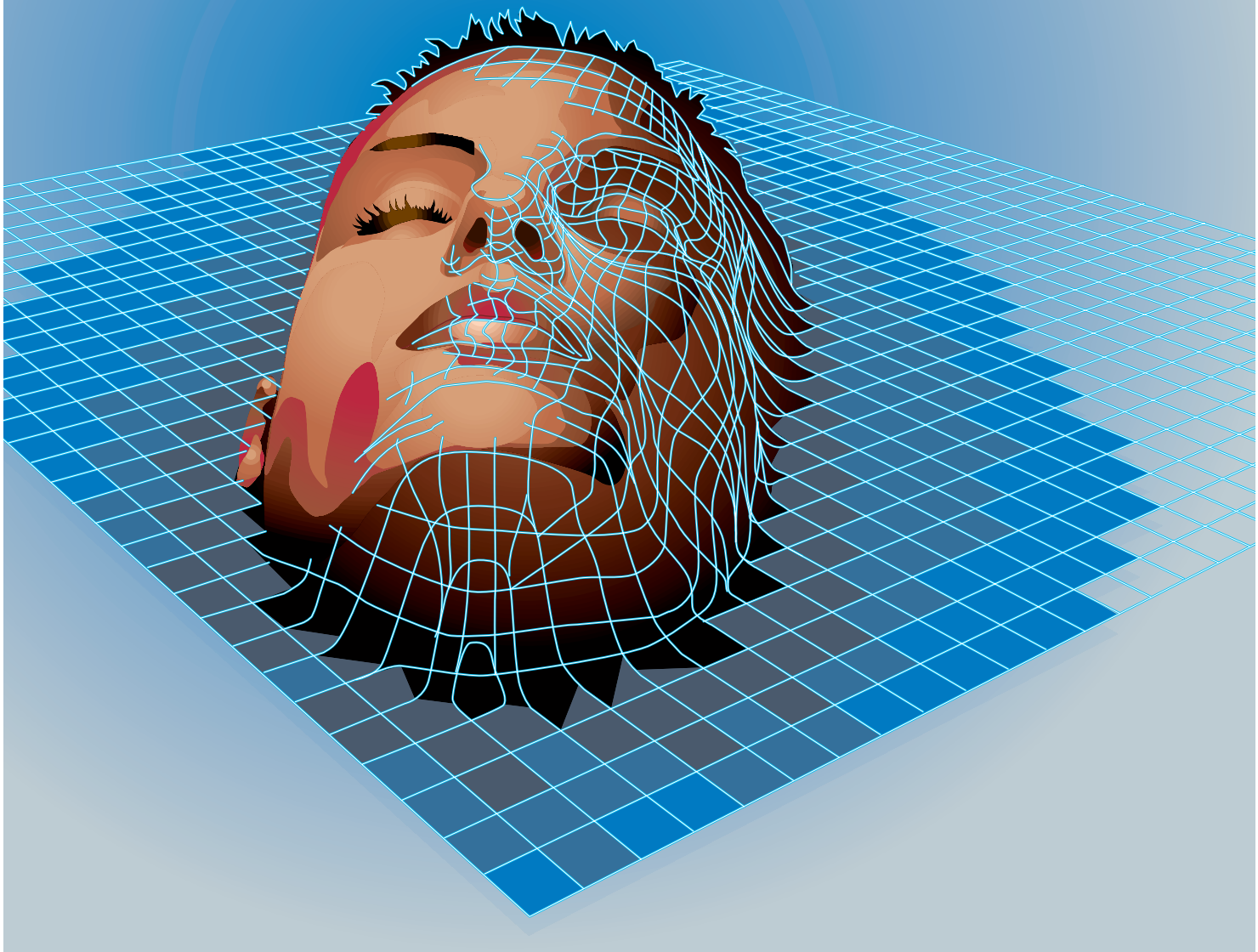
Human Factors In Operations



TEAM AVLIS

USEC

UCRL-ID-131513

DISCLAIMER

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Team Resource Management
Participant's Handbook

for the

Atomic Vapor Laser Isotope Separation Program

May 1, 1998

TEAM AVLIS USEC

LAWRENCE LIVERMORE NATIONAL LABORATORY
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Acknowledgments

Fred Coffield wrote the early draft of the introduction to the workshop and—importantly—graphically mapped out the Team Resource Management process. This visual model of TRM has significantly helped in describing the meta processes that form the "dance" that teams perform to accomplish their tasks. Tony Oravetz, the AVLIS separator technician supervisor, played an essential role in translating some of the abstract concepts of TRM into AVLIS operations reality.

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The following organizations have played an important role in identifying concepts, developing methods of presentation, and focusing the workshop on operations-related aspects of Team Resource Management.

United Airlines

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The Two Most Important Impacts of Team Resource Management (TRM)

First: Predictable, Manageable Performance

A central premise of Team Resource Management (TRM) is that you can generally predict individual and team performance. This does not mean that we know exactly how well a team will perform. Nor does it mean that we know exactly how or when a team will fail.

TRM's central premise of prediction means that there are factors that can be used to predict performance extremely well. What is more important than our ability to use these factors to predict performance is that these factors can be **managed**. How the factors are managed determines the level of performance and what the frequency of errors will be.

TRM helps **leaders** better manage their teams by helping them to identify the factors that influence performance, TRM also helps **workers** better manage the performance-shaping factors that affect their performance.

Second: Formalized, Structured Norms

TRM helps structure our norms (or, how we normally do our jobs). TRM will bring about **observable** changes in the "dance" that teams perform as they conduct their technical tasks. Instead of seeing a team do a "two-step" shuffle that changes each time the team goes out on the floor, you will **recognize** them doing a tango when a tango is called for. The norms of the dance become formalized and reduce role and task ambiguity as they are practiced.

TRM is a tool with which to choreograph the best dance for a team. TRM allows a team to change the rhythm as the tempo of the music changes or even change the dance if the music changes. Because teams know and have practiced the "dance" that is called for, they do not step on each others' toes.

Introduction to Team Resource Management

Goal

The goal of any operation is to complete tasks efficiently and effectively. Working safely is completely consistent with efficient, reliable operations. Working in an unsafe manner is not effective or ultimately efficient. If someone is hurt, work stops. Following the steps advocated by Team Resource Management (TRM) leads to more safe, efficient, effective work habits.

Process

TRM is a method used by teams (i.e., leaders and workers) to conduct technical business. It is used by the aviation industry to improve reliability and safety through formalizing the way it does business.

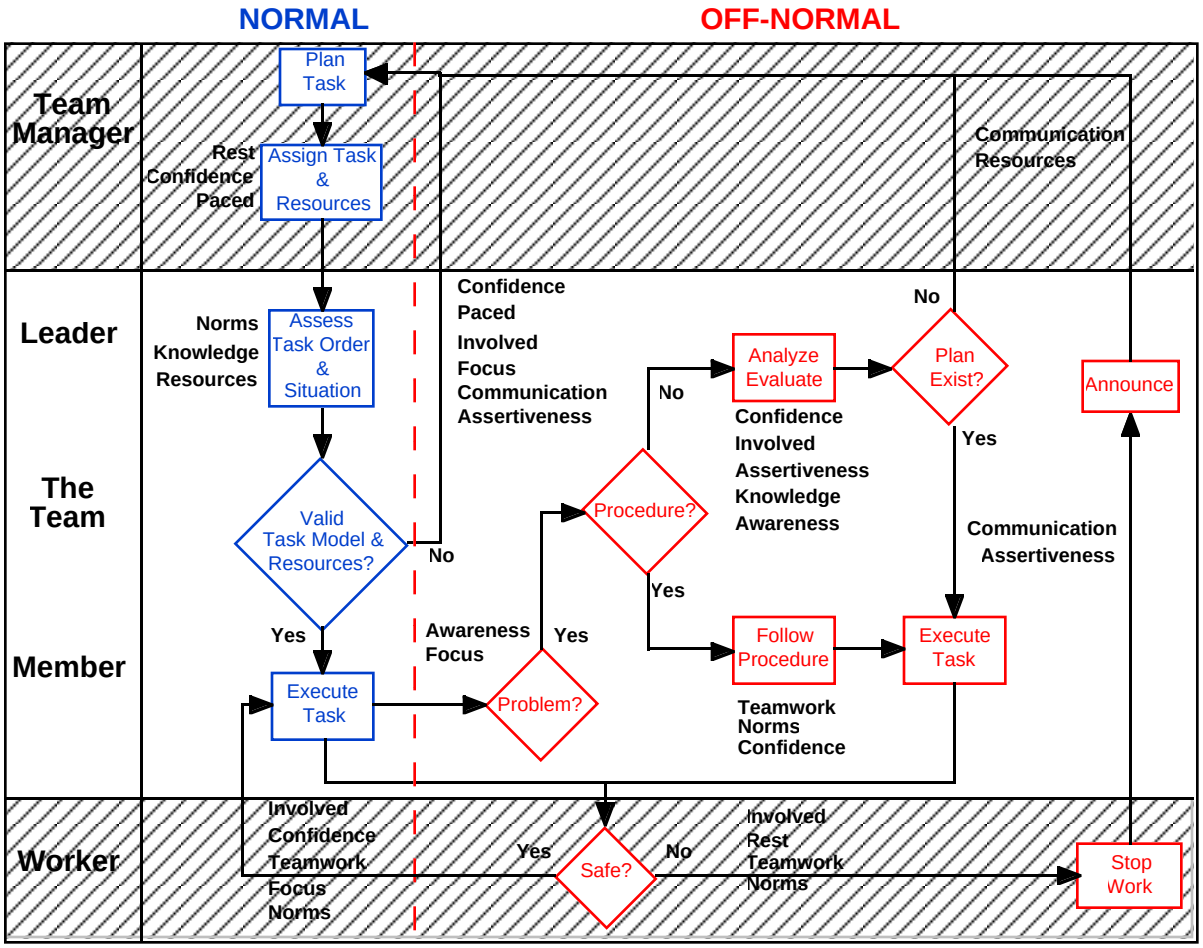


Figure 1. Team Resource Management Process Map.

TRM is like a computer program that runs in the background to monitor how well things are going. For simplicity, all process inter-relationships are not shown in Figure 1. We will talk about this flow chart in detail during the workshop.

1. Workshop Introduction and Human Factors 8:00–9:20

1.1. Get Acquainted and Schedule

Times	The following is a schedule of the workshop:
8:00-9:20	Workshop introduction and discussion of aviation human factors training and approaches to human error.
9:30-10:20	Predicting individual and team performance, culture / norms / values / attitudes, and professionalism.
10:30-11:45	Dirty Dozen: #1-Communication, #2-Carefulness, #3-Knowledge, #4-Concentration, #6-Alertness.
13:00-13:50	#7-Resources, #8-Pressure, #9-Assertiveness, #10-Stress.
14:00-14:50	#11-Awareness, #12-Norms, #5-Teamwork, Operational Risk Management.
15:00-15:50	Exercise and workshop summary.

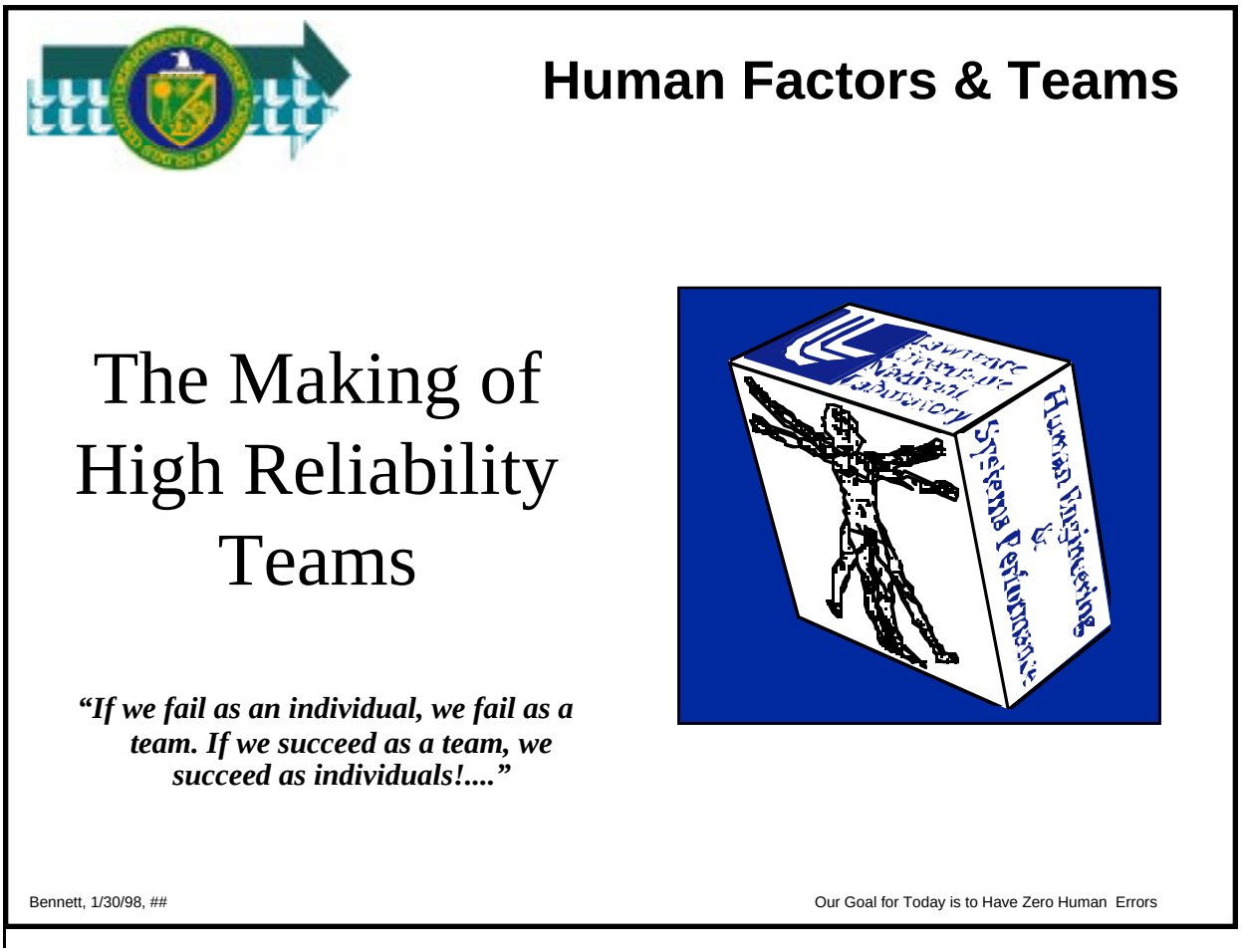
1.2. Course Objectives and Outline

1.2.1. Content

Team Resource Management's motto: "***If we fail as an individual, we fail as a team. If we succeed as a team, we succeed as an individual***."

Introduction, Background, and Goals

High reliability organizations do exist. They conduct thousands of high-consequence operations a year, essentially error-free. Naval air carriers, air traffic control, and commercial aviation are some of these kinds of organizations.



How did they get that way? What kinds of people staff them? Can we become a high reliability organization?

This workshop will look at these questions. When we are done, it will be up to you to determine if we have the right stuff.

Human Factors & Teams

Goals of the Team Resource Management (TRM) Workshop

- **Goal I: Describe Team Resource Management and its purpose**
  - **High-level process to manage technical work**
  - **Improve team reliability and safety**
- **Goal 2: Describe Performance Shaping Factors (PSFs) and their role in predicting and managing team performance and errors**
  - **Internal and external PSFs**
  - **Root Cause analysis and accountability**
- **Goal 3: Describe the principles for managing human error**
  - **Reactive and proactive approaches**
  - **Process management and procedures hazards analysis**

Bennett, 1/30/98, ##

Our Goal for Today is to Have Zero Human Errors

Goal 1: TRM is a process that helps teams manage the conduct of their technical procedure in an orderly, systematic fashion. TRM helps to (a) defines the roles and responsibilities of teams, (b) develop and maintain a shared concept of the task and its status, and (c) provides tools that act as safety nets to optimize team performance and minimize human error.

Goal 2: Individual and team performance can be generally predicted. The factors that influence individual and team behavior are called Performance Shaping Factors (PSFs). Importantly, PSFs can be managed by team leaders and workers.

Goal 3: Just as individual and team performance can be generally predicted, so too can human error.

Human Factors & Teams

Goals of the Team Resource Management Workshop

- **Goal 4: Describe TRM's 12 rules-of-thumb (the "Dirty Dozen") and use of safety nets**
  - **Assume trained people will commit errors and act as part of a team to eliminate errors**
  - **Individual (technical) training and team (process) management training go hand in hand**
- **Goal 5: Conduct Operational Risk Management (ORM)**
  - **Rapid, systematic assessment of situation and task**
  - **"Good-enough" management of risk**
- **Goal 6: Demonstrate ways to keep TRM working**
  - **Measure the processes that TRM is supposed to manage**
  - **Monthly process management meetings, principled shift change meetings, and ORM briefs**

UC-LLNL, Bennett, 1/30/98, ##

Our Goal Today is to Have Zero Human Errors

Goal 4: The "Dirty Dozen" came from Transport Canada and was developed from actual incidents in aviation. We know that task reliability is dependent on more than technically qualified people. Teams, by themselves, do not ensure reliability. Research has shown that most teams must be taught how to manage their processes.

Goal 5: Operational Risk Management (ORM) is a tool that the military uses to understand the hazards to the success of a mission. ORM can be conducted as part of the shift change meetings or pre-job briefs. ORM is used to further clarify roles and responsibilities for a specific job, as well as ensure the existence of a shared task model among all the team members.

Goal 6: TRM improves team reliability and safety. Set high-level, long-term (6 month) and "in-the-trench," short-term (daily and weekly) goals for your work products and safety. Measure them. "What have I produced for the company? How efficiently have I done it? How safely have I done it? Have I followed rules? Have I made my job better?"

1.3. Background on Aviation Human Factors Training

Human factors involves the study of how people interact with physical systems. The physical system could be an electronic game or a nuclear weapon. What is often forgotten is that the human is only one half the system—the other half is the physical system.

Human Factors & Teams

- **Engineering is the art and science of making matter & energy more useful to man**
- **Human Factors Engineering is the art & science of making systems more useful to man**

"The Rule of Proportions," Da Vinci in *Leonardo* by Bacci, 1978.

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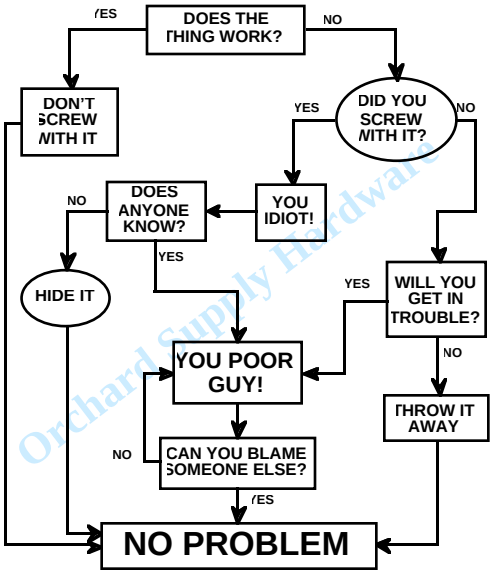
"Systems engineering" is different than "engineering a system." Unfortunately, the latter is more prevalent and means that an engineer got a bunch of parts to work together, regardless of whether anybody can use the system.

Human Factors & Teams

- **A Systems Engineering approach to organizational performance...**
  - **Identifies process problems**
  - **Provides direction to improve process safety and reliability**

PROBLEM SOLVING FLOWSHEET



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The importance of systems engineering is that it can take a complex system and decompose it into components that are more easily understood.

A graphical model of a team activity is essential for being able to completely understand the work we do. It helps ensure that there is a "shared model" of an organization, that everybody is "reading from the same sheet of music."

Research has shown that failure to develop and maintain a "shared model" is one of the most frequent causes of failed missions. A shared model provides all team members with a common notion of what the task is:

- What are the threats to getting the task done?
- Who is supposed to do what... when?
- What is the status of the system and task?

1.4. Organizational Problems are Your Problems...There is a Solution

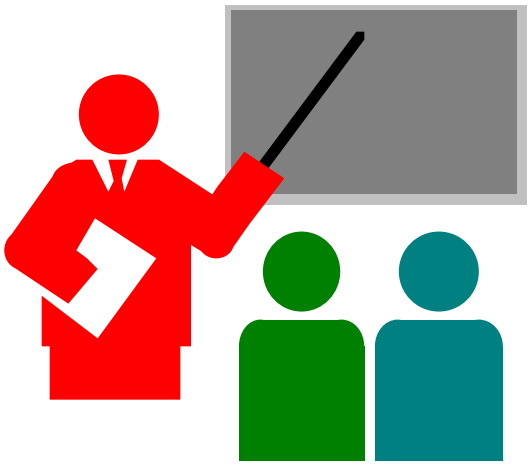
It is important to face facts. You have hired into an imperfect Lab. Its processes are flawed. You work with some individuals who have suboptimal motivation.

Despite this, we all know that your boss assumes it is your responsibility to get the work done and to make the Lab succeed. You will be held accountable if the Lab (or your piece of it) fails.

Human Factors & Teams

Did you know?

- **We do not have a perfect organization!**
  - **Planning**
  - **Resources**
  - **Training....**
- **But....you are expected to be accountable and succeed!**



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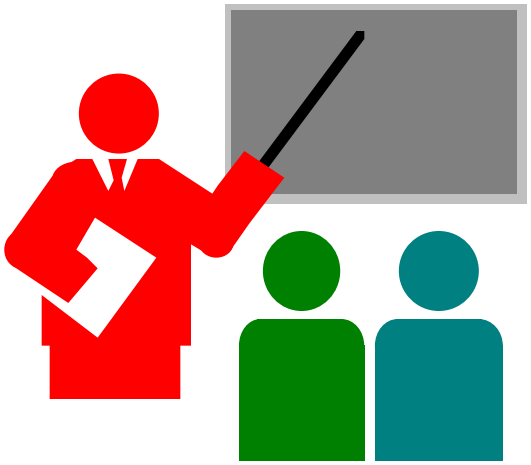
Our Goal for Today is to Have Zero Human Errors

If you don't like how the Lab does business, you can decide to stay and try to fix it using TRM tools; or, you can decide to leave.

Human Factors & Teams

What do you do?

- **Do you....**
  - **Throw in the towel?**
  - **Whine?**
  - **Blame someone else?**
- **Do you....**
  - **Model your team's job?**
  - **Define a shared team model?**
  - **Measure your team's work?**
  - **Know your organization's faults and still accept accountability as a team?**



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If you elect to stay, there are solutions....but, they take work. If you want to become one of the high reliability organizations mentioned, there are principled approaches—TRM—to at least minimizing the problems.

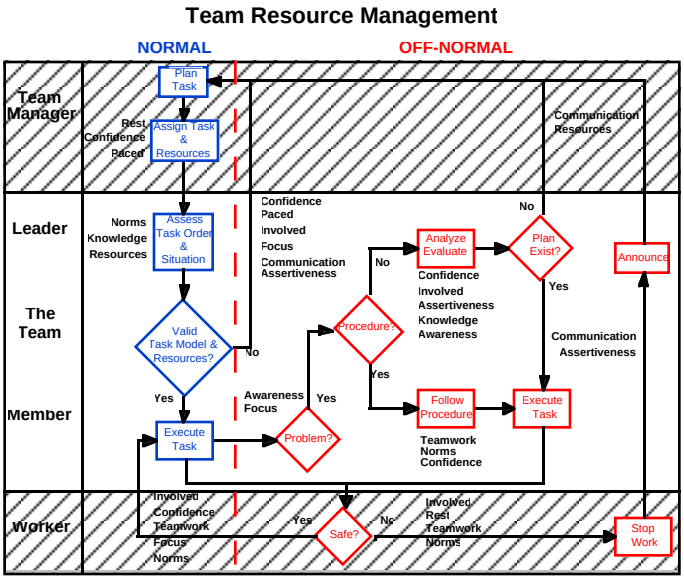
TRM includes the following activities:

- Process Management
- Shift change meetings
- Operational Risk Management
- Safety nets

Human Factors & Teams

A Meta Procedure Controlling Technical Work

- Consistent with lab policy
  - Individuals are responsible for their own safety
  - Stop work policy
- Team Manager could be:
  - Group leader or supervisor
  - Program leads
- There may not be a formal team leader
- Thinking about work procedures & the Team Resource Management process is the first step to working... Efficiently, Effectively, & Safely.



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The principal operation of a team is the technical one that turns out its product. The other operation is one that should be running in the background all the time and continuously doing the following:

- Comparing the ideal process developed in process management with the actual work being conducted.
- Looking for signs that the process is not reliable.
- Looking for signs that the process is not safe.
- Looking for the Dirty Dozen.

In the past, it was assumed that once a team started its technical operation, the team would just naturally know how to

- Organize itself
- Ensure that each team member was doing the right job at the right time, and

- Check to see if it was doing the job reliably and safely.

Was this ever wrong! In aviation, it took several decades, thousands of lives, and billions of dollars before they discovered how the technical work of teams can break down, even if the team members are the most qualified in the world.

Team Managers

The **Team Managers** have the responsibility of taking organizational requirements and setting them in motion. They determine what and when tasks have to be done, and they plan the task at a fairly high level. Team Managers establish the overall goals and performance criteria. They also ensure that the written culture of the organization (e.g., procedures and Facility Safety Procedures is in place and that the unwritten norms (the implementation of the culture) reflect the goals of the organization and task.

The Team

The Team Leader is responsible for assigning and monitoring the physical and human resources needed for a task. The Team Leader is responsible for developing detailed plans on how the task is to be accomplished and making decisions regarding utilization of resources and schedule.

Team Members are required to

- Keep the team's task and goals in mind.
- Continually appraise the situation in which the task is being conducted.
- Monitor the reliability and safety of the Team Leader and the other Team Members.
- Communicate changes in the situation and the status of their individual tasks.

The Workers

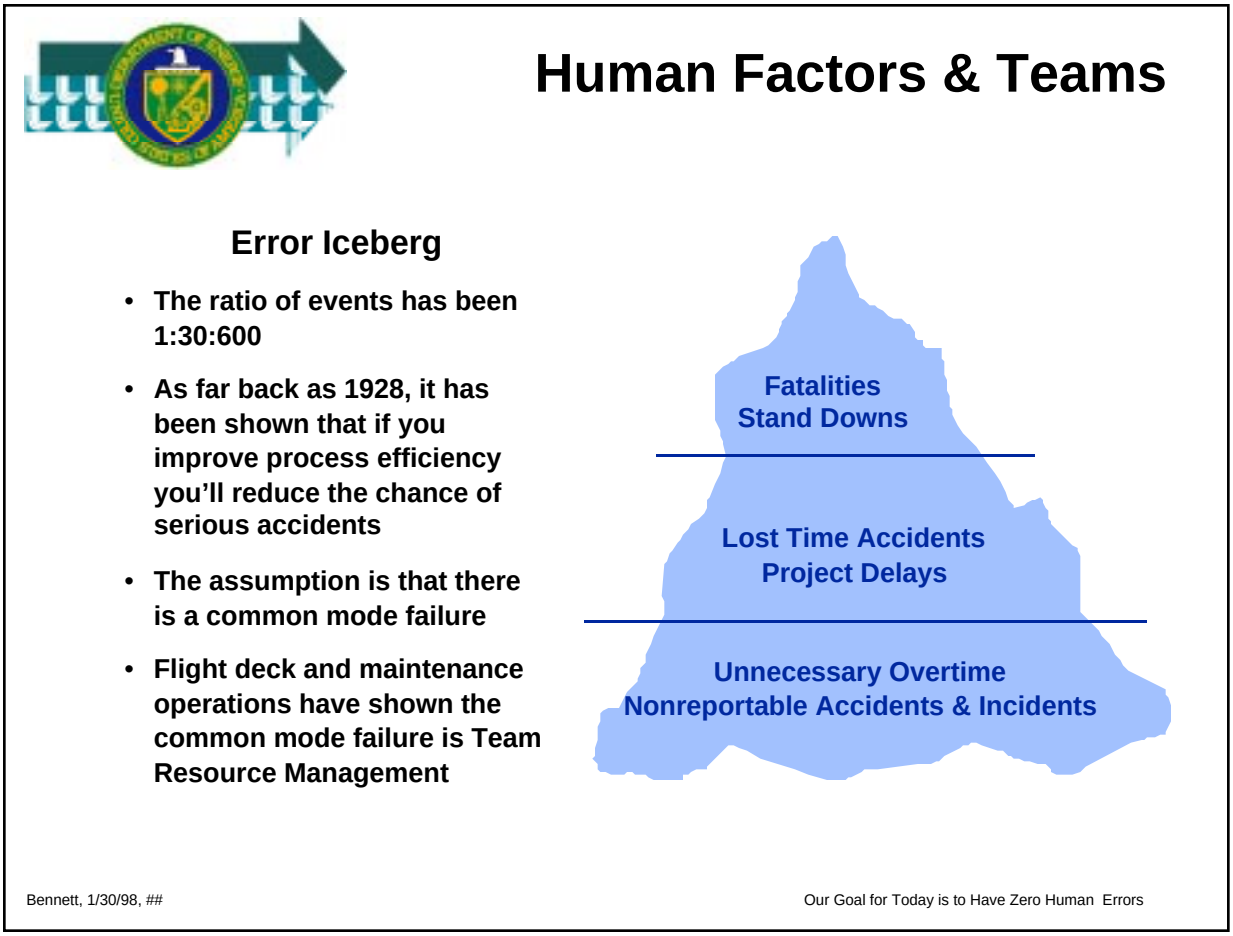
The **Workers** are called out separately because, while we all work as a team to achieve our organizational goals, we are individually responsible for our own actions and ensuring that the team succeeds. We must remember....

If we fail as an individual, we fail as a team. If we succeed as a team, we succeed as individuals....

1.5. Human Error and Accountability

We know that in many high-consequence industries (e.g., aviation, nuclear research), **approximately 90% of the accidents are caused by human error.**

That is, the engineering designs and controls have become so good, that few accidents are the result of mechanical failure.



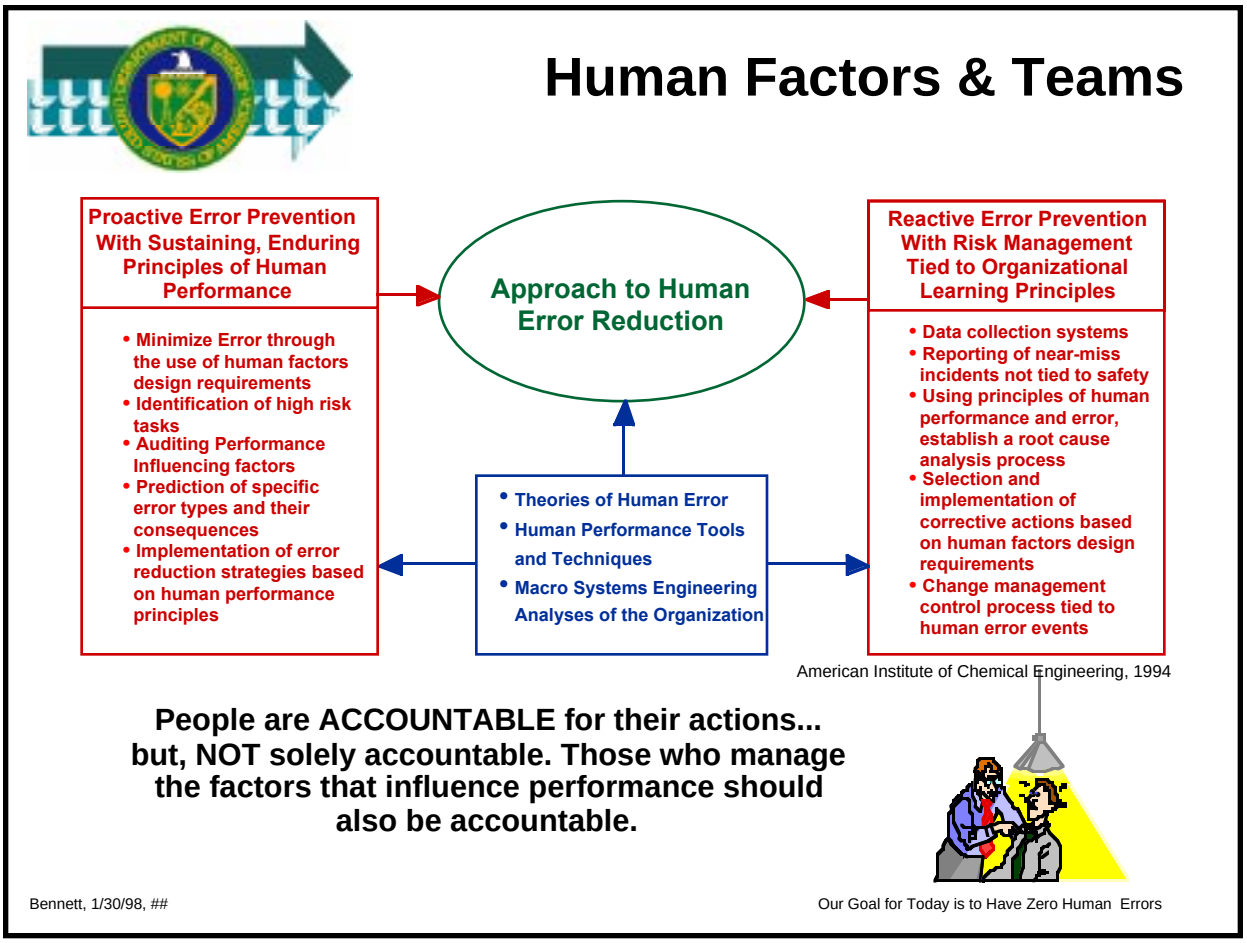
These are the error iceberg statistics for aviation. Most people believe that if you work on reducing the lowest level of human errors (the ones that lead to minor injuries, overtime, missed schedules), you will ultimately reduce the frequency of the most serious accidents.

Team Resource Management uses the military approach to training.

- It is organized on the basis of tasks, conditions, and standards.
- It uses scenario-based training.
- It teaches individual technical skills and trains people about how to perform together.

TRM is an adaptation to meet schedule and resource demands. The worth of TRM has been proven by NASA and USC studies that have shown significant decreases in

- Maintenance errors (33%) and
- Lost-time accidents (21%).

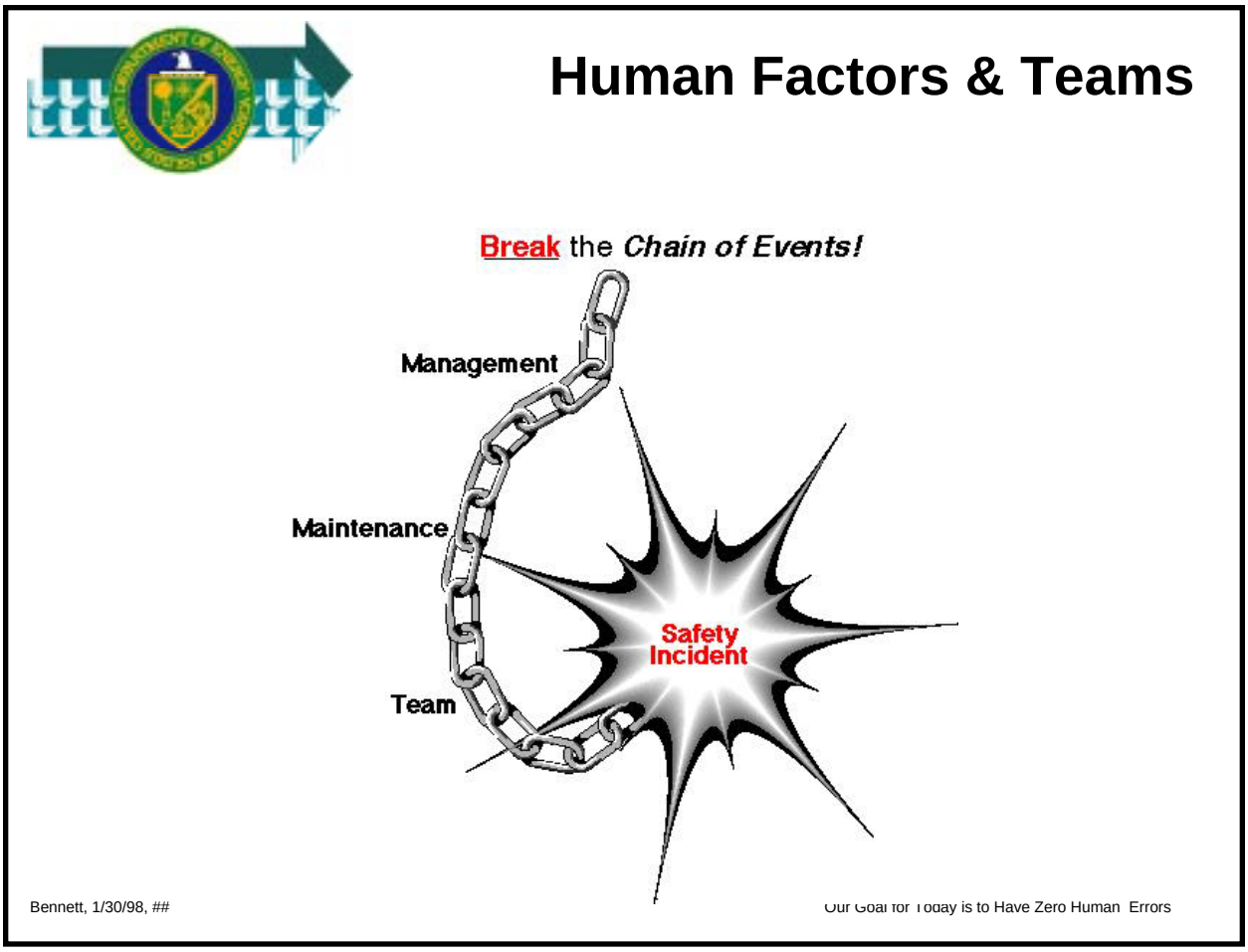


Are You Accountable?

IF YOU DON'T HAVE A PROACTIVE PROCESS.... YOU'LL ALWAYS BE REACTIVE....DEALING OUT BAND-AIDS.

- **YES**...people should be accountable if they screw up.
- **BUT**...people **SHOULD ALSO BE HELD ACCOUNTABLE** who
  - Wrote the procedure that led a technician down "the garden path" to an error....
  - Managed the shift schedule that produced fatigued, inattentive workers....

Let program milestones get in the way of training requirements....

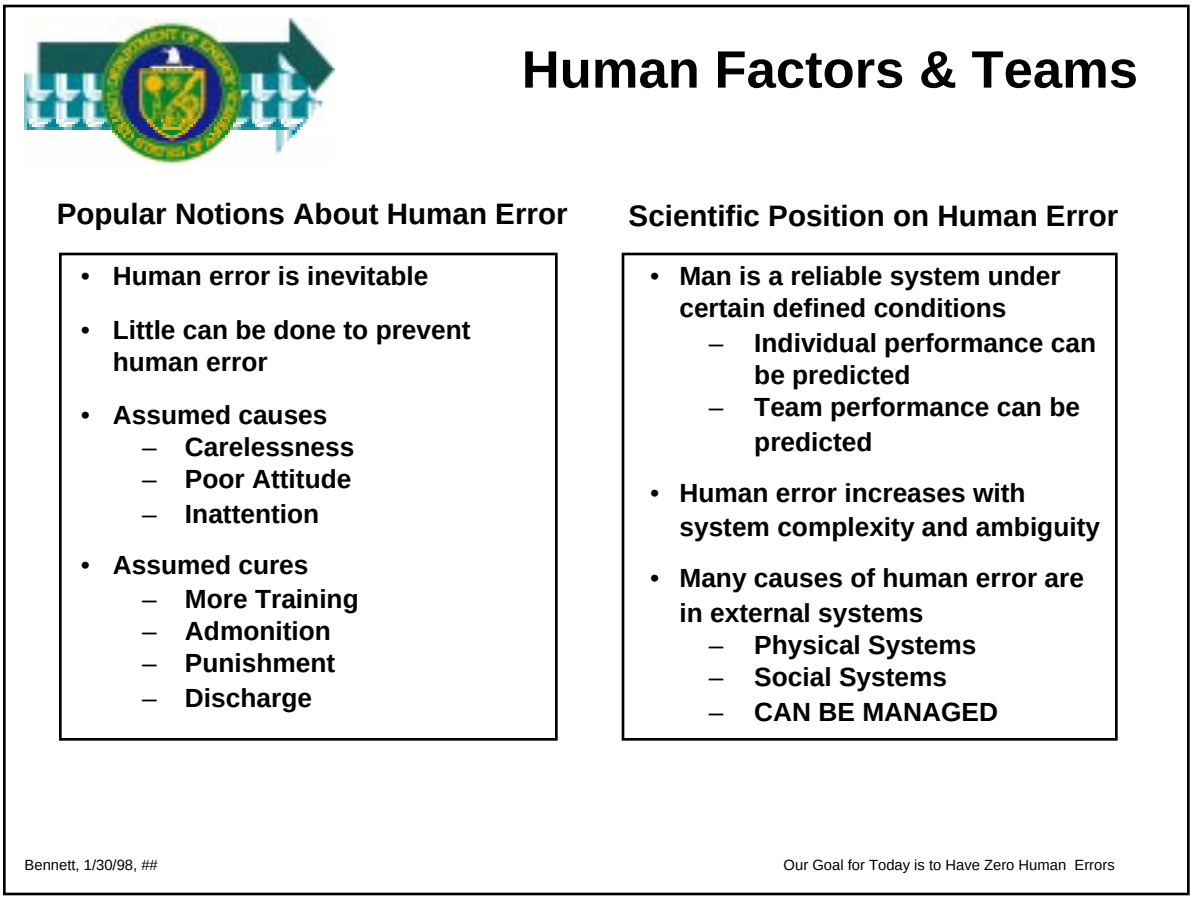


We know now that accidents are the result of a chain of events (contributing factors), that if broken, would have prevented it.

A human error is just the final link in a chain of events that ended in an accident.

Any one of the people involved in the events leading to the accident should be held as accountable as the person whose act finally produced the accident.

Any one responsible for managing PSFs that influence the performance of those involved in the chain should be held accountable.



Just because you "blame and train," does not mean you will change the probability of an accident….

You have to address the root causes of accidents.

- It is not that training is the problem. It is the organizational system that allows problems with training.
- It is not that training is the problem. It is the organizational system that allows problems with communication.
- It is not that resources are the problem. It is the organizational system that allows problems with resources.
- It is not the schedules that are the problem. It is the organizational system that allows problems with schedules.

WHAT DO YOU DO ABOUT THE PROBLEMS?

TRM says the TEAM is responsible for correcting the problems. If the team cannot correct the problems, you may need to rely on the Dirty Dozen's safety nets to be successful. And, just in case you wondered…whining and complaining are not among the safety nets.

2. Predicting Individual and Team Performance and Norms and Culture 9:30–10:20

2.1. The Lab, Individuals, and Teams

How does the Lab do business? In the past, we

- Hired qualified people
- Told them to go work safely, and
- When they did not,
- We would punish them and
- Require that they receive remedial training.

Human Factors & Teams

- **Old Management Mantra...**
  - **Count on skilled experts to work reliably**
  - **Tell people to work safely**
  - **Punish & retrain people who make mistakes**
- **A New Management Mantra...**
  - **Document tasks & procedures**
  - **Train people to work reliably & safely...as individuals & as teams**
  - **Recognize good people make mistakes as the result of latent organizational errors**

- **A New Management Philosophy...**
  - **Process reliability leads to process safety**
  - **A perfectly designed and managed system is inherently safe**

Bennett, 1/30/98, ##

Our Goal for Today is to Have Zero Human Errors

What we should be doing is

- Formalizing our work processes (as opposed to just assuming that people know what is expected),
- Training people to look at their work as a process that can be managed,
- Training people how to work on teams, and
- Realizing that good people make mistakes because of influences that are sometimes out of their control.

The last statement is interesting because….

We occasionally misperceive whether something is actually out of our control. Sometimes we only think it is out of our control.

We sometimes think that somebody else is accountable for something (a boss who is supposed to provide resources) and that we do not have any obligation to step up and find a solution.

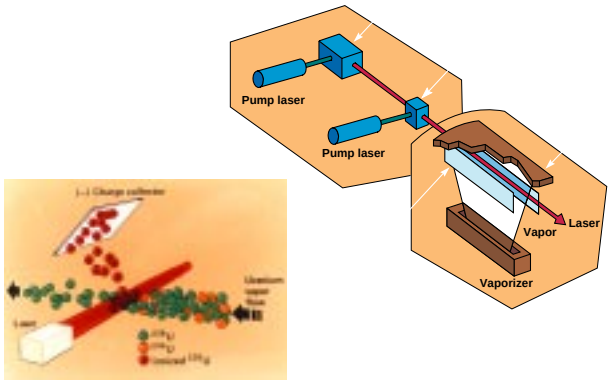
Sometimes we do not step up and find a solution to spite the boss.

Remember… the Lab is imperfect!

If the solution to the problems of managing PSFs was easy, someone else would have already solved it.

Human Factors & Teams

- **AVLIS venting incident...**
  - **The task...calibrate canister load cells with vessel at vacuum**
  - **Two techs and lead briefed task**
  - **Work approved and began....resulting in venting**
- **What happened...**
  - **Techs did what was asked & lead assumed accountability**
- **What really happened...**
  - **Lead thought valves checked**
  - **Techs thought valves checked**



- **Who's accountable...**
  - **The "nuclear" team for the task**
  - **The "extended" team for Team Resource Management**

Bennett, 3/14/98, ##

Our Goal for Today is to Have Zero Human Errors

Just as with pilots, the lead technician blamed himself. Other lead technicians blamed him. He thought he screwed up and was held solely accountable.

But, it was a team operation, anyone could have stopped the operation.

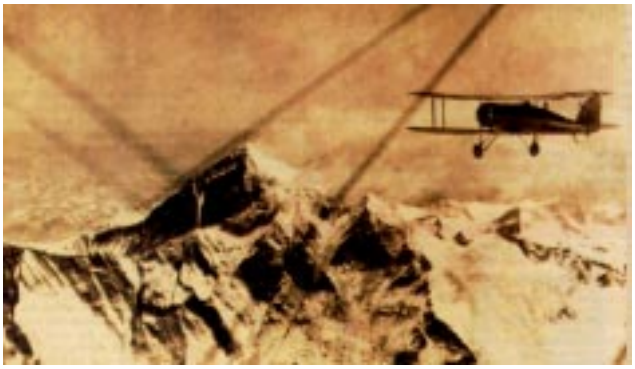
- They just weren't tuned in to the ambiguous communication.
- They weren't on guard against any mishap.
- They were complacent.
- They weren't trained to work as a team.

On the flight deck and in maintenance aviation, it was found that **team performance is something that has to be taught and practiced**.

Organizations must spend time managing the processes and also training workers and lead technicians to work as a team, not as separate individuals working independently.

Human Factors & Teams

- **Into the mid 80s, there were many accidents with experienced, trained crews**
  - **—UAL ran out of gas**
  - **—NWA took off with flap up**
  - **—BAC lost windshield**
- **The management response...**
  - **—We trained & certified them**
  - **—They should have known better**
- **What that meant...**
  - **—You're as good as you can get**
  - **—Errors will happen**
  - **—We'll be waiting**



First Mt. Everest flight, 1933. From *Aviation Week & Space Technology, June 1993.*

- **We assumed...**
  - **– If you technically train people...**
  - **– The team will be reliable**
- **But, the reality was...**
  - **– People get caught in binds on teams...**
  - **– And don't necessarily know how to get out of them**

Bennett, 1/30/98, ##

Our Goal for Today is to Have Zero Human Errors

People thought team performance was just "common sense" performance

Aviation was expecting more from people—something that they had never taught them—how to interact as a team.

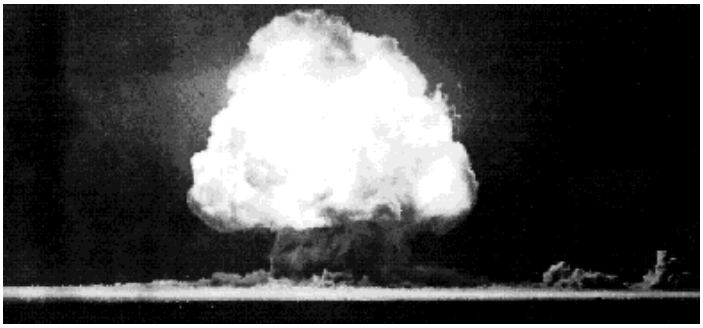
Aviation learned that TRM is not something you necessarily pick up on your own. But, the data show that you can learn TRM.

In aviation, the words safety and reliability are fused together in everyone's mind whether he or she is a pilot, a flight attendant, a mechanic, or someone who works in the tool crib.

Human Factors & Teams

Safety in Nuclear Handling?

- **There have been 42 criticality incidents...**
  - **10 with the loss of life**
- **Of the 42 criticality incidents...**
  - **38 involved human error**
- **Almost all have involved research activities...**



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Our Goal for Today is to Have Zero Human Errors

What these data do not say is that the rate of such incidents has been flat in the United States for many years.

Nuclear research has been safe. We can make it safer by minimizing human error.

Human Factors & Teams

What About Reactors?

- **"Some previous analyses have attributed it (the source term) to human error. *We reject that hypothesis.*"**

- **"There were factors not within the operators' control...poor procedures, inadequate training, and lack of management."**

Rogovin and Frampton, 1980.

From *The President's Commission on The Accident at TMI*, 1980.

Bennett, 1/30/98, ##

Our Goal for Today is to Have Zero Human Errors

They should reject the idea that human error was the cause of the accident at Three Mile Island (TMI). Human error was the last event in the chain of events.

The organization failed to control the PSFs that influenced how well the operators performed.

One of the main points is that the control room operators were viewed in isolation from the rest of the plant. It was assumed that the extended team (procedures, training, management) would have taken care of business.

We know that the TMI team failed.

They failed as individuals.

They failed as a team.

Human Factors & Teams

We Can Have Zero Human Error Today, But....

**"Here is Edward Bear, coming downstairs now,
bump, bump, bump,
on the back of his head, behind Christopher Robin.**

**It is, as far as he knows,
the only way of coming downstairs,
but sometimes he feels that there really is another way,
if only he could stop bumping for a moment
and think of it."**

The opening to Milne's "Winnie the Pooh"

Bennett, 1/30/98, ##

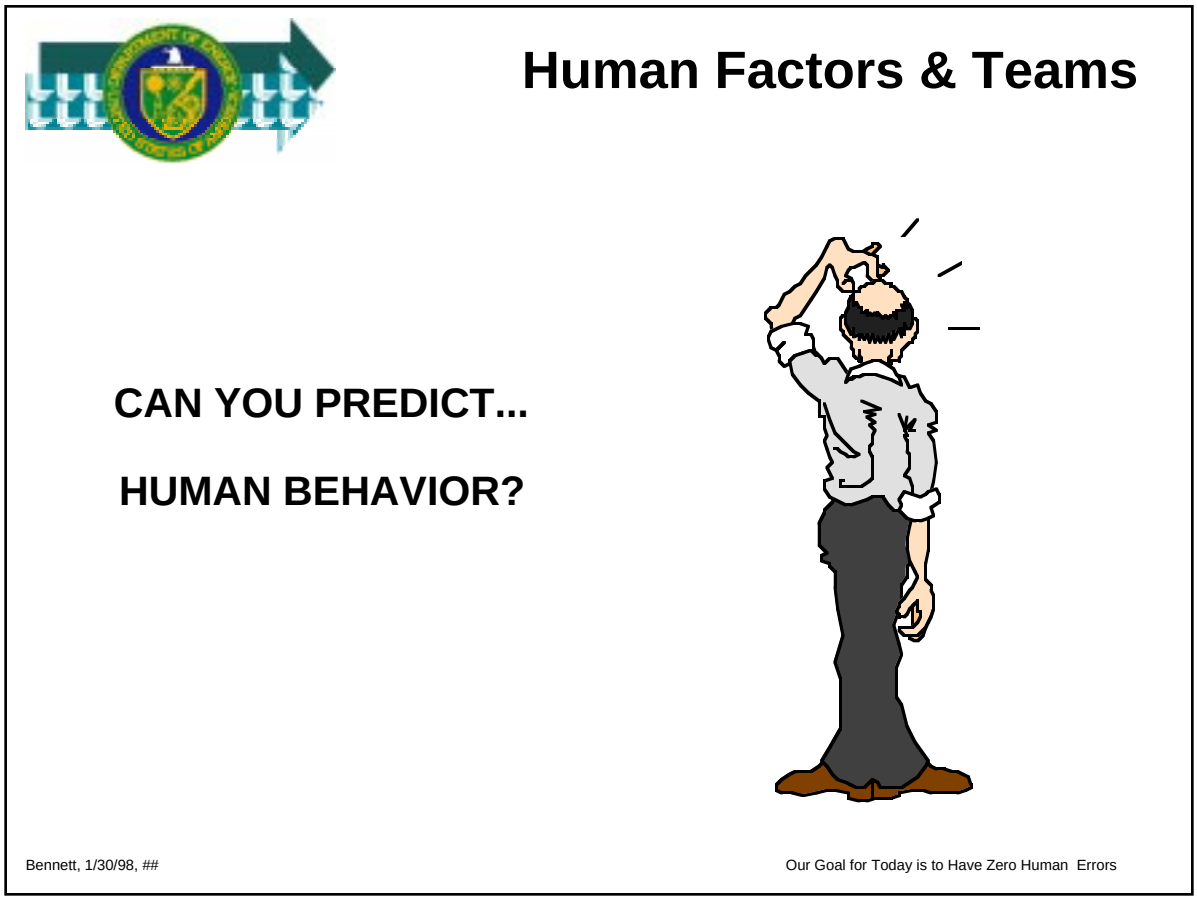
Our Goal for Today is to Have Zero Human Errors

"And, here we are, things keep bumping down the organizational ladder, no one ever taking time to look for a better way."

As we'll see, high reliability organizations have taken the time.

Team Resource Management and Operational Risk Management are ways high reliability organizations have become just that.

2.2. Can You Predict Human and Team Performance?



If you had a difficult, risky job, how would you go about picking the person with whom you would want to work? If your bass asked you if *you* can do the job, how do you know you can or will?

- Do you have the experience and training?
- What are the working conditions like?
- Are you getting paid enough?
- Are you tired?
- Is there stress to get the job done before you go home?

We use Performance Shaping factors all the time to predict human performance. We know if we ask people to do a complicated, high-precision task in a noisy, cluttered environment, they are more likely to make an error.

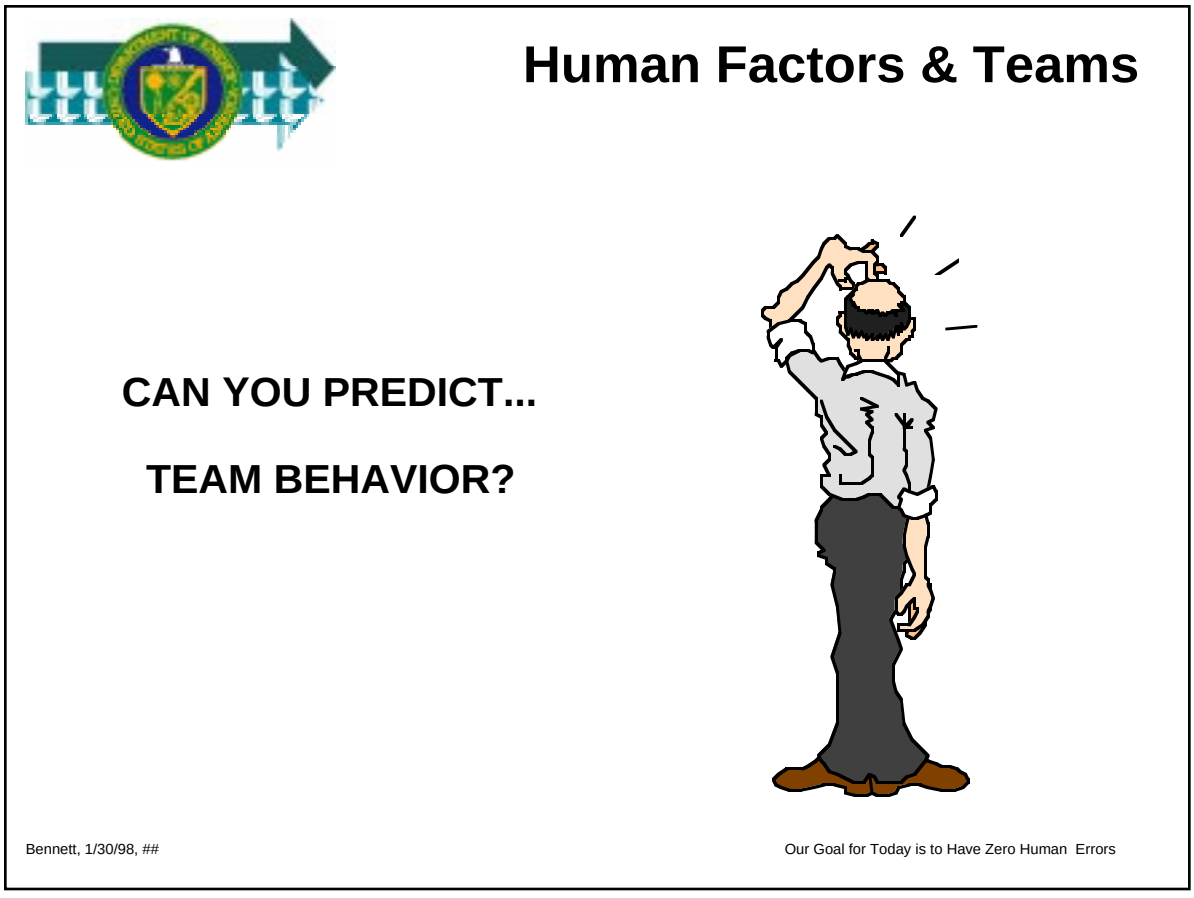
The Dirty Dozen are pointers to where PSFs begin to have negative influences.

Usually PSFs are grouped into:

- **External PSFs**
  - Management
  - Organization
  - Work environment
  - Culture
- **Internal PSFs**
  - Experience and skills
  - Motivation
  - Attitudes and values
  - Fatigue and illness

We may not know precisely how each of these contributes to performance. But, we do know that if they are not managed properly, they are likely to have a negative influence on performance.

Importantly, most of these factors can be managed before the job is started.



Would you bet on the 49ers? What about the Raiders? Teams are not the same as a group of people doing their separate tasks individually.

But, just as with individuals, teams have their own Performance Shaping Factors. What are some of them?

Usually PSFs are grouped into:

- **External PSFs**
  - Management
  - Organization
  - Work environment
  - Culture
- **Internal PSFs**
  - Experience and skills
  - Motivation
  - Attitudes and values
  - Fatigue and illness

Remember…. We cannot make the assumption that a group of technicians working together will form a team.

If we do, we are ultimately setting them up for failure.

2.3. Culture, Norms, Values, and Attitudes

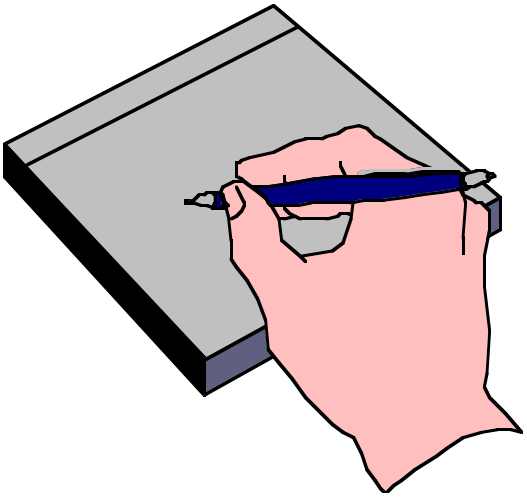
Culture refers to the sum total of the ways we live and work. For simplicity. It is the physical things that we use to transmit our values and the way we go about doing the work we do.

In one sense, our procedures are our physical culture.

Human Factors & Teams

Our Culture and Norms...

- **We have to ESTABLISH A FORMAL PROTOCOL for working as a team...**
  - **CULTURE and NORMS shape our behavior**
  - **Our culture is our totems**
    - **If it's NOT DOCUMENTED, we have NO CULTURE**
  - **Structured, agreed upon norms are positive ways of controlling activities that do not have procedures**



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But, everything about the way we live and work cannot go into our physical culture (procedures); that's where norms come in.

Norms are the accepted way of doing tasks. They are not written down.

But, norms can cause teams to fail. How can norms (unwritten, accepted ways of doing business) cause problems?

- Someone can improve a norm, but not tell the next shift the new system state.
- Norms sometimes allow people to work outside the safety envelope.
- Different people do things differently, resulting in a work product that is not consistent.

On the other hand, norms—structured, agreed upon ways of conducting activities—can be a positive way of doing business and can be a part of TRM. What are some of them?

- Norms can streamline activities.
- Norms allow for individual technique.
- Norms are easy to improve.

Human Factors & Teams

- **Up until the early 80's pilots could develop there own procedure modifications**
- **Then the FAA required, for pilot certification, that they only use manufacturer approved procedures**
- **Then the FAA required that they have the procedures in hand during the operation**

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Aviation is one of the most process-managed, proceduralized industries in the world. But, they found out process management and procedures were not the whole story.

How can procedures fail us?

- They cannot cover all situations.
- If not written clearly, they can cause errors.
- They can be technically incorrect.

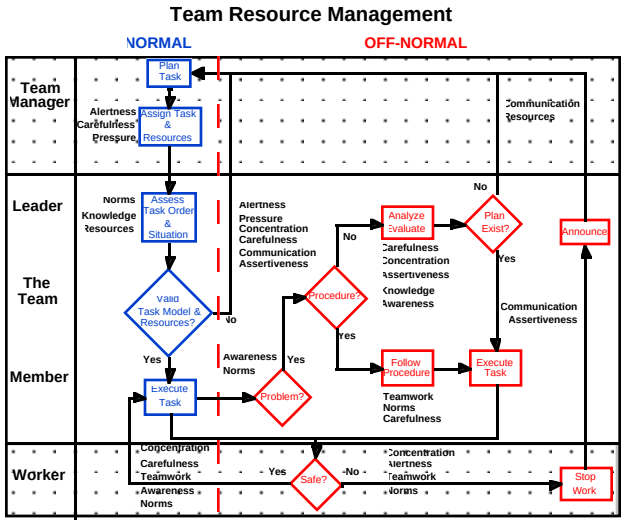
It became clear in aviation that reliability and safety was being compromised by an informal use of procedures for high-risk operations. (An example of negative norms.)

We should look carefully at the formality of our procedure norms.

Human Factors & Teams

Document TEAM LEADER'S roles and responsibilities (who DOES what, who GETS what, and WHEN do they get it)...and include—

- **Team REQUIREMENTS and ACCOUNTABILITY**
- **GRAPHICAL representation of team activity**
- **MANDATE and INFORMATION to TEAM MEMBERS to flag LEADER'S deficiencies**



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The leader has the responsibility to clearly

- Define what is expected,
- Plan for resources, and
- Evaluate the situation.

The leader iterates with the team members on the execution of the plan.

Process maps help perform a task reliability and safely because

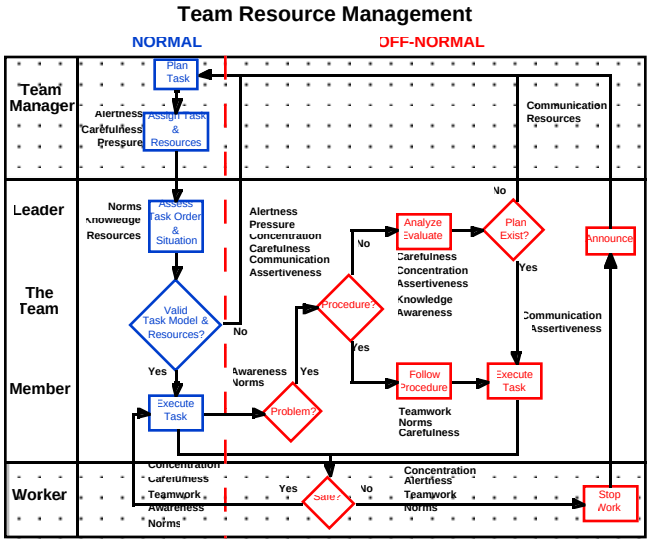
- They help us visualize the process.
- They provide us with a quick overview.
- They allow us to see how changes will impact our work.

The TRM process also mandates that the team members **understand** what is expected of the leader and **question** the leader when those expectations are not met.

Human Factors & Teams

Document TEAM MEMBER'S roles and responsibilities (who DOES what, who GETS what, and WHEN do they get it)...and include—

- **Team REQUIREMENTS and ACCOUNTABILITY**
- **GRAPHICAL representation of team activity**
- **MANDATE and INFORMATION to TEAM LEADER and other TEAM MEMBERS to flag MEMBER'S deficiencies**



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TRM also **mandates** that the team members understand what is expected of

- The leader and
- Other team members

and question the leader and other team members when those expectations are not met.

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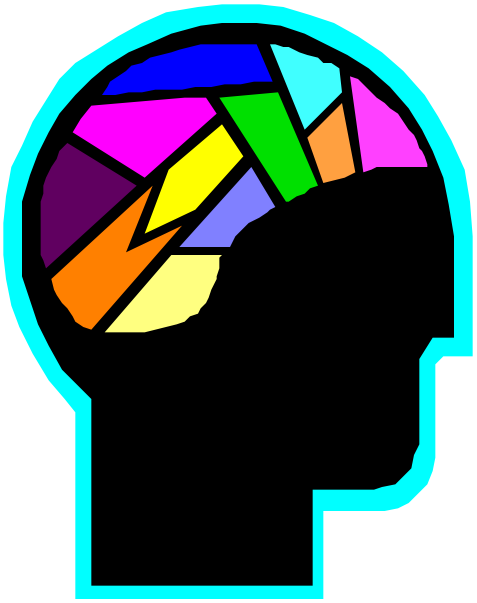
- **TEAM ATTITUDES as norms—**
  - **— ATTITUDES are observable...VALUES are internal**
  - **— Values drive team attitudes, which drive behavior and performance.**



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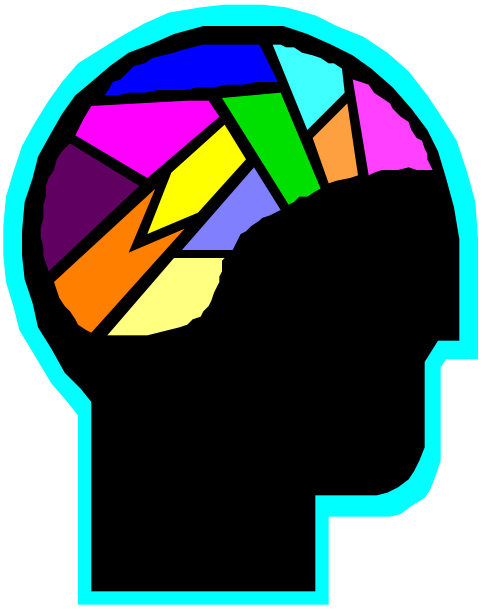
For the most part, attitudes are observable. Some say that 90% of the way we communicate attitudes is nonverbal.

Attitudes reflect our personal feelings about work, the people around us, and our life in general. They influence how we act and behave.

Human Factors & Teams

— THE EASY WAY—
- – Values...
- – Influence attitudes...
- – Which influence norms...
- – Which influence culture...
- – Which influences behavior

— THE HARD WAY—
- – Behavior...
- – Influences culture...
- – Which influences norms...
- – Which influences attitudes...
- – Which influences values



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The Easy Way. Generally, values people have are very enduring and resistant to change. That's why we try to hire people with the right work ethic and who value the same things we do.

The Hard Way. For example, we told all people who are going to work in Building 490 that they needed to submit a work authorization plan, something they had not done before.

This was because they did not "value" communication with us before they started work. Well, it did cause some hard feelings at first. But, people started to see the importance and value in communicating early in the work process. It made their job easier, and it made our jobs easier.

2.4. I'm only a....

Aircraft maintenance technicians are some of the most skilled mechanics around, people not unlike yourselves. Here is a list of characteristics from a study of aviation mechanics.

Some of them would suggest that mechanics are loners and are not necessarily "team" players. This may be right. And, that is why aviation feels so strongly about TRM.

Human Factors & Teams

Characteristics of a Professional Maintenance Technician

- **Dependability**
- **Willingness to put in effort and hours**
- **Integrity**
- **Modesty**
- **Distrust of words**
- **Tendency to be a loner**
- **Doesn't like to ask for help**
- **Tends to be self-sufficient**
- **Like to think things out on their own**
- **Doesn't share their thoughts too frequently**

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One secretary asked. "Why are we taking this course? We don't have anything to do with reliability and safety."

Think about this....

- Who keeps the training and qualification records?
- Who organizes and publishes our procedures?

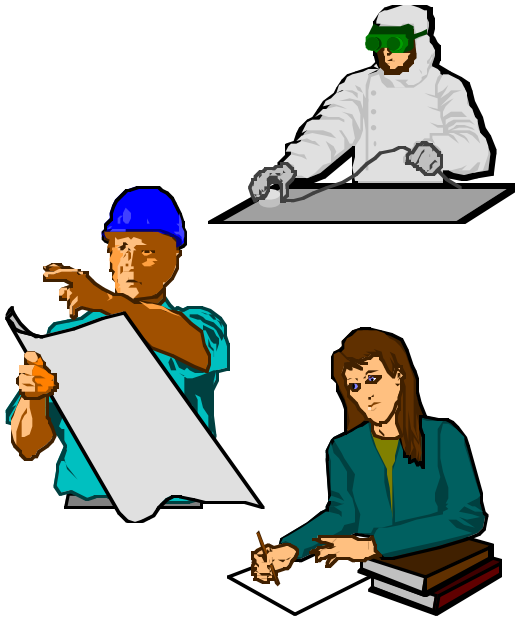
What happens to safety if training records are not maintained? What happens to reliability if a page or step is missing from the procedure?

Our team is not just the people doing work on the floor!

Human Factors & Teams

Professionalism

- What's professionalism?
  - Doing the job well?
  - Playing the role?
  - Maintaining a standard?
  - Setting new standards?
- When are you a professional?
  - At work?
  - During training?
  - Off duty...?
- How do you balance professionalism?
  - Family
  - Religion
  - Recreation



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There are two general parts to professionalism:

- Individual.
- Company-related.

You have to make that judgment about how to balance your professionalism with all the other demands in your life.

Research has shown that people who are the most successful are the ones who have learned how to optimize work and family demands.

To them, it is not a question of family **or** work.

It is a question of family *and* work.

3. Introduction to the Dirty Dozen 10:30-11:45

3.1. The "Dirty Dozen" and Our 12 Rules-of-Thumb...Finding the Balance

NASA and USC studied the effects of TRM at a major airline:

- Cost of repairs due to maintenance-related damage decreased 68%.
- Number of maintenance-related incidents were down 34%.
- Occupational injuries were down 21%.
- Occupational injury-related costs were down 12%.

Human Factors & Teams

Clues To Enhancing Your Reliability & Safety

The Twelve "Rules-of-Thumb" of Team Resource Management

Look for these clues before an incident happens...

1. **Communication**
2. **Carefulness**
3. **Knowledge & Task Experience**
4. **Concentration**
5. **Teamwork**
6. **Physical & Mental Alertness**
7. **Necessary Resources**
8. **"Time-Out" to Pressure**
9. **Assertiveness**
10. **Effective Stress Management**
11. **Situational Awareness**
12. **Positive Group Norms**

(Adapted from Kennedy Space Center.)

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The twelve clues or heuristics (rules-of-thumb) of TRM were adapted by the Kennedy Space Center's Human Factors Team from Transport Canada's Dirty Dozen.

The **Dirty Dozen** point out where the TRM process can break down. The "**Clues**" point to ways to better manage how do our technical tasks. They help us develop "safety nets" or, ways to step in and find solutions to problems in the way PSFs are managed.

3.2. Communication (DD's #1 Lack of Communication)

It is estimated that breakdown in communication is the most significant contributor to human error.

In high consequence, high-reliability settings, communication has become very formalized to avoid ambiguity. It takes training. It takes practice. It may literally take a script or formal "call-backs" during an operation.

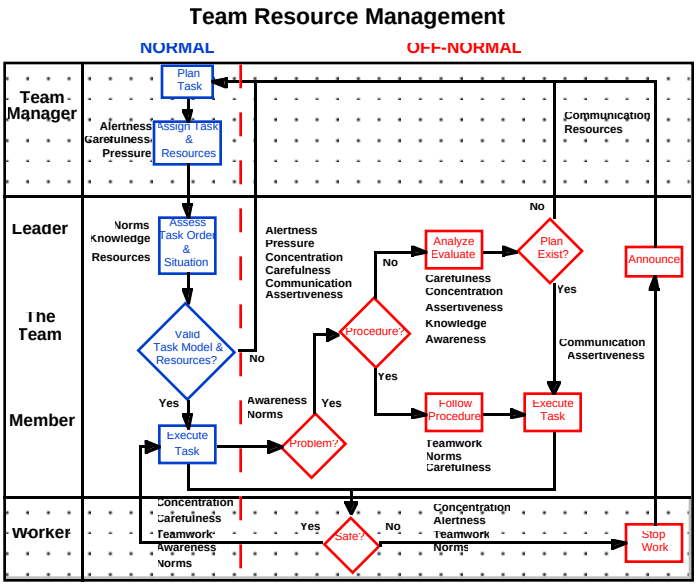
Human Factors & Teams

1. COMMUNICATION

Communication is two-way

Actions speak louder than words! The most powerful form of communication is our behavior.

Don't assume.



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Our Goal Today is to Have Zero Human Errors

#1 Communication

How do we communicate? Scientists say that:

- Words contribute 7%...
- Tone of voice 38%...
- Body Language 55%....

The following is from Transport Canada's course in TRM. The Bottom Line is:

You have to care more about the safety of your co-workers than about your own embarrassment.

- **Do not take too much responsibility for the other person's response**—You can only be responsible for doing what you think is right.
- **Do not jump to conclusions**—The response may not be negative, and the action may not have been intentional.
- **Prepare yourself emotionally**—Take a minute to calm down and get your thoughts collected. Your emotional state will influence the effectiveness of your feedback.

GUIDELINES FOR GIVING FEEDBACK:

- **Be specific**—If you are too vague, the person will not get your point.
- **Describe behaviors, not the person**—Do not attack an individual's personal worth. We see only behaviors, not intentions. (Say, "When I see you not wearing your eye protection, I worry about your safety." Not, "You are an unsafe person.")
- **Be objective and honest**—Keep personal biases and hearsay out of the feedback process. Care enough to give open and meaningful feedback even if it is difficult to do.
- **Show respect**—Check your motivation. Do you want to help or hurt? Providing positive motivation to improve reliability and safety enhances relationships. Using punishment as the initial response can hurt.
- **Do not overload with too much data all at once.**
- **Speak for yourself, not others**—Speaking for "the group" is unfair and counterproductive. The receiver is likely to feel "ganged up on" and will probably react defensively.

GUIDELINES FOR RECEIVING FEEDBACK:

- Clarify the data you receive—Ask for more information and/or examples if you are unclear on the feedback.
- Listen before you respond—Take extra time if you are feeling emotional.
- Look for the useful part of the feedback.
- Do not let defensiveness get in the way of listening and learning.
- Do not debate, detour, plan your response, or tune **out.**

Scenario: Unintended Copper Light Delivery.

People: Several technicians and supervisors. All were qualified and experienced.

Job: Conduct Quarterly Interlock Check (QIC) on the Copper Laser System.

What Happened: While performing the QIC, high-powered copper light was delivered into both dye sets one and two. The dye sets were not in an operational configuration at the time, and it was believed by the individuals who were performing the QIC that the copper laser system configuration would not allow delivery of any copper light. The portion of the QIC that was being performed during the incident was a test of the seismic detectors. According to the procedure, all shutters are directed to be open.

Problem: There was an apparent breakdown in communication during this step that resulted in delivering the third corridor amplified copper laser chains to the dye sets. This caused the generation of 100% amplified spontaneous emission in all four dye chains for a period of at least 20 minutes. While no one was injured, this presented a serious potential for injury, since no light propagation was intended or expected. Operation of the dye chains in this manner potentially damages dye amplifiers, fiber-to-amplifier relays, fiber optic faces, and waveform generator components.

Safety net: Complex systems require very structured communications. Determine the state the system needs to be in to operate or be maintained safely. Then establish a communication protocol that clarifies that state in everyone's mind. Don't assume. Ask.

In the Appendix is a description of the Venting Incident and the communication problems that occurred.

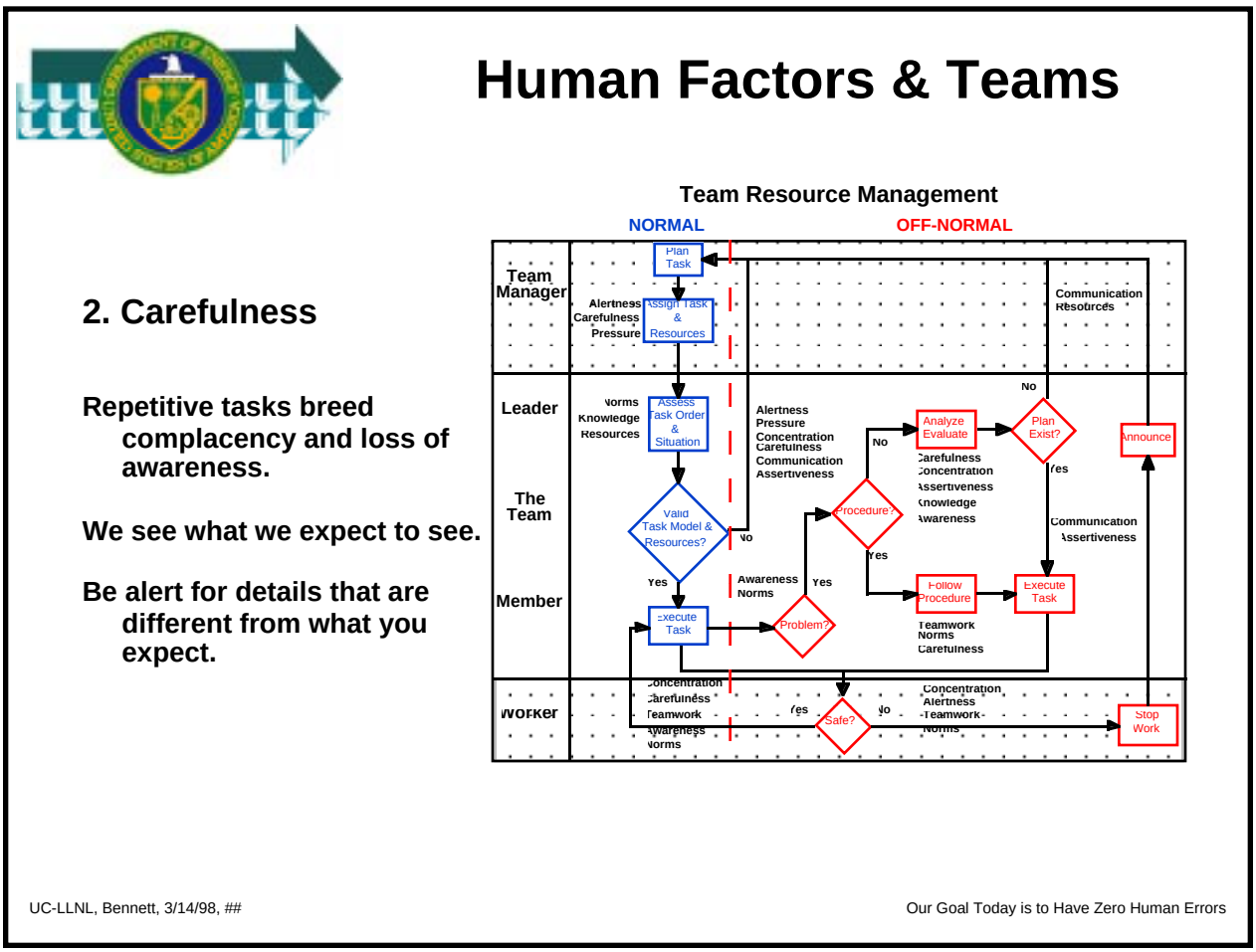
Dirty Dozen's Safety Nets;

- Use logbooks, worksheets, etc. to communicate and remove doubt.
- Discuss work to be done or what has been completed.
- Never assume anything.

3.3. Carefulness (DD's #2 Complacency)

#2 Carefulness

You have done the task a thousands times. Why should it be any different today? A check is the hallmark of professionalism. You shut a lathe down before lunch. When you come back, you can't assume nothing has changed before you get on with the work.



If you're concerned that you won't finish before quitting time, think how late you'll be if you get hurt.

Be professional and go through the start up procedure again. Good project planning will incorporate the time it takes to conduct these operations.

But, remember, the Lab is imperfect and won't always have the perfect project schedule. Being accountable means that you will help out the manager with imperfect planning.

There will always be a normal amount of tension between management and workers when it comes to schedules. It can be healthy. The tension can help push you to be even better.

So, don't confuse "normal" tension from management's desire to get the most work done in the shortest amount of time with management's disregard for safety or morale.

The hard job you have is making the right call between unreasonable demands and what might be called a "management challenge" to improve your work.

Complacency is often linked with **Expectancy** in situations in which a technician will often see what he or she expects to see rather than what is actually there. If other factors are present such as fatigue, a shortage of resources, and/or stress (from different sources), the chance for error becomes even greater. (From Transport Canada's and United Airlines' TRM course.)

Scenario: High voltage shock.

People: One technician, an engineer, and a supervisor. The supervisor was monitoring the operation. The technician was qualified.

Job: Repairing the pulsed power emitter tank. The technician proceeded to fill the tank with Freon so it could be tested. The tank was then turned on, running into the dummy load. The engineer and technician were having a discussion about how to get the peaking current signal out to the oscilloscope.

What Happened: The technician leaned over the workstation to see if he had plugged in the correct grid-driver output cable in the PPE tank. When he put his hand on the power supply to lean over the workstation, he got shocked and was stunned.

Problem: People were thinking about one task (getting the signal out) and started to do it without reviewing how the task should be done

Safety net: Know the high-risk point in the operation. The operation of getting the signal out was a separate task that should have been reviewed for safe, reliable operations.

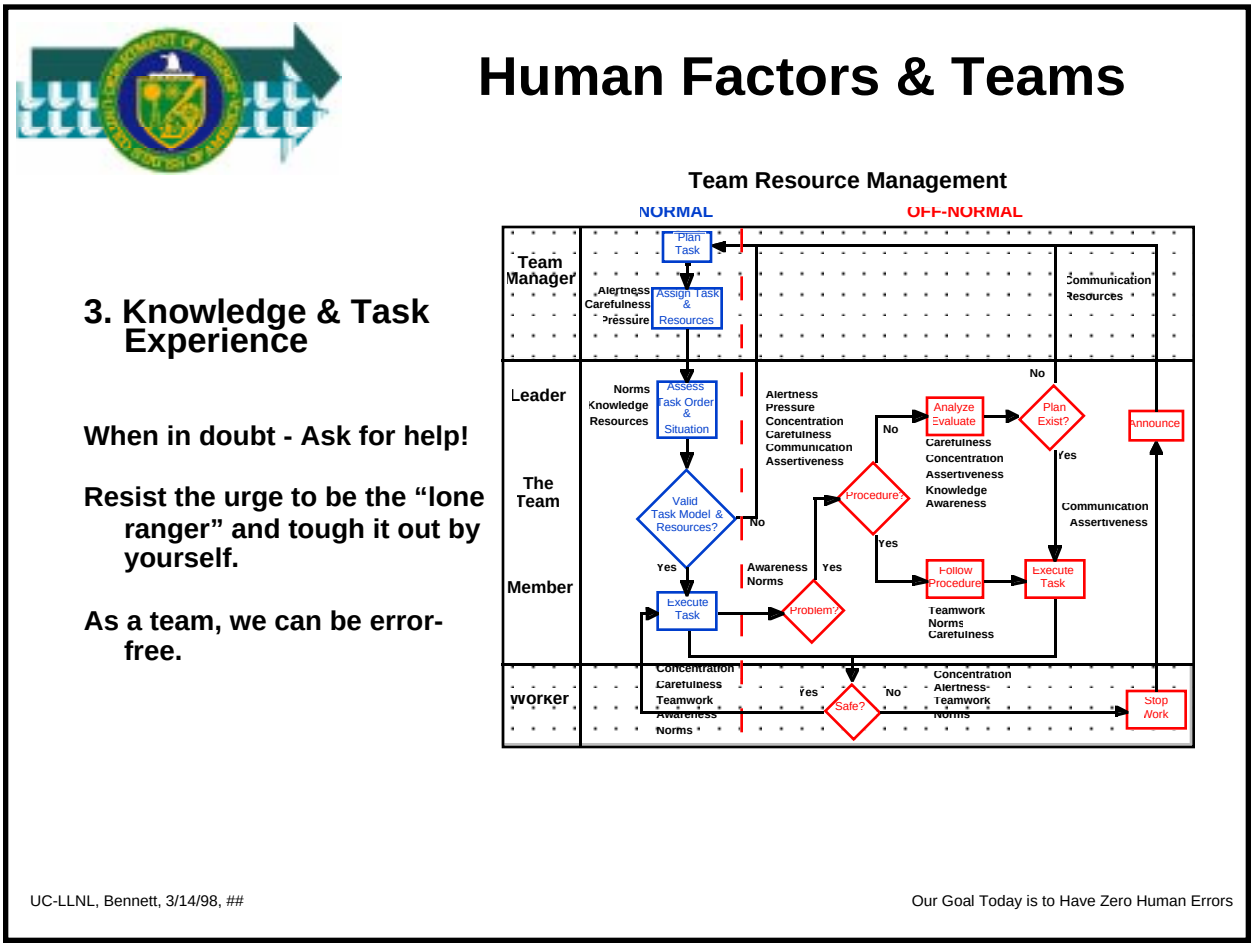
Dirty Dozen's Safety Nets:

- Train yourself to expect to find a fault.
- Never sign for anything you didn't do.

3.4. Knowledge and Task Experience (DD's #3 Lack of Knowledge)

#3 Knowledge and Task Experience

Technical information is often assumed. Professionalism is founded in the routine, ensuring you have all the facts and tools prior to starting a job.



Professionalism is also founded in knowing your limitations.

- When was the last time you did this job?
- Just because you're technically qualified, is this job right for you?
- Does the job have to be done too quickly for your skills?

Scenario: Cut finger incident.

People: Technicians were not a qualified to conduct the operation.

Job: Sectioning a melt of uranium from the pod.

What Happened: During donning, technicians realized they didn't have the required leather gloves and asked someone to get some. The person was taking too long, and the technicians put on some vinyl gloves so they could get on with the job. While lifting a sectioned melt, the technician cut his finger, which resulted in a radiological exposure. The person who went to get the gloves showed up about the time the ambulance arrived.

Problem: Technician was not qualified, but had done the operation before. New lead technicians, who had assigned the task to him, assumed he was qualified. They did not ask or check the records. The technician never mentioned his lack of qualifications because he thought he knew how the task was done.

Safety net: Never assume you know how a high-consequence task is to be done. Check training records as a lead technician. Technicians should check to make sure they have been qualified on the task and let the supervisor know if they aren't. Check local inventories to make sure protective equipment is at each station.

Dirty Dozen's Safety Nets:

- Get training on specific equipment.
- Use up-to-date manuals.
- Ask a Tech. Rep. or someone who knows.

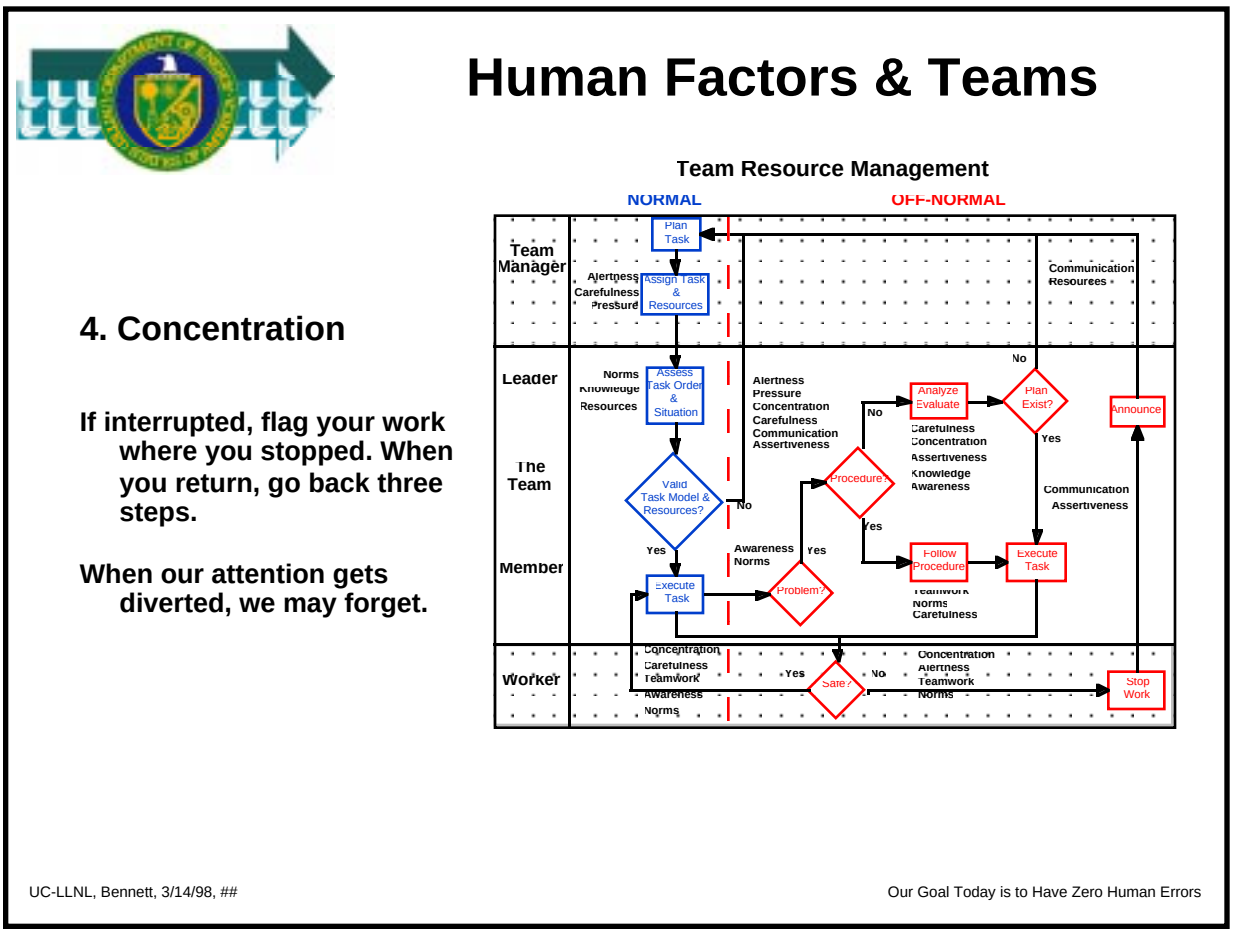
3.5. Concentration (DD's #4 Distraction)

#4 Concentration

Know when your concentration levels are down and when you are easily distracted. If there are family problems, let your supervisor know that you would feel better if you have a backup for the job you are doing that day.

A team is more robust than individuals working by themselves **only** if individuals take advantage of support when they need it.

Recognizing when you might be distracted (thinking about going home on a Friday afternoon) is **not** being unprofessional. Being unprofessional is sitting in the emergency room missing the family trip—the one you were thinking about when you got hurt.



- Using a detailed checklist is the mark of a professional. Cowboys try to wing it. We can't afford to be cowboys.
- If called away from a job, mark where you are.
- Have somebody else check the details.

Scenario: Missed step.

People: Qualified technicians and supervisor.

Job: Doing routine assembly tasks in the High Average Power Facility.

What Happened: During assembly, the procedure was being used, but notes were being taken on the back of the instruction sheets. The technicians were going back and forth, from the front to the back of the sheet. Later, it was noticed that a step had been missed.

Problem: During routine tasks, the slightest distraction can affect reliability and safety. If tasks are disrupted, concentration can be broken.

Safety net: Never assume you know where you were in a task. Check the status of the system. Anything can be a distraction, from taking a break to a co-worker stopping to ask a question. Concentrating on the task AND the safety nets will make the reliability and safety of a job more robust.

Dirty Dozen's Safety Nets:

- Always finish the job or unfasten the connection.
- Mark the uncompleted work.
- Lockwire where possible or use Torqueseal.
- Double inspect by another or self.
- When you return to the job always go back three steps.
- Use a detailed check sheet.

3.6. Physical and Mental Alertness (DD's #6 Fatigue)

#6 Physical and Mental Alertness

One of the insidious problems in the management of fatigue is that the more and more fatigued we become, the harder and harder it is to manage.

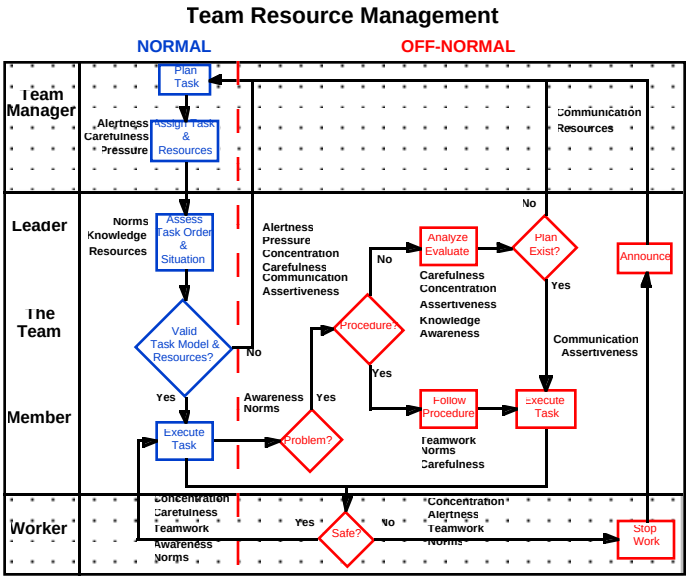
Human Factors & Teams

6. Physical & Mental Alertness

Illness, Fatigue, and lack of sleep are detours to error.

Drugs & alcohol are detours to error.

Over-The-Counter Drugs are just that....Drugs!



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There are daily biological rhythms that all of us experience and that affect our performance. Most of us start to experience degraded performance during late afternoon. The biological neurological reasons for this are complex, but very real.

When we are conducting high consequence operations, we need to appraise our current status. In aviation, pilots are taught to do the "I'M SAFE" check before takeoff:

Illness—Am I healthy? If not, will the illness impact the reliability and safety of my work?

Medication—Am I taking any? Even over the counter drugs will affect my performance.

Stress—What happened at home, on the way to work, while at work?

Alcohol—When was the last drink? Less than 12 hours? Beware.

Fatigue—Have I gotten 8 hours of sleep? How little is too little for today?

Emotion—Which one affects my reliability and safety?

Supervisors should do this check on a routine basis with all their employees. We will talk more about "I'm safe" during the section on Operational Risk Management.

Symptoms of Fatigue

Because the symptoms of fatigue come on slowly, it is important that we learn to recognize them and be aware of their effect. Often we are unaware that we are fatigued until the symptoms and effects have become extreme. The following are symptoms to watch for (from Transport Canada's and United Airlines TRM workshop):

- **An enhanced stimulus is required in order to respond**.
  —The greater the fatigue, the greater the stimulus required.
  —A crack would have to be larger in order for us to see it.
- **Attention is reduced**
  —We begin to overlook basic task elements.
  —We become preoccupied with a single task to the exclusion of others.
  —We begin to reduce our visual scan.
  —We become less aware of poor performance.

Scenario: Controls reversal during Demo 85.

People: Senior engineer and several qualified technicians.

Job: Aligning the e-beam.

What Happened: After several long shifts to get ready for a run, the people involved tried to align the beam. The engineer kept wanting it to go one way and the technicians kept pushing it the other way.

Problem: The controls were labeled improperly. At first people didn't notice it. They kept trying to align the beam even after the incorrect labels were noticed. They were all tired.

Safety net: Double check labels. Set rest cycles ahead of time.

Dirty Dozen's Safety Nets:

- Be aware of the symptoms and look for them in yourself and others.
- Plan to avoid complex tasks at the bottom of your circadian rhythm.
- Sleep and exercise regularly.
- Ask others to check your work.

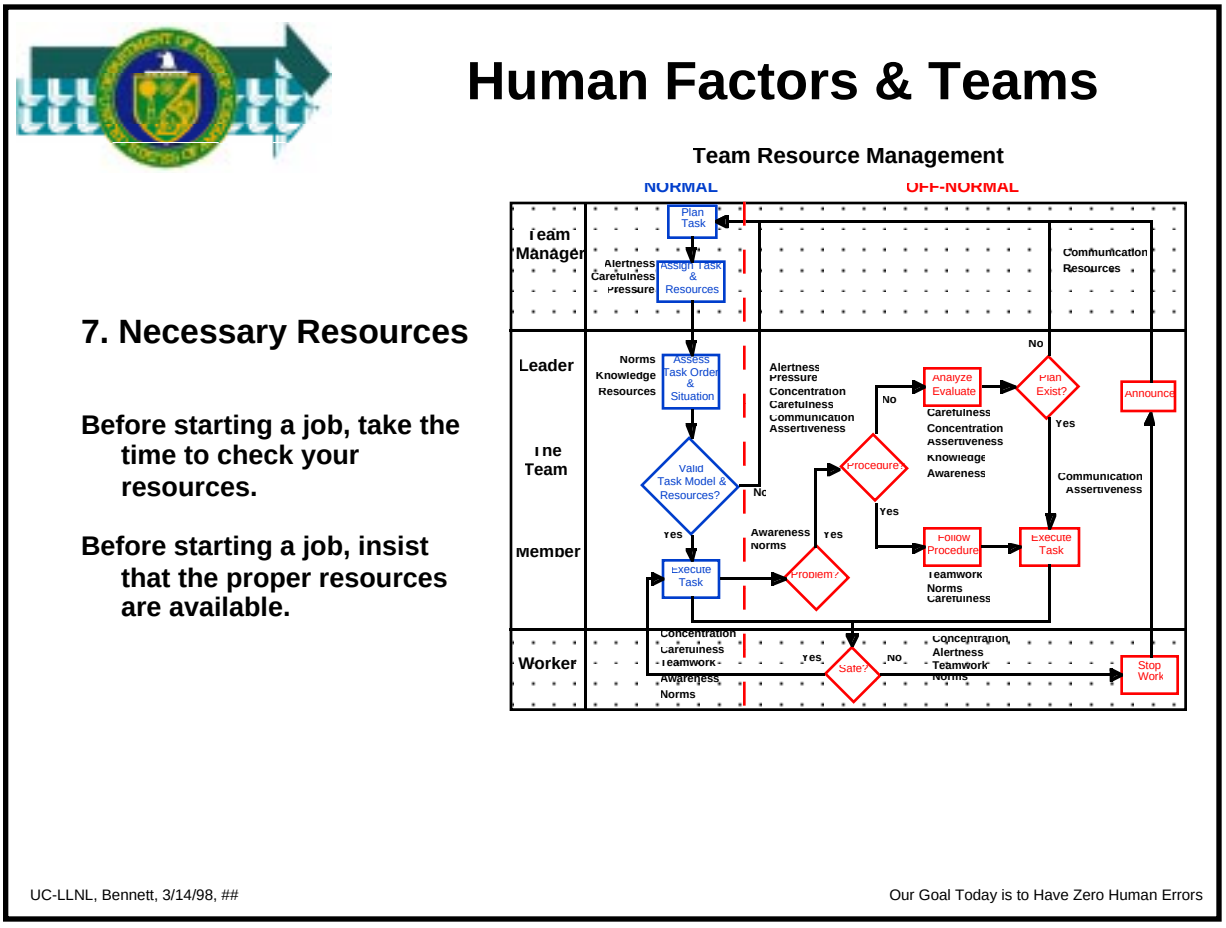
3.7. Necessary Resources (DD's #7 Lack of Resources)

#7 Necessary Resources

Teamwork is crucial when it comes to resources. This is the time to think about your team as more than the people you work with on a day-to-day basis.

For example, you use parts. Part of the grundge of being a professional technician is checking to make sure you have what you need to do the job. Resource people need to make sure all the parts are there. Bur first, they need to know what parts you need and when you will need them.

- Gather all your tools and parts before work starts.
- Keep situationally aware of your tool and part inventory levels. Order ahead of time.
- If you don't have a part, don't improvise the job with a "kludged" tool or part.
- Order tools and parts by technical specification and not by part numbers.



The lack of, or improper use of, resources (tools, equipment, information, etc.) has been the cause of many accidents. Technicians can be notorious for making do with less than adequate resources to get the job done.

In fact, some technicians view themselves as “a person who learns to do more and more with less and less until he/she is fully qualified to do everything with absolutely nothing.” (These comments are from Transport Canada’s and United Airlines workshop when discussing lack of resources.

In the past, we called these kinds of technicians heroes. Now we call them **unprofessional**.

Scenario: The failed array.

People: Senior engineer and several qualified technicians.

Job: Assembling the array.

What Happened: During assembly, it was noticed that some of the available parts of the array were the wrong length. A judgment was made that the array would make it.

Problem: Due to schedule demands and availability of material, all array components were not available.

Safety net: During program scheduling, risk assessments need to be made, which balance procurement and assembly times against run dates.

Dirty Dozen’s Safety Nets:

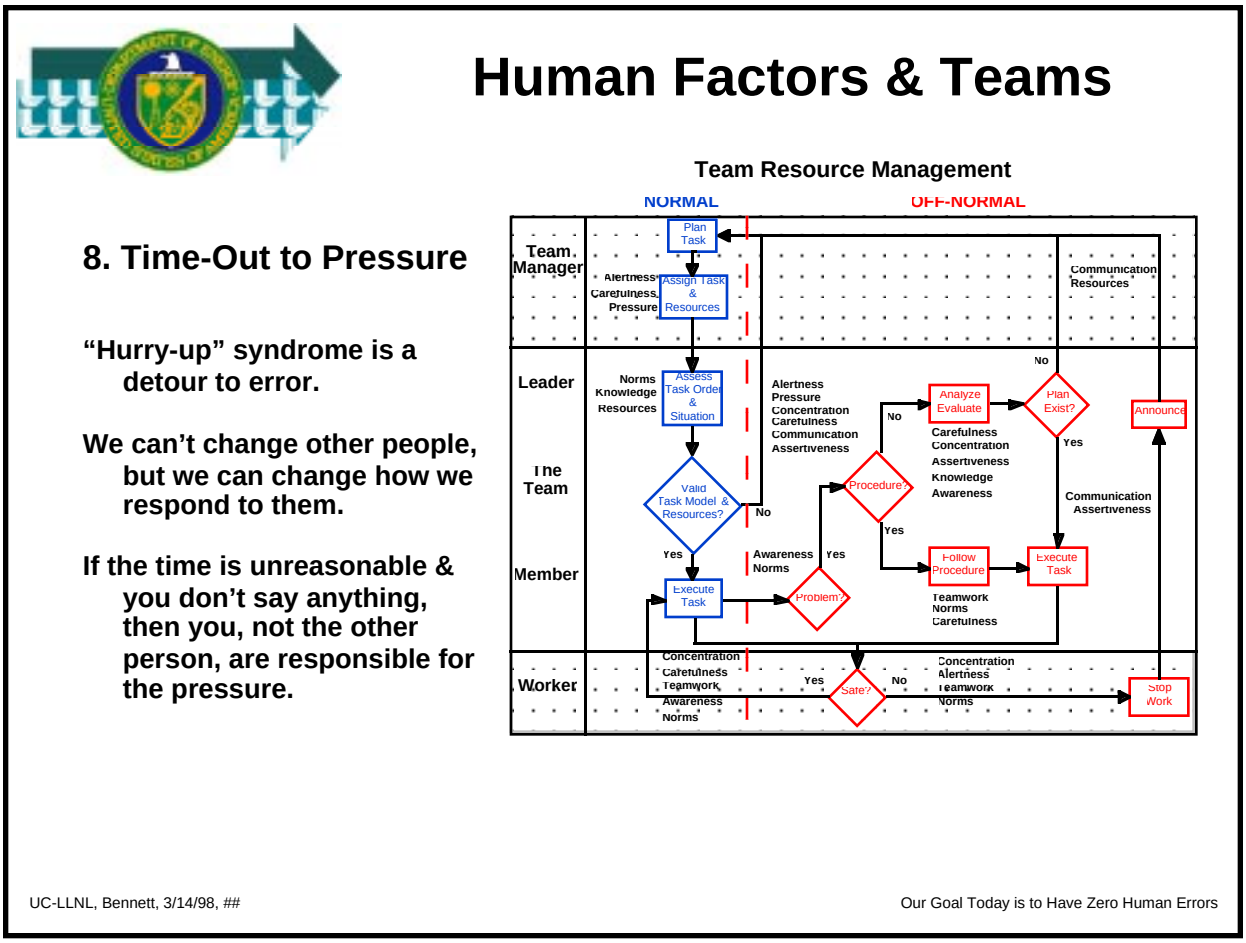
- Check suspect areas at the beginning of the inspection to determine what is needed.
- Order and stock anticipated parts before they are required.
- Know all available parts sources and arrange for pooling or loaning.
- Maintain a standard and if in doubt stop work.

3.8. "Time-Out" to Pressure (DD's #8 Pressure)

#8 Time-Out to Pressure

In our work, the program schedule will come back to bite us if not planned well in the beginning. Too often, schedules only incorporate program requirements. A program manager sometimes forgets low-level waste clean up, time for machine set ups and test runs, training, tours, honest mistakes.

- Get buy-off from management to incorporate these into the schedule before agreeing to a task.
- Supervisors need to budget overhead tasks.



United Airlines cautions their mechanics in the following way about pressure. In most cases, the pressure we feel with a job comes from within ourselves. The boss may say, "I need this job completed by shift end." **However, if the time**

frame is unreasonable, and you don't say anything, then you, not the boss, are responsible for the pressure.

When confronted with pressure,

- **Stop** and assess the situation.
- **Look** at the situation rationally.

  —What is the reality of the situation? Can I safely complete the work on time?

  —Have I communicated my concern in a concise and rational way?

  —What is the worst thing that could happen to me?

- **Listen** to your rational mind.

  —Has this happened before and what can I do better?

  —What is the best rational plan?

- **Act**—Speak up and ask for help or extra time as required.

Scenario: Wrenched Back.

People: Qualified, experienced laser electro-optics technician.

Job: Fill nitrogen dewar and move it to a transporter.

What Happened: To avoid wasting time, the technician did not wait for help and severely wrenched his back. Filed workman's compensation suit.

Problem: There was a tight schedule and the technician was impatient.

Safety net: We all get to the end of the day at the same time. There are tight schedules. But, that schedule is blown if you are hurt.

Dirty Dozen's Safety Nets:

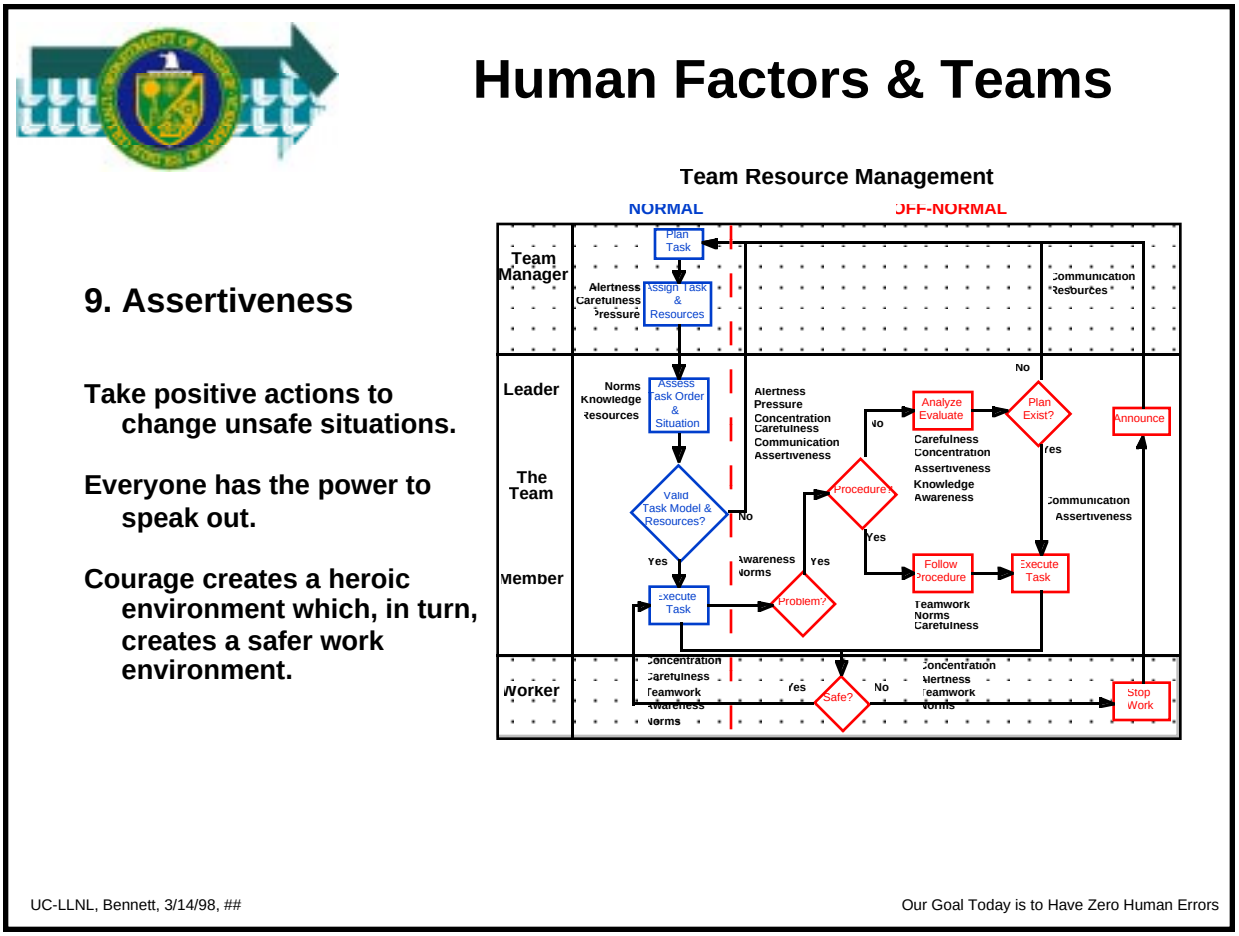
- Be sure the pressure isn't self-induced.
- Communicate your concerns.
- Ask for extra help.
- Just say no.

3.9. Assertiveness (DD's #9 Lack of Assertiveness)

#9 Assertiveness

If we encounter a programmatic problem with an engineering lead, or a safety problem with our co-workers, we must walk a tightrope when we try to communicate the problem.

Will they think we are too uppity or bossy? Will they think we are acting like know-it-alls? Is it my job at all?



When there is a technical problem, don't just say there's a problem. Be specific, giving actual values and what the nominal values should be.

If it is a safety critical system, you must know how to short circuit the normal communication system to let people know about the problem. Management has to provide those pathways and show by example that they are there.

Scenario: Crossing high-voltage danger signs.

People: One involved a trained area worker, another involved an electronics technician (E-tech).

Job: In the first case someone saw a worker who had crossed the roped-off area. In the second, the E-tech leaned across the rope to check to see if anyone was in the area.

What Happened: No one was hurt. A senior E-tech saw the incidents and brought a sign to a shift change meeting. He brought the danger sign (concrete example) and asked if everyone knew what it meant. (Laughter.) Then he explained exactly how if you cross into the roped-off area, you can get hurt even if you don't touch anything because you could be a point for the source to drain. This is TRM at its finest.

Problem: The people who reported it should have stepped up and said something immediately. They had a hurry-up-and-get-it-done attitude.

Safety net: It takes courage to use shift change to disseminate safety information. Humor helps diffuse the situation. (People could have thought the E-tech giving a safety tip at the meeting was a know-it-all. They didn't.)

Dirty Dozen's Safety Nets:

- If it is not critical, record it in the journey log book and only sign for what is serviceable.
- Refuse to compromise your standards.

3.10. Effective Stress Management (DD's #10 Stress)

#10 Effective Stress Management

Stress can have positive or negative influences. What are some examples of positive or negative stress?

- Positive stress:
  - Improved attention as a anew job begins.
  - Concern as a risky job begins.
  - Sense of well being that improves confidence in doing a job.
- Negative stress:
  - Family problems that cause distractions.
  - Concern about job appraisal that affects mood.
  - Uncertainly about job security that results in decreased job performance.

There are two basic types of negative stress, chronic and acute. What are some examples of each?

- Chronic"
  - Long-term family problems.
  - Boss and coworker negative interactions that last for months.
  - Poor self-image that results in a continual depression.
- Acute:
  - Somebody who cuts you off on the highway on the way to work.
  - A schedule change that conflicts with a vacation.
  - An error that is easily correctable.

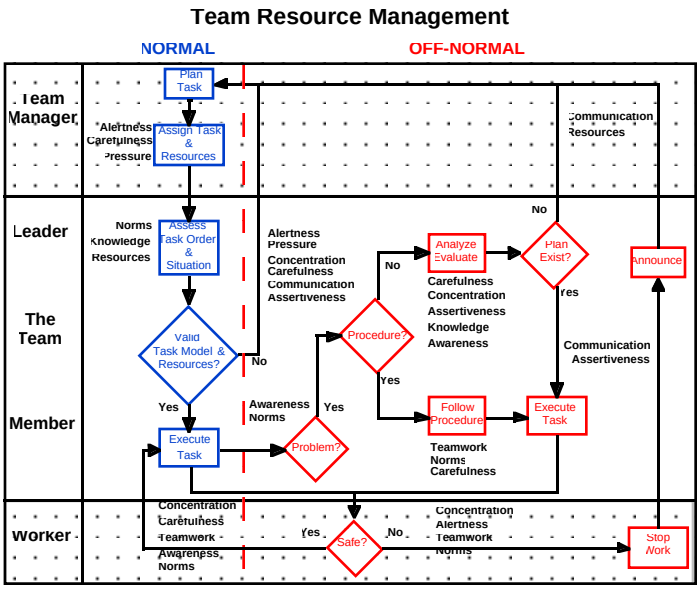
Chronic stress will take the most significant debilitating toll. Chronic stress is usually the type that you need help to manage because it is often due to factors that you cannot control. Or, importantly, you **perceive** that you cannot control the factors.

Human Factors & Teams

10. Effective Stress Management

Stress is not the problem. It's how we respond to it that makes it a negative or positive force in our lives.

We manage stress through problem solving, communication, and flexibility.



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Our Goal Today is to Have Zero Human Errors

Acute stress is more manageable. You can take short breaks at work. You can have fellow workers monitor your work products. You can exercise.

Here are some suggestions about managing stress that Transport Canada and United Airlines gives to their mechanics. There are three basic ways to cope with stress:

- Eliminate the stressor or change our response to it.
- Use the coping skills / resources available to us.
- Develop new coping skills / resources.

The major skills/resources needed for coping with stress are:

- Problem Solving.
- Communication.
- Flexibility.

Problem Solving focuses on our ability to deal directly with difficult situations we face and to make positive changes to resolve them. It builds on our creative skills and can be a useful resource to successfully cope with stress. Following are some suggestions for building problem-solving skills:

- **Solve it now.** Do not assume the problem will go away with time. It is easier to deal with problems before they become serious.
- **Define the problem.** Is what you perceive as the problem really the problem? What is the source of the problem?
- **Separate people from the problem.** What is the behavior that is causing the problem? Attack the problem, not the people.
- **Separate emotions from the problem.** Recognize and separate the emotions surrounding the problem from the actual issue at hand. This helps us make clearer decisions.
- **Determine your desired outcome.** What is your goal in solving the problem? If other people are involved, you must focus on shared interests and outcomes.
- **List a variety of creative and practical solutions.** Do not evaluate your ideas until the list is completed.
- **Do not get trapped into thinking there is only one resolution.** Try some new ways.

Scenario: Pod-Drop Incident.

People: Several supervisors, trained technicians, and a forklift trainee.

Job: Transfer the lower pod from B490 to B491.

What Happened: A trainee had requested that she use the transfer as a training experience. A "C" clamp was used instead of the usual system to hook the transfer cart to the forklift. The pod tipped off the cart. No one was hurt, nor was there any significant damage to the pod.

Problem: The driver had not traveled the route before. Supervisors gave verbal permissions without physically being present. People wanted to continue to meet schedule demands.

Safety net: Supervisors should have been present. Workers could have pressed the supervisors to be present. Drivers could have pre-walked the route with an experienced technician.

Dirty Dozen's Safety Nets:

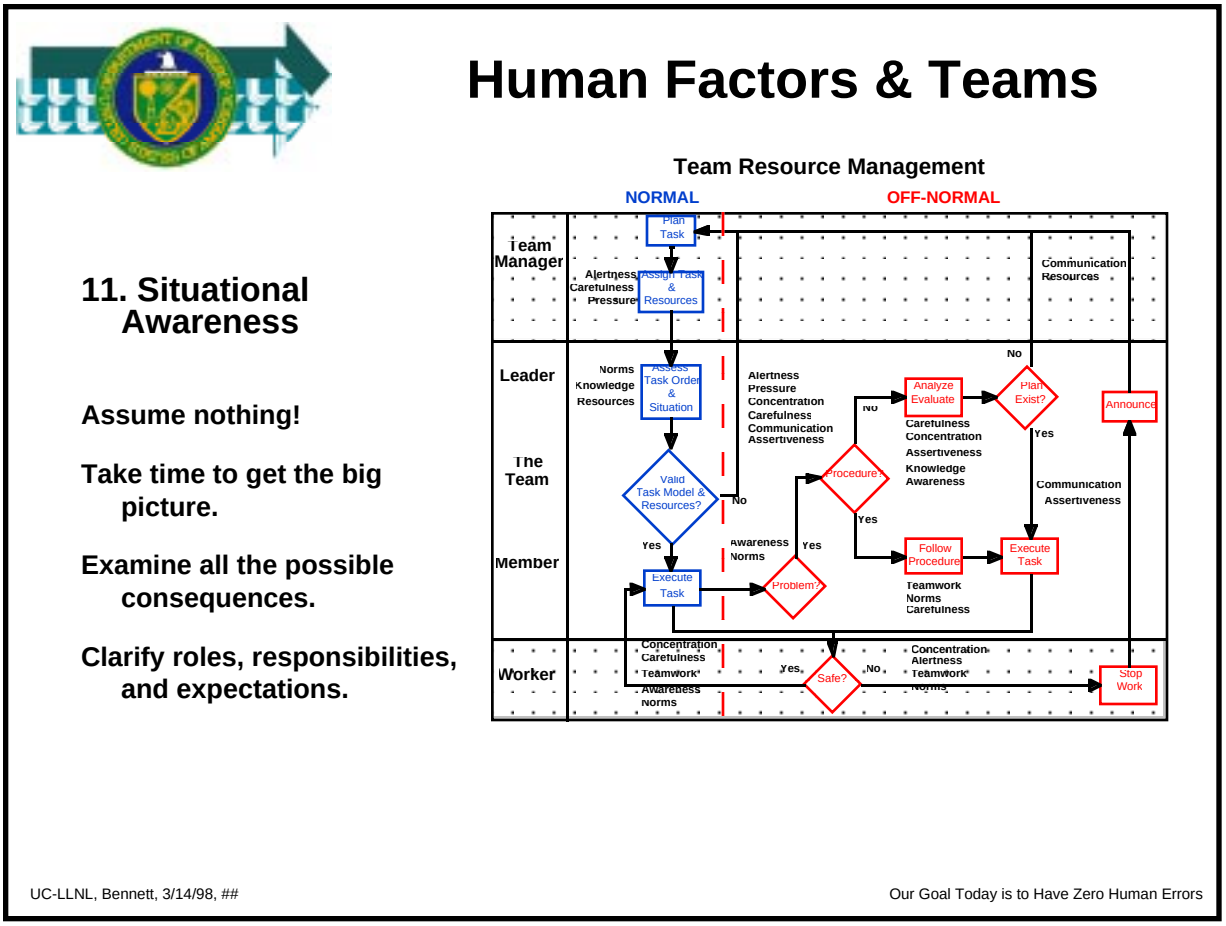
- Be aware of how stress can affect your work.
- Stop and look rationally at the problem.
- Determine a rational course of action and follow it.
- Take time off or at least have a short break.
- Discuss it with someone.
- Ask fellow workers to monitor your work.
- Exercise your body.

3.11. Situational Awareness (DD's #11 Lack of Awareness)

#11 Situational Awareness

We work in a complex setting from a technical and regulatory perspective. We have engineers writing project instructions. We have facilities people writing Facility Safety Plans. We have compliance folks writing Occupational Safety Plans. Each use their own language, some of which maybe conflicting. These communication problems make it difficult to understand how our actions will affect the whole system.

The more complex the system, the more difficult it is to know all the inter-reactions. We can't assume we know!



We must know the context of our task. For example, you have to do maintenance on a pump. But first, should you check on the affects on the system of turning it off? The more complex the system and higher the consequence, the more important it is to check.

Scenario: Loss of communication and a pump.

People: Experienced controls technician.

Job: Routine preventive maintenance on fiber optic cables used to control various systems.

What Happened: Due to operational considerations during routine maintenance, there was a break, and a technician decided to reseat cable terminators to ensure that they were making good contact. When one of the cables was pulled out, it shut down a pump that spewed oil into the vessel. No one was hurt, but it was a considerable mess to clean up.

Problem: The system was extremely complex. The technician thought he knew the current state of the whole system. The job had not been completely discussed with all personnel.

Safety net: The technician should have checked with a lead operator and told him/her what he was going to do. Never assume.

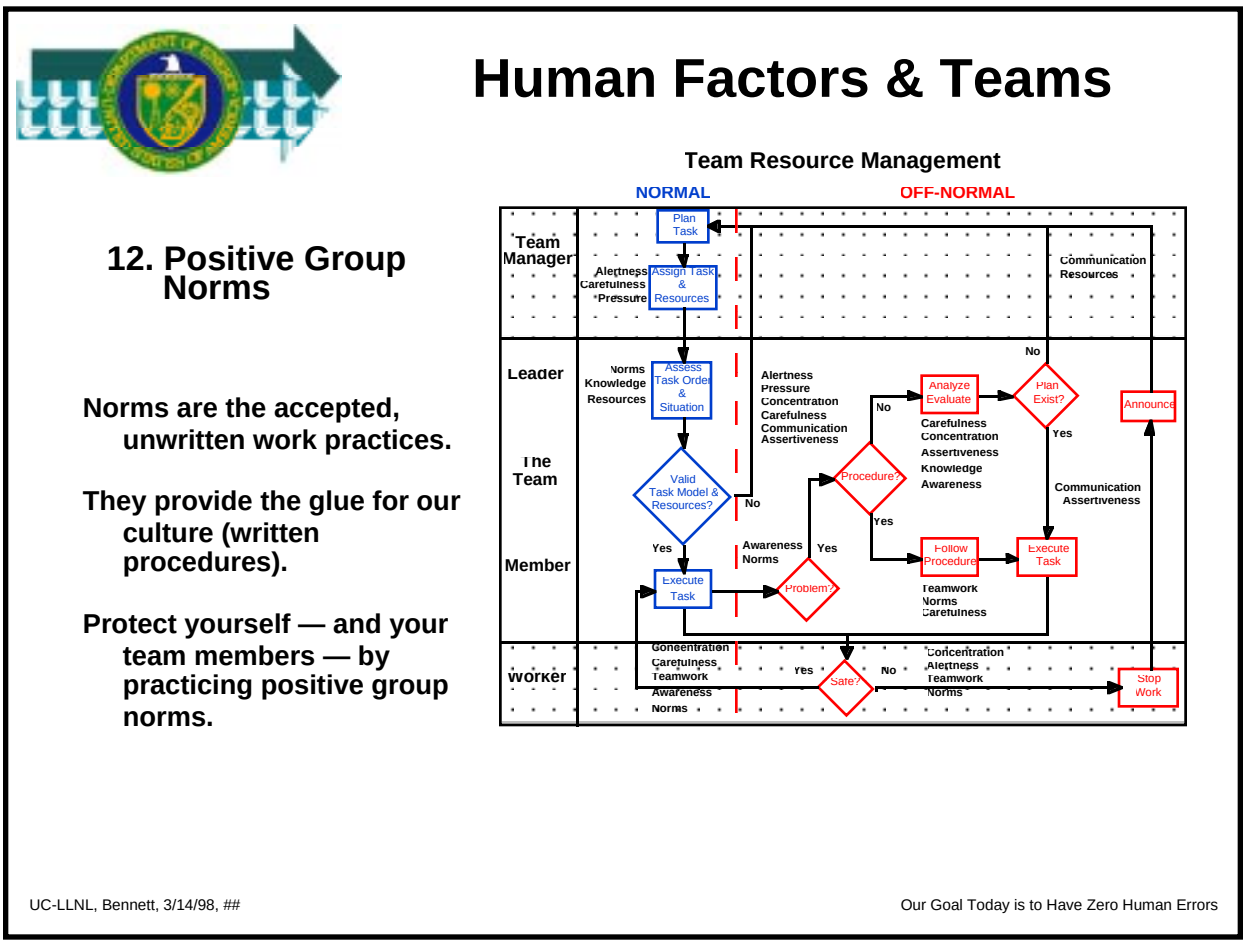
Dirty Dozen's Safety Nets:

- Think of what may occur in the event of an accident.
- Check to see if your work will conflict with an existing modification or repair.
- Ask others if they can see any problem with the work done.

3.12. Positive Group Norms (DD's #12 Norms)

#12 Positive Group Norms

Norms can be easier and quicker than written procedures. Norms allow for flexibility and improvisation. Norms allow for technique.



But, norms allow for confusion if not communicated properly. Procedures always allow for some interpretation—always allow for some unwritten techniques.

What are some of the ways norms can help?

- Norms can streamline activities.
- Norms allow for individual technique.
- Norms are easy to improve.

What are some of the ways norms can hurt?

- Someone can improve a norm, but not tell the next shift the new system state.
- Norms sometimes allow people to work outside the safety envelope.
- Different people do things differently, resulting in a work product that is not consistent.

What are some of the ways procedures can help?

- They help formalize the way we work.
- They maintain consistent corporate knowledge.
- They establish a way to audit our work.

What are some of the ways procedures can hurt?

- They cannot cover all situations.
- If not written clearly, they can cause errors.
- They can be technically incorrect.

Scenario: Laser alignment and near laser exposure.

People: Several senior laser technicians.

Job: Routine alignment and preventive maintenance.

What Happened: During a period of shift overlap, a technician received permission from a laser lead technician to enter the East wall. The lead technician from the other shift was not aware of this and had control of the system. The technician entered the East wall and mistakenly shut the door behind himself, "making" the interlocks. The lead technician controlling the system, unaware that anyone was in the East wall, opened the end-of-chain shutters just as the technician was standing up, barely missing a retinal exposure.

Problem: Informal procedures during shift turnover.

Safety net: Have a standard shift change meeting with everyone and go over the day's operations, including a discussion of where people are going to be.

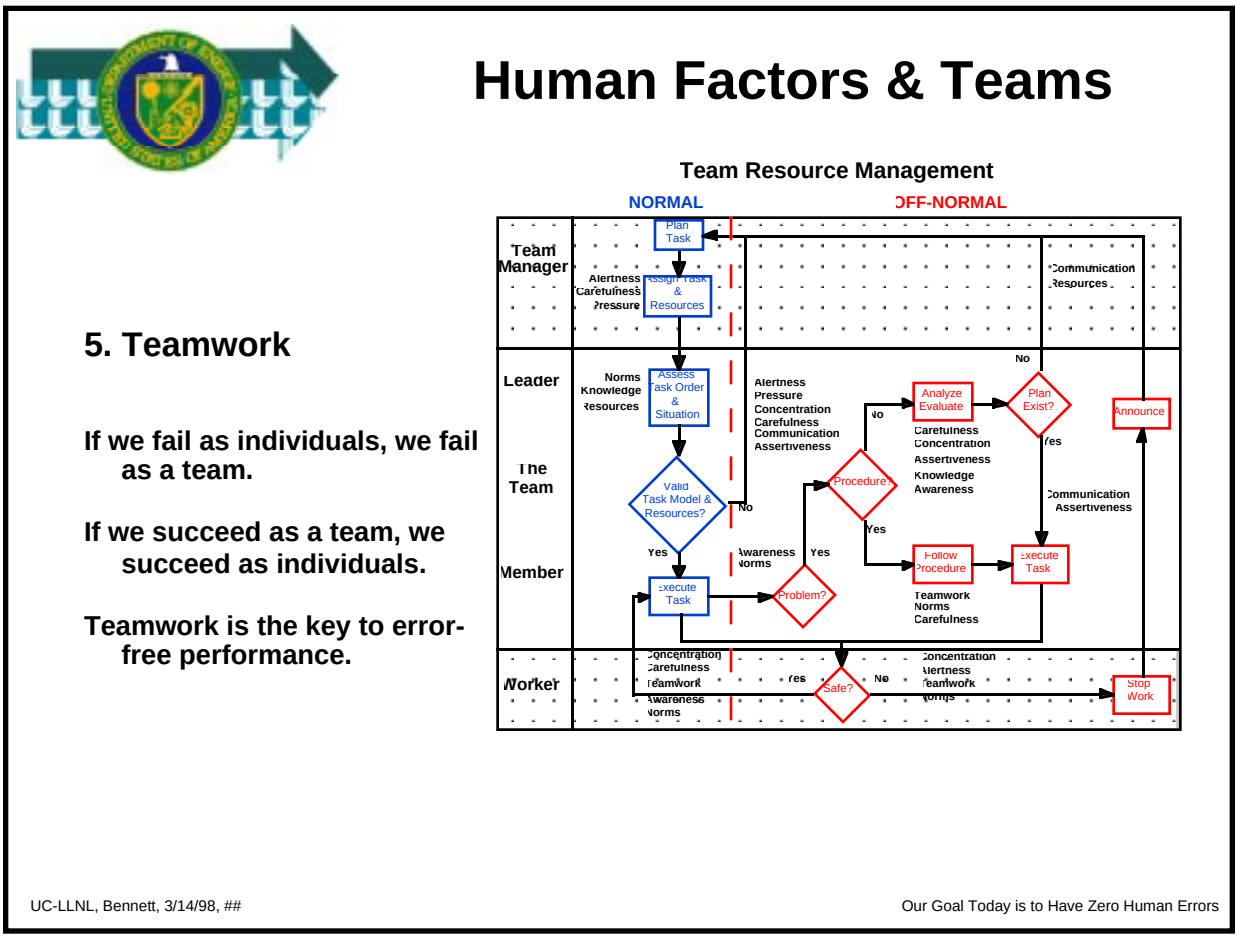
Dirty Dozen's Safety Nets:

- Always work as per the instructions or have the instructions changed.
- Be aware that "norms" don't make it right.

3.13. Teamwork (DD's #5 Lack of Teamwork)

#5 Teamwork

Technical people are often trained as individuals, and we pride ourselves in our individual skills. In our academic or technical training, very rarely do we think as a team, with team goals, values, and attitudes.



We must understand the task **and** what is going on around us. We must understand our roles **and** responsibilities as team members, not just as technical people.

Research shows that teams bring reliability and safety robustness **only** if the members know their roles and know how to communicate problems concerning task performance and safety.

Can we assume that people will naturally work as teams? Why not?

- Data shows that some groups develop bad teamwork habits.
- When teams focus on a problem, they tend to forget to monitor their normal work.
- Some people have learned to work with a group of people, but have never learned what a team really is.

Just as managers need to take leadership courses, technicians need to take courses on teamwork!

Scenario: Sweeping on the night shift.

People: Several experienced technicians and supervisors.

Job: Conducting routine tasks during a swing shift.

What Happened: During the next day shift, it was realized that the required assembly tasks had not been completed. But, the facility was clean. Technicians said that no task instructions had been left.

Problem: Clear, detailed, unambiguous task instructions were not prepared and conspicuously posted. Technicians did not check with supervisor about such a list.

Safety net: The supervisor needs to clearly define roles and responsibilities. Team members have a mandate to challenge leaders about incomplete and ambiguous task lists.

Dirty Dozen's Safety Nets:

- Discuss what, who, and how a job is to be done.
- Be sure that everyone understands and agrees.

3.14. Operational Risk Management (ORM)

Risk on the Job

We have been trained well to work as individuals. There are techniques for working as a team. We need to take responsibility for achieving our team goals.

Not only is our organization less than perfect, it never will be perfect.

One of our responsibilities is to achieve our goals despite those imperfections. That is what the Safety Nets are all about. That is what Operational Risk Management is all about.

Human Factors & Teams

Operational Risk Management

From *Power,* April, 1993.

**Sometimes the source of errors is not obvious....
But, usually it's an inadequate analysis that causes errors.**

UC-LLNL, Bennett, 1/30/98, ##

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Risk Analysis

Some of our systems are extremely complex; and, sometimes we get blind-sided by things that we could not have anticipated. Research has shown that in some industries the majority of accidents could have been easily avoided with proper planning. That is, people started an operation without thorough preparation or without assessing current conditions and how those conditions could affect the operation.

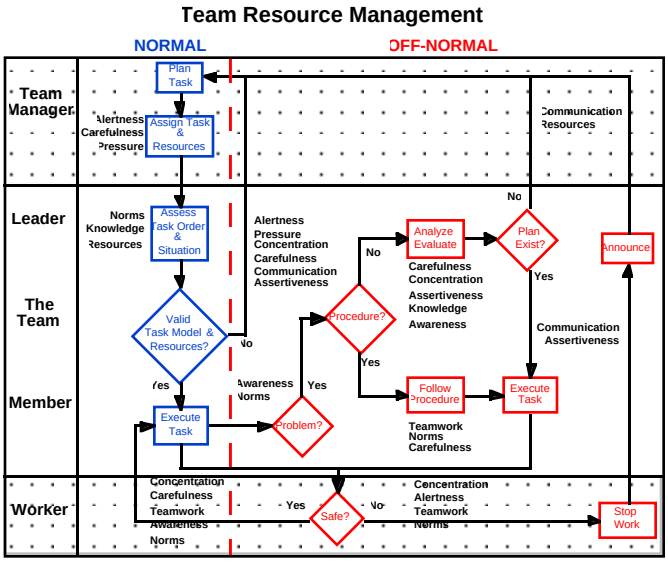
Decades ago, army ground operations had solved the problem of conducting rapid, thorough, "good enough" risk analysis and management. It's called Operational Risk Management (ORM) and has now been adopted throughout the aviation community.

Human Factors & Teams

Operational Risk Management

The Five Step Process

1. **IDENTIFY HAZARDS — Potential error producing conditions.**
2. **ASSESS HAZARDS — In terms of probability and severity of consequences.**
3. **MAKE RISK DECISIONS — Do a tradeoff analysis.**
4. **IMPLEMENT CONTROLS — Decide how to manage the risk you accepted.**
5. **SUPERVISE — Continually monitor the process.**



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AVLIS Implementation

ORM is conducted as a part of the TRM process.

Our current shift change is actually doing most of this right now. We do a high-level brief of the operation and current conditions. During shift meetings, we could easily, quickly step through ORM's five-step process. Most of the time it would be rather straightforward. But, for completeness, it would force us to at least consider the situation:

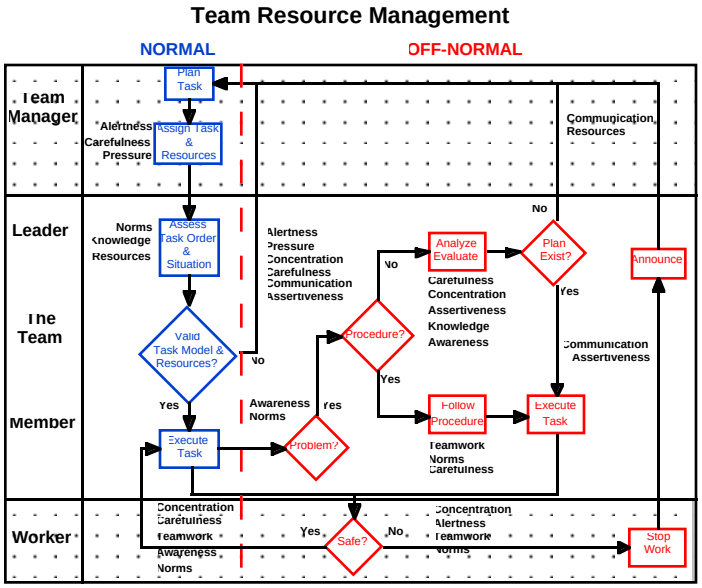
- What could bite us? How badly?
- Are there other ways to do it?
- What are we going to do to mitigate the risk?
- How are we going to monitor it?"

Human Factors & Teams

Operational Risk Management

The Four Rules of ORM

1. Accept risk when benefits outweigh costs.
2. Accept no unnecessary risk.
3. Anticipate and manage risk by planning.
4. Make risk decisions at the proper level.



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Our Goal Today is to Have Zero Human Errors

The Four Rules

First Rule. Recognize that some degree of risk is associated with all operations and minimize and manage risk so that a task can be accomplished with minimal acceptable loss.

Second Rule. Take only the risks that are necessary to accomplish a task.

Third Rule. Address risks in the initial planning stage of a task when they are more easily managed. This is a rule of efficiency and economy.

Fourth Rule. Make decisions at the lowest level where the decision maker has the necessary information, experience, and authority to make a good decision. The level of approval should be commensurate with the level of risk accepted.

Scenario: Routine maintenance.

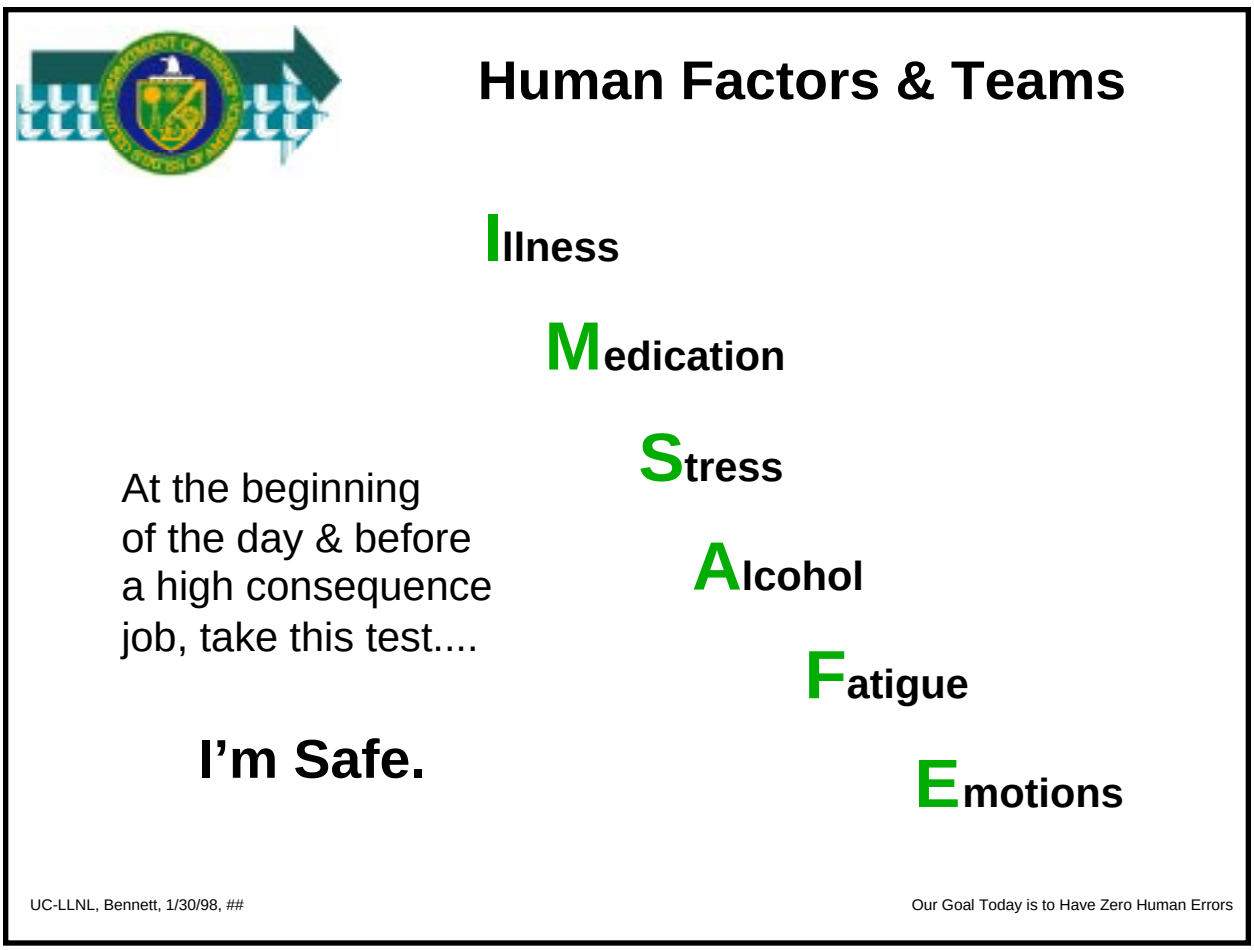
People: Supervisor and technician.

Job: Lock and Tag pump prior to routine maintenance involving an oil change.

What Happened: Lead operator was not present to authorize Lock and Tag. The technician went to the supervisor to get approval for the tagging. The supervisor was not completely sure of total system status and requested a walk through and analysis of the task. The technician was initially miffed that his supervisor challenged his knowledge of the task.

ORM Application: Each task or change in task needs to be assessed. It can take a few seconds or it may take days depending on complexity and the consequences.

Problem: The pump needed maintenance. But, because of the complexity of our systems, the risks were not completely obvious. Failure modes were assessed at the lowest possible level. The complexity of the Operational Risk Assessment matched the hazards and the consequences. Because it provides a systematic approach, Operational Risk Management is a “just-good-enough” assessment of the task.



I'm Safe

Here is one example of how ORM is used in aviation. We may want to adopt it here.

This is one of the first mnemonics that flight instructors teach their students. It's a simple ORM assessment that each of you can do, too.

Illness....Am I healthy? If not, will the illness impact the reliability and safety of my work?

Medication....Am I taking any? Even over the counter drugs will affect my performance.

Stress....Did anything happen at home...on the way to work...that will affect my performance.

Alcohol....When's the last time I had a drink. (Aviation uses a twelve hour "bottle-to-throttle" rule of thumb.)

Fatigue....Have I gotten eight hours of sleep? If not, how much will my performance be affected?

Emotion....Are there any that will impact the reliability and safety of my work?

If any of these questions raise “flags,” go to your supervisor or team members. Supervisors should encourage technicians to routinely assess their status.

3.15. Risk and Teamwork Exercise

Human Factors & Teams

- **Survival at a mountain lake**
- **The attached summary identifies the problem**
- **You will work individually, then as a team**
- **After the excercise, we'll look at how the different teams solved the problem.**

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TEAMWORK

As our systems become more sophisticated, the maintenance procedures required to maintain them become more complex. Because of this, the relationships between the people involved in maintaining our systems becomes more critical and important.

SURVIVAL ACTIVITY: LOST SOUTHWEST OF GOOSE LAKE

Synopsis

Your group has decided to spend two weeks fishing at a friend's isolated cabin near GOOSE Lake, deep in the Sierra Nevadas. Your company has loaned your group the use of the boss's float equipped DHC2 Beaver as a reward for your hard work in keeping the company's systems up and running through the summer. One member of your group, in addition to being an Aviation Maintenance Technician, is also a seasoned Beaver pilot. Because of the isolation of the cabin, you leave a two-week flight plan with your company.

Pertinent Information

The flight though the mountains begins on a beautiful November day and everything goes without an incident until, north of Alturas, the engine begins to run rough and lose power. The pilot decides to turn back but finds he is unable to maintain altitude due to limited power. He radios your approximate position, but does not receive a reply. Suddenly the engine loses all power and the pilot is forced to land near a rocky shoreline of a small lake. The heavy swells are smashing the aircraft against the rocks. Everyone jumps safely to shore with what they can grab before the aircraft breaks up and sinks in the deep water. It is a beautified late fall afternoon on the coast except the wind is howling and you can see storm clouds on the horizon.

Everyone is dressed in heavy wool clothing, work boots, company caps and comfortable wool jackets.

You decide that you will all stick together no matter what the circumstances and that all decisions will be made by consensus. You have crashed on the shore of a small lake southwest of Goose Lake. The pilot believes there is a closed camp a few miles to the Northeast and the settlement about 20 miles North.

The emergency locator transmitter is with the aircraft and it is doubtful that it activated before the aircraft sank. You do not know if the pilot's call was heard by anyone. There appears to be no readily available source of flesh water.

Weather Synopsis

The weather for this region varies considerably, with the temperature averaging a daily of 47°F and an average low of 38°F. The extremes can vary from 9 to 68°F.

The area averages 14 inches of rain or snow in November and you can expect an average of 24 days of measurable precipitation in the month. The region is often subjected to heavy rain or snow with accompanying winds. The wind is generally from the southeast at an average of 16 m.p.h. with a maximum of 66 m.p.h.

Analysis

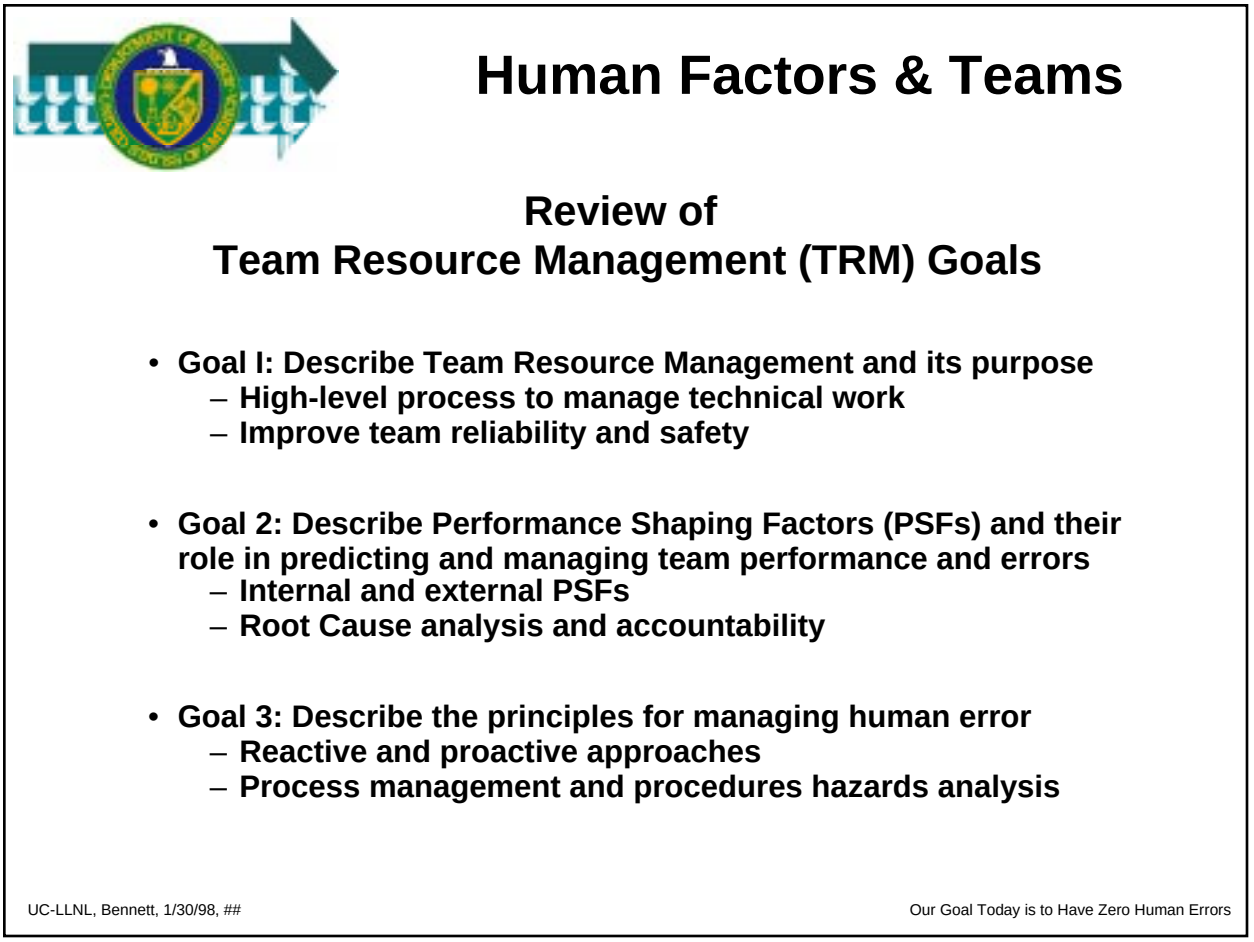
Listed in the Appendix are the articles salvaged from the aircraft before it sank. Your task is to individually, without assistance, list each item in order of importance in Column A with 1 being the most important and 15 the least important.

After everyone has listed them individually, you will work with your group to arrive at a group decision on each item and record your rankings in Column B.

Do not change Column A once you start Column B. Good Luck.

See Appendix A for score sheet, questionnaire, and larger black and white map. The circle on the map shows the approximate location of the crash. How to interpret the scores is presented in the appendix.

3.16. Workshop Summary



Goal 1: TRM is a process that helps teams manage the conduct of their technical procedure in an orderly systematic fashion.

Goal 2: Individual and team behavior can generally be predicted (specific internal and external factors increase the likelihood that we will act in a certain way). PSFs influence performance negatively or positively. PSFs can be used to predict performance. PSFs can be managed by team leaders, and, by you.

Goal 3: Just as human and team behavior can be generally predicted, so too can human error.

Human Factors & Teams

Review of Goals of the Team Resource Management Workshop

- **Goal 4: Describe TRM's 12 rules-of-thumb (the "Dirty Dozen") and use of safety nets**
  - **Assume trained people will commit errors and act as part of a team to eliminate errors**
  - **Individual (technical) training and team (process) management training go hand in hand**
- **Goal 5: Conduct Operational Risk Management (ORM)**
  - **Rapid, systematic assessment of situation and task**
  - **"Good-enough" management of risk**
- **Goal 6: Demonstrate ways to keep TRM working**
  - **Measure the processes that TRM is supposed to manage**
  - **Monthly process management meetings, principled shift change meetings, and ORM briefs**

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Our Goal Today is to Have Zero Human Errors

Goal 4: People can be well qualified individually, but fail as part of a team. Team performance is dependent on clearly defined roles and responsibilities and a shared model of the task. We know that task reliability is dependent on more than technically qualified people. Teams, by themselves, do not ensure reliability. Teams must be taught how to manage their processes.

Goal 5: ORM provides a systematic, rapid process for assessing the risk of a mission by evaluating (a) the task (What they are supposed to do?), (b) conditions (What are the environmental factors?), and (c) the standards (How will they know they've succeed?). ORM can be conducted as part of the shift change meetings or pre-job briefs. ORM is used to further clarify roles and responsibilities for a specific job, as well as ensuring the existence of a shared task model among all the team members.

Goal 6: TRM improves team reliability and safety. Set high-level, long-term (6 month) and "in-the-trench," short-term (daily and weekly) goals for your work products and safety. Measure them. "What have I produced for the company? How efficiently have I done it? How safely have I done it? Have I followed rules? Have I made my job better?" Process management gets at monitoring and improving the job. Shift change gets at the daily work. ORM gets at safety. In a sense then, activities like process management, shift change meetings, and ORM provide the framework for TRM.

We are a Team

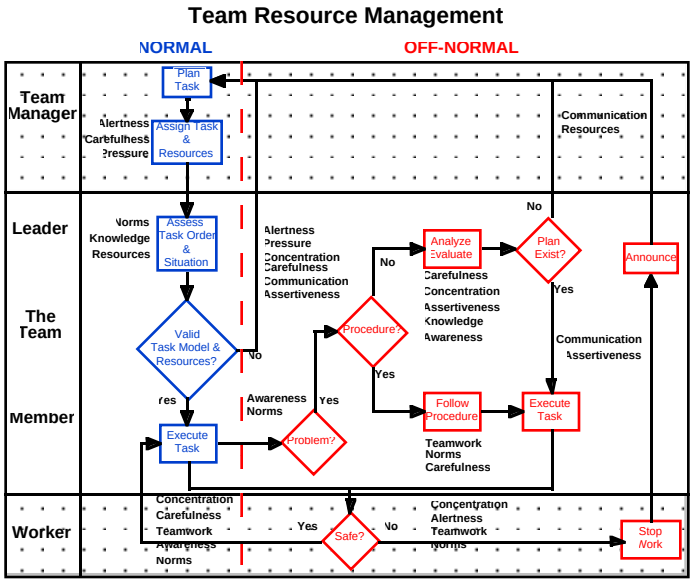
Human Factors & Teams

We Do Not Work Alone!

As a team....

We can achieve the goal of zero human errors today!

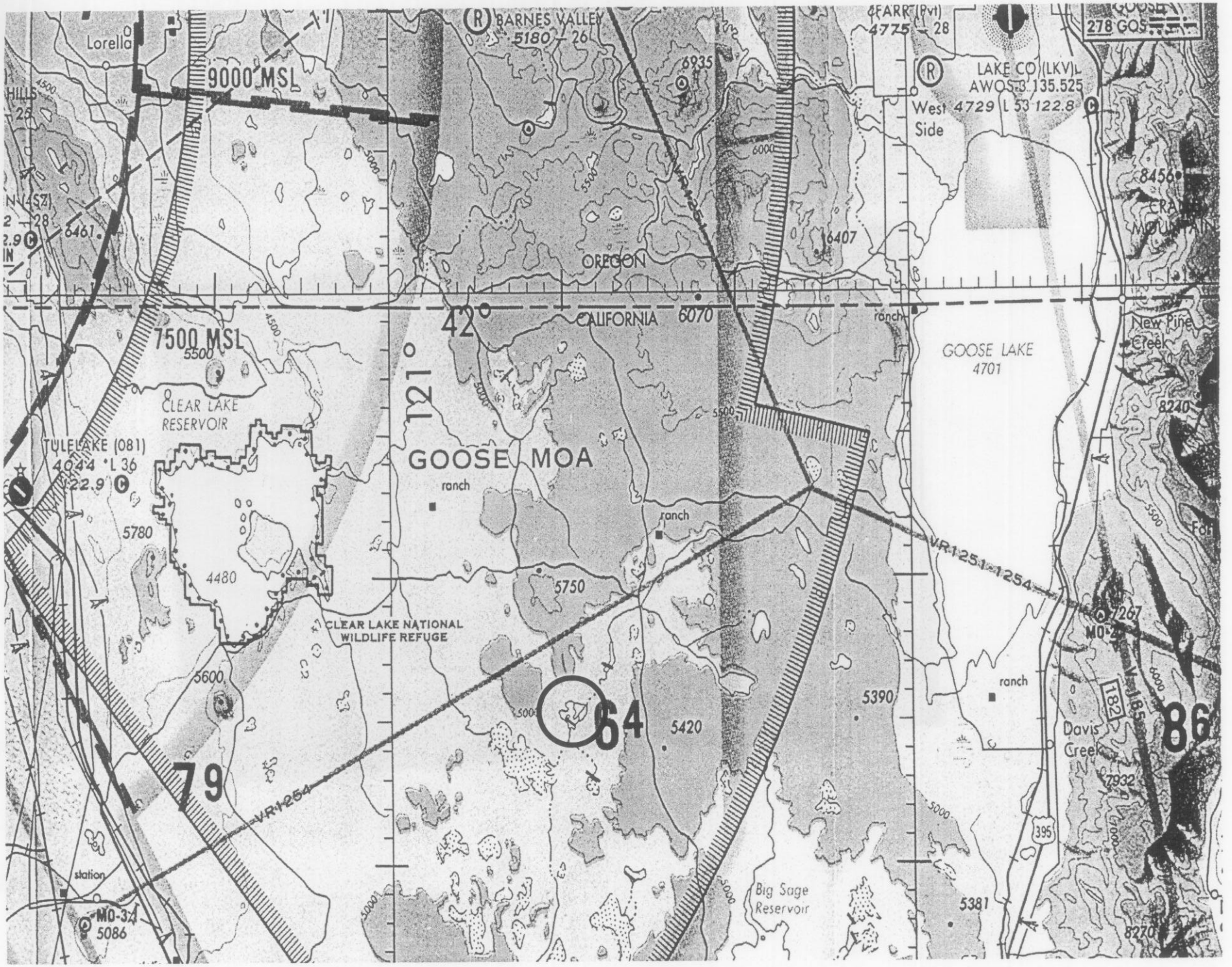
But, we must remember....
"If we fail as an individual, we fail as a team. If we succeed as a team, we succeed as individuals!"



Appendix A

SURVIVAL ACTIVITY SCORE SHEET

ITEMS SAVED	A Your Priority List	B Team Priority List	C 442 Sqn Priority List	D Diff A&C	E Diff B&C
An AM/FM portable radio					
50 feet of 1/4" nylon rope					
A shotgun with 4 bird-shot cartridges					
A case of evaporated milk					
A copy of November's *Sports Illustrated*					
A mechanic's tool roll with hammer, wrenches, 3/8" socket sec sidecutters, vicegrips and screwdrivers					
A box of matches					
A magnetic compass					
A damaged aircraft float with 7 compartments but one has a hole in it					
An area sectional air map					
A roll of 041" locking wire (50 ft.)					
A 15' x 15' lightweight orange tarpaulin					
An aircraft survival ax (2 lb.)					
A box of 10 large heavy-duty garbage bags					
A shaving kit with a 5" round mirror					
			Total		
				Your score	**Team score**


Lorella
9000 MSL
BARNES VALLEY
5180
26
6935
FARR (Pvt)
4775
28
278 GOS
LAKE CO (LKV)
AWOS-3 135.525
West Side
4729
L 53 122.8
8456
6461
6407
OREGON
CALIFORNIA
6070
42°
121°
7500 MSL
5500
CLEAR LAKE RESERVOIR
TULELAKE (081)
4044 L 36
122.9
GOOSE MOA
ranch
5780
4480
5750
CLEAR LAKE NATIONAL WILDLIFE REFUGE
5600
64
5420
5390
GOOSE LAKE
4701
New Pine Creek
8240
V.R.1251-1254
7267
MO-3
182
Davis Creek
7932
395
79
V.R.1254
station
MO-3
5086
Big Sage Reservoir
5381
8270
86

Scenario:	Venting Incident
People:	Two technicians and a supervisor. The supervisor was completely qualified on the systems. The two technicians were in the process of qualifying for the jobs.
Job:	Calibrate load cells on uranium canisters, with the system at vacuum. There is a procedure for canister changeout, but not the calibration. All three had done the task before.
What Happened:	After briefing the job, the lead gave the OK to proceed and went to the phone to start a new job. One tech went to lay out the calibration task. The other sent to pull the canister, at which time the vessel vented, creating a large cleanup task. No one was hurt. The techs had assumed that the valves sealing off the vessel were closed. The lead thought they were going to close the valves.
Problem:	People were thinking about the individual tasks they were going to be doing. They briefed the task, but not the system status. Written procedures were not used in the area. Ambiguous communications broke down any shared model they had of the system and task.
Safety net:	Know the high-risk points in the operation. Don't assume someone has done something if you can't visually check it. Ask.

Dirty Dozen's Safety Nets:

- Use logbooks, worksheets, etc., to communicate and remove doubt.
- Discuss work to be done or what has been completed.
- Never assume anything.