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Department of Energy
Human Performance Handbook

HUMAN PERFORMANCE IMPROVEMENT CONCEPTS AND PRINCIPLES

November 2007

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CHAPTER 1 – INTRODUCTION TO HUMAN PERFORMANCE

INTRODUCTION

This *Human Performance Improvement Handbook* is a reference for anyone working in the Department of Energy (DOE) community who wants to learn more about human performance and how it can be improved. The handbook consists of five chapters entitled: "An Introduction to Human Performance," "Reducing Error," "Organizations at Work," "Managing Defenses," and "Culture and Leadership." The handbook addresses the roles of individuals, leaders, and the organization in improving performance. Five simple statements describe the principles of human performance outlined in this chapter. These principles are the foundation blocks for the behaviors described and promoted in the handbook. The strategic approach for improving performance is to reduce human error and manage defenses so as to eliminate events. This strategy is expressed in the formula $R_e + M_d = ØE$.

Human performance improvement is not a program, but rather a distinct way of thinking based on a performance *model* that illustrates the organizational context of human performance. The model contends that human performance is a system that comprises a network of elements that work together to produce repeatable outcomes. The system encompasses organizational factors, job-site conditions, individual behavior, and results. This system approach puts new perspective on human error: it is not a cause of failure, alone, but rather the effect or symptom of deeper trouble in the system. Neither is human error random! It is systematically connected to features of people's tools, the tasks they perform, and the operating environment in which they work. A separate manual, *Human Performance Tools for Individuals, Work Teams and Management* , is a companion document to this handbook. It describes methods and techniques for catching and reducing error, and locating and eliminating latent organizational weaknesses.

The Institute of Nuclear Power Operations (INPO) generously provided assistance in helping the department roll out its human performance (HP) courses, which were patterned on the INPO model. This handbook reflects heavily on the HP research and practical applications so expertly chronicled in INPO's *Human Performance Fundamentals Course Reference* (2002) and its later revision of the material in *Human Performance Reference Manual,* INPO 06-003 (2006). The Department is greatly appreciative of this outstanding assistance and support. It is just one more recent example of a long-standing collaborative relationship between these two industries that spans more than two decades.

DISTINCT WAY OF THINKING

In its simplest form, human performance is a series of behaviors carried out to accomplish specific task objectives (results). Behavior is what people do and say—it is *a means to an end*. Behaviors are observable acts that can be seen and heard. In the Department of Energy (DOE), the behaviors of operators, technicians, maintenance crafts, scientists and engineers, waste handlers, and a myriad of other professional positions are aggregated into accumulative acts designed to achieve several major mission objectives. The primary objective of our operating facilities is the continuous safe, reliable, and efficient production of mission-specific products. At our national

laboratories, the primary objectives are the ongoing discovery and testing of new materials, the invention of new products, and the technological advancement of these products for use in national defense or in the commercial sector. The storage, handling, reconfiguration, and final repository of the legacy nuclear waste materials are another objective. Decontamination, decommissioning, and dismantling of old facilities and support operations used to produce America's nuclear defense capabilities during the cold war is another significant mission objective. Improving human performance is a key to improving production facilities' performance, to improving the performance of our national laboratories, and to cleanup and restoration performance.

It is not easy to anticipate exactly how apparently trivial conditions can influence individual performance. Error-provoking aspects of facility design, procedures, processes, and human nature exist everywhere. No matter how efficiently equipment functions; how good the training, supervision, and procedures are; and how well the best worker, engineer, or manager performs his or her duties, *people cannot perform better than the organization supporting them.*[1] Human error is caused not only by normal human fallibility, but also by incompatible management and leadership practices and organizational weaknesses in work processes and values. Therefore, defense-in-depth with respect to the human element is needed to improve the resilience of programmatic systems and the facility to human error and events.

The aviation industry, medicine, the commercial nuclear power industry, the U.S. Navy, DOE and its contractors, and other high-risk, technologically complex industries have adopted human performance principles, concepts, and practices to consciously reduce human error and bolster defenses in order to reduce accidents and mishaps. However, performance improvement is not limited to safety. Organizations that have adopted human performance improvement (HPI) methods and practices also report improved product quality, efficiency, and productivity. HPI, as described in this handbook and practiced in the field, is not so much a program as it is a distinct way of thinking. This handbook seeks to improve understanding about human performance and to set forth recommendations for how to manage it and improve it to prevent events triggered by human error.

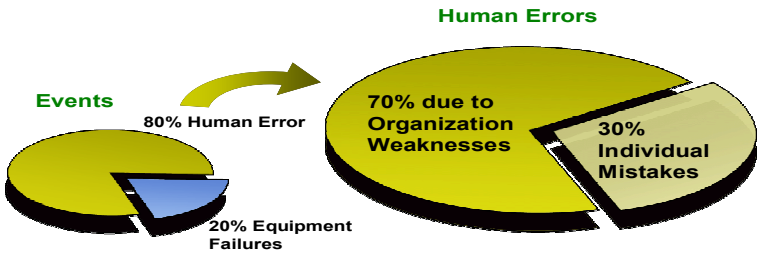
This handbook promotes a practical way of thinking about hazards and risks to human performance. It explores both the individual and leader behaviors needed to reduce error, as well as improvements needed in organizational processes and values and job-site conditions to better support worker performance. Fundamental knowledge of human and organizational behavior is emphasized so that managers, supervisors, and workers alike can better identify and eliminate error-provoking conditions that can trigger human errors leading to facility events. Ultimately, the attitudes and practices needed to control these situations include:

- the will to communicate problems and opportunities to improve;
- an uneasiness toward the ability to err;
- an intolerance for error traps that place people and the facility at risk;
- vigilant situation awareness;
- rigorous use of error-prevention techniques; and

- understanding the value of relationships.

Perspective on Human Performance and Events

The graphic below illustrates what we know about the role of human performance in causing events or occurrences. About 80 percent of all events are attributed to human error. In some industries, this number is closer to 90 percent. Roughly 20 percent of occurrences involve equipment failures. When the 80 percent human error is broken down further, it reveals that the majority of errors associated with events stem from latent organizational weaknesses (perpetrated by humans in the past that lie dormant in the system), whereas about 30 percent are caused by the individual worker touching the equipment and systems in the facility.[2] Clearly, focusing efforts on reducing human error will reduce the likelihood of occurrences and events.



An analysis of significant events in the commercial nuclear power industry between 1995 and 1999 indicated that three of every four events were attributed to human error, as reported by INPO. Additionally, a Nuclear Regulatory Commission review of events in which fuel was damaged while in the reactor showed that human error was a common factor in 21 of 26 (81 percent) events. The report disclosed that *"the risk is in the people—the way they are trained, their level of professionalism and performance, and the way they are managed."*[3] Human error leading to adverse consequences can be very costly; it jeopardizes an organization's ability to protect its workforce, its physical facility, the public, and the environment from calamity. Human error also affects the economic bottom line. Very few organizations can sustain the costs associated with a major accident (such as, product, material and facility damage, tool and equipment damage, legal costs, emergency supplies, clearing the site, production delays, overtime work, investigation time, supervisors' time diverted, cost of panels of inquiry). It should be remembered too that costs to operations are also incurred from errors by those performing security, work control, cost and schedule, procurement, quality assurance, and other essential but non-safety-related tasks. Human performance remains a significant factor for management attention, not only from a safety perspective, but also from a financial one.[4]

A traditional belief is that human performance is a worker-focused phenomenon. This belief promotes the notion that failures are introduced to the system only through the

inherent unreliability of people—*Once we can rid ourselves of a few bad performers, everything will be fine. There is nothing wrong with the system*. However, experience has shown that weaknesses in organizational processes and cultural values are involved in the majority of facility events. Accidents result from a combination of factors, many of which are beyond the control of the worker. Therefore, the organizational context of human performance is an important consideration. Event-free performance requires an integrated view of human performance from those who attempt to achieve it; that is, how well management, staff, supervision, and workers function as a team and the degree of alignment of processes and values in achieving the facility's economic and safety missions.

Human Performance for Engineers and Knowledge Workers

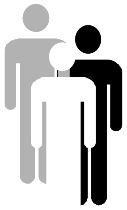
Engineers and other knowledge workers contribute differently than first-line workers to facility events. A recent study completed for the Nuclear Regulatory Commission by Idaho National Engineering and Environmental Laboratory (INEEL)[5] showed that human error continued to be a causal factor in 79 percent of industry licensing events. Within those events, there were four latent failures for every active failure. More significantly, design and design change problems were a factor in 81 percent of the events involving human error. Recognizing that engineers and other knowledge workers make different errors, INPO developed a set of tools specific to their needs.[6] Many of these tools have been incorporated into DOE's *Human Performance Tools* manual.

With engineers, specifically, the errors they make can become significant if not caught early. Because engineers as a group are highly educated, narrowly focused, and have personalities that tend to be introverted and task-oriented, they tend to be critical of others, but not self-critical. If they are not self-critical, their errors may go undetected for long periods of time, sometimes years. This means that it is unlikely that the engineer who made the mistake would ever know that one had been made, and the opportunity for learning is diminished. Thus, human performance techniques aimed at this group of workers need to be more focused on the errors they make while in the knowledge-based performance mode described in Chapter 2.

The Work Place

The work place or job site is any location where either the physical plant or the "paper" plant (the aggregate of all the documentation that helps control the configuration of the physical plant) can be changed. The systems, structures, and components used in the production processes make up the physical plant. Error can come from either the industrial plant or the paper plant. All human activity involves the risk of error. 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 oral or written directives and personal example. The activities of all these individuals need to be controlled.

Individuals, Leaders, and Organizations



This handbook describes how individuals, leaders, and the organization as a whole influence human performance. The role of the individual in human performance is showcased in Chapter 2, "Reducing Error." The role of the organization is central to the discussion in Chapter 3, "Managing Defenses." Chapter 4, "Culture and Leadership," is all about the leader's role and responsibilities for excellence in human performance.

- **Individual** — An employee in any position in the organization from yesterday's new hire in the storeroom to the senior vice president in the corner office.
- **Leader** — Any individual who takes personal responsibility for his or her performance *and* the facility's performance *and* attempts to positively influence the processes and values of the organization. Managers and supervisors are in positions of responsibility and as such are organizational leaders. Some individuals in these positions, however, may not exhibit leadership behaviors that support this definition of a leader. Workers, although not in organizational positions of responsibility, can be and are very influential leaders. The designation as a leader is earned from subordinates, peers, and superiors. Those who follow define the leader.
- **Organization** — A group of people with a shared mission, resources, and plans to direct people's behavior toward safe and reliable operation. Organization directs people's behavior in a predictable way, usually through processes and its value and belief systems. Workers, supervisors, support staff, managers, and executives all make up the organization.

HUMAN PERFORMANCE

What is human performance? Because most people cannot effectively manage what they do not understand, this question is a good place to start. Understanding the answer helps explain why improvement efforts focus not only on results, but also on behavior. Good results can be achieved with questionable behavior. In contrast, bad results can be produced despite compliant behavior, as in the case of following procedures written incorrectly. Very simply, human performance is behavior plus results (P = B + R).[7]

Behavior

Behavior is what people do and say—a means to an end. Behavior is an observable act that can be seen and heard. It can be measured. Consistent behavior is necessary for consistent results. For example, a youth baseball coach cannot just shout at a 10-year old pitcher from the dugout to "throw strikes." The child may not know how and will become frustrated. To be effective, the coach must teach specific techniques—behaviors—that will help the child throw strikes more consistently. This is followed up with effective coaching and positive reinforcement. Sometimes people will make errors despite their best efforts. Therefore, behavior and its causes are extremely valuable as the signal for improvement efforts to anticipate, prevent, catch, or recover from errors.

For long-term, sustained good results, one must look closely at what influences behavior, what motivates it, what provokes it, what shapes it, what inhibits it, and what directs it, especially when handling facility equipment.

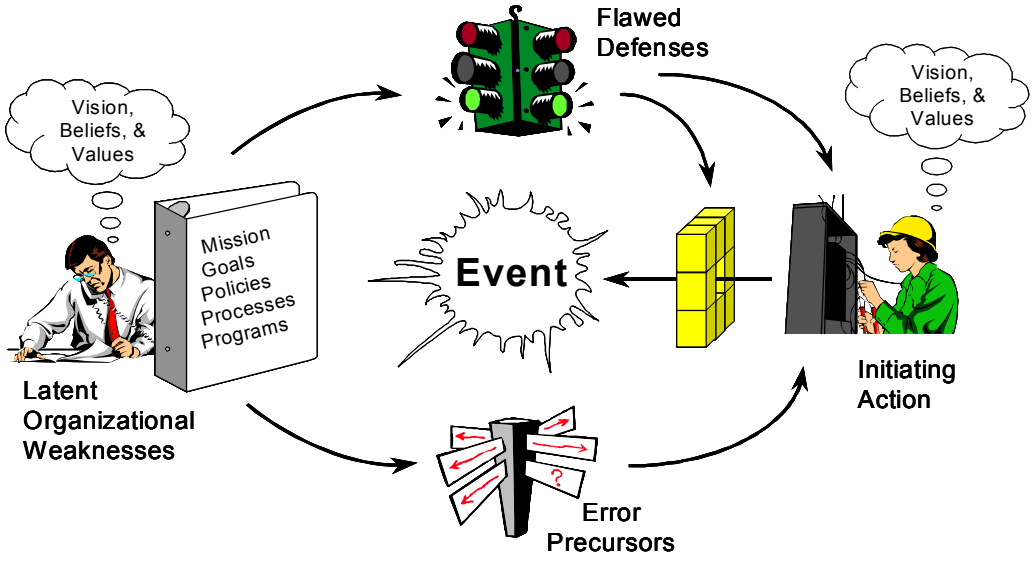
Results

Performance connotes measurable results. Results, good or bad, are the outcomes of behavior encompassing the mental processes and physical efforts to perform a task.[8] In our industry, the "end" is that set of outcomes manifested by people's health and well-being; the environment; the safe, reliable, and efficient production of defense products; the discovery of new materials; the invention and testing of new products; and the disposition of legacy wastes and facilities. Events usually involve such things as challenges to reactor safety (where applicable), industrial/radiological safety, environmental safety, quality, reliability, and productivity. Event-free performance is the desired result. Event-free performance depends on reducing error, both where people touch the facility and where they touch the paper (procedures, instructions, drawings, specifications, and the like). Event-free performance is also dependent on ensuring the integrity of defenses, controls, barriers, and safeguards against the residual errors that still occur.

ANATOMY OF AN EVENT

Events are caused. Typically, they are triggered by human action. In most cases, the human action causing the event was in error. However, the action could have been directed by a procedure; or it could have resulted from a violation—a shortcut to get the job done. In any case, an act initiates the undesired consequences. The graphic below provides an illustration of the elements that exist before a typical event occurs. Breaking the linkages may prevent events.

Anatomy of an Event



Event

An event is an unwanted, undesirable change in the state of facility structures, systems, or components or human/organizational conditions (health, behavior, administrative controls, environment, and so on) that exceeds established significance criteria. Events involve serious degradation or termination of the equipment's ability to perform its required function. Other definitions include: an outcome that must be undone; any facility condition that does not achieve its goals; any undesirable consequence; a difference between what is and what ought to be.

Initiating Action

The initiating action is an action by an individual, either correct, in error, or in violation, that results in a facility event.[9] An *error* is an action that unintentionally departs from an expected behavior. A *violation* is a deliberate, intentional act to evade a known policy or procedure requirement. Active errors are those errors that have immediate, observable, undesirable outcomes in the physical facility. They can be either acts of commission or omission. The majority of initiating actions are active errors. Therefore, a strategic approach to preventing events should be the anticipation and prevention of active errors.

Flawed Defenses

Flawed defenses are defects that, under the right circumstances, may inhibit the ability of defensive measures to protect facility equipment or people against hazards or fail to prevent the occurrence of active errors. Defenses or barriers are methods that:

- **protect** against various hazards (such as radiation, chemical, heat),
- **mitigate** the consequences of the hazard (for example, reduced operating safety margin, personal injury, equipment damage, environmental contamination, cost), and

- **promote** consistent behavior.

When an event occurs, there is either a flaw with existing defenses or appropriate defenses are not in place.

Error Precursors

Error precursors are unfavorable prior conditions at the job site that increase the probability for error during a specific action; that is, error-likely situations. An error-likely situation—an error about to happen—typically exists when the demands of the task exceed the capabilities of the individual or when work conditions aggravate the limitations of human nature.[10] Error-likely situations are also known as error traps.

Latent Organizational Weaknesses

Latent organizational weaknesses are hidden deficiencies in management control processes (for example, strategy, policies, work control, training, and resource allocation) or values (shared beliefs, attitudes, norms, and assumptions) that create work place conditions that can provoke errors (precursors) and degrade the integrity of defenses (flawed defenses).[11] Latent organizational weaknesses include system-level weaknesses that may exist in procedure development and review, engineering design and approval, procurement and product receipt inspection, the training and qualification system, and so on. The decisions and activities of managers and supervisors determine what is done, how well it is done, and when it is done, either contributing to the health of the system(s) or further weakening its resistance to error and events. System-level weaknesses are aggregately referred to as latent organizational weaknesses. Consequently, managers and supervisors should perform their duties with the same uneasy respect for error-prone work environments as workers. A second strategic thrust to preventing events should be the identification and elimination of latent organizational weaknesses.

STRATEGIC APPROACH FOR HUMAN PERFORMANCE

The strategic approach to improving human performance within the DOE community embraces two primary challenges:

I. **Anticipate, prevent, catch, and recover from *active errors* at the job site.**

II. **Identify and eliminate *latent organizational weaknesses* that provoke human error and degrade defenses against error and the consequences of error.**

If opportunities to err are not methodically identified, preventable errors will not be eliminated. Even if opportunities to err are systematically identified and prevented, people may still err in unanticipated and creative ways. Consequently, additional means are necessary to protect facility equipment from errors that are not prevented or anticipated. Reducing the error rate minimizes the frequency, but not the severity of events. Only defenses can be effective at reducing the severity of the outcome of error. Defense-in-depth—defenses, barriers, controls, or safeguards arranged in a layered fashion—provides assurance such that if one fails, remaining defenses will function as needed to reduce the impact on the physical facility.

To improve human performance and facility performance, efforts should be made to (1) reduce the occurrence of errors at all levels of the organization and (2) enhance the integrity of defenses, barriers, controls, or safeguards discovered to be weak or missing. Reducing errors (Re) and managing defenses (Md) will lead to zero significant events (0E). The formula for achieving this goal is: **Re + Md → 0E**. Eliminating significant facility events will result in performance improvement within the organization.

Reducing Error

An effective error-reduction strategy focuses on work execution because these occasions present workers with opportunities to harm key assets, reduce productivity, and adversely affect quality through human error. Work execution involves jobs or tasks during which workers directly have contact with facility equipment; that is, when they touch facility equipment. During work execution, the human performance objective is to anticipate, prevent, or catch active errors, especially at critical steps, where error-free performance is absolutely necessary. The three phases to work execution are the following:

- **Work Preparation** — *planning* – identifying the scope of work, associated hazards, and what is to be avoided, including critical steps; *job-site reviews* and *walkdowns* – identifying potential job-site challenges to error-free performance; *task assignment* – putting the right people on the job in light of the job's task demands; and *task previews* and *pre-job briefings* – anticipating possible active errors and their consequences and incorporating appropriate defenses, especially at critical steps.
- **Work Performance** — performing work with a sense of *uneasiness;* maintaining *situation awareness; rigorous use of human performance tools* for important human actions, avoiding unsafe or at-risk work practices; supported with quality *supervision* and *teamwork.*
- **Work Feedback** — *reporting* – conveying information on the quality of work preparation, related resources, and work place conditions to supervision and management; *behavior observations* – workers receiving coaching and reinforcement on their performance in the field through observations by managers and supervisors.

Chapter 2 focuses more on anticipating, preventing, and catching human error at the job-site.

Managing Defenses

Events involve breaches in defenses, controls, barriers or safeguards. As mentioned earlier, errors still occur even when the opportunities to err are systematically identified and eliminated. That is why an aggressive approach is needed to find and correct vulnerabilities with defenses. The most important aspect of this strategy is an assertive and ongoing verification and validation of the health of defenses. Ongoing self-assessments are employed to scrutinize defenses, and then the vulnerabilities are mended using the corrective action program. Defenses against human error involve four primary lines of defense (controls) all to improve facility resilience to human error and related events.

- **Engineered Controls** — provide the facility with the physical ability to protect itself from errors. To optimize this set of controls and defenses, equipment is reliable and is kept in a configuration that is resistant to simple human error and allows systems and components to perform their intended functions when required. Facilities with high equipment reliability, effective configuration control, and minimum human-machine vulnerabilities tend to experience fewer and less severe facility events than those that struggle with these issues. How carefully facility equipment is designed, operated, and maintained (using human-centered approaches) affects the level of integrity of this line of defense.
- **Administrative Controls** — Procedures, training, work processes, and various policies and expectations direct people's activities so that they are predictable and safe, especially for work performed in and on the facility. All together such controls help people anticipate and prepare for problems. Written instructions specify what, when, where, and how work is to be done. The rigor with which people follow and perform work activities according to correctly written procedures, expectations, and standards directly affects the integrity of this line of defense.
- **Cultural Controls** — These are the assumptions, values, beliefs, and attitudes and the related leadership practices that encourage either high standards of performance or mediocrity, open or closed communication, and high or low standards of performance. Personnel in highly reliable organizations practice error-prevention rigorously, regardless of their perception of a task's risk and simplicity, how routine it is, and how competent the performer. The integrity of this line of defense depends on people's appreciation of the human's role in safety, the respect they have for each other, and their pride in the organization and the facility.
- **Oversight Controls** — Accountability for personnel and facility safety, for security, and for ethical behavior in all facets of facility operations, maintenance, and support activities is achieved by a kind of "social contract" entered into willingly by workers and management where a "just culture" prevails. In a just culture, people who make honest errors and mistakes are held blameless while those who willfully violate standards and expectations are censured. Workers willingly accept responsibility for the consequences of their actions, including the rewards or sanctions (see "accountability" in the glossary). They feel empowered to report errors and near misses. This accountability helps verify margins, the integrity of defenses and processes, as well as the quality of performance. Performance improvement activities facilitate the accountability of line managers through structured and ongoing assessments of human performance, trending, field observations, and use of the corrective action program, among others. The integrity of this line of defense depends on management's commitment to high levels of human performance and consistent follow-through to correct problems and vulnerabilities.

Chapter 3 focuses on controls and defenses and their management. Chapter 4 emphasizes the role managers and informal leaders play in shaping safety culture.

HPI SUPPORTS DOE'S INTEGRATED SAFETY MANAGEMENT SYSTEM

As stated earlier, human performance improvement is not a program. It is a distinct way of thinking about people, human error and improving performance in the work place. It is not intended to replace, supplant, or be a substitute for any existing DOE program. Rather, HPI is intended to support and strengthen these programs. How HPI works can be illustrated with the Department of Energy's Integrated Safety Management System (ISMS).

The objective of the ISMS is to systematically integrate safety into management and work practices at all levels so that work is accomplished while protecting the public, the workers, and the environment. This is accomplished through effective integration of safety management into all facets of work planning and execution. In other words, the overall management of safety functions and activities becomes in integral part of accomplishing the work.[12]

Human error can negatively affect each stage of the ISM core functions (work processes). The ISMS core functions (italicized below) are positively influenced by the HPI strategic approach to reducing error.

1. *Define the scope of work* — eliminating error related to defining the work leads to zero mistakes in analyzing the associated hazards.
2. *Analyze and categorize the hazards* — eliminating error in identifying and analyzing the hazards reduces errors in identifying adequate controls associated with those hazards.
3. *Develop and implement controls* — locating and eliminating latent organizational weaknesses strengthens defenses that reduce the consequences of an active human error that may initiate a mishap or an occurrence.
4. *Perform work* — the effective use of error reduction tools when performing work reduces the probability that an active error may cause a mishap, failure, or serious event.
5. *Feedback and improvement* — focusing on problems deeper in the system, beyond the individual (engineering flaws, manufacturing flaws, weaknesses in work processes, unworkable procedures, ineffective tools, poor working conditions, training short-falls, etc.), when a near miss, mishap, or event occurs helps identify latent conditions that provoke error.

Clearly, using HPI methods and techniques to reduce error supports the ISMS core functions.

The leadership behaviors promoted in HPI and shown below support ISMS guiding principle #1—*line management responsibility for safety*.

- Facilitate open communication.
- Promote teamwork.
- Reinforce desired behaviors.
- Eliminate latent organizational weaknesses.

- Value prevention of errors.

The HP error reduction tools listed below specifically support two ISMS principles—i*dentification of safety standards and requirements* and *hazard controls tailored to work being performed.*

- task preview,
- questioning attitude,
- job-site review, and
- pre-job briefing.

PRINCIPLES OF HUMAN PERFORMANCE

Five simple statements are referred to as the *principles* or underlying truths of human performance. Excellence in human performance can only be realized when individuals at all levels of the organization accept these principles and embrace concepts and practices that support them. These principles are the foundation blocks for the behaviors described and promoted in this handbook. Integrating these principles into management and leadership practices, worker practices, and the organization's processes and values will be instrumental in developing a working philosophy and implementing strategies for improving human performance within your organization.

1. **People are fallible, and even the best people make mistakes.**

   Error is universal. No one is immune regardless of age, experience, or educational level. The saying, "to err is human," is indeed a truism. It is human nature to be imprecise—to err. Consequently, error will happen. No amount of counseling, training, or motivation can alter a person's fallibility. Dr. James Reason, author of *Human Error* (1990) wrote: *It is crucial that personnel and particularly their managers become more aware of the human potential for errors, the task, workplace, and organizational factors that shape their likelihood and their consequences. Understanding how and why unsafe acts occur is the essential first step in effective error management.*

2. **Error-likely situations are predictable, manageable, and preventable.**

   Despite the inevitability of human error in general, specific errors are preventable.[13] Just as we can predict that a person writing a personal check at the beginning of a new year stands a good chance of writing the previous year on the check, a similar prediction can be made within the context of work at the job site. Recognizing error traps and actively communicating these hazards to others proactively manages situations and prevents the occurrence of error. By changing the work situation to prevent, remove, or minimize the presence of conditions that provoke error, task and individual factors at the job site can be managed to prevent, or at least minimize, the chance for error.

3. **Individual behavior is influenced by organizational processes and values.**

   Organizations are goal-directed and, as such, their processes and values are developed to direct the behavior of the individuals in the organization. The organization mirrors the sum of the ways work is divided into distinct jobs and then coordinated to conduct work and generate deliverables safely and reliably. Management is in the business of directing workers' behaviors. Historically, management of human performance has focused on the "individual error-prone or apathetic workers."[14] Work is achieved, however, within the context of the organizational processes, culture, and management planning and control systems. It is exactly these phenomena that contribute most of the causes of human performance problems and resulting facility events.[15]

4. **People achieve high levels of performance because of the encouragement and reinforcement received from leaders, peers, and subordinates.**

   The organization is perfectly tuned to get the performance it receives from the workforce. All human behavior, good and bad, is reinforced, whether by immediate consequences or by past experience. A behavior is reinforced by the consequences that an individual experiences when the behavior occurs.[16] The level of safety and reliability of a facility is directly dependent on the behavior of people. Further, human performance is a function of behavior. Because behavior is influenced by the consequences workers experience, what happens to workers when they exhibit certain behaviors is an important factor in improving human performance. Positive and immediate reinforcement for expected behaviors is ideal.

5. **Events can be avoided through an understanding of the reasons mistakes occur and application of the lessons learned from past events (or errors).**

   Traditionally, improvement in human performance has resulted from corrective actions derived from an analysis of facility events and problem reports—a method that reacts to what happened in the past. Learning from our mistakes and the mistakes of others is reactive—after the fact—but important for continuous improvement. Human performance improvement today requires a combination of both proactive and reactive approaches. Anticipating how an event or error can be prevented is proactive and is a more cost-effective means of preventing events and problems from developing.

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