

Introduction to Pantex High Reliability Operations

A Practical Approach to Avoid the System Accident

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B&W Pantex
technical services

Break the Chain
Between
Threat and Hazard

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Background

In 2007 about 39 B&W Pantex senior-level managers began a journey to learn about High Reliability Organizations (HROs) and to understand how a more rigorous process to conduct Causal Factors Analysis (CFA) investigations on events could provide insight into Pantex in becoming an HRO. This journey consisted of nine seminars using a variety of textbooks. The format for the seminars, although very informative, was not formally structured nor optimized for Pantex. Since that time, Greg Meyer, the B&W Pantex Plant Manager has requested that a Pantex-specific approach be developed to make the material easier to understand and more applicable to Pantex operations. The program is being introduced to new hires and to a broader management audience in early FY 2009.

Introduction

Systems failures can lead to catastrophe: "Some types of system failures are so punishing that they must be avoided at almost any cost. These classes of events are seen as so harmful that they disable the organization, radically limiting its capacity to pursue its goal, and could lead to its own destruction." (Laporte and Consolini, 1991)

In today's regulatory climate, many high hazard sites realize the consequences of a mishap in their operations are so devastating that they employ a high reliability organization (HRO) systems approach to minimize the vulnerability of human error. To paraphrase Karlene Roberts (2003), a professor in the Haas School of Business at the University of California at Berkeley and a pioneer of HRO theory:

An HRO is an organization that conducts relatively error free operations over a long period of time, making consistently good decisions that result in high quality and reliable operations.

Because of its hazardous mission, Pantex has no choice but to be an HRO. Being an HRO requires taking a systems approach to avoiding catastrophic accidents because we cannot rely upon everyone to have a perfect day, every day. To become an HRO is not easy—it requires knowing the desired end-state, having a well-designed and practical strategy to get there, and perseverance by everyone to see the job done. The new B&W Pantex HRO program is introduced in this document to provide insight into upcoming efforts. More detailed information will be available in early FY 2009 with the publication of the two B&W Pantex texts: High Reliability Operations: A Practical Guide to Avoid the System Accident and Causal Factors Analysis: An Approach for Organizational Learning.

THE ALTERNATIVE TO HRO – THE NORMAL ACCIDENT:

Bophal
Three Mile Island
Challenger/Columbia
Chernobyl
Exxon Valdez
Texas City

HRO Desired End-State

As a company that manages many high-hazard operations, we searched existing literature to learn how to help our organization operate as HROs. Our goal was to discover not just what approaches and tools to use, but why we should use them. Toward this end, we adapted the approach of many HRO researchers (Sagan, Weick & Suttcliffe, Reason, Dekker, Hopkins, and Schein) and developed an overarching management structure using W.E. Deming's Theory of Profound Knowledge, which serves as an umbrella under which we assimilate our own practical experience as well as information gleaned from HRO theories. In essence Deming's theory provides the "why" behind the "what" of HROs (Figure 1). Deming's theory, taken at a high level, is simple to conceptualize. First, have knowledge of systems. That is, know what a system can do for you to avoid the catastrophic event, but also be aware of the challenges the system will present to include understanding how your system works with both internal and external environments. Second, understand variability with regards to implementing your system. That is, find ways to measure its performance to provide feedback of how far you are varying from your original game plan. Third, have a knowledge of psychology or on an organizational level, understand organizational culture because it will either provide you the stamina to stay the course of being an HRO or it will prevent you from being successful. And last but probably most important, have knowledge of knowledge. The idea is that management is nothing but theory put into action based upon management's prediction of what will occur. Feedback on how the system (prediction) is working is vital to allow continual improvement of the system resulting in greater safety with enhanced production. Using this framework and drawing on the theories of other researchers, validated from our own experience, we developed four

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HRO practices that can be applied to Pantex operations. These HRO practices fully integrate Integrated Safety Management and Human Performance Improvement hence should not be thought of as a new safety program but a logical framework to better understand how existing programs support safe Pantex operations and to take those operations to the next level of safety. These are shown overlaid on Deming's Theory of Profound Knowledge in Figure 1:

- Manage the system, not the parts
- Reduce system variability
- Foster a strong culture of reliability
- Learn and adapt as an organization

In a healthy HRO, these practices are internalized to the degree that they inform all major management decisions.

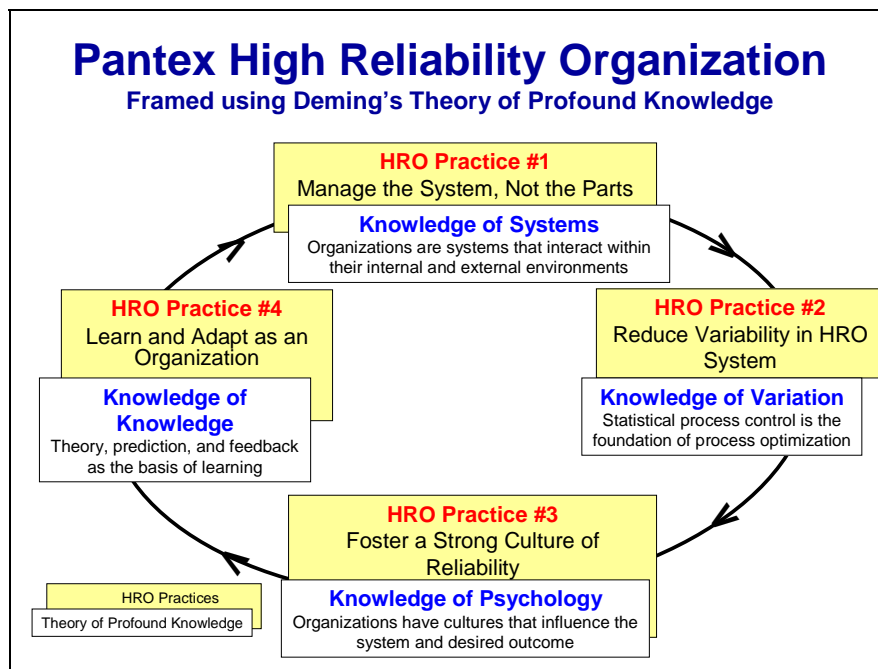


Figure 1 Pantex High Reliability Organization End-State

HRO Practice #1: Manage the System, Not the Parts

HRO Practice #1 focuses on, and must be implemented by, managers. HRO Practice #1 establishes the management of the other three HRO practices. Without management buy-in and commitment there is no HRO. B&W Pantex adopts a systems approach to reduce the vulnerability of human error. To do this, B&W Pantex management ensures the system provides the requisite level of safety and doesn't introduce more significant failure mechanisms with other, perhaps unforeseen, consequences. B&W Pantex management oversees the development and deployment of the system and relentlessly drives to obtain accurate, timely, and continuous feedback on the system's health. In this endeavor, managers communicate their commitment to safety and reliability not only through their talk but also through their actions. That is, B&W Pantex managers foster a culture of reliability in which open and honest communications from the workforce are expected and acted upon resulting in continuous organization learning and adapting.

The described systems approach to safe operations is essential to the continued success of Pantex.

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HRO Practice #2: Reduce System Variability

The second HRO practice is focused on deploying the robust HRO system, evaluating the performance of the system, and continuously reducing performance variability to decrease the likelihood of unexpected system events. The B&W Pantex HRO system consists of six steps in the Break the Chain Framework (Figure 2).

- Step #1:** Identify the system accident (i.e. consequence) we want to avoid (e.g. explosion).
- Step #2:** Identify and reduce the hazard (e.g. explosives) that can cause this undesirable consequence.
- Step #3:** Recognize we are all human and make errors so we want to determine our error precursors (things that make us trip) and avoid them.
- Step #4:** Put barriers between the threat (our mistakes) and the hazard (e.g. explosives) so that the probability that our human mistakes will cause a consequential accident are reduced.
- Step #5:** Foster a culture of reliability in which we are expected to challenge the viability of the safety system, fix what we find wrong, then trust and police the system so that everyone remains safe.
- Step #6:** Learn from our small mistakes in order to avoid challenging the hazard to cause the undesired consequence.

SAFETY BASIS AND SAFE OPERATIONS

Organizations that deal with nuclear processes are familiar with the term *safety basis*, which is used by the U.S. Department of Energy (DOE) to indicate the level of rigor required by a nuclear facility to assure safe operations and activities. The intent of a safety basis is to identify and document a comprehensive set of controls—administrative, technical, and personnel—to establish a safety envelope within which operations can be safely carried out.

It is important to understand and implement the requirements of the safety basis; it is equally important not to be lulled into thinking that simply meeting these requirements will ensure safe operations. Hence the need to become an HRO.

To reduce variability in the Break the Chain Framework, hazards will be minimized, the negative influences of complex interactivity and tight coupling reduced, human error minimized; and the explicit use of redundant independent barriers implemented in case other actions fail.

Feedback, corrective actions and learning are key to reducing variation in this HRO system. To ensure proper feedback, managers will clarify what they want reported and choose monitoring metrics wisely.

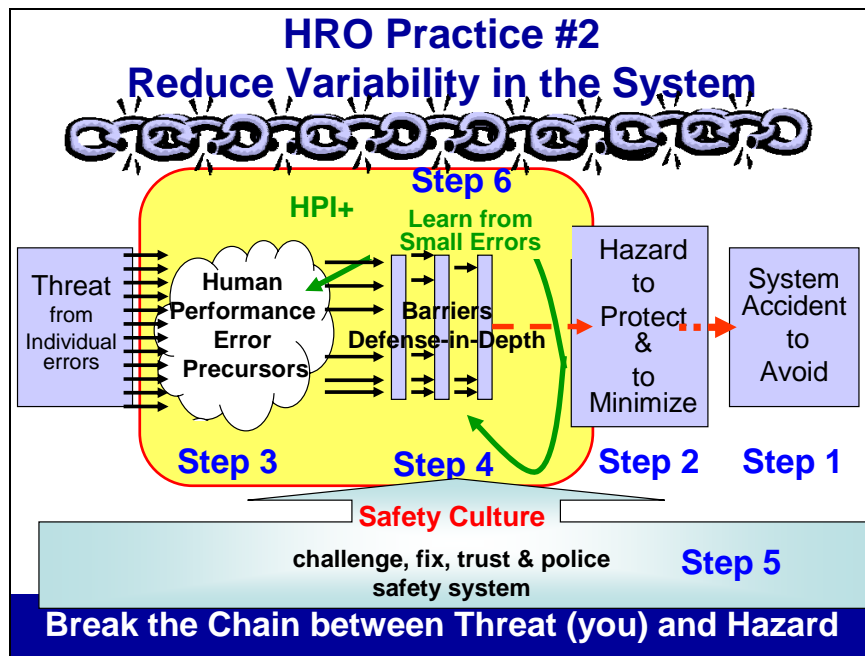


Figure 2 Break the Chain Framework for HRO System

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The above framework, although simplistic, is logical and validated by the workers and can be readily adapted to fit the specific needs of Pantex operations. This framework fully integrates Integrated Safety Management, Human Performance Improvement, and all efforts related to nuclear operations. However, because of its general applicability, the framework applies to any process at Pantex which will help attain consistency in all operations from quality, safety, security, to routine business systems.

HRO Practice #3: Foster a Strong Culture of Reliability

No system works unless it is used, so we want our employees to fully implement, believe, and police the use of the deployed HRO system (Step #5 in Figure 2). No system is perfect, so we want our employees challenging the system to identify shortcomings before events occur. To improve the effectiveness of both requires leaders to learn and to understand the psychology of individuals, groups, and of change to better understand people, the interaction between people and circumstances, and between managers, employees, and any system of management. This equates to understanding the culture of the organization. We prefer to use the term *culture of reliability* to indicate an organizational culture that focuses not only on safety, but on consistent, dependable, and excellent products and services. A culture of reliability, according to our definition, encompasses three concepts:

- Employees trained, empowered and expected to make conservative decisions on the shop-floor.
- Employees who retain their proficiency through continuous hands-on work.
- An organization (managers and employees) that daily demonstrate this culture of reliability by transparently walking-the-talk and challenging and acting on unsafe conditions to protect against the system accident.

To have a strong culture of reliability, the leaders of the HRO need to be learners and strategists; they must never be satisfied with the status quo and must constantly push for improvement within the context of the strategic plan and objectives. B&W Pantex managers are committed to constantly reinforce the desired cultural traits through words, actions, and decisions.

A culture of reliability, in particular an environment that encourages open reporting is particularly critical for Pantex as we deal with their hazardous operations. There must be a strong sense of trust between the workforce and management to ensure safety critical items do not get pushed aside waiting for accidents to occur. Because of this importance, HRO Practice #3 is key to success at Pantex.

HRO Practice #4: Learn and Adapt as an Organization

HROs cannot live solely by safety statistics. HROs must be learning organizations. They strive for excellence through continuous organizational renewal. Because safety is a core value for HROs, the aim is to gather as much relevant information as possible and turn it into knowledge to learn as an organization. The continuous flow of cross-functional information is essential to learning. To support this need for information, HROs need an effective mechanism of reporting that includes feedback mechanisms. To provide this essential feedback, we provide a tiered approach to organizational learning (Figure 3) that provides feedback from start-up processes, daily supervisor-employee interactions, tracking and trending of data, causal factors analysis, and learning from the mistakes that others have made. In each of these, the Break the Chain Framework is worked backwards to help us understand where our safety system is weak so that our HRO can be continuously refined. This level of learning involves gaining a true understanding of the underlying causes of a deviation from the norm (evaluating safety culture), and then if necessary managing the culture to achieve specific goals.

The Lure of Counting Errors

Counting errors and stuffing them away in a measurement instrument (and handing the results to management in the form of a bar chart) removes the context. It is gone, no longer there.

- Without context, you cannot reconstruct local rationality
- Without local rationality, you cannot understand human error.
- So counting error is contrary to understanding error.

Dekker (2006)

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This critical aspect of HROs of being learning organizations is particularly important to Pantex. B&W Pantex is committed, through active and consistent communications, to address with the workforce the best venues to continue to learn as an organization to ensure the mission of serving as the Nations only nuclear weapon assembly/disassembly plant remains viable.



Figure 3 Tiered Approach to Organizational Learning

Transition Strategy to the HRO

The previous section introduced the four guiding practices that characterize high reliability operations. Having this vision of the end-state is the first step in the process of transformation to an HRO. The second step is developing the transformation strategy from a normal organization to a High Reliability Organization.

The journey to become an HRO requires the same sort of strategic planning as any other organizational transformation. First, the strategic objectives are determined, then a gap analysis is performed to determine the difference between the current state and the desired future state. Once the gaps are identified and measured, modified strategies with specific objectives, measures, targets, and initiatives are formulated. Figure 4 illustrates the major steps of the transformation process.

System events or accidents reveal weaknesses in the overall system of an organization. These weaknesses may be manifested in the structure of the organization, an incompatible business strategy, the wrong type of staff for the job, a management style that does not stress high reliability, improper procedures or the failure of employees to follow procedures, lack of communication, or a dozen other symptoms. The McKinsey 7S Framework, first published by Thomas J. Peters and Robert H. Waterman, Jr. in the book *In Search of Excellence*, is a systematic tool to expose and evaluate systemic weaknesses, imbalances, or incongruities. We employ the 7S framework to each HRO practice to systematically ensure every facet of business is explicitly considered during the gap analysis.

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As shown in Figure 4, the 7S construct uses seven interdependent variables to drive the HRO gap analysis:

- *Structure*
- *Strategy*
- *Staff*
- *Management style*
- *Systems and procedures*
- *Guiding concepts and shared values* (i.e. culture)
- *Corporate strength and skills*

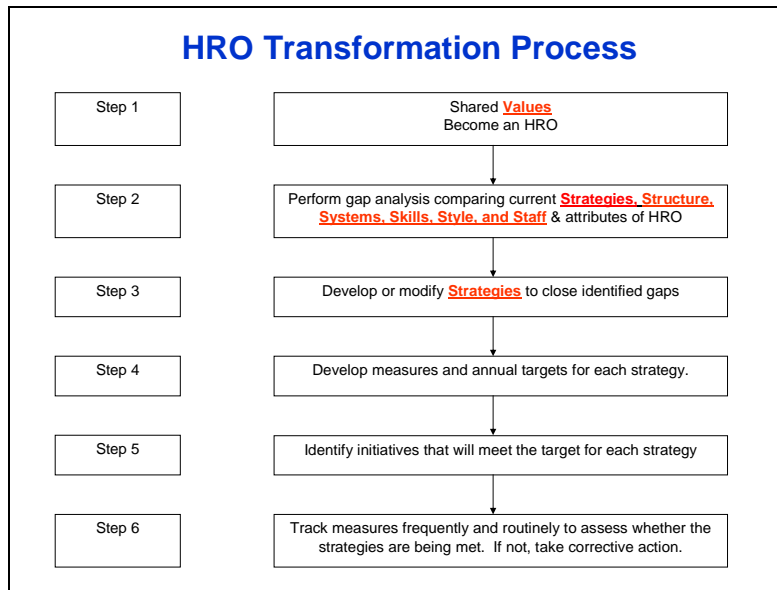


Figure 4 Transition Process to the HRO

This scheme encourages managers embarking on change to realize that such change involves at least seven elements of complexity. This approach is particularly pertinent to organizations attempting to transform to HROs because—like the four practices—it is based on a systems approach that is mindful of the interdependencies of and need for balance among the various organizational attributes.

Using Figure 4 as a guide, the first step in the transformation is to ensure that *shared values* are in place. For the HRO journey, this shared value or vision is to *become the HRO*. The specific strategies to be used to reach this overriding goal are determined in Step 2, the gap analysis. During this critical step, existing strategies, structure, systems, skills, style, and staff are compared against the desired end-state defined in Step 1. The identified gaps between the current state of the organization and its end-state will be used to focus management attention on strategies to close these gaps (Step 3). Steps 4 and 5 involve the development of performance measures, targets, and initiatives for each of these strategies.

The final step in the transformation process involves tracking and reporting against the developed measures to determine whether the strategies are succeeding. This is an important point: the measures selected are used to determine if a strategy is working, not that an initiative is finished. The initiatives are designed to meet the performance target for a given strategy. In other words, they are used to measure the effectiveness of the transformation process, not to indicate that the organization is functioning at the level of an HRO.

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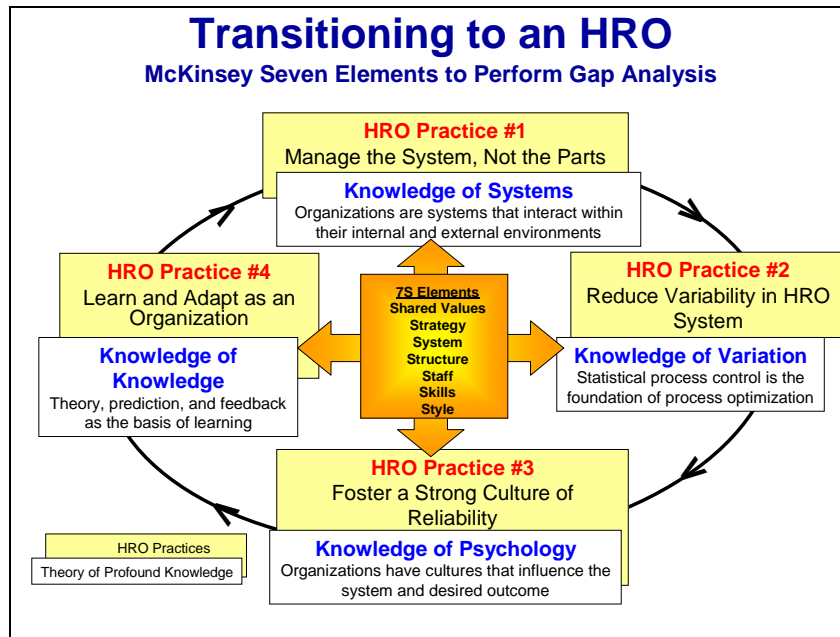


Figure 5 Transition to HRO using Seven Elements to Perform Gap Analysis

The six-step transformation is the same for every organization embarking on the HRO journey, but the individual prescriptions will vary depending on what the gap analysis reveals. Figure 5 shows that the 7S fundamentals should be used for each HRO practice to determine the gaps between current and desired practices. This will allow strategies to be developed for each important element of complexity for each of the four HRO practices.

Evidence of HRO Effectiveness

It is always difficult "proving" a safety system is effective as the outcome of an effective safety system is the lack of occurrence of safety events, or the null set. Outcome data such as total recordable rate or lost time injury rates can only reveal the negative face of safety. Also, because the measures of success of an HRO is the positive change in attitude of the workforce toward safety, i.e. the culture of reliability, it is difficult to quantify and even harder to change.

With this being said, positive evidence as to the viability of the described HRO approach has been demonstrated at B&W Pantex. Pantex has one of the lowest total recordable case rates (0.27) and loss time work case rates (0.05) for DOE nuclear production facilities. As a result, this site was recently voted as one of the top eleven safest companies in the United States by Occupational Hazard Magazine. But safety statistics show only a fraction of the positive effects. We believe that it takes not only an excellent safety and production record but, it also requires daily that the organization strive to implement and sustain practices that ensure both safety and reliability. The positive indicators of this qualitative, but very essential, component of striving to be an HRO include:

- A stronger understanding of the fundamentals of HROs and causal factors analysis among the senior management.
- Joint union, contractor, and DOE investigations into low consequence, yet organizationally rich events to not only find the root cause of the error but, to dig deep into the organizational issues that set the events up to happen in the first place.
- Evidence of a much more positive atmosphere where workers feel less afraid for their jobs to report errors as evidenced by information coming forward during event investigations (causal factors analysis).

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- An ability to begin seeing deeper organizational issues from a new method of conducting causal factors analysis that not only looks deeply into the organization with each investigation but, allows comparing like issues systematically across the plant by comparing the results from multiple investigations.
- An improved systems approach to track and trend issues noted in the startup of new nuclear processes that are fed back to those preparing for future process startups to continue to improve the rigor and success of the startup process.
- The initiation of management self-assessments to evaluate the success of learning lessons from internal or external events as evidenced by fewer similar issues with current processes.

In addition to the above, very positive indications are being received from numerous sources to include:

- The local DOE site office manager who has stated the process is one of the best at any DOE site
- Headquarters DOE NNSA and HSS visits to the B&W Pantex site to see first-hand the safety improvements and better understand the safety processes
- The Defense Nuclear Facility Safety Board (DNFSB) both at the staff level and the Board level who are enthusiastic about the B&W Pantex HRO initiative, about the emphasis at Pantex at the highest levels on safety culture, and the thoroughness of the causal factors analysis to dig into organizational level issues
- The Office of Price Anderson Enforcement which is impressed with the thoroughness of the causal factors investigations
- The teaming with Texas A&M University to incorporate the HRO process into their new nuclear safety curriculum for future commercial power nuclear engineers
- The B&W Pantex initiative to sponsor the next international HRO Conference in 2009 to share with the academe, nuclear power industry, and the nuclear regulatory community the progress made in HRO practices

Summary

Pantex is striving to take High Reliability Theory and transform it into High Reliability Practicality. To support this effort B&W Pantex has published two texts:

- High Reliability Operations: A Practical Guide to Avoid the Systems Accident and
- Causal Factors Analysis: An Approach to Organizational Learning.

These textbooks are deeply rooted in published theory but are written to provide a practical approach for the Pantex workforce. The texts were written for Pantex about Pantex to facilitate learning and to demonstrate the many programs that Pantex has that demonstrate a strong commitment to High Reliability.

Pantex will use these guides as it begins its second phase of its HRO journey to provide continued training to managers and orientation to new hires. Any feedback is greatly appreciated and will be used to further adapt the material to further improvements.

