occurs within the context of the organization. Human performance is the system of processes, values, behaviors, and their ultimate results that determine plant performance. The organization is the engine that drives the performance system (see the Performance Model) directing and influencing human performance in the field (See Chapter 3). This perspective contrasts with the more traditional notion that human performance is simply a worker issue. Managers, staff, supervisors, and workers must work as a team to accomplish the station's missions to generate electricity safely and reliably—event-free.

However, when workers, managers, and supervisors do not understand their roles or when expectations are unclear, human performance suffers. Therefore, the leader's role is to *align* organizational processes and values to optimize individual performance at the job site (behavior and results). Success at the job site and in the plant is a chief aim of organizational processes and values and is best achieved by strengthening defenses as illustrated in the Performance Model in Chapter 3.[3]

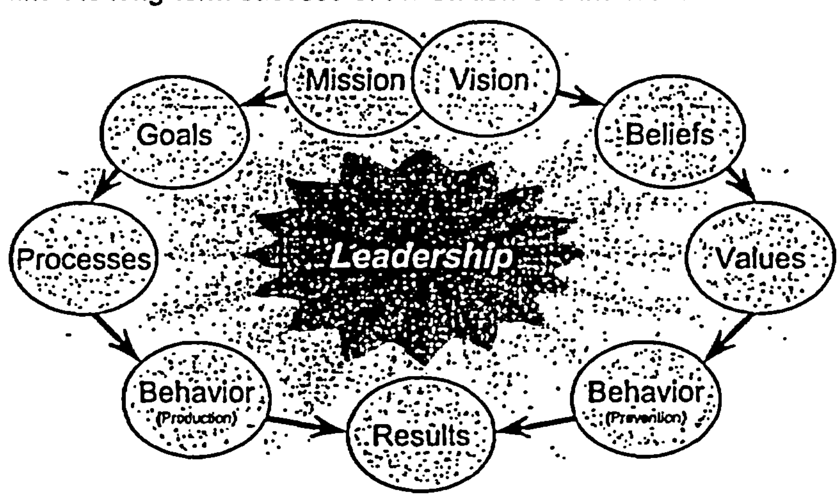
Production and prevention practices will always compete. Leaders (not simply "managers") must work to keep the physical plant and personnel safe. Well-informed leadership at all levels of a station organization will ensure that the vision, beliefs, and values do not conflict with the station's mission, goals, and processes. Consistency and alignment is imperative to promote desired production and prevention behaviors, all to generate the desired results for the long term.

Competing Purposes: Production and Prevention

Two types of behaviors are required to generate electricity safely and reliably.

Production Behaviors. Traditionally, managers have emphasized the production effort. Production behaviors are those actions or activities aimed toward generating electricity. Management-centered structures (mission, goals, work processes, schedules, and procedures) are needed to achieve production goals. The outcomes of production are self-evident, such as completing jobs on schedule, running equipment, generating electricity, minimizing expenses, and satisfying the customer. Such feedback—most of it positive—informs people how they are doing.

Prevention Behaviors. Prevention behaviors, such as self-checking, peer-checking, reviews and approvals, and procedure use, are applied as a work situation requires to minimize the risk of error. Production activities slow down long enough to allow people to think, while executing prevention tactics, before proceeding with an activity in order to prevent errors and events. *Excellence in Human Performance* (1997) was written to provide the industry with a set of principle-based prevention behaviors. If used correctly, nothing (bad) happens! Plant events are minimized, and the long-term success of the station is enhanced.



Studies have shown that the initial stages of a disaster usually began with the degradation of the organization's beliefs about hazards in the workplace.[4] This observation is consistent with long-term success. Complacency builds up, and prevention practices weaken as people forget about what can go wrong. Lacking constant emphasis and reinforcement, prevention can be perceived as less important than production. People, including mangers, may come to think that prevention activities are optional when they conflict with the accomplishment of production objectives.

Without leadership intervention, production practices will overcome those aimed toward prevention. Production behaviors will take precedence over prevention behaviors unless there is a strong safety culture—the central focus of leadership. Healthy relationships between managers and workers are necessary to promote a sense of wariness toward error and an intolerance toward error-likely situations. Wariness and intolerance are attitudes, generally derived from one's beliefs about hazards in the plant. Hence, the need for leadership.

Together, prevention and production behaviors are necessary for long-term success. But sometimes managers err when they assume people will be *safe*. Safety and prevention behaviors do not just happen. They are value-driven, and people may not choose the conservative approach because of the stronger production influences in the short term. To help understand the need for leadership, the differences between production and prevention behaviors are listed in the table below:

Production Behaviors:	Prevention Behaviors:
• will *accomplish* the station's mission	• will *avoid* challenges to the mission
• will *achieve* desired results	• *will protect* desired results
• are *process* driven	• are *values* driven
• are *easy* to measure	• are *hard* to measure
• are frequently *reinforcing*	• are perceived as *burdensome*
• provide natural feedback	• provide little or no feedback
• can be perceived as *mandatory*	• can be perceived as *optional*
• involve the *mind* (logic)	• involve the *heart* (emotion)
• require *management* practices	• require *leadership* practices

A robust safety culture requires aggressive leadership emphasizing healthy relationships that promote open communication, trust, teamwork, and continuous improvement.[5] Continuous improvement needs ongoing leadership attention to improve the plant's resistance to events triggered by human error (defense-in-depth).[6] Those in positions of responsibility must *see* themselves as leaders as well as managers to create an atmosphere of open communication. Therefore, *leadership is a defense.* Interactions involving quality coaching and counseling will promote clear values and improve performance. An illustration explaining the relationship between coaching and counseling is provided at the conclusion of this chapter.

Vision: Event-Free Operation Through Excellent Human Performance

To achieve event-free plant performance, station management creates a defense-in-depth philosophy that functions at all levels of the organization. Therefore, managers in their leadership role establish healthy relationships that promote the following conditions and practices sitewide:

1. Leaders demonstrate a commitment to improving human performance by establishing, communicating, and reinforcing clear expectations for professional behavior, continuous improvement, appropriate policies, efficient and effective processes, and common values.
2. Organizational processes and values include a defense-in-depth philosophy that considers human fallibility. These processes are also designed to function efficiently and to support safe operation.

3. Training and leadership forums are used to improve human and station performance, including the sharing of operating experience and beneficial techniques to reduce errors and eliminate events. All employees reinforce desired individual behaviors at every opportunity including subordinate and peer coaching. Reward and discipline practices are linked to professional behaviors.
4. Individuals at all levels demonstrate an intolerance of error-likely situations and flawed defenses, routinely consider how their actions can affect the plant, and take the initiative to communicate concerns. Individuals also demonstrate accountability for thorough task preparation, process execution, use of error prevention techniques, and contingency planning.
5. Individuals at every level seek to continuously improve their performance, equipment performance, the work environment, and organizational processes by aggressively communicating opportunities for improvement. Managers and supervisors promote a continuous improvement culture by being highly responsive to employee input and by involving employees in developing actions to improve processes and techniques. Improvements are pursued through benchmarking, training, and innovation.
6. Managers and supervisors assess and trend human performance through in-field observations, formal assessments, and performance data analyses. Results are used to develop corrective actions, to improve training, and are shared with all personnel.
7. A culture exists, involving respect, fairness, and honesty that places a high value on healthy relationships among individuals and among groups. This is evident in the work quality, the conduct of business, and the way communication occurs.

These statements are not intended to supplant the principles of *Excellence in Human Performance* but to enable their application, which depends heavily on leadership. *Leadership is not optional.* Consequently, sustaining prevention behaviors for the long-term success of the plant requires application of several key leadership practices. A "gap" analysis survey tool is provided as an attachment to this chapter that may be used to facilitate the senior leadership team's alignment on human performance issues.

KEY LEADERSHIP PRACTICES

1. *Facilitate open communication.*
2. *Promote teamwork.*
3. *Reinforce desired behaviors.*
4. *Eliminate latent organizational weaknesses.*
5. *Value prevention of errors.*

These practices, when used consistently, optimize worker behavior at the job site by aligning organizational processes and values to support desired behaviors. But, effective alignment depends on the presence of healthy relationships. That is, a culture based on respect, fairness, and honesty among individuals and groups. It takes teamwork to achieve excellence, and effective teamwork demands trust. Mismatches in the expectations associated with the "psychological contract"[a] between management and the workforce hinders improvement in human and station performance.

Front-line workers have traditionally been perceived as the largest contributors of risk that management has to control. However, individuals at all organizational levels should be regarded as critical resources in identifying opportunities for improving human as well as plant performance. *This includes managers seeing themselves as an integral part of the system, part of the team.* Workers should perceive themselves as an integral part of the station organization as well, providing feedback to supervision and management on opportunities for improvement. Everyone has the opportunity to be a leader when it comes to preventing human error and plant events. In this sense, leadership is considered more a set of behaviors than a position.

Facilitate Open Communication

Communication is the most effective defense against events. An organization must have, without fear, the *will* to communicate in order to sustain long-term safe and reliable operations.[7] Obstacles to communication must be eliminated immediately. Leaders make communication happen instead of assuming it happens. The organizational atmosphere must promote open, candid conversations among individuals. Leaders, no matter what positions they hold, actively encourage others to identify error-likely situations and respective organizational weaknesses.

> *Managers, ask for what you need to hear, not for what you want to hear. Subordinates, tell your boss what they need to hear, not what you think they want to hear.*
>
> *-Roger Boisjoly*
> *Morton-Thiokol Chief Engineer*
> *Space Shuttle Challenger*

Healthy personal relationships occur only when workers are actively engaged in improving plant performance. An atmosphere of teamwork and collaboration will motivate individuals to improve the effectiveness of the organization. A safe atmosphere is cultivated when people treat each other with honesty, fairness, and respect—that is, when they establish healthy relationships. Eventually, people become more willing to be held accountable and seek assistance by admitting to and learning from mistakes. Listed in order of importance, the more effective ways to promote productivity in people's jobs involve the following top 10 situations:[8]

1. Knowing what is expected from me
2. Having the equipment and resources to do the job correctly
3. Giving me the opportunity to do my best every day
4. Receiving recognition and reinforcement for my efforts during the last week (while the performance is fresh in the worker's minds) (See "Effective Reinforcement Techniques" later in this chapter.)
5. Perceiving that the boss cares about me as a person

---

[a] A psychological contract is an unwritten set of expectations between managers and workers in an organization that is in effect at all times. Organizational expectations are related to rewards and incentives such as salary, wages, working hours, benefits, and privileges that go with the job and involve a person's sense of dignity and worth. For more information see Edgar Shein, *Organizational Psychology*, 1994.

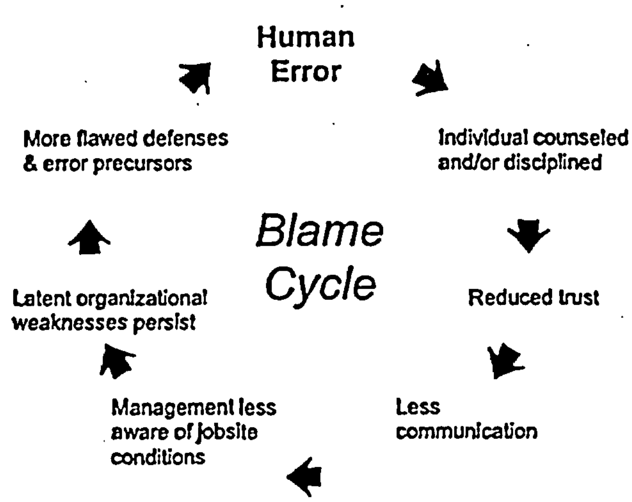
6. Having a mentor or someone who helps with personal development
7. Discussing my progress within the last six months (quarterly is common.)
8. Knowing that my opinions count
9. Making me feel my job is important
10. Knowing that the people I work with are committed to quality work

These are consistent with the job-site conditions that are most influential on quality work: task-related information, resources, and incentives (see Chapter 3).

Communication Plan. A communication plan guides manager and supervisor verbal and written interactions (formal and informal) with line workers so that a consistent message about safety is passed on. It identifies multiple forums, media, and opportunities for managers and supervisors to engage the workforce. The plan supports understanding of the organization's mission, vision, values, priorities, and expectations. One plant has developed a methodical process for developing communications.[9] Forums such as formal meetings, maintenance shops, classrooms, job sites in the plant, and even hallways provide opportunities to send messages. In addition to production improvement, forums should exist that allow dialogue on safety and cultural issues. Media such as station newspapers, weekly bulletins, e-mail messages, closed-circuit television, and posters can be used to communicate in a written form. Managers must also be sensitive to informal interactions in which a careless, unthinking word or action may send an unintended message.[10] Leaders set the example with their communication practices.

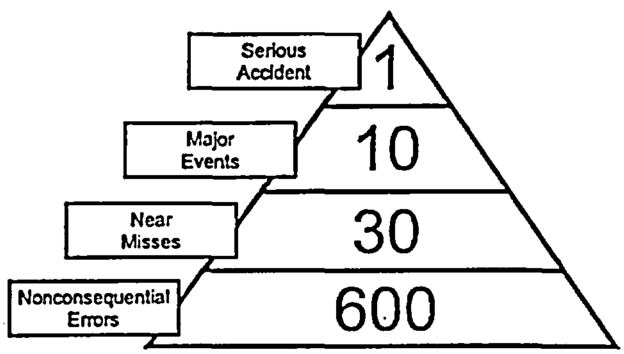
Generally, a communication plan should accomplish the following:

- Clarify the purpose and goals of the plan.
- Identify target audiences (work groups). Generally, it is more effective to focus on positive role models than on those who habitually resist and complain.
- Summarize the key messages to (or not to) communicate.
- Identify settings in which managers, supervisors, and workers interact, such as outage meetings, training, observations, and prejob briefings.
- Specify *what is paid attention to, measured, or controlled* for each target audience, setting, or situation.
- Suggest guidance for controlling manager's emotional reaction to incidents and conflicts. Inconsistencies between espoused values and unguarded reactions can adversely affect the widely held values and beliefs of the workforce.



A Just Environment. An organization cannot consistently learn from error/failure and punish professional individuals at the same time. If a workforce believes errors will be punished, then information related to errors in the plant, if not self-revealing, will likely remain unknown. To an erring employee, knowing how one's manager will react to error is important to one's willingness to report the problem.[11] In a just environment, the likelihood that a problem will be reported will increase. People want to be treated fairly, honestly, and with respect, and they want the same for others. High-performing organizations do not punish employees who make mistakes while trying to do the right thing.[12] These organizations view error as an opportunity to learn.

When an event happens, the organization is culpable, not simply the individual. As illustrated, the "blame cycle" is urged on by the belief that human error occurs because people are not properly motivated.[13] In reality, no matter how motivated an individual is, human error will continue to occur, though at a slower rate. No amount of punishment, counseling, or training—in fact, nothing—will change a person's future fallibility. Events will continue as long as root cause analyses are stopped prematurely, before the *real* causes are identified. The true causes (typically organizational weaknesses) will not be discovered (will remain latent or hidden), and errors and events will persist.

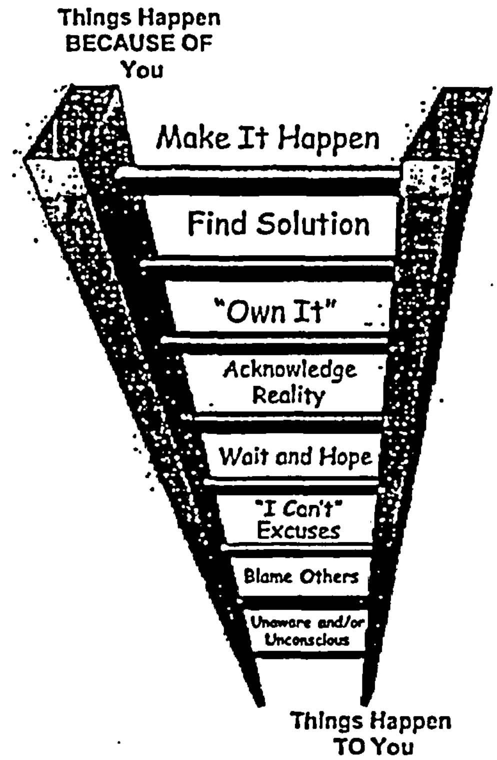


Most errors do not result in events because of defenses-in-depth. The severity of an event is always a function of the type and number of defenses that failed, not the error itself (as illustrated by the severity pyramid at right). However, the error that triggers a serious accident is often the error that has been happening for years at the nonconsequential level. People have, more often than not, been disciplined for "honest" mistakes. Error is not a choice. Discipline or punishment does not influence future fallibility, but it should be used as a tool for behavior change if the person acted purposely, knowingly, or recklessly. In high-performing organizations, punishment is not used for restitution. Dr. James Reason, a former psychologist at the University of Manchester in the United Kingdom, provides a "culpability decision tree" that helps managers determine a person's guilt regarding a recent mistake made.[14] A "culpability decision tree" can be developed using station-specific criteria by following Dr. Reason's description in the referenced publication.

When potential discipline is considered, the *substitution test* provides a means of determining culpability (see endnote on Diablo Canyon's policy).[15] For a given set of circumstances in which an individual erred, perhaps triggering an event, mentally substitute several of the person's peers into the same situation. If most of them could have done the same thing, then the individual passes the substitution test—it is a "blameless" error. However, if the individual has a history of error or unsafe acts, then the person probably does not have the aptitude for the job, or there may be extenuating circumstances.

Accountability. Accountability is a necessary characteristic for the long-term success of any organization. The American Heritage Dictionary defines accountability as "answerable for performance; liable for being called into account for actions."

The perceived threat of punishment is a major obstacle to gathering information about human performance. People in the nuclear power industry are professionals and are generally proactive with their work situations as implied by the accountability ladder illustration (below). However, the severity of an event has traditionally been used as a criterion for determining whether punishment or discipline is necessary. To err or not to err is not a choice.[16] While consequences greatly impact one's emotional response to an event, disciplinary decision-making should be guided by the error—the behavior—that triggered the event, not by the consequences.[17] Using consequences to establish accountability diminishes trust and ultimately communication. Also, a "zero tolerance" policy toward human error creates frustration and solves nothing. Improvement is more effective when people learn from errors (nonconsequential events) rather than trying to "motivate" employees to refrain from error.[18] Learning is promoted if the "system" is held accountable. Calvert Cliffs accomplishes this with "200% Accountability," in which accountability is shared among all parties to a task, and people are aware of their dependence on each other, working together to accomplish the task event-free.[19]



When an event is initiated by an *honest mistake,* the entire system that supports the performance in question should be evaluated (see "Systems Thinking" in Chapter 1). Events triggered by human error are symptomatic of a *system failure.* Instead of asking how the individual failed the organization, the question "How did the organization fail the individual?" would be more appropriate. In addition to the individual, what or who could have *prevented* the event? What flaws or oversights in work processes, policies, or procedures contributed, promoted, or allowed the error and event to occur? Because the majority of the causes of events originate in the system of controls, processes, and values established by the management team, the former should be management's first reaction to events.

Coaching. According to the dictionary, to coach is to 'tutor, train, give hints to, prime with facts.' Fundamentally, coaching is a method to help unlock another person's potential to maximize his or her own performance, to self learn.[20] Teaching is not coaching. Effective coaching helps people become aware of their need for change and to take personal responsibility for taking appropriate steps to change. Consequently, coaching is an essential tool for organizational change. Coaches create awareness and responsibility, best, through effective questioning and sequencing. With the other person's interest in mind, effective questions start broad (open-ended) and increasingly focus on detail (close-ended). The following mnemonic, GROW, helps guide this sequence of questions:[21]

- Goal – the short- and long-term objectives, what is to be accomplished (results), during the particular encounter between coach and individual being coached
- Reality – exploration of current results, practices, behavior, attitudes, beliefs, motives etc.
- Options – alternatives, strategies, or courses of action to change performance in light of the goals; best developed by individual
- What – actions to take when, by whom, how well, and the willingness to change

Questions asked in the above sequence help create awareness and responsibility. Coaching will be more effective if the above sequence is used iteratively. For instance, while discussing "Whats," verify they are consistent with the "Goals."

Promote Teamwork

Team skills are needed to identify and eliminate error-likely situations and to reinforce defenses. Humans experience difficulty detecting their own errors, especially when working alone. Teamwork improves the ability of individual team members to collectively prevent human performance problems. This is particularly important when a team or crew is confronted with an unfamiliar problem (knowledge-based). Since people are fallible in their thinking, teamwork can make individual thinking and reasoning *visible* to the other members of the team. Dialogue among team members allows each one to challenge assumptions and to detect team errors. But without trust, open dialogue suffers, and team errors multiply. Team errors were addressed in Chapter 2.

Errors can be caught three ways: machines, others, and oneself. Human factors and ergonomic designs are built into the physical plant to catch errors that have been anticipated. An individual can catch most errors, but not at the degree of reliability desired. Consequently, other people become necessary to help "see" error-likely situations and to defend against error in team activities.

Peers and supervisors are used through independent verification, concurrent verification, peer-checking, challenge, and devil's advocate, among others. As described earlier, independent verification is a technique to find errors that have already happened. Concurrent verification attempts to prevent an error from occurring in the first place. Challenge is an unsolicited peer check. A devil's advocate aids team decision-making and problem-solving activities by challenging assumptions and mindsets of other team members.

The U.S. aviation industry's extensive studies on crew resource management, a study of teamwork on commercial air carriers, identified characteristics vital to the success of pilot performance on the flight deck. Many of these characteristics were adapted into INPO's High Performance Teamwork Development course, as follows:

Inquiry. Inquiry involves asking a series of questions to understand what is happening with the plant. Here it is important to distinguish between fact and assumption. Statements such as "I think" or "I believe" are hints that an assumption has been made. Assumptions can be challenged using the following process:[22]

1. Identify conclusion(s) being made by another person or yourself.
2. Ask for or identify the data that leads to the conclusion(s).
3. Ask for the reasoning (mental model) that connects data with the conclusion.
4. Infer possible beliefs or assumptions.
5. Test the assumption with the other person.

Assumptions must be challenged to detect unsafe attitudes and inaccurate mental models regarding the task. See Chapter 1 on how inaccurate mental models promote erroneous assumptions that may lead to errors.

Advocacy. Expressing a concern, position, or solution—making certain others understand what an individual knows—is perhaps the most important team practice. The individual is assertive for the plant's sake. People must not be timid when communicating their concerns. Without advocacy and clear communication practices, team errors continue unchecked.

Leadership. Leaders take the initiative to influence the behavior of others, especially when it comes to the physical plant. The individual demonstrates leadership by taking responsibility for not only his or her own behavior, but also for team performance as it alters the state of the plant through its activities. Challenge and peer-coaching are outgrowths of this characteristic of teamwork.

Conflict Management. Resolving differences of opinion and getting all information on the table to reach the best solution are critical elements to successful team performance. Understanding the personalities of a work team is particularly important to solving problems, especially if people take a devil's advocate approach.

Critique Performance. Learning from experience, identifying what works well, and pinpointing what areas need improvement are important for continuous improvement. Without feedback from workers, management cannot optimize the processes to support the workforce in the field. Critiquing performance can occur periodically during a task to make sure everyone is aware of current job-site conditions. Post-job reviews are particularly important and are helpful in identifying not only errors that occurred, but also process-related flaws that did not adequately support work in the field.

Tone. Tone is an important success factor for effective team performance. Tone is important for boosting the situation awareness of individuals and work teams. Setting the tone is a leadership practice that conveys the demand for wariness and communication among team members. The combination of wariness, good situation awareness, and open communication leads to an effective questioning attitude. This way, unplanned situations or unusual conditions are more often recognized and resolved without incident.

Reinforce Expectations

Peter Drucker, a well-known authority on management, states:

> *"...the fundamental reality for every worker, from sweeper to executive vice president, is the eight hours or so he (or she) spends on the job. In our society of organizations, it is the job through which the great majority has access to achievement, to fulfillment, and to community."*[23]

For achievement to occur, the worker has to take responsibility for the job. People will take responsibility if their jobs are well designed *and* their bosses 1) see what they do and 2) know who they are.[24] Learning and having the personal satisfaction of doing a job well occurs if a person is to take that responsibility. In turn, jobs and reinforcement must be well planned for learning and satisfaction to occur. Planning is necessary—a manager responsibility.

There is a direct cause-and-effect relationship between a manager's actions and an employee's behavior, and *behavior is motivated by its consequences.* Therefore, managers can take specific actions to improve performance for the long term by managing the consequences that follow behavior, especially after effective execution of error-prevention tools.[25] Consequences, not training, directives, or threats, reinforce behavior. For the principles of reinforcement to work, clear expectations and standards must exist, the work force knows them, and managers accurately model them.

Expectations. Expectations for error-prevention and other defensive practices require thoughtfulness and accuracy. Expectations explicitly define acceptable and unacceptable behaviors, norms, and practices, along with circumstances that necessitate each expectation. If it is a well-designed job, expectations establish high standards for the conduct of station activities and controls to achieve uniform adherence to those standards. Many expectations are consolidated in "Conduct of ..." administrative procedures as well as being contained in goals and objectives, policies and directives, procedures, action plans, and training programs.

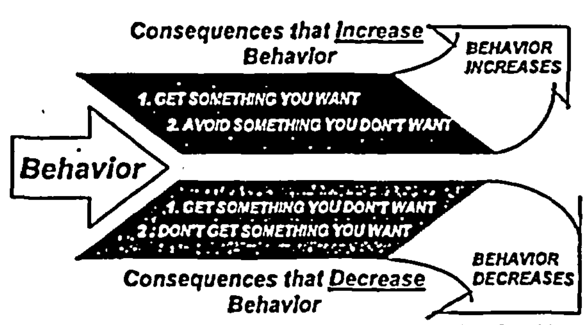
Good expectations follow the ABC format: antecedent or cue, behavior or action to occur, and consequences for the behavior. With the involvement of front-line workers, managers can identify at-risk behaviors that are unacceptable and prevention behaviors that workers would readily accept, reinforce, and correct. Prevention behaviors are best defined in terms of the following:

- Action that is observable by others
- Person(s) to apply the behavior (or group)
- Situation in which the prevention behavior is to be performed.[26]

The action or behavior should be defined so that two or more observers of the same action would agree whether the behavior occurred. Good expectations can be characterized as *specific* (concise definition), *observable* (countable or recordable), *objective* (no interpretation required), and *doable* (in the respective work place).[27] In some safety-critical situations, expectations explicitly define what is *unacceptable.* These are corrected when observed. To coach expectations effectively, managers and supervisors should be able to model any expectation. To ensure expectations do not become obsolete, they should be compared with best industry practices on a periodic basis (benchmarking).

People tend to seek/do things they like and avoid things they do not like.[28] This is a fundamental principle of human behavior. Positive consequences must be associated with job-site behaviors if people are to continue using them. Positively reinforce individuals who obtain value-added results using preferred behaviors, not those who cut corners to get jobs done on schedule and under budget. As noted above, expectations should provide the cue for the new behavior. This gets the new behavior going. Consequences either keep the behavior going or extinguish it in the long term. What people decide to do while at work, above and beyond minimum requirements, depends on consequences. Therefore, leaders should take time to understand and learn how to use reinforcement—consequences—to promote targeted behaviors; that is, expectations.

All behavior that is occurring in the station right now is the result of consequences that are also occurring right now. In a manner of speaking, the organization is perfectly attuned to get the performance it is getting, right now. All behavior is reinforced. If at-risk behavior is common, it is because management has not made a difference with consequences. Behavior has four basic consequences.[29] The following model describes the effect consequences have on behavior:



The following consequences can be used to get the desired performance by targeting specific behaviors:

Positive Reinforcement – "Get something you want" enhances the probability the preferred behavior will recur and maximizes performance. This optimizes use of discretionary effort by the individual.

Negative Reinforcement – "Avoid something you don't want" enhances the probability the preferred behavior will recur, but only to meet the minimum standard.

Note: Consequences that cause behavior to either increase or continue at a high standard are known as "reinforcers."

Punishment – "Get something you don't want" reduces the probability undesired behavior will recur if unwanted consequences are consistently coupled with the behavior. Punishment may also involve "losing something you don't want to lose," a penalty. Sometimes this is necessary to get the new expectation started for an individual. However, it should not be used for the long term.

Extinction – "Don't get something you want" reduces the probability undesired behavior recurs, since nothing happens when that behavior occurs. Usually, the behavior eventually disappears after several repeated attempts.

Activators take the form of procedure steps, training, incentives, reminders from supervisors or peers, administrative policies, and expectations. Activators are stronger if they a) specify the behavior, b) specify whom, c) occur at the point of attack, and d) imply the consequences.[30] Similarly, consequences in terms of reinforcers need to be determined. Expectations need positive reinforcers, while unacceptable behaviors need penalties—disincentives—or the *elimination of positive reinforcers that motivate the undesirable behavior. Punishments and* penalties also need to be eliminated for expected practices. Positive reinforcers are more effective if they are *positive* for the individual, *immediate* with respect to the behavior, and *certain*. Penalties are stronger if the consequence is negative, immediate, and certain for the individual concerned.[31]

For specific expectations important for safety-critical activities, develop a rewards and reinforcement plan at least for the general population and ideally for each individual. Such a plan is described below. Reinforcement is something that should happen every day. However, from time to time, celebrations and reward ceremonies are conducted to recognize results. Remember, celebrations reward results, and reinforcement rewards behaviors. Be certain to single out the behaviors or actions that were key to achieving the results.

Rewards and Reinforcement Plan. This plan strengthens desired job-site performance and is best used in conjunction with systematic measures and feedback to the individual or group.[32] Similar to how preventive maintenance is planned and scheduled for plant equipment, rewards and reinforcement for employees are planned and scheduled. To be effective, rewards and reinforcement demand time. A rewards and reinforcement plan is defined by the following considerations:[33]

1. Pinpoint desired *results* for selected task(s)—key outcomes.
2. Target specific *behaviors* to obtain results—expectations.
3. Identify specific *opportunities* to apply reinforcers (positive reinforcers, mostly). (Specified "at-risk" behaviors are targeted with particular penalties.)
4. Develop *measures* of results (quantity, quality, cost, timeliness).

5. Provide *feedback* about past behavior that will help an individual change (specific, sincere, immediate, personal). This is known as coaching.
6. Celebrate *results* (highlight preferred behaviors that achieved results).

Reinforcers matched to the individual's motivations (personal needs for affiliation, achievement, security, or power) are the most effective.

Effective Reinforcement Techniques. Rewards and reinforcers for front-line workers come from three sources: the work, their peers, and the boss.[34] It is uncommon for workers to compliment or even correct their peers. So do not count heavily on peer reinforcement except from role models. Aside from the personal satisfaction people may get from their work, employees simply want to know that their bosses "saw what you did and know who you are."[35] This is important. Personal, or social, reinforcers are the most powerful, the easiest, and the most cost-effective means of reinforcing behavior. Managers and supervisors must know how to reinforce expectations. The following strategies go a long way toward improving performance without time-consuming programmatic changes being made:[36]

1. Provide feedback specifically and frequently.
2. Verbally reinforce preferred behavior specifically and frequently (personal).
3. Remove obstacles or give workers a strategy for going around obstacles.
4. Let workers know the work priorities.
5. Remove negative consequences for preferred behavior.
6. Remove positive reinforcers and rewards for at-risk behavior.
7. Use penalties only with consistent undesirable behavior (progressive discipline).
8. Accommodate those with personal, non-work-related problems, if practicable. Otherwise, assign the job to someone else without such distractions.

Common Mistakes with Rewards and Reinforcement. Avoid the following mistakes:[37]

1. delayed reinforcement – Reinforcement's power to influence behavior is robbed if the act(s) is not fresh in the mind of the performer.
2. infrequent reinforcement – If desired behavior is ignored, the individual may believe it is unimportant.
3. generic rewards – Recognition is most effective if it specifically recognizes the achievement of the individual vice the group. If awarded en masse, people will not remember what behaviors helped accomplish the goal. Reward, as well as reinforcement, must be personal.
4. unearned reinforcement or reward – Cynicism becomes rampant if people are reinforced for being lucky or rewarded for meaningless accomplishments.
5. impersonal reinforcement – Reinforcers, whether tangible or social, must match the individual's preferences. For example, some people dislike public praise.

In summary, plan positive reinforcement to sustain the use of prevention behaviors (expectations), and develop appropriate sanctions or disincentives (with worker input) to discourage unacceptable behavior (including targeted at-risk behaviors). Remember, this is a change. Preparation, management, and follow-through are necessary.

Eliminate Latent Organizational Weaknesses

Strategically, if problems with processes and values can be identified and resolved proactively, many events may be prevented. Eliminating the causes of flawed defenses and error precursors (see Anatomy of an Event) helps minimize both the error rate (frequency) and the severity of events.

Error is a symptom. All organizations possess hidden weaknesses in their processes and culture that will eventually, under the right circumstances, result in an event. As explained earlier in this chapter, communication is an important means to success. Identification and resolution of the hidden causes of performance problems in the field cannot occur without it. Communication is a requirement for a *learning culture.* A learning culture promotes continuous improvement in human performance by improving organizational processes, shared values, and job-site conditions. A learning culture is based on the premise that the causes of recurring performance problems and minor, nonconsequential events are the same as those of significant events. In an odd way, error is a good thing, when there are no negative consequences. It occurs often enough to expose the weaknesses in defenses, organizational processes, and the culture.

Worker Feedback. The workforce is the best source of information about the weaknesses in the organization. It is important that those not in positions of management or supervision realize the influence they have on station performance. Who is better than workers to provide the feedback managers need to optimize processes that support work in the field? Front-line workers are the beneficiaries of what the work organization provides them. They know its shortcomings. Also, it takes courage to report personal mistakes—to be self-critical. Finding and eliminating latent organizational weaknesses improves dramatically when worker feedback and communication are encouraged. Along with training in human performance fundamentals, improving the workforce's questioning attitude will improve its sensitivity to problems at the job site that went unrecognized before. Leadership seeks this feedback and provides a vital link between the job site and the organization that is needed for continuous improvement. This is why the self-identification ratio is an important measure of human performance improvement. In another way, this is a measure of leader effectiveness. Therefore, effective self-assessment and corrective action programs characterize a strong learning culture.

Methods. Can organizational weaknesses be identified and corrected *before* they cause an event? Yes.[38] Self-assessment and corrective action processes offer tangible, effective methods for achieving high levels of resistance against events. Self-assessment methodologies help with the proactive identification of weaknesses that can lead to error and events, while corrective action programs promote resolution of problems.

Excellence in Human Performance (1997) lists three ways of identifying organizational weaknesses:

- Solicit and act on feedback from workers about problems that may lead to error (such as postjob reviews, problem reporting programs, and voluntary reporting (confidential) methods).
- Determine the fundamental cause(s) of performance problems (such as root cause analysis).
- Monitor trends in plant and human performance (such as performance indicators, leading indicators, common cause analyses, and performance monitoring reports).

However, since the publication of that document (1997), additional methods have surfaced that have proactive value in identifying organizational weakness. Other methods include the following:

- self-assessments
- observation of work in the field
- surveys and questionnaires
- process mapping
- task analysis (see Chapter 6)
- benchmarking

To be effective, these methods must identify *how* the organization shapes job-site conditions (recall the Performance Model). Knowing how a process or value influences worker behavior will offer insight into how to improve the particular process or value. Generalities are unacceptable; specifics are needed. Self-assessment and corrective action programs have to be tuned to do this. However, identifying and eliminating organizational weaknesses cannot simply be relegated to these programs. These are leadership challenges. Keeping the organization focused on continuous improvement (learning culture) while meeting ever-challenging production goals is a daunting task. Instead of waiting for periodic self-assessments or for errors and events triggered by error to reveal organizational weaknesses, leaders must clearly show the value of preventing the next event from any path. Prevention is much less expensive than recovery.

Value Prevention of Errors

> *Long-term survival in the wilderness depends on having the right attitude.*
>
> -Scott McMillion
> *Mark of the Grizzly*
> *True Stories of Recent Bear Attacks and the Hard Lessons Learned*

By valuing error prevention, the number of "shots on goals" will be reduced. High standards communicate the value of error reduction. By clinging to high standards regardless of the perceived importance, adherence to expectations will be more consistent. People's beliefs and attitudes toward hazards and error traps tend to drive adherence to high standards. But attitudes are hard to manage. Personal factors such as motives and attitudes are resistant to change. However, positive attitudes are more widespread when workers attempt to achieve a goal rather than try to avoid failure. Consequently, positive attitudes about error prevention depend greatly on what is rewarded and which behaviors are reinforced. Also, it is easier to change behavior when positive attitudes exist. To develop positive attitudes, the focus must be on behavior. Positive values and attitudes will follow behavior if those behaviors (expectations) consistently result in personal success. It is not necessary for values and attitudes to precede behavior, but it is preferable.

The emphasis is on behavior—acts or actions by individuals that can be observed, what people say and do, as opposed to what they think, feel, or believe. Ultimately, the aim of leadership is to instill error-prevention values and practices into the fabric of all performance, regardless of the task's priority. Getting dressed each day helps explain this concept. Regardless of how hurried people are, they do not leave home without putting on their clothes.[39] People value wearing clothing over the priorities of the day. Fundamentally, prevention practices are value-driven, which benefit the station in the long run. The primary tool to develop error-prevention values is positive reinforcement of safe practices.

Manager Behaviors That Influence Values. The only effective way to communicate values is to act in accordance with them and reinforce them.[40] According to experts in organizational culture and leadership, the following behaviors convey the values of the organization, in order of strength of influence:[41]

1. what managers pay attention to, measure, and control
2. reactions to critical incidents or crisis
3. allocation of resources
4. deliberate attempts to coach or role model
5. criteria for allocation of rewards and punishment
6. criteria for selection, advancement, and termination

If those in positions of responsibility react appropriately, with integrity and consistent with stated values, people will change their behavior. When management's responses are in harmony with the importance of safety and reliability, then front-line workers will more likely choose error-prevention behaviors and avoid at-risk actions.

Studies of "high-reliability organizations" have shown that leadership is a key ingredient to long-term success. Leaders promote event-free operation by advocating the value of error-free behavior and encouraging a healthy belief in human fallibility. High reliability organizations tend to exhibit the following characteristics:[42]

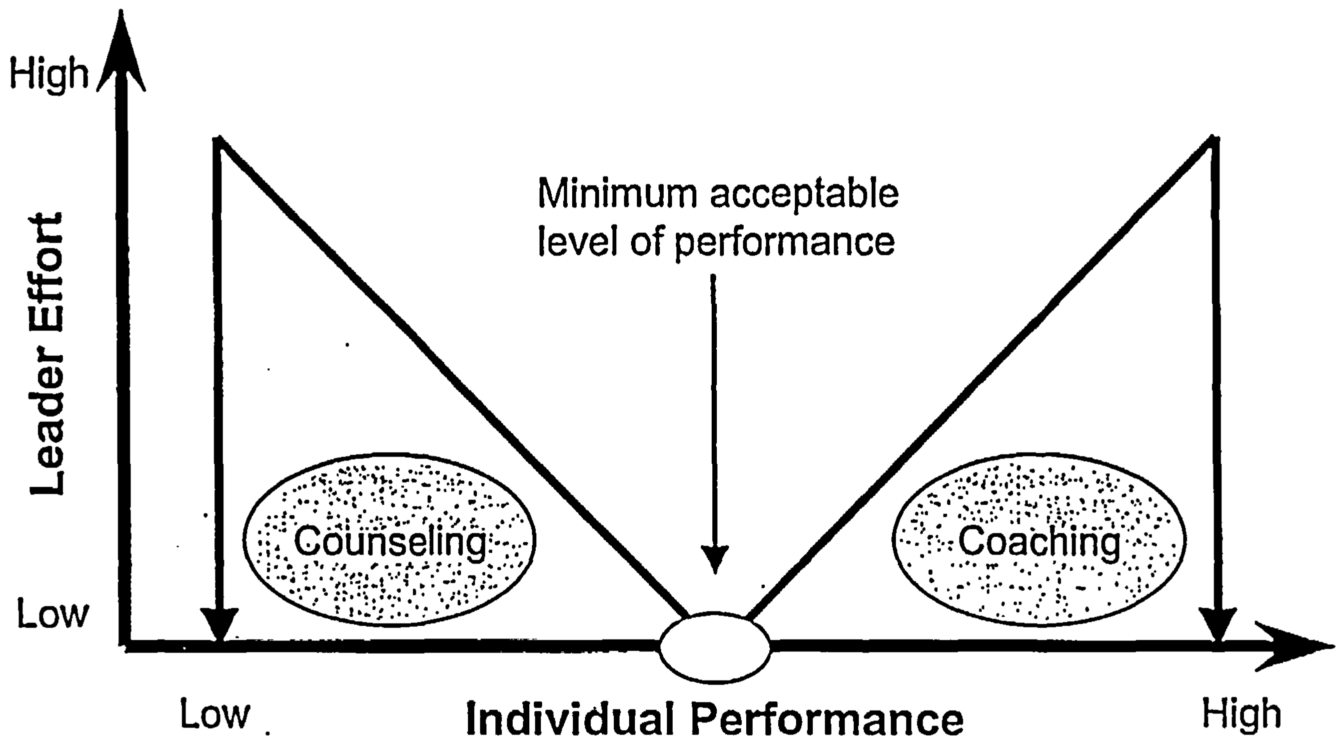
- **The Will to Communicate.** The most important factor in the prevention of events and for continuous improvement in human performance is communication. In all major disasters worldwide, someone knew something that could have prevented the outcome.[43] "Obstacles in communication" have been noted as a cause in more than 80 percent of all aviation accidents.[44] A constant flow of information about hazards (error traps and flawed defenses) must exist throughout the organization.
- **Wariness for and Intolerance of Error Traps.** The greatest risk to plant safety and reliability is human. Personnel in high-reliability organizations are keenly aware of their limitations; and because of human fallibility, they are sensitive to job-site conditions that provoke error. Consequently, they are intolerant of error traps, recognizing the absence of defenses and the potential consequences of their actions. Healthy attitudes such as these help offset the human tendency toward complacency.
- **Vigilant Situation Awareness.** Situation awareness is the mental activity of developing and maintaining an accurate mental model of the plant state and task situation based on knowledge of critical parameters, observations of system or equipment condition, work environment, team members, and recall of basic knowledge of the plant. Situation awareness improves one's foresight—understanding the significance and nature of one's actions before proceeding with a specific action. Setting a tone of wariness and intolerance, especially during the prejob briefing, improves one's *questioning attitude* and sensitivity to potential hazards and error traps.
- **Rigorous Use of Error-Prevention Tools.** To identify and defend against error-likely situations at the job site, techniques to prevent, catch, and recover from errors are rigorously used at every organizational level and in all station functions. Such practices make personnel continually conscious of hazards, especially error traps and industrial safety dangers in their work places. An understanding of the limitations of human

performance and how they apply to work situations improve people's abilities to apply error-prevention tools.

- **The Value of Relationships.** Without a foundation built on respect, honesty, and fairness, interpersonal and interdepartmental relationships will suffer and so will open communication. Anger, embarrassment, and resentment choke off communication between people, and cooperation suffers. To allow the organization to move to the next level of human performance and plant performance adversarial relationships must be turned around.

Notice the similarity between the above characteristics and the description of safety culture by the International Atomic Energy Agency (IAEA).[45] IAEA states that "the response of all those who strive for excellence in affecting nuclear safety" is characterized by 1) a questioning attitude, 2) a rigorous and prudent approach, and 3) communication.

COACHING AND COUNSELING ('M' Model)



Coaching – to tutor, train, give hints; to prime with facts. Any time an individual is at or above the minimum acceptable level of performance, we can coach them to higher levels of performance. The coaching slope line indicates, absent other factors, higher performance is a direct result of more coaching (slope indicates the total amount of coaching provided in the aggregate). Once performance gets to a given maximum level, an individual is considered for assignments with greater responsibility (or promoted if ability exists).

Counseling – a process of listening, giving advice or instruction; judgment with the intent of influencing a person's attitude or behavior. Counseling is performed anytime a person's performance is below the minimum acceptable level of performance. Depending upon the amount below this point warrants the increased counseling (and other actions deemed appropriate by policy such as decision making leave of absence). Depending on the sustained below par performance, individuals are moved to less challenging jobs or, in extreme cases, actions such as termination are taken.

Site Leadership Team Gap Analysis Tool

Purpose

This tool was developed to assist the site leadership team (SLT) in performing an organizational gap analysis of human performance. The attributes used in this tool were derived from a variety of references* and include key elements commonly observed in top performing organizations.

Method

This analysis tool is intended to guide members of the SLT through a series of statements for which each member provides an independent rating. Responses on this internal analysis should be based on the current understanding and opinion of each member and should not require reference to performance reports or other performance indicators. Clarifying comments should be encouraged for identified problem areas.

Rating categories

- Strength: This attribute is an obvious strength; no changes necessary.
- Satisfactory: This attribute appears satisfactory, no further actions anticipated.
- Worrisome: Although functional, this attribute has troublesome symptoms; several aspects need attention.
- Problem: This attribute may be inhibiting station performance improvement; intervention should be considered.

Interpretation

Each attribute should be summarized for the organization and sorted by the number of respondents rating the attribute as a problem. For example, if 10 of 12 SLT members rated *'Effective communication'* as a problem, the organization could then focus discussions on clearly defining this problem and discuss actions that the SLT should take to address the issue. Some organizations may choose to make responses anonymous and others may choose to identify specific departments. Facilitated discussions of organizational problems can help gain alignment and establish a common understanding of important issues facing the organization.

Suggestions for follow-up

Resulting actions by the SLT to the collective analysis of these attributes could include actions such as the following:

- The SLT could conduct facilitated discussions focused on the worrisome or problem areas identified. These discussions should include a clear definition of barriers or impediments to improvement and a consensus agreement on corrective actions for the SLT.
- Benchmarking to industry top performers could be considered in identified problem areas.
- Self-assessment activities could be focused on developing a clear understanding of the problem. Follow-up interactions could include engaging station staff to help establish proposed solutions.
- Focused assistance visits from outside organizations should also be considered.

References

INPO, *Excellence in Human Performance*, September 1997

INPO, *Performance Objectives and Criteria for Operating Nuclear Electric Generating Stations* (INPO 97-002)

IAEA, *Safety Culture*, Safety Series No. 75-INSAG-4

Review of INPO Plant Evaluation and WANO Peer Review report insights associated with organizational strengths and weaknesses

INPO, Executive Review Group meeting input, November 2000

1. Leaders demonstrate a commitment to improving human performance by establishing, communicating, and reinforcing clear expectations for professional behavior, continuous improvement, appropriate policies, efficient and effective processes, and common values.

Attribute	Strength	Satisfactory	Worrisome	Problem
a. Senior management demonstrates commitment				
b. The strategy for improving human performance is understood				
c. Human performance goals are defined & measurable				
d. Individuals can describe the vision and mission, in their own words, of human performance improvement initiatives.				
e. Expectations clear				
f. Managers demonstrate commitment and model expected behaviors				
g. Vertical & horizontal alignment of station priorities				
h. Appropriate resources to reduce human performance-related events (balanced procedures, supervision, knowledge)				
i. Desired behaviors are reinforced				

Comments ('Worrisome' or 'Problem' areas):

2. Organizational processes and values include a defense-in-depth philosophy that considers human fallibility. These processes are also designed to function efficiently and to support safe operation.

Attribute	Strength	Satisfactory	Worrisome	Problem
a. Performance goals are balanced with safety and production				
b. Department operating plans aligned with the business plan				
c. Work Management Processes				
d. Procedures are accurate				
e. Procedures are updated in a timely manner				
f. Key initiatives and equipment upgrades are successful				
g. Effective change management				

Comments ('Worrisome' or 'Problem' areas):

3. **Training and leadership forums are used to improve human and station performance, including the sharing of operating experience and beneficial techniques to reduce errors and eliminate events. All employees reinforce desired individual behaviors at every opportunity including subordinate and peer coaching. Reward and discipline practices are linked to professional behaviors.**

Attribute	Strength	Satisfactory	Worrisome	Problem
a. Training is valued, useful, and reinforces expected behaviors				
b. Universal ownership of training				
c. Workforce is knowledgeable and confident (all levels)				
d. Professional development encouraged				
e. Personnel welcome and appreciate coaching				
f. Error avoidance is recognized				
g. Incentives not based solely on production				
h. Successes celebrated (individual & unit)				
i. Operating experience is valued and solicited				

Comments ('Worrisome' or 'Problem' areas):

4. **Individuals at all levels demonstrate an intolerance of error-likely situations and flawed defenses, routinely consider how their actions can affect the plant, and take the initiative to communicate concerns. Individuals also demonstrate accountability for thorough task preparation, process execution, use of error prevention techniques, and contingency planning.**

Attribute	Strength	Satisfactory	Worrisome	Problem
a. Awareness of top station issues				
b. Individual awareness –understand consequences of mistakes				
c. Consistent focus on error-prevention (eliminate error-likely situations)				
d. Problems are anticipated				
e. Accountability – applied up front				
f. Clear individual roles and responsibilities				
g. Workforce feels empowered				
h. Self starters – voluntarism high				
i. Procedures are followed				

Comments ('Worrisome' or 'Problem' areas):

5. **Individuals at every level seek to continuously improve their performance, equipment performance, the work environment, and organizational processes by aggressively communicating opportunities for improvement. Managers and supervisors promote a continuous improvement culture by being highly responsive to employee input and by involving employees in developing actions to improve processes and techniques. Improvements are pursued through benchmarking, training, and innovation.**

Attribute	Strength	Satisfactory	Worrisome	Problem
a. Commitment to improve (publicly asserted)				
b. Individuals search for and eliminate organizational weaknesses				
c. Most improvement issues are self-identified				
d. Most problems are self-identified				
e. Workforce is engaged				
f. Ownership, pride, & satisfaction (dedication)				
g. Employee contribution encouraged				
h. Low problem reporting threshold				
i. Everyone is considered a problem solver				
j. Materiel condition of plant and work areas				
k. Feedback is solicited (encouraged)				
l. Timely resolution of grievances				
m. Productive and prompt feedback provided				
n. Benchmarking is valued and effective				

Comments ('Worrisome' or 'Problem' areas):

6. **Managers and supervisors assess and trend human performance through in-field observations, formal assessments, and performance data analyses. Results are used to develop corrective actions, to improve training, and are shared with all personnel.**

Attribute	Strength	Satisfactory	Worrisome	Problem
a. Intervention occurs when expectations are not met				
b. Effective root cause determinations				
c. Management presence in field is apparent and welcomed				
d. Useful performance indicators and trends available				
e. Self-assessments are driven from within				
f. Timely feedback				

Comments ('Worrisome' or 'Problem' areas):

7. **A culture exists, involving respect, fairness, and honesty that places a high value on healthy relationships among individuals and among groups. This is evident in the work quality, the conduct of business, and the way communication occurs.**

Attribute	Strength	Satisfactory	Worrisome	Problem
a. Mutual respect demonstrated				
b. Effective communications				
c. Open communications-both directions – frequent and precise				
d. Good teamwork is fostered and apparent				
e. Good conflict management (achieve best solution)				
f. Low absenteeism				
g. Professional work environment				
h. Individual responsiveness to management				

Comments ('Worrisome' or 'Problem' areas):

REFERENCES

[1] Ramsey & Modarres. *Commercial Nuclear Power, Assuring Safety for the Future.* 1998; pp.220-221.

[2] Helmreich & Merritt. *Culture at Work in Aviation and Medicine.* 1998; p.133-139.

[3] Drucker. *Management: Tasks, Responsibilities, Practices.* 1974; p.528.

[4] Turner and Pidgeon. *Man-Made Disasters.* 1997; pp.85-89.

[5] Kotter. *Leading Change.* 1996; pp.25-30.

[6] Reason, *Managing the Risks of Organizational Accidents.* 1998; p.191-196.

[7] Allinson. *Global Disasters.* 1990; p.41.

[8] University of Michigan.

[9] Oconee Nuclear Station. *Site Level Communication Process.* March 2000. In addition to describing the process, it provides a worksheet to aid the user by asking key questions regarding objectives, audience, message, strategy, and so on.

[10] Entergy Operations, Inc. *Equipment Reliability Achievement Anchor, Communication, Interaction and Expectations Plan.* 2001. This sample communication plan lists examples that are representative of actions and behaviors expected toward equipment performance. It is meant to be all-inclusive and creativity to communicate effectively with employees is expected.

[11] Marx. "The Link Between Employee Mishap Culpability and Aviation Safety." 1998; p.30.

[12] Pool. "When Failure is Not an Option," Technology Review Magazine, July 1997; p.45.

[13] Reason, *Managing the Risks of Organizational Accidents.* 1998; p.127-129.

[14] Reason. *Managing the Risks of Organizational Accidents.* 1998; p.208.

[15] Diablo Canyon Nuclear Power Plant instituted a revised Personnel Accountability Policy that includes a tool to assess an individual's "culpability" in a human performance situation. It was developed using Dr. James Reason's guidelines. This tool is intended primarily for use by first-line supervisors to help determine the level or severity of disciplinary actions in response to events or near misses caused by human error. 2000.

[16] Dekker. *The Field Guide to Human Error Investigations.* 2002; p.11.

[17] Marx. "The Link Between Employee Mishap Culpability and Aviation Safety." 1998; p.18.

[18] Marx. "The Link Between Employee Mishap Culpability and Aviation Safety." 1998; p.26. Although David Marx is an expert in this field, he does not reference the research that supports his assertion.

[19] Calvert Cliffs. *Standards of Conduct Handbook.* 2001.

[20] Whitmore. *Coaching for Performance, A Practical Guide for Growing Your Own Skills.* 1994; p.5.

[21] Whitmore. *Coaching for Performance, A Practical Guide for Growing Your Own Skills.* 1994; p.38-40.

[22] Senge. *The Fifth Discipline Fieldbook.* 1994; p.245-246.

[23] Drucker. *Management: Tasks, Responsibilities, Practices.* 1974; p.267.

[24] Allen & Snyder. *I Saw What You Did, and I Know Who You Are, Giving and Receiving Recognition.* 1990.

[25] Fournies. *Why Employees Don't Do What They're Supposed to Do, and What to Do About It.* 1999; p.xv.

[26] Hersey & Blanchard. *Management of Organizational Behavior.* 1993; p.162.

[27] Geller. *The Psychology of Safety.* 1998; pp.118-119.

[28] Daniels. *Bringing Out the Best in People.* 1994; p.25.

[29] Daniels. *Performance Management.* 1989; p.29

[30] Geller. *The Psychology of Safety.* 1998; p.133.

[31] Daniels, *Bringing Out the Best in People.* 1994; pp.65-66.

[32] Geller. *The Psychology of Safety.* 1998; p.217.

[33] Daniels. *Performance Management.* 1989; p.217.

[34] Fournies. *Why Employees Don't Do What They're Supposed to Do, and What To Do About It.* 1999; p.50.

[35] Allen & Snyder. *I Saw What You Did, and I Know Who You Are, Giving and Receiving Recognition.* 1990.

[36] Fournies. *Why Employees Don't Do What They're Supposed to Do, and what to do about it.* 1999; p.133.

[37] Kam. "Positive Reinforcement Improves Organizational Performance," The Public Manager magazine. (date of issue unknown)

[38] Reason. *Managing the Risks of Organizational Accidents.* 1998; p.237.

[39] Geller. *The Psychology of Safety.* 1998; pp.34-35.

[40] Larkin and Larkin. "Reaching and Changing Frontline Employees," *Harvard Business Review on Effective Communication.* 1999; p.147.

[41] Schein. *Organizational Culture and Leadership.* 1992; p.231

[42] LaPorte, Roberts, Rochlin, & Schulman. "High Reliability Organizations: The Research Challenge." Working Paper, University of California at Berkeley, Institute of Government Studies. 1987. A general description of high reliability organizations is available in James Reason's book, *Managing the Risks of Organizational Accidents*, pp.213-218. A description of this information as it relates to nuclear power plant operation is described in "Identification and Assessment of Organisational Factors Related to the Safety of Nuclear Power Plants," February 1999; Committee on the Safety of Nuclear Installations under the auspices of the Organization for Economic Cooperation and Development, Nuclear Energy Agency, pp.24-25.

[43] Allinson. *Global Disasters.* 1990; p.40.

[44] John Nance, Speech at 1998 Plant Managers Workshop. Atlanta, GA.

[45] IAEA. *Safety Culture* (75-INSAG-4). 1991; p.13.