Hanford

Human Performance Improvement (HPI)

Lessons Learned

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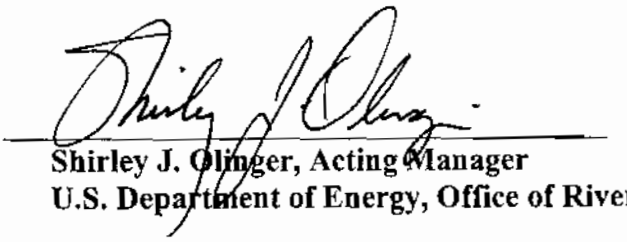
Approved by: 

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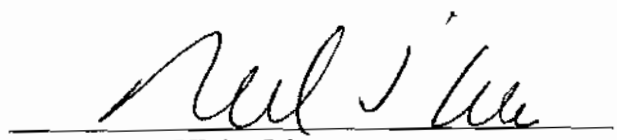

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1 EXECUTIVE SUMMARY

This document provides the results of a pilot initiative to implement Human Performance Improvement (HPI) tools and techniques by U.S. Department of Energy (DOE) Office of River Protection (ORP) and DOE Richland Operations Office (RL) and their respective Prime Contractors. The report describes the results and lessons learned of both the DOE and Contractor participants. In response to a DOE Environmental Management (EM) initiative to improve safety and Integrated Safety Management System (ISMS), DOE ORP and RL senior management agreed to implement a HPI pilot at Hanford which included DOE and Prime Contractors. HPI is a tool that has been very successful in reducing the occurrence of events in the commercial power industry.

Although Site Safety Performance had been generally acceptable, the rate of improvement appeared to have reached a plateau. To achieve a quantum leap in safety and operational performance, a new approach within the context of our existing Integrated Safety Management (ISM) was needed. The approach needed to integrate seamlessly with the existing ISM structure and improve mission capability. After ORP and RL senior management received initial training at the Nuclear Executive Leadership Training Course in the Fall of 2005, HPI appeared to be a process that had high potential to cause a step change improvement in ISM that also could yield results within DOE itself.

Pilot results concluded that HPI is fully compatible with ISMS. HPI is a tool that provides additional insights not evident by just using existing, traditional tools such as root cause analysis or event investigations. It became evident during the pilot how important it was to establish a "just culture" in order to ensure open communication of event circumstances. A "just culture" recognizes human potential for error and that the organization plays a role in events, clearly defines an open and objective event investigation process, and ensures any disciplinary actions are done in a consistent and just manner. HPI principles, such as "just culture" are integrated into the recently issued DOE ISMS Manual (DOE M 450.4-1, 2006).

Example benefits identified during the pilot included:

- Reduced events with consequences;
- Increased identification of lower significance problems with resulting improvement in continuous improvement and development of a learning culture;
- Realization that people make mistakes, and the role of the organization in causing individual errors, resulting in improved identification and correction of organizational weaknesses that contribute to human error;
- Simpler procedures and work packages;
- Improved identification and control of critical steps;
- Improved event investigation;
- Consistent and fair disciplinary process that emphasizes HPI principals and encourages reporting;
- Reduced numbers of documented Employee Safety Concerns; and
- Improved Employee Feedback (via documented surveys).

Resources required to implement HPI varied based on the degree of implementation and maturity of their ISMS. Results of the pilot indicate that the effort and resources expended to implement HPI tools are worthwhile, improve operational performance, and improve ISMS implementation.

After the completion of this pilot, ORP, RL, and their respective Prime Contractors plan to continue to implement various tools of HPI into normal business activities. The HPI process is a continuous improvement process that is expected to have a positive impact on work at Hanford. As a minimum, periodic lessons learned meetings are expected to continue. Some Hanford Contractors are expected to participate in Energy Facility Contractors Group (EFCOG) HPI development activities. Application of HPI tools is expected to continue in day-to-day work processes.

This report should be used as a starting point to initiate HPI at a facility. The report provides a broad perspective on lessons learned at Hanford, but may need to be supplemented with additional mentoring, training, benchmarking, or other assistance to successfully implement it at a facility. The first part of the report describes background information, benefits, and preliminary activities to initiate the pilot at Hanford. The second part of the report describes actual implementation of the pilot, first describing DOE experience and then Contractor experience. Six HPI applications are included in this report: HPI Steering Committee, HPI Self Assessment, HPI Training, Work Planning and Control, Culpability Matrix, and Event Investigation/Cause Analysis. Links are included in the report which provides additional resources generated during the pilot. To view the report electronically, go to http://www.hanford.gov/orp/uploadfiles/HPI%20LL.pdf**.**

Every organization in the DOE should consider application of HPI within their organization as a proven way to improve performance and reduce events with consequence.

2 HPI BACKGROUND AND OVERVIEW

2.1 WHAT IS UNIQUE ABOUT HPI?

HPI was developed and used in the commercial nuclear power industry for a number of years with impressive results related to the reduction of significant events. HPI was developed by the Institute of Nuclear Power Operations (INPO) and contributed to a quantum leap in event reduction in the commercial nuclear industry since it was implemented in the 1990's. INPO recognized the need for safety culture principles that included emphasis on reporting, free flow of information, and a "just culture." It is within this environment that HPI flourished in the commercial nuclear power industry.

A critical element of HPI is to establish a "just culture" in an organization. A "just culture" recognizes human potential for error and that the organization plays a role in events, clearly defines an open and objective event investigation process, and ensures any disciplinary actions are done in a consistent and just manner. (Just Culture Presentation from September 2006 DOE ISMS Champions Conference). Attributes of "just culture" include recognition of fairness related to the identification and resolution of human performance problems, and distinction between honest mistakes and intentional shortcuts with respect to discipline. When a "just culture" exists, positive benefits such as free flow of information across all levels of an organization and high level of self-reporting at lower thresholds will be evident in the organization. Open communication and reporting helps assure that events with minor consequences are being evaluated and addressed before events with more significant consequences occur (e.g. zero threshold problem reporting systems have been established by CH2M HILL Hanford Group, Inc. [CH2M HILL], Fluor Hanford, Inc. [FHI], and Bechtel National, Inc. [BNI]).

Human error is a normal and natural part of being human. It can also be provoked by conflicting management and leadership practices and weaknesses in an organization, its processes, or by its culture. HPI explores the foundations of individual and leadership behaviors as well as organizational factors that either lead to or prevent errors and their events. Figure 1, depicts results from commercial nuclear power events that reveal that 80% of events involved human errors. Of this, 70% (or 56% of all events) were attributed to latent organizational weaknesses and 30% (or 24% of all events) to individual error. HPI provides insights and tools to reduce the number of events caused by latent organizational weaknesses or individual error, thereby improving operational performance, while at the same time encouraging open reporting of issues, leading toward further continuous improvement.

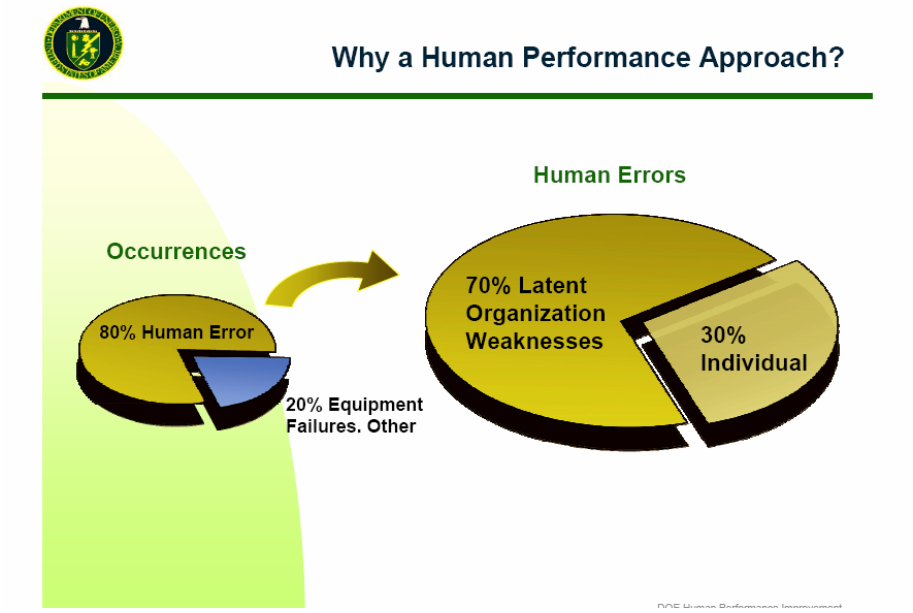

Figure 1

2.2 PROCESS TO INITIATE PILOT

Perhaps the most critical step in implementing HPI at a DOE facility is DOE management commitment to implement HPI. DOE sponsored HPI training sessions for DOE and Contractor management. This training was influential in providing one HPI vision to DOE and Contractor management. Joint DOE/Contractor "All Employee Messages" signed by the DOE managers and Contractor presidents announcing the Hanford HPI Initiative followed and the pilot was initiated. Additional HPI training sessions were jointly established with DOE and Contractor management. DOE sponsored joint Contractor/DOE regular HPI meetings to discuss progress and lessons learned. Training was perhaps the most significant activity involved with initiating a HPI program, both in terms of resource commitment and in bringing the organization up to speed quickly on the principals, language, and applications such as event investigations. Once training occurred, post event investigations could be performed using new HPI tools which provided significant insights into event causes not evident by conventional means such as organizational factors which caused workers to act a certain way under certain conditions.

The next step was to create an implementation plan. DOE senior management worked with Contractor senior management to ensure a plan was developed that both organizations could support. Specific aspects of HPI implementation were focused on by various organizations early in the process to maximize the learning experience:

- Training, Steering Committee, Self Assessment, and Work Planning and Control – CH2M HILL;
- Training and Event Investigation – BNI;
- Training, Culpability Matrix and Worker Involvement – FHI; and
- "Just Culture" and Oversight Training – DOE.

Once that was done, the Contractor began to implement the plan with DOE involvement. DOE personnel also received training and looked for opportunities to apply HPI tools within DOE in parallel with Contractor efforts. As an example, Facility Representatives received training on recognizing when the Contractor was using HPI tools and how to encourage and reinforce the Contractors use of HPI tools. Facility Representatives also needed to recognize where HPI stood in contract space.

A useful reference for establishing a HPI program is contained in the INPO Human Performance Fundamentals Course Reference Manual. The process described here is that used by DOE to successfully implement the pilot with each Contractor.

1. Four hour introductory training was provided to senior DOE and Contractor management using a well known and experienced HPI training facilitator.
2. Senior management vision and commitment was established, followed up by an All Employee Contractor memo stating this commitment including joint DOE and Contractor management signatures.
3. A Contractor specific HPI implementation plan was prepared by the Contractor and reviewed by DOE. The degree of participation varied among Contractors. The most elaborate plan used the approach described in the INPO Course Reference Manual. Additional three to four day practitioner training was established early in the process.
4. A DOE/Contractor HPI committee was formed. This committee provided leadership, tracked progress of implementation plans, made course corrections as needed, and discussed lessons learned.
5. DOE provided ongoing support to Contractors as they implemented their respective plans in their organizations.
6. DOE encouraged positive collaboration between Contractors.
7. DOE periodically consulted DOE Headquarters (HQ) HPI resources for support and feedback.

2.3 BENEFITS OF HPI

Some Hanford Contractors experienced noteworthy decline in reportable events and injuries during the Pilot. Other Contractors had an increase in the total number of occurrences but the significance of the events was dramatically reduced (the threshold for reporting was lowered). Benefits resulting from implementation of HPI included:

- Reduced events with consequences;
- Increased identification of lower significance problems with resulting improvement in continuous improvement and development of a learning culture;
- Realization that people make mistakes, and the role of the organization in causing individual errors, resulting in improved identification and correction of organizational weaknesses that contribute to human error;
- Simpler procedures and work packages;
- Improved identification and control of critical steps;
- Improved event investigations; and

- Consistent and fair disciplinary process that emphasizes HPI principals and encourages reporting.

2.4 INTEGRATION WITH ISMS

HPI is yet another tool that can be used to improve an organization's ISMS. For this pilot, both DOE and its Contractors identified key areas that they wanted to improve upon. The following are examples of specific aspects that were targeted for improvement:

- Work planning and control;
- Event investigation;
- Training;
- Lower threshold for reporting (just culture);
- Fair disciplinary process (culpability matrix); and
- Worker involvement.

3 IMPLEMENTATION OF THE HPI PILOT AT HANFORD

3.1 DOE EXPERIENCE

Both ORP and RL scheduled general HPI training (one day) for key management and technical staff to establish a base understanding of HPI principles. In addition, a smaller group of DOE staff were provided with three or four-day HPI training to establish them as "practitioners" with the intent that these staff members would help integrate HPI throughout DOE and especially in the DOE/Contractor interface. One ORP Facility Representative has developed individual training modules that have been provided to DOE and Contractor staff to further illustrate HPI and promote understanding.

In addition to the training, DOE staff used HPI principles in routine oversight (four key questions for briefings, lines of inquiry, documentation of oversight results) and assisted Contractor staff in HPI investigations to foster increased knowledge and use of the tools to supplement historical techniques. This was accomplished by Facility Representatives within their normal job duties.

The following lessons learned from the Hanford HPI pilot reflect lessons learned from a DOE perspective. Separate Contractor lessons learned will be discussed in the Contractor section of this report. Based on the experience gained by the pilot, the following HPI activities would have been implemented differently by the DOE Field Offices which should be considered by organizations embarking on a HPI initiative:

> An up front training needs analysis should be performed to identify who needs HPI training, how much training they need, and the focus of the training. Initial communication should have more closely aligned this new initiative with ISMS, recognizing it as a tool to improve operational performance. The maturity of the Contractor's ISMS implementation should be considered when determining the degree of HPI implementation and should be taken into account. Contractors should be encouraged to identify and use existing, experienced personnel to train and implement HPI such as personnel with previous experience in the commercial power industry to achieve results quicker.

3.2 CONTRACTOR EXPERIENCE

Specific aspects of HPI implementation were focused on by various organizations early in the process to maximize the learning experience which are described in subsequent sections:

- HPI Steering Committee;
- HPI Self Assessment;
- HPI Training;
- Work Planning and Control;
- Culpability Matrix; and

- Event Investigation/Cause Analysis.

Having a foundation of employee involvement established within the organization improved the efficiency of implementing HPI. Organizations that have a 'participative safety management' style, where employee teams and/or committees are used to implement safety improvement processes will see higher rates of success with HPI. DOE sites that have achieved Voluntary Protection Program (VPP) status will see the logical fit of HPI with enhanced worker involvement and participation in both implementation and improvements in existing forums of partnering for safety excellence.

3.3 HPI STEERING COMMITTEE APPROACH

Introduction

The *Human Performance Improvement Initiative Stages* advocated by INPO prescribes eight stages, all of which must be accomplished for successful change to occur. The eight stages are:

1. Obtain senior management commitment;
2. Establish a Steering Committee;
3. Perform a self assessment;
4. Develop an improvement plan;
5. Communicate and empower stakeholders;
6. Implement the strategy and plan;
7. Evaluate and improve human performance; and
8. Maintain excellent human performance.

Stage 2 prescribes the importance of creating a HPI Steering Committee designed to ensure responsibility for implementation remains with line management. (Initial Steps to Integrate HPI into ISMS Continuous Improvement). An effective human performance Steering Committee comprises key line managers, expertise in human performance, and credibility in terms of reputation, worker representation, and proven leadership capability. As a minimum, various line organizations should be represented. Establishing a Steering Committee with champions representing functional groups improves buy in and ownership of the HPI initiative. The HPI Steering Committee provides broad strategic direction for company-wide HPI priorities and resources, and schedules, monitors, and evaluates HPI effectiveness, and provides a forum for HPI process improvements and dissemination of HPI related information. It also helps to assure consistent implementation of the HPI initiative.

Resource Expectations

Resource expectations are based on the size of the organization. As an example, 1 Contractor's operation had 3 significant operational projects and comprised approximately 1200 employees and contractors, including support personnel. As described above, the Steering Committee was comprised of: one executive-level operations manager, three champions from each significant project organization; four support organization

representatives; and one bargaining unit representative. The committee met monthly for one hour.

Summary of Hanford Experience

Two organizations established Steering Committees. One organization was comprised primarily of management representatives from line organizations, while the other was a worker led effort established as part of the VPP. Establishing a charter for the HPI Steering Committee is important for identifying scope, membership, expectations, and responsibilities.

Establishing the committee with a strong line executive manager chairperson was important in setting the tone for expectations, implementation, and communications for CH2M HILL (CH2M HILL Steering Committee Charter). Other members of the Steering Committee included effective, proactive, decision-making line management to facilitate initiatives coming out of the committee. These individuals performed as champions and emissaries for the HPI initiative. The balance of the committee benefited by HPI Subject Matter Experts and representatives from facilitating organizations (Training, Procedures, Environment, Safety, Health, and Quality Assurance) and organizations implementing the initiative (Engineering, Work Planning and Control, Maintenance, Emergency Preparedness, and Event Investigation).

For CH2M HILL, one of the first action items for the Steering Committee to undertake was to sanction a Management Assessment that would compare existing performance and practices with established HPI standards to determine gaps in performance. A multi-discipline assessment team was established, developed a plan for committee approval, conducted the assessment, and provided the results back to the Steering Committee (Self Assessment). Based on the results of the Government Accountability Project (GAP) Analysis, the Steering Committee determined where the company should focus its efforts for improving performance. An Improvement Plan was established with clear actions and schedules for implementation (CH2M HILL ISMS PIP). The Plan included determining the types and magnitude of training needed, as well as the target populations and an implementation plan for addressing the focus areas.

The Steering Committee met monthly for one hour to evaluate Improvement Plan action status, training progress, implementation issues, and communication needs. An evaluation was made on whether additional direction or oversight was necessary, or course adjustments were appropriate.

This committee provided a fresh perspective on improving human performance. A tangible benefit of the committee was to share the results of initiatives in different work areas. For example, one project group used a VPP awareness day to integrate worker HPI training for all employees. Lessons learned and lesson plans could be shared with other groups at the committee meeting for use by others.

A company strategic plan was first prepared for FHI (Fluor Hanford, *Human Performance Improvement Strategic Plan for DOE Richland Operations Office*, rev. 1 (2006)). FHI established a Steering Committee linked closely with the VPP champions committee in the

Waste Stabilization and Disposition (WSD) project used as a pilot. Committee membership consisted primarily of representatives from the Bargaining Unit and VPP Champions Committee (Fluor Hanford WSD HPI/VPP Steering Committee and HPI Champions). The Steering Committee incorporated the HPI initiative into the VPP safety improvement plan (Fluor Hanford, 2007 WSD Safety Improvement Plan). The Committee then established a specific HPI implementation plan and schedule for the plan (Human Performance Management Improvement Plan Actions and Schedule), (Fluor Hanford, WSD Implementation of HPI), and WSD HPI Implementation Plan.

Steering Committee Lessons Learned

1. A representative from DOE or regular dialogue with DOE, helped facilitate understanding, acceptance, and support of the approaches and initiatives the Contractor was implementing.
2. Allowing appropriate run time (at least six months) before major course corrections are imposed is critical so that implementers will not become irritated with too frequent changes. A change in direction should only be initiated following a management or self assessment identifying enhancement opportunities for continuous program improvement.
3. The committee added the most value when focused on issues at least six months out. The natural tendency of the committee is to focus on short term, tactical activities. This is important, but a long term committee focus provides a unique planning approach that no other group is likely to be thinking about. A long term focus actually accelerates the overall pace of change in the organization.

3.4 HPI SELF ASSESSMENT

Introduction

The self assessment involves comparison of current performance or practices with established standards to determine gaps in performance. This self assessment, or GAP Analysis, is an evaluation of the nature and extent of the facility's current state of human performance and is an essential first step in the change process. The self assessment is best performed using institute of INPO principles and practices for HPI. It is important to recognize that results do not necessarily represent ineffective procedure or process implementation. It is also important to note that this GAP Analysis evaluates performance against standards of excellence.

Resource Expectations

CH2M HILL performed a self assessment. They have 3 significant operational projects and approximately 1200 employees and contractors, including support personnel. Assessment resources consisted of 9 assessors with an average man-hour estimate of 2 man-weeks per assessor, or 18 total man-weeks.

Summary of Hanford Experience

The methodology used in the analysis followed the INPO recommended approach of a team conducting an assessment of the performance criteria individually using the Site GAP Analysis tool. The team included primarily members of facility line organizations who would be potentially responsible for implementing any recommendations that are generated from the assessment. This helped improve ownership for issue resolution. The performance criteria are evaluated using this methodology to identify strengths, weaknesses, and associated recommendations for the facility to achieve high performance. The performance criteria selected for the GAP Analysis can be obtained from three INPO sources:

- The Human Performance Improvement Initiative Site GAP Analysis Tool;
- Performance Objectives and Criteria, (INPO 05-003, May 2005) Human Performance Criteria (OR.l3); and
- Job-Site Conditions Self-Assessment Questionnaire.

The results of the analysis were validated by:

- Data in the facility corrective action system;
- Procedure/process reviews based on applicable criteria from the job site conditions self-assessment questionnaire; and
- Cross-organizational interviews using questions based on guidance found in INPO 05-003 *Human Performance* criteria (OR.3).

The assessment (Self Assessment) provided valuable insights into error likely situations such as procedures and work instructions written with excessive detail which could actually increase the chance of not being followed correctly, or the recognition of critical tasks with proper hazard identification and mitigation.

Implementation Lessons Learned

1. Assessment objectives must be linked directly to an operational related outcome (i.e. preventing events, improving hazards identification and mitigation, reducing engineering error rates, etc).
2. Team members should receive some HPI training prior to the assessment.
3. Steering Committee review of the assessment scope and assessment results provided a valuable independent review of the assessment.
4. The assessment methodology needed to be modified to address ISMS criteria.
5. Upfront senior DOE and Contractor management recognition of assessment standards of excellence is recommended to prevent misinterpretation of results.
6. The assessment was used to focus the training needs analysis and subsequently the HPI training course content and class durations.
7. HPI assessment effectiveness is improved by using mentors from other organizations with HPI experience and/or benchmarking other existing HPI programs.
8. Implementation should closely align with the recommended INPO approach to implementing HPI at a facility such as an internal Steering Committee and an initial self assessment to focus on the greatest opportunities.

3.5 HPI TRAINING

Introduction

Training on HPI concepts and theories is an essential part of implementing a HPI program. HPI training generally involves a significant upfront commitment and investment of time, resources, and money. Without executive sponsorship and up front HPI training, there is a low probability of beneficial results from a HPI program. HPI addresses a specific way of approaching human performance issues that requires knowledge of underlying assumptions, concepts, and tools. Training is a proven method to introduce and help integrate these concepts.

Resource Expectations

Student training typically consisted of three basis training classes:

- 8 hour fundamentals training provided to field managers and selected support managers. This training can also be customized to specific programs and work disciplines.
- 24-32 hour practitioner training provided to work planners, event investigators, trainers, management, and program managers.
- 3-4 hour introductory training for all field workers. (Part 1, Part 2, Part 3).

Actual numbers of training attendees for each class are provided in the training resource link. Training development was minimal with the use of outside contractors to conduct the training. In house training estimates for course training development are:

- Training needs analysis - 40 hours.
- Training lesson plan development – 160 hours.

Summary of Hanford HPI Training Experience

(HPI Training Panel Workshop – Hanford Experience)

Several Contractors made early decisions to rely primarily on standardized HPI training provided by subcontractors. The training was essentially off-the-shelf HPI training endorsed by the DOE HPI Center of Excellence. The targeted population varied from company to company and within DOE. Target audiences included management, Subject Matter Experts, (SME) HPI trainers, union safety representatives, operations personnel, work planners, engineers, and event investigators. The training focused primarily on event investigation and cause identification principles. Training course lengths varied depending on the audience and purpose, but were typically either 4 hour, 8 hour, or 24-32 hour.

One Contractor adopted a different approach in designing its own site specific HPI training. In addition to the introduction of HPI philosophy and concepts, the training focused directly on the development and application of error prevention tools tailored to field operations and safety management programs. The training was initially conducted by internal trainers with

nuclear industry HPI experience until others were brought up to speed. The Systematic Approach to Training (SAT) was used in the training development process. A self assessment was used to compare INPO HPI methodology to the current status of integration of HPI principles within various work processes. The assessment was followed by a training needs analysis to identify the processes and target audiences that would most benefit from application of HPI principles. The needs analysis identified three target populations and corresponding training courses. The target audiences were:

- HPI practitioners, trainers, and process owners requiring a 24- hour course;
- Managers and SMEs requiring an 8-hour course; and
- General workers- requiring a 3-4-hour course.

The training material was reviewed and concurred with by DOE and INPO prior to implementation. Management oversight of the training program was provided by the HPI Steering Committee during monthly meetings.

HPI Training Implementation Lessons Learned

1. Joint Contractor/DOE training is beneficial.
2. Management participation enhanced training effectiveness.
3. Different lesson plans and classes for different audiences allowed for specific HPI application training targeted for the audience which improved training effectiveness, for example specific field applications can be integrated into the training to enhance the training experience.
4. The HPI self assessment (GAP Analysis) and training needs analysis were effective methods for determining training content and durations.
5. Medium class size provided the best feedback, e.g. 15 – 20 people.
6. Facility trainers, both primary presenters and supplemental SMEs teamed with contracted trainers, added credibility and sustainability to the material.
7. Upfront training emphasis on ISMS integration minimizes “flavor of the month” perception.
8. Issuance and use of student aids such as HPI concepts badge cards were beneficial.
9. Employees need to understand the “why” (i.e., what’s in it for me?).
10. There are an abundance of HPI resources and tools available. Management needs to assess their needs and select a focus on which resources and tools to use for their specific situation. There is no need to reinvent the wheel. This includes training lesson plans.
11. HPI training effectiveness is improved by using mentors from other organizations with HPI experience and/or benchmarking other existing HPI programs.

3.6 HPI WORK PLANNING AND CONTROL

Introduction

In integrating HPI concepts into Work Planning and Control it is important to involve a core group of people to understand the principles and fundamentals of Human Performance. This core group of people needs to consist of line and program managers in the Operations, Work

Control, and Safety organizations along with representation of the workers. Reducing the complexity of hazard analysis, planning, reviewing, and approving work instructions and then performing the work are key elements. The more complex these processes are the more likely they are to introduce errors. By simplifying these processes focus can be placed on the things that are important and minimize the potential for error likely situations.

Resources

CH2M HILL took the lead to implement this HPI element into their work planning and control processes. As part of this leadership, they have conducted several industry presentations on their experiences such as the DOE ISMS Champions conference (Integrating HPI Concepts and Tools into Work Planning), as well as conducting a workshop for the National Nuclear Security Administration (NNSA) Work Planning and Control Improvement Team. This effort took a team of eight people meeting once a week for six months, with about four hours per week dedicated to HPI. One additional person spent up to 75% of their time for 6 months on HPI. Total man-hours dedicated to this task were approximately 1000 man-hours. The implementation required a complete rewrite to two procedures and minor changes to several other administrative procedures. The changes to the Job Hazards Analysis (JHA) process required changes to most of the several hundred technical procedures. Briefing sessions and training were provided to the organizations involved. Implementation of HPI in these processes is on the order of scale to the introduction of the Conduct of Operations and will require a couple of years of consistent reinforcement of the behaviors and practicing the use of the new tools delivered as a part of this process.

Summary of Hanford Experience

Three general areas for improvement were initially identified:

1. Get workers more involved with Hazard Analysis (specifically Hazard Identification and Selection of Controls) and use a process that focuses work teams on the critical tasks for more complex work hazard reviews.
2. Reduce the number of skill based tasks for the performance of work in order to simplify the process and procedures. Emphasis on critical steps instead helps focus workers on the most important steps and hazards in a work package. Critical tasks are irreversible actions with potential for significant negative consequences that require a higher level of planning and discussion.
3. Integrate HPI concepts, specifically error likely situations, into the front end of the planning process through worker involvement such that as many situations as possible are looked at before the workers have to use their experience and training at the job site.

The Work Site Hazard Analysis tool was put together for the planning teams to use during their walk-downs, planners to use in development of instruction, and workers to use when they were in the field as a checklist of things to look for such as work site and environmental conditions. This allowed the rest of the hazard analysis process to focus on the critical tasks and hazards associated with the work. A JHA Checklist was developed to ensure that critical

tasks were identified, and that any error likely situations that could be foreseen were discussed as part of the hazard analysis process **(JOB HAZARD ANALYSIS)**.

The work planning process was reduced from nine ways of planning or performing a work activity to three. This simplification reduced the complexity of the procedure and allowed the procedure for work control to be reduced from over 80 pages to fewer than 40 **(TANK FARM CONTRACTOR WORK CONTROL)**. The work planning process graded approach was based on complexity of the work. Work planning complexity levels now consist of:

- Minor work is skill based and allows the workers with their supervisor to perform work with them using the Worksite Hazard Analysis form to identify and select the appropriate controls.
- Standard work that uses the supervisor and planner to develop the work instructions after performing a walk-down of the jobsite using the worksite hazard analysis and then reviewing the tasks selecting any critical hazards and using a Hazard Analysis Checklist that asks thought provoking questions to ensure the work includes the proper controls and instructions.
- Complex work uses a team approach of workers and SMEs to perform the same activities as described for standard work with a Safety Plan being developed to capture the team's collective decisions.

Implementation Lessons Learned

1. It is important to take the theoretical concepts introduced in HPI training sessions and explore opportunities for practical implementation.
2. It is important not to try and force fit all of the concepts in HPI into all aspects of organizational processes.
3. It is important to keep all facilities and organizations involved during the process. Not doing this makes implementation in that facility or organization a lot less effective and slower to evolve than it could be and jeopardizes the entire process changes.
4. It takes significant management attention to make significant change and that change will not happen immediately. It is expected that we have at least another year for a total of two years before the changes made in our processes will be institutionalized and understood by everyone.
5. Many of the HPI concepts were dramatic shifts in the way we do business. The people and in some cases managers have difficulty keeping on a course to improve if they are not coached or mentored regularly.

3.7 EVENT INVESTIGATION/CAUSE ANALYSIS

Introduction

Event investigation is a unique opportunity to improve performance because the event investigation can assess the performance of the organization to identify areas for improvement and the event provides motivation to improve performance. HPI assesses the

role of the organization in an event which may not be thoroughly done by conventional root cause analysis. The advantage of applying HPI to an investigation is that it defines the context of processes as they relate to individuals involved in an event, and establishes a process to identify organizational issues. HPI in combination with Root Cause Analysis (RCA) allows for the identification of underlying reasons for a failure, problem, or deficiency, which if corrected, will provide a more comprehensive evaluation. Both processes play a very important role in answering question and solving issues. Experience has shown that the two processes are not exclusive of each other, but rather are a holistic process for performing causal analysis. BNI took the lead in exploring how HPI tools could help with their event investigation process. They conducted several event investigations using both HPI and RCA processes to allow a comparison of results. This paper provides a summary of their experience.

Resource Expectations

In addition to HPI training, the time needed to complete the investigations ranged from one to two weeks, utilizing a minimum of two trained investigators. However, the level of effort required performing the combined HPI/RCA investigation was not appreciably greater than that historically required to do an RCA.

Summary of Hanford Experience

The process used by the investigators closely followed the process described in the book "*The Field Guide to Human Error Investigations*" by Sydney Dekker. The investigators used HPI tools to help recreate the mindsets and environment of the people involved to determine how the environment influenced their decision making process. Once the context was understood then the performance of the organization was evaluated.

The process used was to conduct interviews of the personnel involved in the event one at a time. The interviewers asked the person to describe their involvement in the event in their own words. All questions were phrased in an open ended way and were designed not to lead the person. Once the person finished their story in their own words, the interviewer would ask any questions necessary to clarify any points in the story. The interviewer then asked the person to help identify any critical junctures in the process where critical decisions were made, or where critical decisions should have been made but were not.

Once all the people were interviewed, the investigators developed the context of the critical junctures to understand why the decisions and actions of the people involved in the event made sense to them at the time. HPI tools were used to identify error precursors and organizational weaknesses at the critical junctures. Issues identified at multiple critical junctures were then pulled together and used as the basis for improvement.

The investigators used HPI tools to help recreate the mindsets and environment of the people involved to determine how the environment influenced their decision making process. In other words, the process attempts to assess the context of the decisions and behaviors of the people involved in the event. No employee functions in a vacuum without the influence of multiple factors weighing in on every decision that is made. The context of the employee's efforts becomes paramount to understand how to assess and improve the performance of the

organization. Once the context is understood, then the performance of the organization can be evaluated to locate latent organizational weakness. Latent organizational weaknesses will lead to failed defenses that increase the likelihood of events.

Because of the differing perspective of an RCA and a HPI investigation each review provides a different but important view of the event. The RCA is designed to look closely at the event to identify the root cause, and therefore focuses closely on the people and procedures involved in the event. The HPI investigation develops the context that made the decisions and actions of the people involved rational at the time they were made so that the role the organization played in the event can be determined. For example, the table below lists the conclusions made during a recent HPI/RCA investigation. Workers were tasked with removing steel beams that had been installed to provide temporary support for large embed items until the concrete obtained sufficient strength to support the load. Permanent and temporary beams looked alike so someone at an earlier time had marked some beams with the word "remove" to prevent commodities from being attached to the temporary beams. The work package contained drawings with the temporary beams marked with "**" after the item number. After cutting each end of a beam, a first line supervisor reviewing drawings determined that the workers had inadvertently cut the wrong beam and stopped the activity. A review team was assembled to identify organizational weaknesses by evaluating the event using the HPI evaluation process. A RCA was also performed to provide a supplemental analysis process complimentary to the HPI. The following conclusions were made during the HPI/RCA investigation.

Identified by Root Cause Analysis	**Attributes identified during the investigations**	**Identified by HPI investigation**
X	No written process was in place to control removal activities.	x
X	Management needs to create and communicate clear expectations for pre-job briefings and walk downs.	x
	Site work processes failed to ensure that work was performed safely and a quality product was produced.	x
	The process has involved supervision to the point that their ability to perform the role of a supervisor has been impacted.	x
X	Work execution followed informal processes.	x
	Processes failed to identify and communicate critical attributes (e.g. don't cut the wrong beam, protect workers).	x
	Multi – tasking by supervision.	x
	Workers are responsible to request technical expertise needed for relevant safety issues.	x

The RCA found that people failed to adequately communicate and that the procedures were inadequate. The HPI investigation found that the organization failed to support the workers. Supervisors were so involved in the work and had so many responsibilities that they were

unable to step back as a supervisor and observe to ensure that the work was progressing safely and a quality product produced. The organization failed to define the critical attributes of success for workers. For example, a critical attribute of success was "don't cut a permanent beam." Cutting the wrong beam was not only a quality issue, but also could have been a safety issue had the beam cutting resulted in a structural collapse. Had the attribute "don't cut a permanent beam" been identified, then the Quality Control (QC) inspection specified in the work package would have been moved from an inspection after a beam was removed, to an inspection to verify that it was the correct beam before starting to cut the beam.

During the HPI investigation interviews it was discovered that in addition to cutting the wrong beam, the workers became very ill and could have been over exposed to zinc oxide. It was found that the organization had failed to properly protect the workers from the smoke resulting from the burning coatings on the beam while cutting the beam. The HPI investigation determined that the site culture relied on workers to determine the controls necessary to protect workers instead of requesting technical expertise needed for relevant safety issues. The RCA did not find the worker exposure issue in their review. The full report for the beam cutting investigation is contained in HLW Beam Removal Investigation. The following additional event investigation reports can be reviewed for comparison: Human Performance Improvement Assessment of Recurring Inadvertent Impacts by Construction Equipment, DOE ORP Human Performance Assessment/Accident Investigation Report, and Human Performance Improvement Review – Incorrect Welding Rod Verification.

As a point of emphasis, the purpose is not to demonstrate that one technique is better than the other, but rather they are complimentary. Organizations continually miss opportunities for improvement by relegating human error to a fault based system (blaming people, training, and procedures) rather than truly understanding the role of the organization in events (56% of all events are caused by the organization). People make errors, events occur because of failed defenses. The RCA provides the structure for identifying causes of unwanted conditions and actions and allows for development of specific corrective actions to prevent recurrence. HPI compliments RCA by identifying areas for improving the performance of the organization. Because the organization supports all activities, improvements in performance have the benefit of preventing events in other areas of the organization by correcting weaknesses that affect all.

Lessons Learned

Based on BNI's experience, human performance is closely related to the system of processes, values, job-site conditions, behaviors, and their outcomes. Event-free performance is affected by error-prevention practices and by the integrity of an organization's administrative and work processes, culture, policies, technology, etc. Unwanted events, which are the subject of RCA, must account for the affect of organization on human performance.

Buy in by functional organizations that own corrective action management, event investigation and RCA is necessary, as RCA is highly institutionalized in processes like the Corrective Action Management (CAM) system, Non-compliance Tracking System (NTS), and deficiency tracking systems.

In the beginning, HPI investigations should be done in addition to the traditional methods of investigation established in the organization in order to demonstrate the value of 'context' and the role that error likely situations and organizational weaknesses had on influencing the error.

HPI investigations need to evaluate both error precursors and performance of the organization, focusing in on the eroded or lacking defense/barrier as the cause and not the error precursor as the cause of an event.

Additional Event Investigation References

Human Performance Interview Questions

Human Performance Interview and Investigation

Event Investigation Process

Apparent Cause Analysis and Corrective Action Planning

Root and Common Cause Analysis and Corrective Action Planning

Human Performance Interview

Human Performance Improvement

3.8 CULPABILITY MATRIX

Introduction

Approximately 70% of all human error related events are influenced by organizational processes and values. Traditional management of human performance and disciplinary processes have focused on the 'error prone' or apathetic individual. These processes focus on the individual, their knowledge of the rules and requirements, and punish them for non adherence and violations. Determining the level of Culpability between the individual error and the weaknesses in the organizational processes is necessary in order to apply the right corrective actions and improvements for both the situation and the behavior. Hanford embarked on the use of the Human Performance Culpability Matrix (HPCM) as a tool used to establish the level of personal responsibility one would expect to accept for an act (behavior) that resulted in an adverse event.

Resource Expectations

Commitment to implementation of the HPCM and a process of determining the appropriate level of responsibility for adverse events is less financial and more an effort to change traditional mindsets. Resource requirements include education of labor representatives, workforce services representatives, and supervision on HPI Fundamentals, including the HPCM. Formalization of the process through development of procedure or guidance

information on the HPCM's use, and also development on an investigative tool (interviews) to provide the details and context of the situation being analyzed.

Summary of Hanford Experience

Installing the use and proper application of the HPCM (Human Performance Culpability Matrix), requires education and buy in by labor representatives, workforce services personnel, and legal counsel. In addition, the proper incorporation of the HPCM tool and use of its results must be established and clearly communicated.

The HPCM was an easy sell to labor representatives because it addresses the belief that most individuals are trying to accomplish work in a safe manner. It also brings forward into the investigation process those issues that ultimately are raised during grievance and arbitrations in the form of "the worker was set up to fail." Those issues of "set up for failure" come in the form of statements that "everybody does the job that way," "the procedure has always been wrong," "supervision told us just to get it done." All of these issues, if valid, are the erosion of the expected work processes (procedure norms) and the new 'norm' for the organization is something less than the written requirement.

Buy in from workforce services and company legal counsel is somewhat more difficult than organized labor agreeing to use of the HPCM. Here the traditional mindset of structure and consistency 'glues' the world together and results in successful corporate outcomes to hearings and arbitrations. The real belief by workforce services and legal, that if the rules change in the current discipline process that past applications of discipline will come into questions, prevents an immediate buy in to the new HPCM process. Agreements between labor and workforce services to 'draw a line in the sand' and start a new process are required to be successful in implementing the HPCM.

Appropriate placement of the HPCM tool and instruction on its use is important to the success. The HPCM should not replace processes of critiques or event investigations, but instead be viewed as separate, or at least prior to critiques or incorporated into the interview process of event investigations. Information gained from interviews during Critiques and Event Investigations is vital in reconstructing the individual's mindset and the context of the situation in order to properly use the HPCM and to effectively determine Error Modes (knowledge, rule-based, skill).

Once the interviews and events investigations are near completion, the HPCM becomes useful in framing the information and determining the degree of influence the organizational weakness may have had on the human error within an adverse event. Once the HPCM process has been used the results should be the basis for corrective action, reporting and any review of individual improvement plan or discipline.

Implementation Lessons Learned

1. Client (DOE) understanding and commitment to the HPCM is necessary as the local DOE Field Element will begin to see changes in the contractor information, labor discussions and event reporting. Without the client's knowledge and buy in to the use of the HPCM, the outcome results of the HPCM could be viewed as contract or

compliance failures, rather than explained as isolated employee errors, and result in negative criticism of the Contractor's performance that would quickly end the implementation of the HPCM.

2. Traditional workforce representatives, human resource managers, and legal counsel are focused on a structured disciplinary process that relies on consistency in its application entrenched in a belief that safety rules are established and individuals adhere to the rules or are subject to some level of discipline. The concept of structure and consistency must be maintained in the disciplinary review process, with the addition of a new view of human error. The HPCM should be a tool used to provide information and clarity of organizational influences on the particular event and the degree of individual responsibility to influence the event. Once these influences are understood, they can be used for the purposes of defining corrective actions, including levels of individual discipline.

3. Beginning the process with a meeting to gain understanding and mutual buy-in of labor, workforce services, and legal organizations is essential to success.

4. The perception that the HPCM is a way to avoid individual disciplinary action can cause confusion on the part of employees and workforce service personnel. Addressing these misconceptions as they arise, and reinforcing in HPI training that culpability means the degree of responsibility and does not always equal 'blameless' error in events.

5. Implementation and use of the HPCM must address the misconception that information from the HPI interview process conducted during an event is 'in confidence' and will not be used in a review of individual discipline. Results from investigations, interviews, and statements are vital in reconstructing the mindset of individuals and the context of the situation when using the HPCM. The results of the HPCM being used for determining corrective actions, including reviews of individual discipline is a proper used of the tool.