Office of Independent Oversight and Performance Assurance
Office of Security and Safety Performance Assurance
U. S. Department of Energy

Investigation of Worker Vapor Exposure and Occupational Medicine Program Allegations at the

Hanford Site

April 2004

SSA

Office of Security and Safety Performance Assurance

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA ·

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Abbreviations Used in This Report

ACGIH	American Conference of Governmental Industrial Hygienists
AIHA	American Industrial Hygiene Association
ALARA	As Low As Reasonably Achievable
AMZ	Air Monitoring Zone
AOP	Abnormal Operating Procedure
APF	Assigned Protection Factor
BHI	Bechtel Hanford, Incorporated
BHS	Behavioral Health Service
BNI	Bechtel National, Incorporated
CAIRS	Computerized Accident/Incident Reporting System
CAM	Continuous Air Monitor
CFR	Code of Federal Regulations
CRD	Contractor Requirements Document
CVST	Chemical Vapor Solutions Team
CY	Calendar Year
DOE	U.S. Department of Energy
DRI	Direct-Reading Instrument
DST	Double-Shell Tank
DTPA	Diethylenetriaminepentaacetate
EJTA	Employee Job Task Analysis
EM	DOE Office of Environmental Management
ERT	Employee Response Team
ES&H	Environment, Safety, and Health
ESQ	Environmental Safety and Quality
FHI	Fluor Hanford, Incorporated
FR	Facility Representative

(Continued on inside back cover)

OVERSIGHT

1.0 Introduction

At the direction of the Secretary of Energy, the Office of Independent Oversight and Performance Assurance (OA) conducted an investigation of selected aspects of worker safety and health systems at the U.S. Department of Energy (DOE) Hanford Site in February-April 2004. OA is part of the Secretary of Energy's Office of Security and Safety Performance Assurance. In February 2004, the Secretary of Energy directed OA to evaluate recent allegations of deficient safety and medical practices and to assess past practices and current operations to determine whether additional actions are needed to ensure a safe work environment at the Hanford Site.

The allegations address whether workers were adequately protected against exposure to vapors at the Hanford Site Tank Farms, whether workers received appropriate medical treatment after a perceived exposure, and whether exposure events are reported properly and accurately. Consequently, OA focused its investigation on vapor management at the Tank Farms and the occupational medicine program and illness/injury reporting practices as they relate to Tank Farm operations. Because the occupational medicine program and injury/illness reporting processes encompass all workers at the Hanford Site, OA also examined whether the allegations might have implications for other Hanford Site workers.

OA coordinated with the DOE Office of the Inspector General in the conduct of this investigation. OA focused on the aspects of the allegations relating to worker safety. Concurrently, the Office of the Inspector General investigated the allegations to determine whether any laws were broken and whether there was any evidence of waste, fraud, or abuse.

The Hanford Site Tank Farms

The Hanford Site is located in southeastern Washington. The Hanford Site Tank Farms are used to store and process highly radioactive and hazardous waste, which was generated by past Hanford Site activities. Sixty percent of the nation's high-level radioactive waste is stored at Hanford in 177 large underground tanks. The tanks are aging and some are deteriorating, and some tanks are of a single-shell design that provides less assurance of containment than the newer double-shell design. If not properly managed, this waste poses a threat to the Columbia River and the Pacific Northwest.

The current mission of the Tank Farms is to safely prepare the waste so it can be vitrified into glass logs by processing through a new vitrification treatment plant currently being built on the Hanford Site. This mission includes retrieving waste from single-shell tanks so they can be closed. Tank Farm activities involve various potential hazards that need to be effectively controlled. These hazards include exposure to external radiation, radiological contamination, hazardous chemicals, and various physical hazards associated with facility operations.

Hanford Site Tank Farm During Construction

Of particular relevance to this investigation is that the materials in the tanks generate various gases, such as hydrogen, and vapors, such as ammonia and various volatile organic compounds. These gases and vapors can escape the tanks through normal venting and other leak paths. Some of the vapors produce unpleasant odors and can cause such reactions as coughing and skin irritation; at higher concentrations, some of the vapors are hazardous to human health. Additional information on Tank Farm operations, materials, release paths, controls, and vapor exposures is provided in Appendix C of this report.

Hanford Site Organizations

The DOE Office of Environmental Management (EM) is the lead program secretarial office for the Hanford Site. As such, it has overall Headquarters responsibility for most activities at the site. In March 2002, EM issued a letter of intent documenting the agreement between the State of Washington, the United States Environmental Protection Agency, and the DOE to accelerate completion of the cleanup of the Hanford Site from a 2070 timeframe to 2035, and possibly as soon as 2025. A key element of this accelerated strategy was accelerated tank waste retrieval and closure demonstration. The tank waste retrieval and closure work forms the bulk of work efforts at the Tank Farm today.

At the site level, line management responsibility for the Tank Farms falls under the Manager of the DOE Office of River Protection (ORP), which manages the prime contract for Tank Farm Activities – CH2M HILL – and one other ORP prime contract – Bechtel National, Incorporated (BNI). ORP was established as a separate organization reporting to EM in 1998 in an effort to increase accountability for the success of the Tank Waste remediation efforts and streamline the management structure and the decision-making process. Major objectives of the ORP included completing cleanup sooner; driving early progress on waste retrieval, treatment, and tank closure; improving the environment for contractor performance; reaching agreements with regulators and stakeholders for better technical solutions; and better management of risks and vulnerabilities.

The DOE Richland Operations Office (RL) manages relevant sitewide programs, including the site occupational medicine contract and the sitewide DOE employee concerns program. RL also has DOE line management responsibility for most other Hanford Site activities (excepting the River Protection Project) and manages site contracts for work performed by two other site prime contractors: Fluor Hanford, Incorporated (FHI) and Bechtel Hanford, Incorporated (BHI). RL currently has contract management responsibility for the Pacific Northwest National Laboratory (PNNL), pending a transition to the Office of Science (SC). RL also provides support to ORP in some areas through memoranda of agreement, including technical support in such areas as industrial hygiene. The Hanford Environmental Health Foundation (HEHF), under contract to RL, manages the Hanford Site occupational medicine program, which encompasses all Hanford workers (including Tank Farm workers) except BNI.

PNNL is being managed and operated by Battelle Memorial Institute under the existing contract with RL. SC and RL plan to transfer responsibility for contract management of PNNL to SC in the near future. SC recently established the Pacific Northwest Site Office (PNSO) to assume site-level DOE line management responsibility for PNNL. PNSO staff previously reported to RL as the mission element responsible for PNNL oversight. In the interim, PNSO staff perform oversight activities of PNNL in support of RL.

The Allegations

In September 2003, the Government Accountability Project (GAP) issued a report entitled *Knowing Endangerment* that alleged deficiencies in worker protection at the Hanford Tank Farms that led to worker vapor exposures and illnesses. Specifically, GAP alleges that workers were sick and injured after being exposed to vapors from high-level nuclear waste tanks and other toxic and carcinogenic substances. The GAP report and subsequent GAP statements also allege that there were instances of improper medical record keeping (including falsifying records and collusion to undermine worker compensation claims). Further, GAP alleges that there have been instances where injuries and illnesses have not been properly reported. DOE line management and contractor organizations with safety and health responsibilities for the Hanford Site Tank Farms have been working to address the allegations in the GAP report.

The Investigation

The OA team consisted of 23 experts from various disciplines, including occupational medicine, industrial hygiene, radiological protection, nuclear engineering, waste management, environmental protection, chemistry, maintenance, operations, and management systems. The OA team included personnel from other DOE sites, who had specialized expertise in industrial hygiene and Tank Farm operations. The OA team conducted four site visits during February-April 2004. Details of the investigation schedule and team members are included in Appendix A.

OA conducted its review using standard OA protocols for work observations, facility and system walkdowns, interviews, and document reviews. OA also designed and implemented a sampling strategy to

collect a set of independent samples at the Tank Farms. The sampling and analysis were performed by another DOE organization at the direction of OA. OA followed established protocols for communications with the site, including frequent communications and an extensive validation process.

Scope

The OA investigation addressed organizations with safety and health responsibilities relevant to the Tank Farm workers and GAP allegations, including: EM, RL, ORP, HEHF, and CH2M HILL. To gain a broader perspective on the medical program and injury and illness reporting, OA also examined relevant practices and records of other Hanford Site contractors, including FHI, BHI, BNI, and PNNL.

The OA investigation focused on worker vapor exposures and associated allegations about the medical program and injury and illness reporting. OA reviewed past practices as they relate to issues and allegations identified in the GAP report, with emphasis on the timeframe relevant to the GAP allegations (nominally January 2002 to the present). The intent of the OA investigation was not to evaluate each individual GAP allegation; rather, OA focused on evaluating the effectiveness of the underlying safety programs and processes in the areas of alleged weakness. OA also reviewed current institutional safety and health processes and work performance at the Tank Farms, including recent and ongoing modifications to safety systems and procedures.

The OA investigation and report addressed three major areas:

- **Tank Farm worker vapor exposures**. OA examined current and past worker safety practices to determine their effectiveness in preventing worker exposures to vapors and other hazardous materials that could cause illnesses. Because engineered safety systems are a critical barrier in preventing worker exposures, OA reviewed selected aspects of safety systems, including recent modifications. OA also looked at various processes by which Tank Farm workers may raise safety questions or report concerns.

- **Occupational medicine program.** OA examined current and past occupational medicine program practices, focusing on aspects relevant to the recent allegations. OA reviewed the medical treatment of Tank Farm workers, focusing on those with vapor exposures, and also examined occupational medicine program issues for sitewide applicability.

- **Injury/illness investigation and reporting.** OA evaluated the adequacy of the injury and illness policies and processes for CH2M HILL and the other Hanford Site prime contractors. Documentation related to injuries and illnesses was reviewed to determine whether contractor policies and procedures have been properly implemented and whether DOE and Occupational Safety and Health Administration (OSHA) requirements have been met. Selected workers involved in Tank Farm exposure incidents were interviewed to determine the effectiveness of illness and injury reporting.

For the above focus areas, OA evaluated identified weaknesses to determine contributing causes by examining relevant safety management systems, such as contractor feedback and improvement systems, and DOE line management oversight.

Organization of the Report

Sections 2, 3, and 4 summarize the results of the review for the three major focus areas: Tank Farm vapor exposures, occupational medicine program, and injury and illness reporting, respectively. Appendix A provides supplemental information, including the team composition. Appendix B presents the findings that require development of formal corrective action plans. Appendices C, D, and E provide the detailed investigation results for the three major focus areas, respectively.

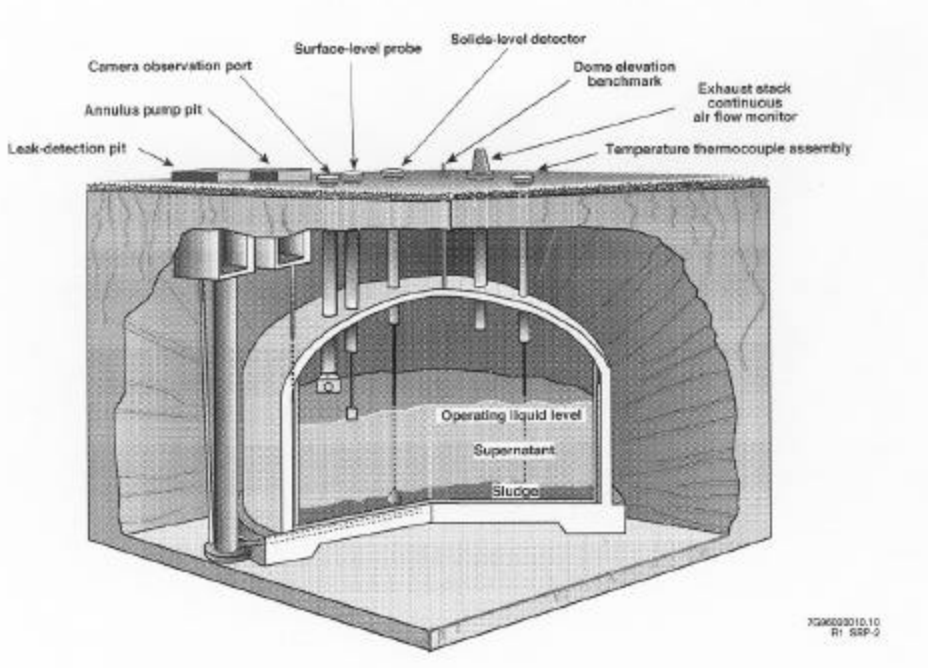
2.0 Tank Farm Workers' Exposure to Vapors

The strategy for protecting workers against vapor exposures starts with a characterization of the types and quantities of hazardous materials in the tank that could be released in gaseous or vapor form. Based on the site's characterization of the hazards, the protection strategy relies on three general types of controls: engineered controls (e.g., venting and filter systems), administrative controls (air monitoring zones), and personal protective equipment (e.g., respirators). Historically, the CH2M HILL strategy has been to implement protective measures that keep worker exposures below established regulatory limits.

2.1 Positive Attributes

EM, ORP, and CH2M HILL have taken interim actions to improve worker safety. After the two-week data collection portion of this investigation, all non-essential work at the Tank Farms was curtailed, and CH2M HILL mandated that workers use personal respiratory protection while performing the remaining, essential tasks at the Tank Farms. This decision was made as a result of several additional vapor exposures that occurred during the investigation and discussions among EM, ORP, and CH2M HILL, as a result of which ORP directed CH2M HILL to continue the use of respiratory protection until they completed several interim corrective actions to address worker protection issues. Those actions included requirements for respiratory protection for any entry to the fenced area of the Tank Farms, re-evaluation of existing industrial hygiene data, acceleration of engineered controls, revision or development of procedures for industrial hygiene monitoring and sampling, implementation of personal breathing zone sampling, increased training and qualification for respirator use, and accelerated self-assessment of the radiation protection program. On April 15, 2004, based on potential nitrous oxide exposure concerns identified by the OA team, additional respiratory protection measures and industrial hygiene monitoring controls were imposed by CH2M HILL management for all waste tanks without active ventilation.

Over the past two years, ORP and CH2M HILL have devoted significant resources and management attention to resolving the vapor exposure issue and enhancing



Schematic of Tank

communications with workers. CH2M HILL has recently introduced several mechanisms to improve communication channels between management and Tank Farm workers regarding tank vapor issues, including formation of the Chemical Vapor Solutions Team and increased involvement of the Employee Response Team (an ombudsman group) in vapor concerns. CH2M HILL has also increased the number of Hanford Atomic Metal Trades Council safety representatives in the past year. In addition, CH2M HILL developed an eight-hour Chemical Hazards Awareness training course to provide basic fundamentals training for Tank Farm workers. Management has also established its "as low as reasonably achievable" (ALARA) approach to chemical exposures to address worker concerns. In 2003, the company implemented a tank chemical vapor project, formalizing and scheduling the various activities addressing tank vapors. As part of this effort, a number of enhancements to engineered controls, personal protective equipment, and administrative controls have been implemented, and various other options are being evaluated. Many of these enhancements were under way when the GAP report was issued. For example, CH2M HILL's program to seal potential leak sources from the tanks has been successful in reducing many of the fugitive vapor emissions.

ORP and CH2M HILL have taken actions to develop a better understanding of the vapor exposure issue and its potential impact on the workers. ORP and CH2M HILL have tasked several external organizations and consultants to perform assessments of the vapor exposure issue and/or the industrial hygiene program. The reviews were performed by health and safety professionals contracted by CH2M HILL; a Paper, Allied-Industrial, Chemical & Energy Workers International Union (PACE) health and safety specialist; Dupont Safety Resources; and the National Institute for Occupational Safety and Health (NIOSH). Collectively, these reviews provide a comprehensive assessment of a number of programs and practices for the identification and control of hazards associated with chemical vapor exposures in the Hanford Tank Farms. CH2M HILL also instituted a low threshold problem reporting system, which encourages reporting vapor odors. About 70 recommendations were made for improvements in such areas as engineered controls, characterization of gases in tank headspaces, measurements of vapors in work areas, personal exposure monitoring, respiratory protection, exposure databases, and training and worker involvement. Many of these recommendations were only recently received by CH2M HILL and thus have not yet been fully implemented.

2.2 Weaknesses

CH2M HILL tank characterization and personal sampling data is too limited to conclude that the exposure of all workers is below regulatory thresholds for all chemicals to which they might be exposed. In the waste tanks evaluated by the OA team, concentrations of some chemicals in the tank headspaces were above levels of regulatory concern. Although there are no records of Tank Farm workers having been exposed to chemical vapors from the Hanford waste tanks in excess of regulatory limits, the CH2M HILL personal sampling data is too limited to conclude that the exposure of all workers is below regulatory thresholds for all chemicals to which they might be exposed. Furthermore, because of weaknesses in the industrial hygiene program identified in this report and through CH2M HILL self-assessments and external reviewers, worker exposures to some waste tank vapors cannot be determined because of insufficient exposure data, uncertainties in the detection of some chemicals, or inconsistencies in the collection and recording of the data.

Significant vulnerabilities in the CH2M HILL industrial hygiene program will, until corrected, continue to raise uncertainties in determining whether some workers are being overexposed to some chemical vapors. Specific concerns that require management attention include insufficient sampling and characterization of tank vapors, insufficient personal vapor exposure data, inadequate direct-reading instrument and personal exposure records, limitations of instruments to detect some vapors, lack of industrial hygiene technician procedures, insufficient industrial hygiene technician training and qualification, and shortcomings in the respiratory protection program.

Implementation of work planning and safety controls is not sufficiently rigorous. Hazard identification and analysis have not always been sufficiently detailed, and in some cases, the predominant hazards of the work were not adequately covered. Identification and implementation of controls have been weak, with significant reliance on individual expertise and interpretation to protect workers from radiological and chemical hazards. Consequently, in some cases workers were not aware of appropriate controls. In other cases, workers did not appropriately implement the specified controls while performing work. Although

the work control processes clearly establish requirements for work planning, these processes need improvement and warrant additional management attention.

Some aspects of communications to workers have not been effective. Reports of worker exposures to chemical vapors have increased over the last few years because of a combination of factors, including lower thresholds for reporting vapor exposures and increased worker awareness of vapor issues. Some Tank Farm workers remain concerned about the health risks associated with chemical vapor exposures, and their concern increases as reported exposure events become more frequent. Some workers fear that their exposures may be higher than indicated by industrial hygiene monitoring because the acute symptoms that some workers are experiencing are more severe than would be expected based on monitoring results. Continuing events involving acute symptoms also contribute to worker distrust in current tank vapor characterization measurements performed by industrial hygiene as well as management's assertions that no exposure limits have been exceeded. Several CH2M HILL workers interviewed by OA did not trust the industrial hygiene program justifications for lack of respirator requirements for Tank Farm jobs. Although CH2M HILL management has established a voluntary respiratory protection program, workers were not comfortable using voluntary respiratory protection because of negative peer pressure and the perception by other workers that it was a sign of weakness. In addition, several CH2M HILL interviewees stated that the process and paperwork needed to obtain voluntary respiratory protection were too much trouble and too time consuming.

Weaknesses in design, testing, maintenance, and configuration management of engineered controls reduce their effectiveness. Over the past 15 years, the conceptualization, analysis, detailed engineering, and execution of engineered measures have not been adequate to provide generally effective engineered vapor controls for the Tank Farms. These efforts have not always been successful, and some currently installed controls are less than optimally effective. Additionally, some fundamental engineering considerations relating to other aspects of tank safety have been overlooked. The most significant of these involves potential threats to tank integrity from excessive vacuum. OA identified a number of specific conditions that could cause excessive vacuum in both the single- and double-shell tanks. For example, contrary to industrial code requirements and commonly accepted

Industrial Hygiene Vapor Sampling

good engineering practice, most actively ventilated tanks did not have specifically engineered relief devices. When these conditions were discovered, the site suspended all activities that could challenge the tanks' integrity, except for routine operator rounds, pending tank-by-tank operational evaluations. The main contributors to these deficiencies appeared to be engineering process weaknesses, including engineering procedures lacking in requirements to specifically consider the reduction of worker vapor exposures and the protection of the tanks from such threats as excessive vacuum. A related weakness is the inadequate application of existing process requirements, such as rigorous configuration controls, to changes in the tanks and related procedures. For example, the tank sealing efforts were not treated as modifications and thus did not undergo all of the applicable rigorous, formal, documented procedural steps that are needed to ensure complete, valid technical considerations and effective configuration control.

CH2M HILL's corrective action program has not always been effective in defining and investigating issues related to Tank Farm vapor releases and exposure incidents or in establishing actions that effectively prevent recurrence of personnel vapor exposures. Notwithstanding the many improvements and actions taken to address tank vapor issues, many systemic deficiencies in the implementation of corrective actions and issues management processes are apparent and are impeding efforts to prevent tank vapor exposures. For the more than 60 vapor exposure incidents reviewed by the OA team, industrial hygiene routinely conducted monitoring of field conditions, but only two were subject to formal event investigations, and only one event investigation related to vapor exposures was conducted in each of the years 2001, 2002, and 2003. Many of the reported

vapor exposures have occurred during routine survey and maintenance operations that are not subjected to formal post-job reviews and, therefore, the post-job review process has not aided in developing measures to prevent vapor exposures. The formal lessons-learned process has also not been used to communicate vapor exposure event lessons. Although informal communications, such as company newsletters and Tank Farm-wide email, have communicated information on vapor events and initiatives, only one of the 161 formal lessons learned issued by CH2M HILL since January 1, 2002, involves vapor exposures. This lesson learned was a bulletin issued on January 9, 2004, regarding the application of ALARA principles to all safety programs, with several mentions of vapor exposures and industrial hygiene. In addition, investigations and corrective actions to address vapor events and issues have not always addressed all pertinent elements, and some actions have not been completed in a timely manner. For example, significant recommended actions from a March 2002 review—for establishing an exposure monitoring program and an exposure monitoring results database—have still not been implemented. Although there may be differences in various characteristics and details, the issues identified in a 1992 Type B investigation of recurring worker exposure events and many of the resultant judgments of need continue to persist, more than a decade later.

ORP has not adequately addressed weaknesses in its oversight of the CH2M HILL industrial hygiene program and has not ensured timely corrective actions for identified issues. ORP currently does not have sufficient industrial hygiene expertise to adequately perform its line management oversight responsibilities, which include industrial hygiene assessments and routine evaluations. Although the recent reactive reviews and interim actions to obtain industrial hygiene support from other DOE organizations are appropriate, ORP has not devoted sufficient attention and resources to performing effective line management oversight of the industrial hygiene program, issues, and ongoing corrective actions at the Tank Farm. Insufficient industrial hygiene expertise on the ORP staff is a particular concern in light of the longstanding and recurring vapor exposures and the need for ORP to understand and evaluate the complex and interrelated industrial hygiene issues raised by various CH2M HILL and external reviews.

2.3 Conclusions

Vapor exposures at the Tank Farm are a longstanding concern, and warrant increased management attention. While there are no known instances of exposures above regulatory limits, the longstanding deficiencies in the characterization of the Tank Farm vapors and industrial hygiene program are such that the site cannot adequately assure that all exposures are below regulatory limits. Regardless, exposure to even low concentrations may have caused symptoms to workers and, thus, need to be addressed.

The interim actions instituted by ORP and CH2M HILL, which include respiratory protection for most Tank Farm work, provide assurance that most aspects of the immediate concerns are addressed. The ongoing and planned actions, including the recent decisions to address tank characterization and industrial sampling issues and to provide better personal sampling, provide a good framework for developing longer-term solutions. To ensure that the vapor exposure issues are fully addressed, improvements are needed in various management systems, including engineering processes, industrial hygiene programs, integrated safety management implementation, communications, CH2M HILL feedback systems, and ORP line management oversight.

Vapor issues at the Tank Farms have been the subject of numerous assessments in the past few years, including this OA investigation. Collectively, these assessments provide ORP and CH2M HILL with a good understanding of the issues and the weaknesses in the current safety and health programs at the Tank Farms. While many individual weaknesses need to be addressed, the overarching weakness is that the overall strategy for protecting workers from vapors is not adequately defined and documented at a level that can be translated into an adequate set of engineered controls, administrative controls, and personal protective equipment.

CH2M HILL has adopted its ALARA approach as the starting point for such a strategy but has not taken the next steps of determining an adequate basis for requisite elements, including characterization of the vapors in the tanks (i.e., the chemicals of concern and the conditions under which they are likely to be released) and a technically sound industrial hygiene program that provides for an appropriate spectrum of sampling, breathing zone monitoring, and personnel air monitoring. Until a protection strategy is defined and supported by an effective industrial hygiene program, a conservative approach to the use of personal protective equipment is warranted.

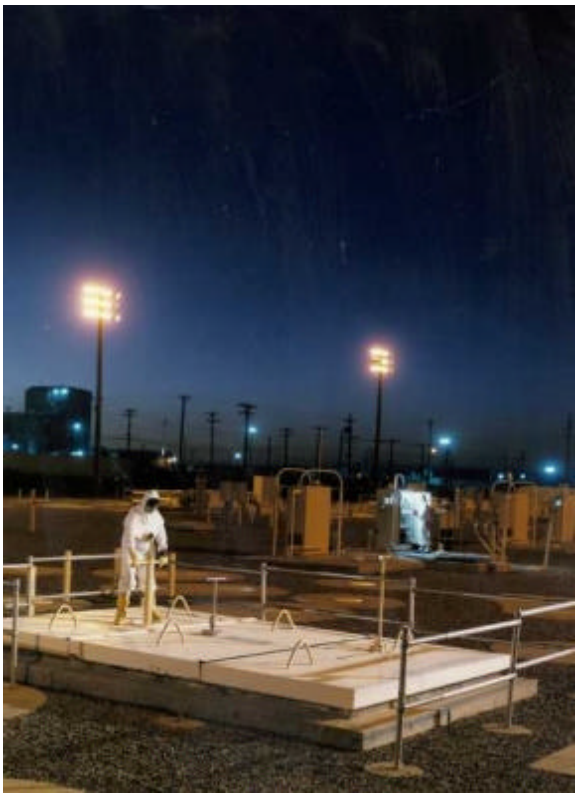
3.0 Occupational Medicine Program

The Hanford Site has an occupational medicine program that serves all Hanford Site contractors except BNI (which was authorized by DOE to subcontract to its own occupational medical provider). Under contract to RL, the HEHF manages and operates the primary occupational medicine program for the Hanford Site, including the main clinic in Richland and a satellite facility in the 200 Area. In 2003, the HEHF medical program contract was up for recompetition, and another company was awarded the contract in January 2004. However, HEHF and other bidders filed protests, and HEHF is continuing to manage the occupational medicine program under contract extensions pending final decisions.

The occupational medicine program performs various functions as required by DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*. For example, the occupational medicine program provides medical treatment, keeps health records for Hanford Site workers, and has responsibility for performing, tracking, and coordinating medical issues, including trending of health issues for all site contractors.

3.1 Positive Attributes

Medical records are effectively maintained and provide an accurate history of treatment. The OA team performed a detailed review of medical records of 75 workers, including the 53 identified in the GAP report; conducted numerous interviews with HEHF medical staff and Tank Farm workers; and reviewed HEHF administrative procedures and protocols. The data collected by the OA team did not substantiate any of the health-related GAP allegations, except for some isolated instances of incomplete treatment information being provided to contractor record-keeping case managers. In fact, medical records were detailed and well organized, and are controlled by strict record-keeping practices. Laboratory and other medical tests, a part of the vapor exposure exam protocol, were accomplished (unless declined by the employee) and properly included in the medical record. In all cases of vapor exposure, the incident history and physical examination were properly conducted and findings were recorded in the medical record. At the time of examination, all cases were documented as work-related.



Hanford Site - Tank Farm at Night

The occupational medicine program is providing quality health care to the workforce. The OA team found the clinical practices and protocols to be consistent with standard occupational medical practices. The medical staff has excellent professional credentials, and it was apparent that quality worker health care was a priority of the organization. In response to workplace exposure incidents, HEHF developed a protocol entitled "Exposure and Unusual Event Service," which has been in effect since 1996 and has been updated five times since then. It provides reasonable guidance to the medical providers at both HEHF and the local hospital for evaluation,

testing, and follow-up on employees after exposure to vapor. Typical symptoms of vapor exposure included weepy, stinging eyes, scratchy throat, metallic taste in the mouth, raspy voice, headache, and skin irritation in some patients. Symptomatic treatment was provided, and many patients were free of symptoms within a day (most within three to five days). A few workers experienced lingering symptoms, usually respiratory in character. Medical follow-up was always afforded to patients until recovery was complete, including consultation with outside specialists.

3.2 Weaknesses

RL has not effectively coordinated with ORP and PNSO, and with the occupational medicine program contractor and site contractors, to ensure effective coordination and interfaces. The Hanford Site has multiple DOE organizations and contractors, most of which use the sitewide occupational medicine program. To be effective, the site contractors and the occupational medicine program contractor must coordinate effectively to ensure that health-related information is exchanged. For example, for an exposure event, medical professionals rely on site industrial hygiene organizations to provide relevant information about the nature of the exposure event (e.g., chemicals involved and concentration measurements), while the site safety coordinators rely on the medical professionals to provide accurate information about treatment so they can determine whether an event is OSHA reportable. RL has the overall responsibility for the sitewide medical program and for establishing the appropriate interfaces among the site contractors. ORP and PNSO must support RL in this effort for their respective contractors. However, RL has not ensured that interface agreements are formally established through memoranda of agreement. Even though informal communication paths are evident, the absence of formal agreements and clear and documented expectations is adversely impacting performance. In a number of cases, information was not provided to other organizations in a timely manner, or information was incomplete. For example, DOE Order 440.1A, Chapter 19, requires contractors to give the provider of medical services summaries of potential worksite exposures of employees before mandatory health examinations. Several instances were found where important industrial hygiene exposure information was not provided to HEHF in a timely manner.

RL has not provided clear direction to the occupational medicine program. RL has not established expectations to focus and prioritize the occupational medicine program on critical activities, such as the population health management program (which is an important program for monitoring potentially exposed workers for long-term health impacts) and enhanced communication projects to dispel worker concerns. In addition, RL has not established supplemental directives or other formal agreements providing specific expectations for how the occupational medicine program is to interface with site contractors and specifically how to address the health concerns of Tank Farm workers. Although occupational medicine has an important role, RL and ORP have not ensured that the occupational medicine program is sufficiently involved with groups that have been established to address vapor exposure issues, such as the Chemical Vapor Solutions Team.

HEHF management has not established clear policies and expectations. HEHF management communications have not been effective in clarifying policy or providing clear direction in a number of cases. These communication problems have been exacerbated through overuse of email to communicate policy and direction; the email messages have often been unclear or misunderstood, contributing to confusion and additional conflict. In addition, HEHF procedures do not adequately address the required coordination and communication between HEHF and site contractors. HEHF uses many methods to collect feedback from staff, contractors, and patients, such as meetings with the President and Chief Executive Officer, “all staff” forums, focus groups with contractors, and patient/staff surveys. These processes provide feedback about the quality of health care, workplace health and safety, workplace restrictions, and other such issues. However, the information gathered is not analyzed, translated into specific action, and implemented and used to improve organizational performance. HEHF has not developed the necessary administrative protocols for properly completing medical records of visits (ROVs), communicating policy and expectations to the professional staff, and integrating exposure information into the medical record.

HEHF has not ensured that complete information is provided to site contractors, contributing to misreporting of recordable injuries in a few cases. In comparing the information recorded on the ROV to that in the providers’ progress notes, discrepancies were found in three cases. In

these records, a provider prescribed an over-the-counter (OTC) medication at prescription strength (making the case recordable), but the corresponding ROV reflected only "OTC." Further, because the employees returned to work without restriction, no other factors were present that would make the cases recordable under OSHA requirements. As a result, these cases would have been improperly recorded.

3.3 Conclusions

The OA team found HEHF clinical practices and protocols to be consistent with standard occupational medical practices. The OA team found no substantiation of any of the health-related GAP allegations, except for isolated instances of incomplete treatment information being provided to contractor record-keeping case managers.

RL has not established the necessary interfaces between prime contractors and the occupational medicine program to address the integration of occupational medicine program services as required by DOE occupational medicine directives and contractor requirements. Weaknesses were found in some administrative HEHF protocols. For example, communications to professional staff were not always effective and contributed to misunderstandings and conflict among staff. Protocols also did not address the proper completion of ROVs to assure that case managers were provided accurate information for properly categorizing work-related incidents.

Inside Double-Shell Tank

Waste Inside a Single-Shell Tank in the B Tank Farm at the Hanford Site

4.0 Injury and Illness Investigation and Reporting

Occupational injury and illness reporting is an important worker health and safety element subject to OSHA regulations and DOE requirements. The information is compiled and used as a management tool for evaluating safety performance and trends.

4.1 Positive Attributes

There are no indications of significant or pervasive underreporting of injuries and illnesses. Based on OA's review of a sample of records for CH2M HILL, FHI, BHI, BNI, and PNNL, most injury and illness events are appropriately categorized. No egregious examples of misreporting were identified.

All contractors have clear requirements and procedures that provide the foundation for their occupational injury and illness investigation and reporting programs. For example, all site contractors have clear requirements to investigate and report events and to determine the apparent cause and needed corrective actions. Some contractors have established processes that provide for independent review of investigations and OSHA recordable decisions to provide assurance that events are properly evaluated, recorded, and reported in accordance with DOE and OSHA criteria. For example, PNNL requires peer review and approval of investigation reports before they are deemed complete. These controls provide a degree of deterrence against deliberate misreporting of events in an attempt to present an overly positive picture of site safety performance.

DOE organizations have performed assessments of contractor injury and illness reporting programs. RL performed assessments of occupational injury and illness recording and reporting programs implemented by FHI and BHI and their major subcontractors in 2003. RL recently began quarterly comparisons of OSHA logs and DOE Computerized Accident/ Incident Reporting System (CAIRS) reports for these two prime contractors and will document the results of these comparisons in assessments planned for later this year. PNSO assessed PNNL compliance with injury and illness reporting requirements in 2003. ORP recently conducted oversight assessments of occupational injury and illness reporting processes for CH2M HILL and BNI. These RL, ORP, and PNSO assessments were generally of good quality and identified a number of needed correction actions for contractor implementation.

Sampling Vents for Vapors

4.2 Weaknesses

The overall quality of records is inconsistent and not always adequate. The contractors that OA evaluated have not established and maintained a sufficiently rigorous system of records to fully support injury and illness reporting. Although procedures are generally adequate, implementation of the procedures and quality assurance processes have not been sufficiently rigorous to ensure that records are complete and accurate. In some cases, information needed to demonstrate the adequacy of recording and reporting decisions was missing or incomplete. Case files had weaknesses in documentation, such as inadequate information

on ROV forms from HEHF, insufficient documentation of personal physician and emergency room medical reports, and inconsistent inclusion of required forms and reports.

Some occupational injury and illness events were not correctly recorded or reported. The requirements for recording and reporting are not complex, but some interpretation and judgment are needed to determine the reportability of each individual case. The OA team identified some incorrect or questionable classifications and reporting of occupational injuries and illnesses by all Hanford contractors. Some of the events that should have been recorded and reported under OSHA and DOE criteria were not, because individuals misinterpreted the criteria or were missing important elements of information. The number of cases that were not correctly recorded do not indicate a systemic or pervasive failure of the system. However, errors that result in misreporting must be kept to a minimum, and instances of incorrect classification decisions need to be corrected and reported as required. The identified errors indicate a need for increased attention to records management, quality assurance, and peer review, as well as effective interfaces between site contractors and the occupational medicine program contractor.

CAIRS data is not sufficiently complete and current. In general, the OA investigation found good consistency between OSHA 300 logs and CAIRS database records for total recordable case rate and lost workday case rate for calendar year 2002. These are the principal performance metrics used by DOE senior management in relation to worker safety performance.

However, consistency between OSHA 300 logs and the CAIRS database for the number of lost and restricted workdays needs improvement. For 55 out of 246 OSHA 300 log recorded cases for calendar year 2002 and part of 2003 that were reviewed by OA, there were discrepancies between the OSHA 300 logs and CAIRS database. These discrepancies included instances of both overreporting and underreporting. Two contributors to these inconsistencies were transcription errors and failure to submit required revisions to the CAIRS database. In general, because of the variability of this performance metric, maintaining consistency between the OSHA 300 logs and CAIRS database requires frequent reconciliation of the data and increased quality assurance. One Hanford contractor had exercised its authority for direct electronic input of information into CAIRS, and had a high degree of consistency between OSHA 300 logs and CAIRS database records. During the final phase of the OA investigation, recent updates to CAIRS, following contractor-submitted updates and revisions had already resolved many of the inconsistencies for calendar year 2002.

4.3 Conclusions

Although improvements are warranted, the number and type of discrepancies identified in this investigation do not negate the overall usefulness of injury and illness metrics as a tool for monitoring safety performance and for focusing attention on problem areas or trends. However, the data on OSHA recordables and in CAIRS is not as reliable as it should be, and the CAIRS database is not being updated in a timely manner to reflect new information or the discovery of errors or omissions. Thus, the CAIRS information used by DOE management does not always reflect the most current and accurate information. Some of the problems with the CAIRS data are being addressed by having contractors update the database electronically, thus eliminating time lags and some transcription errors.

To address these issues, several DOE Headquarters organizations will need to work together in an aggressive and coordinated approach. As the site landlord, EM involvement and leadership are needed to facilitate and ensure that RL, ORP, and PNSO effectively coordinate their efforts to appropriately address occupational medical program issues and build the interfaces necessary for effective injury and illness investigation and reporting. Actions by the Office of Environment, Safety and Health are needed to address the longstanding deficiencies in CAIRS and its interface with site recording and reporting, particularly the time lags in providing information to CAIRS, so that senior DOE management has accurate and timely information about safety and health performance.

APPENDIX A
SUPPLEMENTAL INFORMATION

A.1 Dates of Review

Advance Team Scoping (onsite)	February 23-27, 2004
Scoping Visit (onsite)	March 1-5, 2004
Planning (offsite)	March 8-12, 2004
Onsite Data Collection (onsite)	March 15-26, 2004
Data Analysis (offsite)	March 29-April 2, 2004
Reporting, Follow-up Data Collection, Quality Review, and Validation (onsite)	April 5-16, 2004

A.2 Review Team Composition

A.2.1 Management

Glenn S. Podonsky, Director, Office of Security and Safety Performance Assurance
Michael A. Kilpatrick, Director, Office of Independent Oversight and Performance Assurance
Patricia Worthington, Director, Office of Environment, Safety and Health Evaluations
Thomas Staker, Deputy Director, Office of Environment, Safety and Health Evaluations

A.2.2 Quality Review Board

Michael Kilpatrick
Patricia Worthington
Thomas Staker
Dean Hickman
Robert Nelson

A.2.3 Review Team

Patricia Worthington (Team Leader)

Injury and Illness Investigation and Management Systems Subteam
Phil Aiken, Lead
Robert Compton
Albert Gibson
Timothy Martin

Occupational Medicine Program Subteam
Marvin Mielke, Lead
Connie Eimer
William Greendyke, MD
Bernard Kokenge

Worker Vapor Exposure Subteam
Brad Davy, Work Process Lead
Bill Miller, Engineered Control Systems Lead
Victor Crawford
Mike Gilroy
Jim O'Brien
Mark Good
Joe Lischinsky
Jim Lockridge
Don Prevatte
Ed Stafford
Mario Vigliani
Dave Barber (Augmentee – Los Alamos Site Office)
Harvey Grasso (Augmentee – Lawrence Livermore Site Office)
Scott Nicolson (Augmentee – Savannah River Operations Office)
John Hill, Industrial Hygiene Laboratory Liaison

A.2.4 Administrative Support

Mary Anne Sirk
Lee Roginski
Tom Davis

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APPENDIX B
FINDINGS

FINDING STATEMENTS	REFER TO PAGES
Finding #C-1: CH2M HILL tank vapor characterization is not sufficient to support industrial hygiene exposure assessment and respiratory protection programs.	23
Finding #C-2: Compliance with OSHA and DOE exposure limits for chemical vapors cannot be sufficiently demonstrated due to weaknesses in the CH2M HILL exposure assessment program.	27
Finding #C-3: Chemical vapor exposure data obtained by CH2M HILL through the use of field instrumentation, particularly direct-reading instruments, is in some cases unreliable and may not accurately reflect exposures of workers to some chemical vapors being released from the tanks.	30
Finding #C-4: Limitations in the current CH2M HILL industrial hygiene technician training and qualification program, and the lack of instrument procedures, do not ensure consistency or proficiency when conducting vapor exposure and monitoring activities.	31
Finding #C-5: The CH2M HILL respiratory protection program has not facilitated the voluntary use of respirators, ensured that respirator issuers are trained, or adequately demonstrated that workers are protected from the variety of chemical contaminants in tank vapors.	32
Finding #C-6: CH2M HILL hazards analysis processes have not been sufficiently rigorous to ensure an adequate understanding of potential hazards prior to allowing workers to perform work.	36
Finding #C-7: CH2M HILL's use of the JHA/JSA as a working document in work packages does not ensure all relevant hazards are identified or that workers are fully cognizant of necessary hazard controls and the work steps to which those controls apply.	37
Finding #C-8: CH2M HILL has not required sufficient rigor, formality, or specificity in the processes used to identify and implement controls needed to ensure effective hazard mitigation.	38
Finding #C-9: DSTs and SSTs with active exhaust ventilation systems at the River Protection Project Tank Farms are not provided with adequate vacuum relief devices or other vacuum protection measures, such as positive administrative controls on critical valves, to preclude potential excessive vacuum conditions that could seriously damage the tanks.	44
Finding #C-10: The conceptualization, analysis, detailed engineering, and execution of engineering measures have not been adequate to provide fully effective engineered vapor controls for the Tank Farms, as exemplified by recent modifications to the AY/AZ Tank Farms and the CAM cabinets.	47
Finding #C-11: Engineering processes have not ensured that engineering activities specifically consider potential worker vapor exposures or phenomena that could threaten the integrity of the tanks.	49

FINDING STATEMENTS	REFER TO PAGES
Finding #C-12: CH2M HILL has not properly classified and reported some injury and illness cases, and CH2M HILL injury and illness reporting programs and quality assurance processes are not sufficiently rigorous, contributing to errors and omissions in documentation and case management of reported injury and illnesses.	51
Finding #C-13: CH2M HILL's corrective action program has not been effective in defining and investigating issues related to Tank Farm vapor releases and exposure incidents or in establishing actions that effectively prevent recurrence of personnel vapor exposures and provide assurance that vapor exposures do not have long-term effects on worker health.	55
Finding #C-14: ORP has not adequately addressed weaknesses in its oversight of the CH2M HILL industrial hygiene program and has not ensured timely corrective actions for identified issues.	56
Finding #D-1: RL has not adequately coordinated with ORP, the Pacific Northwest Site Office, and site contractors to ensure that effective interface agreements are in place between the occupational medicine program contractor and site contractors to ensure compliance with DOE occupational medicine program requirements.	66
Finding #D-2: HEHF management has not ensured that administrative processes are effectively implemented for clearly communicating policy, implementing the results of surveys as part of the HEHF quality process improvement initiative, and ensuring that ROVs provide complete information to site contractors to preclude a few cases of misreporting of recordable injuries.	73
Finding #E-1: FHI, BHI, BNI, and PNNL have not properly classified and reported some injury and illness cases, and their injury and illness reporting programs and quality assurance processes are not sufficiently rigorous, contributing to errors and omissions in documentation and case management of reported injury and illnesses.	87
Finding #E-2: RL, ORP, PNSO, and the Office of Environment, Safety and Health have not ensured that CAIRS is updated or corrected in a timely manner to reflect new information or the correction of errors, resulting in discrepancies between CAIRS and OSHA logs, and information being provided to DOE management that does not reflect the most current and accurate data.	87

APPENDIX C
TANK FARM WORKERS' EXPOSURE TO VAPORS

C.1 Background

Tank Farm Description

The 200 East and 200 West Areas of the Hanford Reservation contain 177 underground carbon steel tanks with capacities ranging from 50,000 to approximately 1 million gallons. The tanks are grouped into a number of "farms" throughout the 200 areas. Of the 177 tanks, 149 are the older single-shell tanks (SSTs), constructed between 1940 and the early 1960s. The other 28 tanks are double-shell tanks (DSTs) constructed between 1968 and 1986.

The SSTs are divided approximately evenly into two areas: the 200 East Area and the 200 West Area. The SSTs were removed from service in the 1980s. With the completion of interim stabilization activities, the SSTs now contain only sludge and saltcake. The next step of the cleanup is to remove the sludge and saltcake to the DSTs, where it will be stored pending treatment in the new Waste Treatment Plant, currently under construction. The SSTs are normally passively ventilated through high efficiency particulate air (HEPA) filters on a tank breather.

Twenty-five of the DSTs are located in the 200 East Area, and three are located in the SY Farm in the 200 West Area. Exhausters actively ventilate both the head space and annulus of these tanks through HEPA filters. The tanks are currently used to accept liquid from the SSTs, where it is stored pending future treatment. To conserve volume for the future addition of liquids, the wastes in the DSTs can be sent to an evaporator, where excess water is removed, and the resulting slurry is returned to the tanks. As waste retrieval operations begin in the SSTs, the need for space in the DSTs will become critical.

Transfer and treatment of wastes from the SSTs to the DSTs involve waste transfer piping and specially designed pumps that can be installed through risers on the tanks. A number of other specially designed tools can be inserted through the tank risers to inspect the tanks and mobilize sludge and saltcake. Installation of equipment into the tanks through the risers, as well as repair and replacement of equipment constitute a majority of the current efforts.

Tank Farm Approach to Worker Protection Against Vapor Exposures

The strategy for protecting workers against vapor exposures starts with a characterization of the types and quantities of hazardous materials in the tanks that could be released in gaseous or vapor form. Major efforts to characterize the contents of the tanks were performed in the mid 1990s, in part as a response to Defense Nuclear Facilities Safety Board Recommendation 93-5, which was accepted as closed by the Board in November 1999. That characterization effort resulted in the current characterization data contained within the site's Tank Waste Information Network System (TWINS) database. Limited sampling and characterization of tank headspaces have been performed since then.

Prior to this investigation, the Tank Farm protection strategy has inherently relied on a number of assumptions: (1) that the existing characterization data adequately reflected the actual tank contents, and that studies adequately predicted chemical behavior of the wastes when mixing occurs during waste transfers, and (2) that of the large number of chemical species present in tank wastes, only a few classes of chemicals were of potential concern, and three of them (ammonia, nitrous oxide, and 1-butanol) were present in concentrations above regulatory limits (see Section C.2.1 for discussion of these assumptions).

Based on the site's characterization of the hazards, the protection strategy relies on three general types of controls:

- **Engineered controls.** The primary engineered controls are the venting and filter systems described above. Various modifications have been made at some tanks to enhance the effectiveness of vent systems. In addition, CH2M HILL has implemented a process to identify and seal certain release paths (e.g., tank penetrations) such that vapors do not bypass the vent systems.

- **Administrative controls.** The Tank Farm Health and Safety Plan (HASP) and various other CH2M HILL plans/procedures identify a set of administrative controls, such as industrial hygiene

sampling processes, establishment of air monitoring zones, and processes for curtailing work if measured concentrations are above thresholds. These administrative controls are intended to ensure that workers are not working near sources of vapors or areas of higher concentrations without defined personal protective equipment (PPE).

- **Personal protective equipment.** The primary PPE provided to workers are the various types of respirators used at the Tank Farm, which range from masks to supplied air. Respirators are mandated for certain work (e.g., equipment installation in the tanks) and in certain conditions (e.g., when measured concentrations exceed certain thresholds).

Historically, the CH2M HILL strategy has been to implement protection measures that keep worker exposures below established regulatory limits. Although they believe there is no evidence of long-term health risks, CH2M HILL has recognized that there may be opportunities to further reduce worker exposure to chemical vapors, and is working to establish an approach that would maintain those vapor exposures as low as reasonably achievable (ALARA).

Injury and Illness Investigation and Reporting

The policies for workers and supervisors to report work-related injuries and illnesses are defined in several procedures and policies, and are communicated to all workers during initial and annual refresher general employee training. Workers who are injured or become ill at work, including exposures to vapors where physical symptoms are experienced, are taken to onsite clinics or to a local hospital emergency room for evaluation and treatment. CH2M HILL's environment, safety, and health (ES&H) organization has established a formal process for obtaining notification of injuries and illnesses, obtaining examination and treatment information from medical services, evaluating each case for reporting to the Occupational Safety and Health Administration (OSHA) and the U.S. Department of Energy (DOE) Computerized Accident/Incident Reporting System (CAIRS) in accordance with 29 CFR 1907 and DOE Notice 231.1, and ongoing management of reportable cases. (See Appendix E for additional discussion of injury and illness reporting requirements and other Hanford Site contractors' injury and illness reporting programs.)

CH2M HILL Feedback Mechanisms

In addition to injury and illness investigations, CH2M HILL has various formal feedback and improvement mechanisms for reporting, investigating, and resolving vapor exposure events and evaluating related safety and health processes. CH2M HILL has established processes to conduct independent assessments, including assessments by internal organizations and external contractors, and a variety of management self-assessments that evaluate industrial hygiene program elements, work control processes and performance, injury and illness reporting, and employee concerns programs. Less-structured evaluations of working conditions and performance are conducted by managers and documented as management observation reports.

Management's expectations for the reporting of vapor exposures or the detection of vapors are discussed in an abnormal operating procedure (AOP) and in various written communiqués from management to all Tank Farm personnel. Policies and procedures require that vapor exposure events be reported to the Tank Farms' central command center and documented on Problem Evaluation Request (PER) forms and Event Reports. The event investigation process is detailed in an operations procedure, with the level of rigor and process applied to the investigation of events dependent on the type and significance of the specific event.

CH2M HILL has established and implemented a formal process to solicit and resolve employee safety concerns. Employees may submit safety concerns on PERs or report their concerns to either the CH2M HILL or the DOE Richland Operations Office (RL) employee concerns program. Identified safety issues are managed using the PER process, which provides for documenting, evaluating, and resolving deficient conditions, processes, or performance; opportunities for improvement; or employee concerns.

GAP Allegations

In October 2003, the Government Accountability Project (GAP) issued its report *Knowing Endangerment: Worker Exposure to Toxic Vapors at the Hanford Tank Farms*. In that report, GAP cited a high number of worker exposures and a perceived unwillingness by DOE to adequately investigate those exposures as evidence that DOE was willing to sacrifice worker health and safety in order to meet the accelerated cleanup schedules and minimize costs. The report further cited inadequate chemical

monitoring by CH2M HILL, inadequate use of respiratory protection, inadequate record keeping for monitoring data, overreliance on historical characterization data for current hazards analyses, inadequate engineered controls to limit vapors, and reprisals against workers who raise safety concerns.

Site Response

CH2M HILL has disputed some of the specific facts presented in the GAP report and has denied most aspects of GAP's allegations in various forums, including a report entitled *Vapor Exposure: The Facts, The Science, The Solutions, Worker Safety at the Hanford Tank Farms*, Revision 1, dated March 22, 2004. The CH2M HILL report describes how CH2M HILL has been working to address vapor exposures at the Tank Farms, with increased emphasis since 2002. It describes a number of enhancements that were taken before the GAP report was issued, enhancements that have been taken since the report was issued, and a number of other enhancements that are being implemented or are under consideration. The CH2M HILL report contends that the GAP report assertions are without substantial merit and that the nature and severity of the exposures and cancer risks are overstated in the GAP report. CH2M HILL also asserts that the allegations of record falsification or suppression are unsubstantiated and/or incorrect. CH2M HILL acknowledges that some aspects of the GAP report (e.g., the set of exposure events) may provide a basis for improving communications and that some allegations warrant continued attention (e.g., individual perceptions of a "chilling effect" and retaliation). CH2M HILL has entered the applicable GAP recommendations into the corrective action tracking database for consideration and formal disposition.

Interim Actions

After the two-week data collection portion of this investigation, all non-essential work in the Tank Farms was curtailed, and CH2M HILL mandated that all essential work in the Tank Farms require personal respiratory protection. This decision was made as a result of several additional vapor exposures and discussions among the DOE Office of Environmental Management (EM), the DOE Office of River Protection (ORP), and CH2M HILL. ORP directed CH2M HILL to continue the use of respiratory protection until they completed several actions. In response, CH2M HILL implemented interim corrective actions to address deficiencies in worker protection. Those actions included requirements for respiratory protection for any entry to the fenced area of the Tank Farms, re-evaluation of existing industrial hygiene data, acceleration of engineered controls, revision or development of procedures for industrial hygiene monitoring and sampling, implementation of personal breathing zone sampling, increased training and qualification for respirator use, and accelerated self-assessment of the radiation protection program. These actions were responsive to many of the items discussed in the remainder of this section, but the effectiveness remains to be determined. On April 15, 2004, based on potential nitrous oxide exposure concerns identified by the OA team, additional respiratory protection measures and industrial hygiene monitoring controls were imposed by CH2M HILL management for all waste tanks without active ventilation.

OA Investigation Scope and Conduct

The Office of Independent Oversight and Performance Assurance (OA) examined the GAP allegations as they relate to worker exposures and ORP and CH2M HILL activities, and determined that they fall into the following categories:

- Vapor protection/industrial hygiene basis
- Work control processes
- Communications to workers
- Engineered controls
- Injury and illness investigation and reporting
- Employee concerns programs and other feedback mechanisms
- ORP oversight
- RL employee concerns program (as applied to vapor issues).

To evaluate these areas, OA collected data through several related efforts. The OA team conducted a number of interviews with workers involved in vapor exposure events over the past two years. Of the 45 vapor exposure events reported by GAP, 15 correlated to known first-aid cases or OSHA recordable incidents, which were the most significant vapor exposure events. OA attempted to interview all the workers associated with those 15 events. In addition, interviews were held with five of the nine construction workers exposed to tank vapors during the first week of the onsite

investigation, as well as managers, staff, union representatives, and workers, including personnel on the Chemical Vapor Solutions Committee, Employee Response Team, and other such committees. OA also reviewed engineering documents and performed system walkdowns of selected tanks and engineered controls and discussed technical aspects of engineered systems with interviewed managers, staff, engineers, and operators. The OA team also conducted extensive field observation of work activities, including several waste intrusive activities, as well as routine Tank Farm operations. The OA team reviewed industrial hygiene sampling procedures, activities, and records. The OA team obtained independent vapor samples from the headspace of three tanks, several long-term samples at tank breather vents and ventilation exhaust stacks, and breathing zone samples on workers during the sampling activities. These samples were sent to the Savannah River Technical Center and the Savannah River Industrial Hygiene Laboratory for independent analysis. The selection of sample type and locations was driven by recent vapor exposure events. The OA team also reviewed vapor exposure events and other events and examined documentation to determine whether events were properly investigated and reported. OA reviewed a sample of PERs and employee concerns and associated feedback processes. Lastly, OA reviewed ORP processes and line management oversight activities as they relate to vapor exposures and Tank Farm activities.

C.2 Results

C.2.1 Vapor Protection/Industrial Hygiene Basis

Overview

The CH2M HILL industrial hygiene program is responsible for identifying, recognizing, evaluating, and controlling vapor hazards in the Tank Farm that could result in exposures to workers. Industrial hygienists are the professional staff responsible for the development and direction of the industrial hygiene program. Industrial hygiene technicians are responsible for performing vapor sampling and monitoring, under the direction of the industrial hygienists.

The Tank Farm contractor industrial hygiene program, managed by CH2M HILL since December 1999, has been a focal point of the Hanford tank vapor issues since the late 1980s. During this period, there have been numerous efforts, with varying degrees of success, by the industrial hygiene program to understand and characterize the nature of the hazards presented by the wide range of chemicals in the tanks, and particularly those chemicals that are released from the tank headspaces through ventilation systems (DSTs), or through passive breather filters (SSTs), or through fugitive emissions (tank penetrations). In addition to characterizing the vapor hazards, the Industrial Hygiene Group has the responsibility of protecting the workforce such that neither acute nor chronic exposures to these tank vapors will result in adverse health effects to the workforce. The industrial hygiene program must deal with a number of challenges and uncertainties, including the vast number of chemicals in the tanks, the variability in chemical composition and concentrations in each tank over time, the array of mechanisms by which these chemicals are released, and the number of work activities to which workers could be exposed.

The current CH2M HILL industrial hygiene program is in a state of reorganization to realign programs and personnel to support a new exposure assessment strategy that was issued on March 5, 2004. As a result, most of the industrial hygiene programs and associated documentation are being either revised or developed (e.g., industrial hygiene technician procedures).

In reviewing the concerns raised in the GAP report, the industrial hygiene issues can be categorized into the following areas: characterization of tank vapors, exposure assessments, industrial hygiene instrumentation and records, industrial hygiene training and qualifications, and respiratory protection programs. This section of the investigation report summarizes the OA team's evaluation of the current industrial hygiene program and work activities in these five areas. In addition, this section discusses the results of the OA team's independent sampling.

Characterization of Tank Vapors

Since the late 1980s, considerable sampling has been conducted for many of the tanks with respect to solids, liquids, and vapors contained within the tanks. For example, a significant campaign to sample SST headspaces was conducted during 1996 and 1997. Although radiological releases from the tanks appear to be well characterized, chemical vapors and gases are not always well characterized. Some of the tanks contain over 1,200 chemicals in the vapor headspaces of the tanks. Many tanks contain several hundred

chemicals in the vapor spaces that are above the minimum detection level of 5 parts per billion (ppb), but many are at concentrations that are below regulatory concern. For those waste tanks reviewed by the OA team, concentrations of most chemicals in the waste tank headspaces were below levels of regulatory concern. However, there are some concerns with this data, as further discussed in this section of the report.

Tank Farm operations rely on the continuous release of volatile chemicals to the atmosphere to prevent fire and explosive events resulting from the buildup of tank vapors. All tanks are equipped with HEPA filters to remove radioactive particulates; however, waste tanks are not equipped with systems to capture or remove chemical vapors. Engineered controls for minimizing worker exposures to tank vapors rely primarily on dilution provided by active or passive ventilation systems, or ambient air. However, vapor dilution has many inherent variables and does not always preclude vapors from reaching worker breathing zones. Workers continue to identify odors from the tanks, and a few experience physical symptoms as a result of exposure to vapors, thereby questioning the effectiveness of vapor dilution. As a result, additional administrative controls or PPE are routinely used.

During the past six years, an interim stabilization project has been under way to remove the liquids from all of the SSTs and transfer the waste liquid (i.e., supernatant) to the DSTs. The interim stabilization program was completed in mid-March of this year. However, the interim stabilization for the SSTs, the addition of waste to the DSTs, and the transfer of wastes to and from the evaporator has changed the chemical compositions and/or chemical concentrations of many of the tanks. Other waste tank activities that can result in changes in tank vapor compositions include the following:

- Disturbances of tank wastes. Historically, most tanks have been undisturbed. However, recovery and remediation operations have affected the composition and concentration of chemicals in the tank headspaces.

- A number of tanks within the farms are interconnected, allowing vapors to migrate from disturbed tanks to undisturbed tanks.

- Transfer of wastes to DSTs and subsequent evaporation have resulted in different vapor mixes in some tanks.

As a result of these activities, vapor concentrations, and the chemical mix in the tank headspaces, have changed over time. The tank characterizations conducted in the mid to late 1990s, upon which some exposure assessment assumptions are based, may not adequately represent the current tank contents. A historic review of tank vapor headspace data conducted by CH2M HILL during the first week of April 2004 confirmed the transitory nature of vapors in the waste tanks. The CH2M HILL review, which compared tank headspace vapor samples from the past two years to previous results, concluded that concentrations of tank vapors will change over time based on seasonal events and that specific tank events (e.g., shutdown of ventilators) result in increases in vapor concentrations in the waste tanks. The CH2M HILL review also identified 26 chemical compounds that had higher concentrations than previously identified, and 19 compounds that had previously been below analytical limits and were therefore excluded from toxicological evaluations. The OA independent sampling also confirmed the increasing levels of organics in one of the tanks that was sampled (i.e., Tank AY-102), although analyzed concentrations are below regulatory concern. Similar concerns were suspected by other external reviewers (see Section C.2.6). An understanding of the chemicals in the vapor space is essential to developing a worker exposure sampling plan, because the vapors to which Tank Farm workers are exposed are most likely bounded by those chemical vapors that are identified in the tank headspaces. Without an accurate characterization of chemicals in the tank vapor spaces, the industrial hygiene sampling and monitoring of chemicals in work areas may miss some chemical contaminants that could affect the health of workers. For developing industrial hygiene sampling and monitoring plans, tank headspace characterization data is needed both for the Tank Farm in general, as well as for individual tanks, since some tanks have higher concentrations of specific chemicals than other tanks (e.g., nitrous oxide), or different chemicals, which will impact the industrial hygiene sampling plan.

CH2M HILL tank vapor space data is contained in two data systems: the TWINS database, which contains sampling data on the liquid, sludge, and headspace vapors from the early to late 1990s, and a database recently established by the CH2M HILL Industrial Hygiene Group for SSTs. The primary function of the TWINs database has been for facilitating process and chemistry control of tank waste (sludge, supernatant, and headspace vapors). The CH2M HILL

industrial hygienists also use the TWINS database, particularly the tank headspace data, for identifying chemical contaminants that could be released from the waste tanks and result in exposures to Tank Farm workers. In addition, during the past two years, the SST section of the Industrial Hygiene Group has conducted additional sampling of tank headspaces to supplement the TWINS data, because much of the TWINS data for headspace vapors is six to ten years old, and may not be representative of current tank vapor concentrations, particularly for organics. Collectively, though these databases contain considerable chemical data with respect to the composition of the waste tank headspace vapors, there are a number of flaws, namely:

- The TWINS and CH2M HILL industrial hygiene headspace databases are independent, and not readily consolidated. Without a consolidated database, it is difficult for industrial hygienists to readily obtain consistent data on any tank.

- The presentation of the data in the TWINS database is often in units that are less commonly used by industrial hygienists, and as a result is prone to error in interpretation. This concern was also recently identified by the National Institute for Occupational Safety and Health (NIOSH).

- Much of the TWINS headspace vapor data is more than five years old, and may not be reflective of the current chemicals in the tank headspaces and/or their concentrations, particularly as a result of waste stabilization, tank sluicing and retrieval operations, waste transfer, and evaporator operations conducted during the past few years. For example, the April 2004 CH2M HILL review of tank vapors concluded that the interim stabilization of SSTs has resulted in an increase in organic concentrations in the SSTs. The independent sampling conducted by the OA team also identified a fivefold increase in selective organics in some tanks (e.g., AY-102) when compared to previous headspace sample results.

- In some cases, there is no tank headspace data in either database (e.g., Tank AY-108, an evaporator sludge receiving tank).

- Other than waste transfer, retrieval, and chemical additions, there is no CH2M HILL strategy to routinely collect and maintain chemical headspace data to ensure that the industrial hygiene sampling and monitoring plans accurately reflect the chemicals most likely to be in the tank headspaces. In April 2004, CH2M HILL initiated the development of a tank vapor technical basis document to develop such a strategy.

- The tank headspace data has not been trended over time to assess potential changes in the chemical analytes in headspaces or their concentrations, although CH2M HILL plans such an activity for its planned technical basis document.

Additionally, current sampling protocols and practices have introduced potential unanalyzed errors that make some sample results unreliable. For those samples obtained from the headspaces via SUMMA canister sampling, the following potential sources of measurement error were identified by the OA team, and are now being analyzed by CH2M HILL for their impact on the resulting data:

- There are potential errors in purging sample lines and riser spaces prior to obtaining the SUMMA canister sample. Industrial hygiene sampling strategy procedures do not detail or record purge alignments, procedures, or purge times to ensure representative sampling. Based on OA team comments, CH2M HILL has recently revised some sampling strategy procedures to provide these details.

- Most industrial hygiene headspace vapor samples for SSTs are obtained from tank risers or breather filters. Risers are typically 4 inches in diameter and 8 to 10 feet in length. SST risers for headspace sampling typically do not have sample tubing inserted in the risers, and the sample is extracted from a plug inserted into the top section of the riser. A concern with sampling from the breather filter is the potential of in-leakage of ambient air and subsequent dilution of the headspace vapor sample. There is no verification that vapors in the riser volume are representative of the vapors in the headspace volume, nor are there procedures to ensure that the risers are adequately purged. The April 2004 CH2M HILL review, for example, noted that an industrial hygiene SUMMA sample collected in January 2004 from the ENRAF flush port indicated only low levels of organic vapors present. This was recognized by CH2M HILL

not to be a valid sample of the C-103 headspace because the remaining organic liquid should have resulted in relatively high levels of organic vapors in the headspace. The CH2M HILL review concluded that the industrial hygiene SUMMA sample may have been compromised by the addition of ambient air via leaks in the sampling system or the tank riser used to obtain the sample.

- Potential purging errors in the SUMMA canister are evident. CH2M HILL has recently re-plumbed the SUMMA canister following discussions with OA team members, to minimize this error source for future sampling activities.

- Potential errors associated with plateout of chemical analytes in both the sample lines and the SUMMA canister filter have not been sufficiently analyzed or documented. Of particular concern is the plateout of those chemicals that are moisture reactive, such as ammonia. Plateout in sample lines may result in the sample being degraded or lost.

- There are potential errors in sample equipment use and calibration. There are no industrial hygiene technician procedures for calibration of sample pumps and some other sampling functions, although such procedures are planned for the future.

In addition, CH2M HILL industrial hygiene technicians routinely use direct-reading instruments (DRIs), such as organic vapor and ammonia detectors, to obtain a headspace vapor sample, and record the results in the DRI database. A number of concerns with the use of DRIs are discussed later in this section.

One condition that is clearly evident from the existing tank characterization data is that many potential and known carcinogens and toxins are present in the tanks, although these chemicals are most likely present in levels that are well below current OSHA and American Conference of Governmental Industrial Hygienists (ACGIH) limits. Further, OSHA and NIOSH exposure limits are based on studies of exposure to a single chemical, not on the variety of potential combinations present in the Tank Farms. There is little or no research available in industry to demonstrate that exposure to the mixtures present in the Tank Farm do not have synergistic effects that could result in long-term health consequences. Consequently, those limits, as well as limits established in the CH2M HILL HASP, may not be adequate to ensure that workers are protected from potential long-term health effects of chronic exposure to tank vapors.

Overall, although there is considerable data on waste tank solids, liquids, and vapors in the tank headspaces, the headspace vapor data for a number of tanks is dated and may not reflect current vapor conditions in the tank as a result of process changes. For some tanks there is no data on chemicals contained in the tank headspaces. During the past two years, tank headspace vapors from only 15 of the 177 waste tanks have been sampled and analyzed. Significantly more recent data has been obtained on the chemical composition of liquid and sludge in the waste tanks. The chemical composition of the tank headspaces is important because it provides the basis for selection of which chemicals are to be sampled in tank effluents and for workers. However, the concentrations of some chemicals in the tank headspaces are above regulatory limits established by OSHA and ACGIH for worker protection. The identification, concentration, and any trending of increases in chemical concentrations are important in defining or modifying the industrial hygiene sampling plan for tank sources, areas, and workers.

Finding #C-1: CH2M HILL tank vapor characterization is not sufficient to support industrial hygiene exposure assessment and respiratory protection programs.

Exposure Assessments

DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*, establishes the framework for an effective worker protection program that will reduce or prevent accidental injuries and illnesses. One element of the worker protection program in the order is the exposure assessment. The associated DOE guide defines an exposure assessment as a "systematic collection and analysis of occupational hazards and exposure determinants such as work tasks; magnitude, frequency, variability, duration, and route of exposure; and the linkage of the resulting exposure profiles of individuals and similarly exposed groups for the purposes of risk management and health surveillance." In addition, personal monitoring is defined as "the process of measuring the concentration of a hazardous chemical in the breathing zone of an individual, using a method such as a personal air pump to gather a sample for analysis, a DRI, or a monitor worn by the worker in

the breathing zone… Area monitoring is not considered personal monitoring."

According to the October 2003 CH2M HILL independent assessment of the implementation of the vapor monitoring programs, "there is no comprehensive Tank Farms exposure assessment strategy that is consistent with DOE requirements and expectations to develop and document exposure chemical vapor profiles of individuals for the purpose of risk management and health services," and "personal sampling and monitoring strategies have not been routinely revised to remain commensurate with the changing Tank Farm mission." External reviewers prior to and after the CH2M HILL independent assessment also commented on the lack of personal sampling and the need for a comprehensive exposure assessment strategy.

The OA team's review also confirms that CH2M HILL has not implemented a comprehensive exposure assessment program for tank vapors, and has not conducted sufficient personal monitoring to adequately assess Tank Farm workers exposures to airborne chemical contaminants in the Tank Farms.

On March 5, 2004, CH2M HILL issued an exposure assessment strategy for a comprehensive assessment of worker exposures to Tank Farm vapors. The exposure assessment strategy is consistent with the requirements and expectations of DOE as described in DOE Order 440.1A, associated DOE guidance documents, and general industry practices as set forth in the American Industrial Hygiene Association (AIHA) *Strategy for Assessing and Managing Occupational Exposures*. The exposure assessment strategy is now being implemented, and significant data is expected by the end of CY 2004. Full implementation may require one or more years. Specific concerns identified by the OA team with respect to the current CH2M HILL exposure assessment program are described in the following paragraphs.

There is no comprehensive, well-documented strategy for industrial hygiene sampling of tank vapor spaces, tank ventilation effluents, or tank areas. Although the recently issued exposure assessment strategy outlines a program for obtaining representative worker exposure data through personal sampling, there is no comparable strategy for sampling tank headspaces, tank areas, and source points, other than in support of tank retrieval operations. As indicated in the previous section of this report, for tank vapor spaces, a few tanks have been sampled extensively in the past two years (e.g., C-103), but a number of tanks have not been sampled for nearly a decade. In some cases (e.g., Tank AP-108) there is no headspace chemical data, other than the data recently obtained by the OA team through independent sampling. With changing tank operations (e.g., interim stabilization, waste transfers, and evaporator operations), for many tanks there is insufficient basis to conclude that the dated characterization information in the TWINS database is reflective of the chemicals or the concentrations of those chemicals currently in the vapor spaces. Although the vapor spaces in some tanks are being reanalyzed in preparation for work activities for which there is waste intrusive work, there is no strategy that defines the frequency for sampling tank headspaces based on risk, operations, vapor incidents, hazard quotients, loss of ventilation systems, changes in environmental conditions, or other such factors. Minimum sampling frequencies have not been established. No comprehensive headspace sampling strategy exists, nor does such a strategy exist for sampling tank effluents areas or fugitive emission points. Several years ago, routine "sweeps" of Tank Farm areas were conducted to document vapor sources through DRIs. These "sweeps" were discontinued, although there is no documented technical basis for discontinuing this practice. During April 2004, CH2M HILL recognized the value of developing a technical basis for the tank vapor source, and initiated the development of an ongoing program for headspace vapor characterization. CH2M HILL expects to have an initial draft for such a program developed by June 2004.

The current personal sampling databases used by CH2M HILL for documenting worker exposures to chemical vapors are cumbersome, inconsistent, and incomplete. Personal sampling exposure data for workers exposed to Tank Farm vapors is contained in one of two databases: the Hanford Industrial Hygiene Exposure Database (i.e., Hanford industrial hygiene database), and individual CH2M HILL personal sampling exposure records that have been collected during the past two years, but have not been entered into the Hanford industrial hygiene database. The Hanford industrial hygiene database is operated by Fluor Hanford, Incorporated (FHI) for a number of contractors, such as CH2M HILL. Specific concerns with the Hanford industrial hygiene database are as follows:

- Tank Farm data has not been maintained current in the Hanford database, and data entries often lag by up to a year or more from the date when sampling was conducted. For example, the last entry into the Hanford industrial hygiene database

is from calendar year (CY) 2002. Over 200 CH2M HILL personal exposure records have yet to be entered into the Hanford industrial hygiene database.

- Data entry fields in the Hanford database are inconsistent with the CH2M HILL data collection forms, and some relevant data on the CH2M HILL personal exposure forms may not "fit" into the Hanford industrial hygiene database.

- In some cases, data has not been correctly interpreted or entered into the database by FHI.

- Personal exposure data is not routinely submitted to the occupational medicine program for evaluation of entry into workers' medical records. The incorporation of personal exposure data into medical records is required by DOE 440.1A. Furthermore, without this exposure data, physicians are handicapped in determining the most appropriate medical surveillances for affected workers.

The OA team reviewed the data contained in both the Hanford industrial hygiene database, and over 200 CH2M HILL individual exposure records for CY 2002 and CY 2003, which have not been entered into the Hanford industrial hygiene database. In general, minimal breathing zone sampling has been conducted during the past seven years for Tank Farm workers for the dominant contaminants identified by CH2M HILL (e.g., ammonia, organics, and nitrous oxides). Specific concerns with personal sampling data for Tank Farm workers are as follows:

- Although there are a significant number of personal sampling records for CY 2002 and CY 2003, the vast majority of these records are associated with the saltwell pumping or interim stabilization work during the past few years. However, collectively, personal sampling records are associated with only a few work activities, waste tanks, or a few workers. For most Tank Farm work activities, worker exposure groups (e.g., Tank Farm operators) do not currently have personal sampling exposure data to indicate the level of chemical contaminants to which workers are exposed.

- Many recent industrial hygiene personal sampling survey records are of minimal value because they lack sample results, calibration data, and sampling time and/or sampling volume, and in a number of cases have not met the requirements of the sampling protocols established by OSHA and NIOSH.

- As noted in previous internal and external assessments of the Tank Farm safety and health programs, in some cases, area readings conducted with DRIs have been used to fill the void resulting from a lack of full-shift personal breathing zone sampling, contrary to DOE guidance.

- As noted in the CH2M HILL independent assessment of October 2003, a review of the Hanford industrial hygiene database for fiscal year (FY) 2003 identified only six instances, some associated with the same job, where personal sampling had been conducted by CH2M HILL and subsequently sent by FHI to the occupational medical contractor. Based on information from the OA medical subteam, few exposure records were received or entered into workers' medical records during FY 2003. During CY 2003, the OA team identified over 100 personal exposure sampling records, which often are not provided to the occupational medical program or are not provided in a timely manner (see Appendix D).

- Industrial hygiene technicians have varying levels of knowledge of the chemical contaminants in waste tanks and, in some cases, provide workers with exposure information that is based more on perception than actual chemical data. For example, industrial hygiene technicians interviewed could not identify the type of organic vapors most likely to be present at work activities they were supporting or the health effects of these vapors. Furthermore, some industrial hygiene technicians could not explain the relative importance of some organic chemicals present in the vapor mix. Although most recorded worker exposures have been low, records from DRIs and personal sampling indicate that some work activities may result in significant vapor exposure potential to workers. One observation from a review of the database is that some of the "lesser abundant" chemicals have produced the highest worker exposures relative to the threshold limit values (TLVs). For example, a number of breathing zone samples have detected benzene in the workers' breathing zone. In 2000, benzene levels were detected at concentrations of up to

0.29 parts per million (ppm) for operators (8-hour time-weighted average [TWA]) during waste transfers in the SY Tank Farm. The 8-hour TLV for benzene is 0.50 ppm, but the action level is typically 0.25 ppm. Furthermore, during the last quarter of 2003, DRIs recorded a number of elevated organic concentrations in some work areas in the range of 10 ppm to 39 ppm. In some cases, the record is not clear concerning the location of the measurement within the work zone. The HASP action level for respiratory protection is 2 ppm in the breathing zone. The recorded level of organics in the referenced examples was well above this criterion, if the measurements were conducted in the breathing zone. Most records did not state whether the samples were taken in the breathing zone or whether workers were in respirators during the time of the measurement.

CH2M HILL recognizes the problems with the existing exposure data base and has been developing a CH2M HILL industrial hygiene exposure database, the software for which is nearly complete. Once completed, historical as well as new exposure records will be entered into the CH2M HILL industrial hygiene exposure database. This action will be tracked in the Integrated Mission Execution Schedule.

One administrative control that CH2M HILL has implemented for the control of worker exposures to tank vapors is the establishment of exposure criteria based on breathing zone exposures (either measured or estimated from DRIs). These criteria (e.g., 25 ppm ammonia and 2 ppm organics) are described in the Tank Farm HASP and other implementation documents (e.g., standing orders). However, there is no documented technical basis for the establishment of these criteria, and in some cases the criteria may be incorrect and non-conservative. For example, there is no documented technical basis to support the assumption that an organic vapor limit of 2 ppm (as specified in the Tank Farm HASP) is sufficient to protect workers from exceeding an OSHA permissible exposure limit (PEL) or an ACGIH TLV for individual organic contaminants (e.g., benzene) that may be contained within the vapor mix and have regulatory thresholds that are well below the 2 ppm limit. Other concerns with respect to the exposure criteria described in the Tank Farm HASP are as follows:

- The basis for the 2-ppm limit for organics in the HASP has not been justified and needs to be documented.

- Instantaneous readings from DRIs, some of which are not obtained in the breathing zone, are used to ensure compliance with the HASP criteria. However, there is no technical basis for correlating direct-reading area readings to HASP requirements that are based on eight-hour (full-shift) breathing zone exposures.

- CH2M HILL has not documented how the DRIs used for exposure assessments respond to the variety of chemicals typically found within the vapor spaces, and how the varied response is considered when determining a limit to a chemical mixture.

- Based on conclusions obtained from TWINS characterization data, CH2M HILL has incorrectly assumed that nitrous oxides are present only when ammonia is present and that ammonia is present in greater concentrations than nitrous oxide. As a result, if ammonia is not present, exposure assessments to nitrous oxides were often not considered. A review of a 1996 characterization report, however, indicates that nitrous oxide vapors in tank headspaces can be present in concentrations of up to 500 ppm, even in the absence of ammonia. In addition, CH2M HILL personal sampling data from January 2000 identified breathing concentrations of nitrous oxide of 11 ppm in the presence of only 0.058 ppm ammonia. Worker exposure data to nitrous oxide (TLV of 50 ppm) is minimal, and the team identified fewer than ten exposure records in the past eight years to nitrous oxides. In general, there is insufficient data to determine the extent to which workers are being exposed to nitrous oxides.

A second administrative control measure that is used by CH2M HILL for controlling worker exposures are the air monitoring zones (AMZs). AMZs are established by operations and/or industrial hygiene to control exposures to tank vapors that are generally perceived to be below regulatory thresholds, but could result in unpleasant odors and/or acute health systems. Although the AMZ concept is defined to a limited extent in the HASP and a standing order, many aspects of the AMZ (e.g., establishment and removal of AMZ boundaries, and monitoring/posting requirements) are not well documented. In addition, many workers have expressed confusion with respect to the AMZs. For example, in a recent Chemical Vapor Solutions Committee meeting, several workers complained about

the establishment of AMZs and controls. There was confusion about why the AMZs were established or why AMZ boundaries changed in some cases. In general, CH2M HILL relies on the AMZs to protect workers from exposures to chemical vapors. However, there are no issued procedures that describe the requirements and use of the AMZs.

Overall, there is currently no comprehensive, well-documented strategy for sampling of tank vapor spaces, tank ventilation effluents, or tank areas to support industrial hygiene monitoring and sampling activities, although the development of such a strategy is in process. The current personal sampling databases used by CH2M HILL for documenting worker exposures to chemical vapors are cumbersome, inconsistent, and incomplete, although CH2M HILL plans to implement its new exposure database in the near future. Minimal personal sampling (i.e., breathing zone data) to indicate the level to which workers have been exposed to chemicals has been conducted to date, with the exception of a few tank work activities. Furthermore, administrative controls limiting worker exposures to chemical vapors (e.g., AMZs and action levels for industrial hygiene monitoring readings) do not have a well-defined technical basis and in some cases may not be conservative.

Finding #C-2: Compliance with OSHA and DOE exposure limits for chemical vapors cannot be sufficiently demonstrated due to weaknesses in the CH2M HILL exposure assessment program.

Industrial Hygiene Instrumentation

The CH2M HILL Industrial Hygiene Group currently uses a variety of instruments for evaluating the levels of airborne chemical contaminants and exposures to tank vapors. Industrial hygiene uses DRIs, such as organic vapor detectors, ammonia detectors, colorimetric ammonia badges, and Draeger tubes, for detection of chemical contaminants within general work areas, worker breathing zones, tank ventilation filters, and headspace gases via remote sample tubing connected to the detector input. Industrial hygiene also uses non-direct reading instruments that rely on the collection of chemical contaminants through a variety of sample collection media and subsequent analysis by an analytical laboratory to assess worker exposures to chemical vapors. Non-direct reading instruments include passive monitoring badges, and sampling trains that consist of personal sampling pumps with a variety of sampling media used to collect chemical contaminants over a period of time (e.g., eight-hour work shift). These devices, as well as SUMMA canisters, which are also used to collect samples of airborne contaminants, require an analytical laboratory for processing the sample media.

With respect to the DRIs, a considerable amount of data has been obtained during the past few years for tank operations. DRIs are used by industrial hygiene technicians to support ongoing work activities, monitor tank effluents and areas, including AMZs, and to respond to vapor incidents. The majority of current data on vapors in the Tank Farms has been obtained through DRIs. Although DRIs serve a useful function, they are often inappropriately used to record a workers breathing zone exposure as noted by CH2M HILL and previous external reviewers. Other specific concerns noted by the OA team with respect to the use of DRIs are as follows:

- DRIs for ammonia and total organics are the primary type of DRIs in use by industrial hygiene technicians at the Tank Farms. The selection of these instruments is based on headspace data that indicates that ammonia and volatile organic compounds (VOCs) are the dominant constituents in most tanks. Although nitrous oxide has also been identified as a primary constituent in headspace vapors, concentrations of nitrous oxide (TLV of 50 ppm) are seldom measured in the Tank Farms, and nitrous oxides cannot be detected with the DRIs currently in use (with the possible exception of Draeger tubes). Furthermore, CH2M HILL assumes that levels of nitrous oxide and ammonia are proportional, although there is no documented technical basis to adequately support this assumption.

- Organic vapor monitors that rely on photo-ionization detectors (PIDs) require an internal "lamp," which is used for ionizing the chemical contaminant. The PIDs used by CH2M HILL have 10.6 electron volt (eV) lamps that are not capable of detecting some of the chemicals of interest that are present in the tanks. For example, formaldehyde, nitrous oxide, methanol, acetonitrile, carbon tetrachloride, methyl chloride, and other chemicals identified in tank headspaces will not be detected by these instruments, regardless of the vapor concentrations. Some of these contaminants have also been detected in tank headspaces in concentrations that are above regulatory thresholds (e.g. nitrous oxide). Several of these contaminants

were identified by the OA team's independent sampling in low concentrations in ventilation systems and workers' breathing zones. CH2M HILL personnel have used higher ionizing lamps (e.g., 11.7 eV lamps) that could detect some of these chemicals. However, these lamps were discontinued due to the difficulty in maintaining them. The life expectancy of a PID with an 11.7 eV lamp is three months, compared to the 3-year life expectancy of a PID with a 10.6 eV lamp.

- The sensitivity of some ammonia detectors and the organic vapor monitors may be non-linear at higher ranges. Therefore, when these instruments are used to detect higher concentrations of chemical contaminants (e.g., headspace vapor monitoring), according to the manufacturer the readings are inherently inaccurate to some degree (+/- 15 percent), and statements concerning the inaccuracy of the reading are not entered into the instrument data records. In addition, the multi-gas instruments may provide higher readings in the presence of nitrous oxide when reading ammonia in the headspaces. Work suspension levels identified in the HASP have not factored in uncertainties of instrument response.

- The presence of some chemicals can interfere with the chemicals being measured. For example, the presence of nitrous oxide can interfere with the detection of ammonia and can result in an error in the reading. The impact of such interferences has not been analyzed or documented.

- In some cases, these instruments are attached to lengthy sample lines without a clear technical basis that analyzes the impact of long sample lines on the integrity of the sample or the effect on the instrument. For example, at the CR Vault, the sample line from the DRI extends 15 to 20 feet and into the headspace of a tank underneath a vault. CH2M HILL has not analyzed the configuration to determine whether this long sample line has any effect on sample loss, or reduction in the capacity of the instrument pump. Furthermore, there are no industrial hygiene technician procedures to establish expectations when using instrument sample lines. A few instances of poor field practices were observed where the technician did not allow sufficient instrument sampling time to ensure a representative sample prior to recording the data.

- Sample lines for DRIs include a prefilter to remove potential radioactive particulates from the sample. The effect of this filter on the chemical constituents of the sample has been evaluated by Waste Sampling Characterization Facility (WSCF) scientists, although the evaluation has not been documented.

- Industrial hygiene technicians do not always accurately record data from DRIs in a timely manner as required by procedure, which has resulted in inaccuracies in the recording of instrument data. Although the DRI procedure provides a form on which data is to be recorded in the field, the form was not being used in the field by the industrial hygiene technicians. Industrial hygiene technicians observed by OA recorded their readings on scratch paper and later transferred the data to the formal record form. As observed by the OA team, this process has increased the possibility that data required by the procedure is not captured in the field and appropriately transferred to the permanent record.

- There are no industrial hygiene technician procedures for calibration and field use of DRIs; technicians rely on the vendor's manual, which does not address such concerns as the prefilter, data recording, and common problems experienced in the Hanford Tank Farm (e.g., sampling line losses).

- Calibration for DRIs is conducted with one calibration gas and a one-point calibration on the instrument range, although the instruments are used to detect a variety of chemical contaminants, over a considerable concentration range. For example, the vendor's manual for one monitor (i.e., the ppbRAE) recommends a two-point field calibration.

Non-direct sampling instrumentation for airborne contaminants consist of sampling pumps and associated collection media (e.g., charcoal tubes), and SUMMA canisters (6 liter and 0.4 liter capacities). Concerns identified by the OA team with respect to this type of instrumentation are listed in order of importance as follows:

- To date there has not been a Tank Farm strategy implemented for the use of this instrumentation in obtaining worker exposures (via breathing zone measurements) that meets DOE Order 440.1A,

or industry good practices (e.g., AIHA Exposure Assessment Strategy). This has been a criticism of several external assessments.

- CH2M HILL does not possess sufficient sampling pumps and/or media to implement the new Industrial Hygiene Exposure Assessment Strategy, and a number of the recently purchased sampling pumps are unreliable and cannot be used for personal sampling.

- There are no industrial hygiene technical procedures (other than the vendor manuals) for the operation and calibration of this equipment.

A strength of the industrial hygiene instrumentation and analysis program is the analytical capabilities and proficiencies of the WSCF. The new WSCF is well-equipped with state-of-the art instrumentation, and is staffed by competent and highly qualified analysts. WSCF maintains a number of national certifications and is accredited by the AIHA for a number of analytical processes.

DOE Order 440.1 and associated guidance documents emphasize the importance of documenting and maintaining quality industrial hygiene measurement and exposure data. The CH2M HILL databases that have been established and implemented to achieve these requirements include the Hanford industrial hygiene database, CH2M HILL personal sampling records, and the CH2M HILL DRI database. The first two databases were discussed in the previous section. A discussion of the DRI database follows.

Although a considerable number of data records are obtained from the DRIs, the number of concerns identified by the OA team with respect to data records indicates that much of this data is unreliable or cannot be consistently interpreted. Exposure monitoring, reporting, and records management follow the requirements of Manual HNF-IP-0842, Volume IX, "Safety." The DRI report requirements are outlined in that manual and are required when conducting exposure evaluation surveys for physical agents other than noise. A review of DRI survey reports was performed during this investigation to determine whether previously identified deficiencies documented on PER-2003-3221 for August 2003 were still occurring. The review sampled approximately 20 percent of the DRI records for October through December 2003. The recent review identified concerns essentially identical to those discovered from the August review and indicates that the interim actions of the PER were insufficient to prevent continued errors in the DRIs. A few examples of the deficiencies noted were:

- Incorrect calibration gas (ppm) was used.

- Calibration expiration date was expired for instrumentation used.

- Conflicts were found between "As Found/As Left" data.

- The survey number assigned is required to be placed on each page of the survey form to ensure that records are maintained in the appropriate records package, that the records are retrievable, and that all monitoring forms are present in the package. Most survey forms do not list the survey number on each page.

- The CH2M HILL procedure requires identification of the name of each agent that will be sampled or monitored, limits, and references. In some cases, the inappropriate limit is identified (e.g., 35 ppm ammonia limit, in lieu of 25 ppm as indicated by NIOSH).

- In some cases, the name of the person responsible for reviewing the form and the name of the person who entered the survey data into the system have not been entered on the report as required.

- By CH2M HILL procedures, the calibration effect/ expiration date of the calibration source is required to be identified. The reports reviewed by OA list the calibration effect date, but there is no information for the calibration gas expiration date.

The result of this evaluation of DRI reports has concluded that, in some cases, the personnel are not following the CH2M HILL procedures in recording DRI data. Consequently, the integrity of data collected in this manner is questionable. Deficiencies in industrial hygiene instrument data records have also been identified by external reviewers and by CH2M HILL in their self-assessment program.

Overall, most of the exposure data for Tank Farm workers has been obtained through DRIs (e.g., organic or ammonia vapor meters), or to a lesser extent through personal sampling. Although the capability for detecting low levels of chemical vapors has improved during the

past two years, there are still a number of concerns that affect the reliability and integrity of the results obtained when using these instruments. Specific concerns include the inability of the instruments to detect some of the chemicals that may be released from the waste tanks; the lack of monitoring for some of the chemicals identified by CH2M HILL to be of potential concern (e.g., nitrous oxide), the lack of formal training and procedures for use of the instruments, unanalyzed errors in using the instruments, and errors and omissions in the recorded data.

Finding #C-3: Chemical vapor exposure data obtained by CH2M HILL through the use of field instrumentation, particularly direct-reading instruments, is in some cases unreliable and may not accurately reflect exposures of workers to some chemical vapors being released from the tanks.

Industrial Hygiene Training, Qualifications, and Procedures

DOE Order 440.1A requires professionally and technically qualified industrial hygienists as a key part of industrial hygiene programs.

Most day-to-day monitoring of work areas and exposures to workers is conducted by the industrial hygiene technicians. In general, industrial hygiene technicians observed by the OA team were professional, well-motivated, and respected by most of the workforce. However, in a number of areas, some industrial hygiene technicians lacked knowledge on the limitations of their instrumentation, and were unfamiliar with the potential composition and health consequences of vapors emanating from waste tanks (and therefore could not adequately respond to workers questions). Furthermore, since CH2M HILL has not developed formal procedures for industrial hygiene technicians or established a formal training program, calibration and use of some instrumentation, recording results, and other such functions are inconsistent and sometimes questionable.

At present, CH2M HILL has identified the need for 29 industrial hygiene technical procedures, none of which have been issued. Five of these procedures are currently under development. Industrial hygiene technician training currently consists of informal mentoring by the industrial hygienist to which the technician is assigned, and required reading of instrument vendor manuals, since there are no industrial hygiene technician procedures.

As of March 16, 2004, the CH2M HILL Integrated Training Evaluation Matrix Item report indicated that the industrial hygiene departments consisted of a staff of 11 industrial hygiene professionals and 28 industrial hygiene technicians. Of the industrial hygiene professionals, five are certified by the American Board of Industrial Hygiene. However, only six of the professional industrial hygiene staff had completed Industrial Hygiene Professional Qualification Cards prior to the commencement of the OA investigation. Of the 28 industrial hygiene technicians, 24 have completed their Industrial Hygiene Technicians Qualification Cards. However, completion and sign-off criteria are subjective, and evaluator qualifications are vague. Written testing is not required, and approvers can be the CH2M HILL Health and Safety Director or a designee. Additional observations are as follows:

- Qualification card evaluators can use questions, observations, and reviews of work practices to assess topical or work activity knowledge and skill to "...the satisfaction of the evaluator." Evaluation criteria are not standardized via written testing, standard evaluator question sets, or evaluator observation checklists.

- Evaluators can be managers, supervisors, or a peer.

- Many evaluator signatures/initials were not legible.

- A typical qualification card has more than 41 items requiring signature by the technician and a signature by a reviewer attesting to the technician's knowledge of the subject area. In some cases, all of the elements were signed on the same day and by the same person.

These qualification card observations raise questions about their effectiveness and the degree to which they are being taken seriously by evaluators. Additional training and qualification concerns were identified in the respiratory protection program, and are discussed in the following section.

Overall, a number of industrial hygienists had not met their qualification requirements prior to the commencement of the investigation, and the industrial hygiene technician and staff training and qualification program requires substantial improvement. This has limited the quality and consistency of technician performance when monitoring and sampling for chemical vapors. Technician training currently consists

of required reading, and mentoring by the industrial hygienist to whom the technician is assigned. Qualification is achieved through an informal evaluation process that is documented on a qualification card. Although there are 29 industrial hygiene instrument procedures under development that will be used for training of industrial hygiene technicians as well as implementation, none of these procedures has been issued. Deficiencies in the industrial hygiene training and qualification program were also previously identified by CH2M HILL and external reviewers.

Finding #C-4: Limitations in the current CH2M HILL industrial hygiene technician training and qualification program, and the lack of instrument procedures, do not ensure consistency or proficiency when conducting vapor exposure and monitoring activities.

Respiratory Protection

The CH2M HILL Tank Farm Respiratory Protection Program (TFC-ESHQ-S-IH-C-05, Rev C, dated January 20, 2004) appropriately specifies that it complies with OSHA (29 CFR 1910.134) and American National Standards Institute (ANSI Z88.2) requirements. Respiratory protection must be certified by NIOSH. Respirator issuance and control procedures are contained in ESHQ-S-IH-CD-05.1.

The written respiratory protection program is comprehensive but lacking in a number of areas as described in the following paragraphs. Some of these concerns were also identified by the CH2M HILL Respiratory Protection Program Administrator during an assessment of the respiratory protection program conducted in CY 2003.

The respiratory protection program training and qualification requirements for respirator issuers, which are no different from the requirements to be a respirator user, are not sufficient to ensure that issuers can perform their assigned roles and responsibilities. Likewise, the training and qualification requirements for the respirator administrator are not sufficiently defined. Although OSHA does not identify specific training guidelines for respirator issuers, OSHA requires that "the program must be administered by a suitably trained program administrator." Interviews with training personnel from the HAMMER Training Facility confirmed that respiratory protection training does not adequately address all of the responsibilities expected of respirator issuers.

The current program administrator is a certified industrial hygienist and thus appears qualified for his responsibilities, although he has not received specific training as a respiratory protection program administrator and is not a participant in the DOE Respiratory Protection Program Administrator Committee. Specific training in respiratory protection program administration and participation in a peer group like the DOE Respiratory Protection Program Administrator Committee could improve the credibility of the respiratory protection program, and broaden the knowledge base and experience of those who administer the program.

The respiratory protection program does not clearly define roles and responsibilities for industrial hygiene and radiological control staff and technicians. The written program generically identifies personnel responsibilities for administration of the respiratory protection program. However, the program does not differentiate between the responsibilities of industrial hygiene staff, technicians, and radiation control technicians. A number of the stated functions should only be performed by industrial hygiene professional staff, although the program document does not provide this level of guidance.

Although respirators need to be controlled, the current procedure for issuance of voluntary respirators is unnecessarily cumbersome and has become an impediment for voluntary use of respirators. Voluntary use respirator procedures and policies are detailed in Section 4.13, Figure 9, and Attachment D of the Respiratory Protection Program. These procedures are longer and more complex than procedures for required-use respirators. This cumbersome process has discouraged workers from voluntarily using respirators, even if the worker would prefer to use a respirator. This impediment in issuance and use of respirators on a voluntary basis conflicts with the stated voluntary use respirator policy in Attachment D of the respirator procedure, which states "respirator use is encouraged, even when exposures are below the exposure limit, to provide an additional level of comfort and protection to workers." The criteria for voluntary respirator use assume extraordinary measures or an increase in the other hazards. While these are respirator use considerations, they are not unique to voluntary-use respirators and need not be a part of the voluntary-use respirator section. Singling them out for discussion in this section creates a non-essential obstacle to the voluntary use of respirators. Several workers have complaints about the difficulty in obtaining voluntary-use respirators, and their complaints appear to be valid.

The respiratory protection program does not provide requirements for documenting personnel exposure

measurements (breathing zone measurements) to demonstrate that the respirators are providing adequate protection. All respirators have assigned protection factors (APFs). APFs are concentrations, specified in multiples of the occupational exposure limit, for which the respirators can be assumed to be effective. Personal breathing zone TWA sampling provides the mechanism to verify that the APFs of the respirators being used are adequate, although such monitoring is not routinely conducted.

Weaknesses in hazard identification programs have adversely affected the respiratory protection program. Any respiratory protection program that uses respirators other than self-contained breathing apparatuses hinges on an effective hazard identification, assessment, and monitoring program to ensure that the proper respirators are selected and used within their limits. Ineffective or incomplete hazard identification and characterization can result in the selection and use of the wrong respirator, or a respirator that is not designed to protect the worker from the appropriate hazard(s). For these reasons, hazard identification and exposure assessment issues discussed previously contribute to respiratory protection program vulnerabilities, such as:

- Organic (PID) and ammonia instrument measurements do not detect nitrous oxide, which is one of the abundant gases identified in the tank vapor spaces. The limited breathing zone sampling that has been conducted for nitrous oxide identified nitrous oxide concentrations of up to 11 ppm. Personal sampling or monitoring for nitrous oxide is seldom conducted, and the manufacturer of the respirator cartridges warns against use of the currently issued respirator cartridge for protection against nitrous oxide. As a result, Tank Farm workers may be exposed to elevated levels of nitrous oxide without the appropriate respiratory protection. In response to this concern, on April 15, 2004, CH2M HILL management required any work conducted in non-ventilated waste tanks to be performed using supplied air or self-contained breathing apparatus.

- Organic (PID) and ammonia instrument measurements currently in use do not detect methanol. which is one of the larger organic vapor fractions in some tanks. Personal exposure monitoring for methanol is seldom conducted, and the cartridge respirators currently in use also warn against using these cartridges for protection against methanol vapor.

Overall, the CH2M HILL respiratory protection program, while generally comprehensive, is lacking in several areas. The respiratory protection program is also vulnerable because of limitations in the Tank Farm exposure assessment processes, the cumbersome voluntary-use policy, and unclear industrial hygiene and radiological personnel responsibilities. In addition, respirator cartridges in use do not provide adequate protection for some chemical vapors identified in the Tank Farms, such as nitrous oxide and methanol.

Finding #C-5: The CH2M HILL respiratory protection program has not facilitated the voluntary use of respirators, ensured that respirator issuers are trained, or adequately demonstrated that workers are protected from the variety of chemical contaminants in tank vapors.

Results of the OA Program to Independently Sample Selected Waste Tanks

The OA team independent sampling program consisted of three elements: (1) collection and analysis of tank headspace data from three waste tanks; (2) collection and analysis of ventilation effluents from both SSTs and DSTs; and (3) sampling of selected CH2M HILL workers for chemicals that may be present in a worker's breathing zone for a full 8-hour shift.

Samples obtained by the OA team were analyzed by accredited laboratories operated by the Westinghouse Savannah River Company (WSRC), located near Aiken, South Carolina, or their subcontractors. The WSRC laboratories were selected because the laboratories have experience in the analysis of tank wastes from the Savannah River Site.

Headspace vapor samples were withdrawn from two DSTs (AY-102 and AP-108), and one SST (C-105). The AY-102 tank was selected because there had been a reported vapor incident associated with this tank on the day prior to sampling. The AP-108 tank was selected because this tank, as a receiver for waste effluents from the evaporator, is constantly in a state of waste flux, and there was no prior record of the headspaces of this tank being previously sampled. Tank C-105 was the only SST tank sampled and was selected for its history of odor incidents, and higher organic contents. The headspace for each tank was sampled using a SUMMA canister, which was subsequently sent to the Savannah River Technology Center laboratories for analysis. Prior to obtaining the SUMMA canisters, some changes in sampling protocols, procedures, and

in the SUMMA canister purge system were implemented to correct the deficiencies in these areas as previously discussed. However, not all sampling deficiencies could be corrected due to the complexity of the needed corrective action (i.e., install additional sampling lines in the tank risers). As a result, some systematic errors are also inherent in the headspace samples obtained by the OA team.

In general, the analytes detected by the OA team in the tank vapor headspaces were qualitatively similar to chemicals previously detected by the Hanford Site analytical laboratory (WSCF) and their predecessors. In some cases (e.g., AY-102) concentrations of some organics as identified by the OA team, such as heptane, have increased more than fivefold from previous sample results taken in the same headspace. This confirms recent CH2M HILL analyses that concentrations of organic vapors in headspaces have increased since the completion of interim stabilization.

The ventilation effluent stack for the AP Tank farm (241-AP-108 stack), which serves as the ventilation exhaust for several DSTs, was sampled for a variety of chemical contaminants. A scan for metals was conducted on ventilation effluents, and no detectable metal concentrations were identified being released from the AP-108 stack. Stack effluents were also analyzed for benzene, formaldehyde, methanol, and acetaldehyde, with all results being below quantification limits for the analysis instrumentation. Although hydrocarbons were identified in stack effluents, the concentration of total hydrocarbons was also well below regulatory thresholds. However, a number of chemical contaminants that have either noticeable odors at low concentrations, or chemicals that have low regulatory thresholds, were identified exiting from the AP-108 stack in concentrations that were above minimum detectable levels, but below quantifiable limits. For example, measurable amounts of acetone, tetrahydrofuran, methyl ethyl ketone, toluene, and detectable amounts of methyl isoamyl ketone, and 1,3,5-trimethylbenzene were identified by the laboratory analysis, but in low concentrations that were well below regulatory limits.

Because the SSTs are individually and passively ventilated, the breather filters of tanks C-105, C-107, and C-204 were sampled for a wide variety of organic vapors, at the point in which the breather filters exhaust to the environs. These samples, like the ventilation stack effluent samples, were analyzed by a commercial industrial hygiene laboratory accredited by the AIHA, and under the supervision of the Savannah River Site Industrial Hygiene Laboratory. In all cases, concentrations of chemicals from the breather filters were also well below regulatory thresholds, and in most cases were at levels below quantification.

Personal sampling was also conducted for workers conducting two typical work activities: C-103 saltwell screen removal, and tank grab sampling being conducted on Riser 2 for AP-101. In both cases, workers wore passive organic vapor monitors and a personal sample pump with collection media for ammonia during their 8-hour work shift. These samples were also analyzed by the same commercial industrial hygiene laboratory that conducted the analysis for the ventilation effluents.

These personal sampling results also indicated that concentrations of those chemicals for which an analysis was conducted were well below regulatory thresholds. However, less than quantifiable concentrations of a number of chemicals were identified in the personal breathing zone samples. One of these chemicals, acetonitrile, cannot be detected by the DRIs currently in use.

Summary

In general, for those waste tanks evaluated by the OA team, concentrations of most chemicals in the waste tank headspaces are below levels of regulatory concern. Furthermore, there are no records of Tank Farm workers having been exposed to chemical vapors from the Hanford waste tanks in excess of regulatory limits. The limited independent sampling conducted by the OA team also concluded that vapor concentrations of those chemicals sampled by the team were well below regulatory limits in all cases. This confirms the generally low worker exposures to chemical vapors also measured by CH2M HILL during the past two years.

However, the CH2M HILL personal sampling data is too limited to conclude that the exposure of all workers is below regulatory thresholds for all chemicals to which they might be exposed. Furthermore, because of the number of industrial hygiene vapor issues identified in this report and through CH2M HILL self-assessments and external reviewers, worker exposures to some waste tank vapors cannot be determined because of insufficient exposure data, uncertainties in the detection of some chemicals, or the collection and recording of the data. Significant vulnerabilities exist in the CH2M HILL industrial hygiene program, which until corrected will continue to raise uncertainties in the determination of whether some workers are being overexposed to some chemical vapors. Specific concerns that require management attention include

an insufficient sampling and characterization of tank vapors, insufficient personal vapor exposure data, inadequate DRI and personal exposure records, limitations of instruments to detect some vapors, lack of industrial hygiene technician procedures, insufficient industrial hygiene technician training and qualification, and shortcomings in the respiratory protection program.

CH2M HILL recently developed and is implementing an industrial hygiene improvement plan, which addresses a number of the areas in which deficiencies were identified by the OA team. However, there are also a number of concerns identified by the OA team that were not previously identified or sufficiently evaluated by CH2M HILL. Due to the uncertainties in some aspects of worker exposures to waste tank vapors, CH2M HILL recently implemented additional interim respiratory protection requirements at the Tank Farms.

C.2.2 Work Processes

Overview

To evaluate the effectiveness of current Tank Farm processes for hazard identification, analysis, and control, the OA team selectively sampled current work activities at the Tank Farms, including those with the highest potential for exposure of workers to tank vapors as well as radioactive material. While potential vapor exposures were the primary emphasis, exposure to radioactive material was also considered.

Reviews were designed to be representative of overall Tank Farm activities and included efforts of Waste Feed Operations tanks and Closure Projects tanks. A variety of work was observed during the investigation. Work observations included activities performed by construction, maintenance, and operations personnel, such as intrusive activities, tank surveillance, corrective and preventive maintenance, sampling, operator activities, and routine job coverage by both industrial hygiene and health physics technicians. In addition, the OA team reviewed data collected in support of job coverage, hazards analysis, and hazard control activities, including air monitoring and sampling data and radiological survey records.

At the activity level, proper implementation of the CH2M HILL work control process is designed to encompass all required elements of DOE's integrated safety management core function framework. The process for defining and planning individual work scopes is bounded by TFC-OPS-MAINT-C-01, *Tank Farm Contractor Work Control.* This process uses a graded approach to the level of rigor, planning, and documentation required for individual work scopes, based on the anticipated hazard and complexity of the work. These levels range from simple, verbally directed work for the most routine activities, to enhanced work planning with increased oversight by senior management (Joint Review Group) for the most complex and hazardous jobs, where multidisciplinary teams jointly develop and approve formal work packages.

Analysis of hazards associated with individual work scopes is accomplished through the use of the job hazards analysis (JHA) process. The JHA, in principle, identifies all relevant hazards associated with a scope of work as well as linkage to the appropriate controls. All maintenance work is covered by one or more JHAs. Some broad classes of work activities are covered by a single or "standing" JHA. In the case of construction work, Fluor Federal Services, the construction subcontractor to CH2M HILL, uses a separate job safety analysis (JSA), reviewed and approved by CH2M HILL, to identify and analyze hazards associated with construction-related activities. Mitigation of identified activity-level hazards relies upon an established hierarchy of controls, including engineered controls, administrative controls, and PPE. To ensure proper readiness for performing work, personnel are also briefed on hazards and controls associated with individual work activities.

In general, management and workers at the Tank Farms were competent, conscientious, and genuinely concerned about ensuring a safe work environment. All meetings begin with a safety topic, which serves as a reminder of the importance of safety in daily operations. Work packages and technical procedures covering work under review were generally effective in defining the scope, boundaries, prerequisites, and initial conditions for work activities. In the field, the amount of safety and health coverage was commensurate with the level of risk, and effective controls were evident on jobs where there was an expectation for high potential vapor emissions. For example, the 241-TX-110/111 Breather Filter Replacement work included special boundaries at both tanks to delineate established AMZs. Postings provided instructions, including "Caution Hazardous Vapor Source," and required contact of the Shift Manager prior to entry for specific instruction. Job coverage included full-time industrial hygiene monitoring of ammonia, organics, and flammable gases, and health physics technicians for the provision of radiological contamination and exposure rate monitoring. Similarly, robust safety and health controls were evident on the

241AP 101 pump install work, which involved insertion and removal of a tank depth verification rod, removal of a tank riser extension, and insertion of a new tank pump. This work was being performed by Fluor Federal Services personnel, with safety and health coverage by CH2M HILL. There were five health physics technicians providing radiological support, one industrial hygiene technician performing industrial hygiene sampling, and a senior supervisory watch construction manager from CH2M HILL overseeing the work.

While aspects of Tank Farm work efforts were effective, the OA team noted examples of weaknesses in application of core functions of integrated safety management in the areas of hazards analysis, identification and implementation of controls, and work performance. These weaknesses are discussed in the following sections.

Analysis of Hazards

Effective hazards analysis is necessary to be able to identify and implement appropriate controls. While the site has mechanisms in place to drive proper hazards analysis, observation of Tank Farm work planning activities indicated that an appropriate level of hazards analysis is not always performed before work is allowed to proceed. A number of deficiencies related to work planning were observed that had the potential to impact worker safety, including potential exposure to vapors, radiological material, and other hazards.

One example involved the 241 AZ condensate line mechanical cleaning job. In this case, industrial hygiene monitoring was initially required but was removed from the work package based on a change in work scope eliminating addition of caustics. The potential for tank vapors was not anticipated. The system was the condensate drain line from the condenser of the Primary Tank Ventilation System. Because the system was tied into the Tank's primary ventilation system, vapors should have been anticipated, and the required controls should have been established. An operator was uncomfortable working without monitoring for vapors and requested that industrial hygiene monitoring be performed when the riser plug was removed. This monitoring subsequently identified 25 ppm ammonia levels at the source, and continuous industrial hygiene monitoring during the job was therefore required based on the *Standing Industrial Hygiene Sampling/ Monitoring Strategy*, TF-SIHS-011. Similarly, a general radiation work permit (RWP) was chosen to control the work based on a presumption that radiological contamination was unlikely, rather than attempting to gather radiological survey data or characterization information on the system. As a result, the RWP that was used did not have all appropriate controls, creating the potential for uncharacterized exposure of workers. When the mechanical device was removed from the riser, high levels of radiological contamination levels were detected. The work was appropriately stopped based on unexpected contamination and exceeding RWP suspension limits. Work planners interviewed did not have a clear understanding of the depth the mechanical device would traverse into the condensate catch tank riser, which should have been a key factor in determining whether a radiological hazard might be present. This failure to understand all relevant details associated with the work and the potential hazards is indicative of a need for improvement in work planning.

Another example of deficient work planning and hazards analysis was the work to cut the 241AP depth verifier into smaller segments for disposal. Work methods employed by workers in the field did not match the expectations or assumptions of the work planners responsible for identifying appropriate controls. This disconnect occurred because planners did not include sufficient details on expectations in the work instructions and permits. As a result, work planners were unaware of the actual glovebag method being used by workers for size reduction of the contaminated depth verifier. Planners believed the entire reciprocating saw (used to cut the depth verifier) was to be fully enclosed in the glovebag rather than the partial sleeve-in method set up in the field. The work instructions did not address how to properly sleeve the saw into the glovebag to ensure that glovebag integrity was maintained. The partial sleeve-in method that was used created greater potential for spread of contamination outside the glovebag or airborne radioactivity than was presumed. The glovebag certification checklist provided in the package did not address certification of a non-standard glovebag configuration as required because these additional hazards were not anticipated. In addition, instead of treating the saw as radioactive waste as originally presumed by the work package, the saw was initially surveyed and released outside the radiological buffer area (RBA) as non-radioactive, in conflict with requirements for potential internally contaminated items. The saw was later retrieved and tagged as potentially internally contaminated.

Finding #C-6: CH2M HILL hazards analysis processes have not been sufficiently rigorous to ensure an adequate understanding of potential hazards prior to allowing workers to perform work.

Although CH2M HILL management recently embraced the application of the ALARA concept to potential vapor exposures, implementation is in the early phases, and certain aspects fell short of the intent of the concept. The ALARA philosophy, which is a fundamental regulatory-driven premise regarding occupational radiation exposures, is based on the presumption that there is no threshold below which exposures can be considered negligible, and therefore any amount of exposure entails some, albeit low, risk of long-term health consequence. Such a philosophy requires not only that exposures are maintained well below regulatory limits but that controls are implemented to ensure that exposures are maintained as far below those limits as is reasonably achievable.

The CH2M HILL stated application of the ALARA process for potential vapor emissions is not mature. For example, industrial hygiene hazards analysis conducted in support of closure project work planning does not consider alternative exposure limits other than ACGIH TLVs (required by DOE order) or OSHA PELs (mandated by law) in establishment of controls and routine DRI monitoring. Closure project industrial hygiene staff use ACGIH TLVs to compute a Hazard Index for each chemical based on results of SUMMA or DRI analysis. However in the absence of TLVs, alternative exposure limits, such as temporary emergency exposure limits (TEELs), recommended exposure limits, and derived limits published by other organizations, are not required to be considered in the evaluation of sampling and monitoring results and establishment of controls. This is the case even for chemicals that have no regulatory TLV or PEL, such as butanal. If butanal is detected, other sources of recommended exposure limits (e.g., TEELs) are not used to develop a specific Hazard Index, based on industrial hygiene management direction to only use regulatory-driven limits. Such an approach indicates a shortfall in application of the ALARA philosophy to the vapor issue.

Specific information on potential hazards, including tank vapor emissions, was not always properly reflected in relevant work packages, JHAs, and JSAs, and therefore may not ensure that workers are informed about all potential hazardous conditions applicable to the work. For example, the work package for 241 TX-110 and 111 to replace failed breather filters contained no reference to the location of the work within an AMZ or the appropriate controls or standing orders applicable to the work. SJHA-0001 Rev. 4, which was referenced in this work package, identifies the generic hazards common to Tank Farm operations, but contains no information related to the potential for vapor exposures or the established AMZs. In another example, the work package for a project that required Fluor Federal Services to be working adjacent to an AMZ did not discuss the potential for tank vapor emissions. The CH2M HILL JHA for the work referenced the subcontractor's JSA for hazards and associated controls; however, the JSA did not contain any information related to vapor emissions and indicated that respiratory hazards were not applicable.

Other hazards were also omitted from hazards analysis documentation. For example, JSA 2004-0004, prepared in support of the 241-C-105 Pit Video and Radiation Survey, did not include potential hazards associated with lead sheets, which were utilized as shielding over the riser cover to reduce external radiation exposure rates, or the handling of these bare lead sheets with raw cut edges. Work planning for this activity included industrial hygiene review and analysis of the potential lead hazard, but the results of the analysis and resulting decision-making with regard to the need for controls were not contained in the JSA. As such, the JSA contained no information regarding lead hazards or controls. Similarly, JSAs for construction work did not include information on potential noise hazards associated with compressors and tools being used for the work. In one case, an unattended compressor operating outside the 241 AY Farm measured 89 decibels without any boundary control, noise posting, or specific information in the JSA about the potential hazard and the need for controls for this activity.

The job-specific hazards analysis, TO-630-001, associated with slurry sampling at the 242-A evaporator recognized the potential for spilling waste during the activity. However, there was no requirement for the use of a filter cartridge for protection against chemical contaminants, and there was no requirement to perform industrial hygiene monitoring, only the need for industrial hygiene to be notified of the sampling activity. While there have been no reports of chemical vapors associated with the evaporator operation, the process of condensing waste through evaporation and the recognition of spilling waste during the activity indicate the potential for the formation of vapors. The industrial hygienist responsible for work planning performed an

assessment and determined that potential vapor exposures from this evolution would not require respiratory protection or industrial hygiene monitoring; however, the assessment and technical basis for decision-making were not documented.

Finding #C-7: CH2M HILL's use of the JHA/JSA as a working document in work packages does not ensure that all relevant hazards are identified or that workers are fully cognizant of necessary hazard controls and the work steps to which those controls apply.

Identification and Implementation of Controls

Weaknesses were also observed in the identification and implementation of hazard controls associated with some of the Tank Farm work being reviewed during this investigation in the application of administrative controls and PPE.

Non-conservative and/or conflicting industrial hygiene, radiological, and communication procedures, practices, and controls were observed, increasing the potential for unmonitored exposure and/or spread of contamination. In some cases, a lack of rigor and formality associated with implementation of certain controls resulted in undesirable events. For example, respiratory protection controls were not clearly defined for workers establishing AMZs or replacing stanchions and chains within existing AMZs. In one case observed by the team, workers removed the stanchions and signs, then proceeded to enter the area previously posted as an AMZ. Similarly, workers in the AY Tank Farm were actually exposed to vapors while posting an AMZ without respiratory protection. In neither case was the need for respiratory protection clearly identified to the workers, and the workers did not believe protection was necessary. Routine activities in Tank Farms, such as the establishment of an AMZ, do not require industrial hygiene coverage unless requested by Operations or if source readings are above the HASP limit. In the AY Tank Farm case, industrial hygiene coverage was not provided because the source levels identified a few hours earlier were below the HASP limits. In neither case was a clear protocol established for the control of the monitoring strategies. For example, the initial monitoring plans for the AY/AZ and AN Tank Farms were signed and dated by industrial hygiene and located in the Shift Manager's office, but a change was made to the strategy for the AN Tank Farm. This copy was not signed and dated. The revised plan was provided via email from the Senior Industrial Hygienist. This email also discusses changes necessary for the AY/AZ Tank Farm, including the use of full-faced air purifying respirators with a GME/P100 cartridge while performing monitoring in this area. The AY/AZ initial monitoring strategy was not revised to reflect these changes.

Implementation of controls for vapor emission sources did not always have an appropriate technical basis, particularly for the differences and lack of controls in some areas. Work conducted in most Tank Farms does not have a requirement for a roving industrial hygiene technician or specifically assigned industrial hygiene technician coverage requirement unless entering an AMZ or when a system containing a known vapor source is to be breached. Work is routinely performed in several Tank Farms without industrial hygiene technician coverage. In the event of a vapor emission from these known sources or from other unknown sources, workers would have no indication of potential exposure levels, nor would they be provided information or direction related to any vapors encountered.

CH2M HILL does not have an effective means of ensuring that all workers are informed of protective actions under abnormal conditions, such as vapor releases. A vapor release on March 16, 2004, resulted in evacuation of a Tank Farm; however, two construction employees working inside a structure in the Tank Farm did not receive prompt notification of the evacuation. Following notification by coworkers over a telephone, these two employees encountered vapors while exiting the Tank Farm, experienced physical symptoms, and reported to the medical facility for evaluation. The Hanford Site Conduct of Operations Manual, Chapter 4, "Communications," establishes the guidelines for the Tank Farm contractor for accurate and prompt transmission of essential information in abnormal conditions or emergencies. The 200 East and West areas have an emergency communication system controlled by the Hanford Site contractor. In this vapor release and a subsequent release on March 17, 2004, the emergency communication system was not used to notify employees even though this was an abnormal condition addressed by an AOP. Instead, the facility depended on radio communications, pagers, bullhorns, and telephone calls to alert personnel to evacuate these areas. Construction craft have reported during fact-finding meetings that they were not aware of the need to evacuate because their radios are not on the same frequency as Operations, and they did not receive the message. In addition, construction first-

line supervisors were not on the pager call list. Although the guidelines in the Conduct of Operations Manual address abnormal conditions, facility management has limited the use of the emergency communication system to declared emergencies.

A number of safety and health controls at Tank Farms are being implemented through the use of standing orders rather than procedures or other work control mechanisms, in conflict with Chapter 15 of the CH2M HILL *Conduct of Operations Manual*. According to the manual, standing orders are for dissemination of essential short-term information and administrative instructions to Tank Farm contractor operations personnel and shall not be used to revise or substitute for approved procedures. However, standing orders are being used at Tank Farms to implement numerous safety and health-related controls, including industrial hygiene instrument alarm responses, special controls to prevent cross connection of breathing air systems, C-farm work control for vapor issues, and compensatory controls for chemical and/or radiological leaks and spills, including revisions to pre-job briefing requirements. While administratively simpler, the use of standing orders for these types of activities circumvents the more rigorous and formal procedural and work control mechanisms designed to control work. Further, there is no formal mechanism to ensure that standing orders are implemented for all workers.

With regard to radiological hazard controls, RWPs were not always tailored to the specific work being performed and were sometimes written in a manner that required the user to interpret the conditions and necessary controls. For example, the specific RWP E-1494 for the caustic addition to the 241AP seal pot required workers and/or the health physics technician to interpret the necessary radiological posting for the area, which would then determine the PPE requirements. However, this information was known in advance and should have been clearly specified in the work instructions or the RWP. As a result, there was uncertainty during the pre-job brief as to the exact radiological requirements and PPE for the work. Similarly, RWP TF-001 was used to cover a variety of intrusive work with the potential for changing radiological conditions; however, this RWP is a general RWP, intended to be used only for non-intrusive-type work with stable and well-characterized conditions (e.g., tours and inspections). As a result, the RWP did not include specific information on the expected radiological conditions applicable to the work.

In a third example, the 242A evaporator slurry sample RWP included extraneous information on entering contamination areas and RBAs when all the work was being performed in an airborne radioactivity area and high-radiation area.

As previously indicated, the 241AP depth verifier pipe size reduction work involved use of a sleeved containment device to contain contamination while cutting the contaminated depth verifier. The depth verifier was wrapped in plastic during a previous phase of the work and was being stored in the RBA while awaiting size reduction. The work package did not specify which of the two RWPs included in the work package was applicable to the size reduction work. In the absence of definitive direction, the workers chose the job-specific RWP, which included glovebag-type controls. However, the job-specific RWP was written primarily to control the AP pump replacement work inside a containment tent, so it was not specified whether temporary contamination area controls and PPE should be established for the size reduction portion of the work within the RBA. Again, this RWP allowed for work under a variety of different radiological conditions and required interpretation by workers and/or the health physics technician as to what the radiological posting for the area should be, which would drive the PPE requirements and other radiological controls.

Finding #C-8: CH2M HILL has not required sufficient rigor, formality, or specificity in the processes used to identify and implement controls needed to ensure effective hazard mitigation.

Performing Work Within Controls

Readiness to perform work at Tank Farms is effectively verified and controlled through plan-of-the-day schedules, morning work clearance meetings, shift manager approvals, crew briefings, and pre-job briefs. The morning work clearance meetings were effective for providing first-line supervisors and support organizations with management expectations for the day's work. Pre-job briefings for Tank Farm projects involved supervisors and workers and with few exceptions were through and comprehensive. In addition, when controls were clearly identified, Tank Farm workers generally performed observed activities safely and in accordance with established controls. This included compliance with work packages, procedures, and administrative requirements.

Most of the workers interviewed expressed comfort in raising safety concerns to their supervisors. Additionally, some workers have used their "stop work

cards" when they felt safety concerns were not receiving adequate response. Workers did raise questions during pre-job briefs regarding controls, demonstrating comfort in addressing safety issues.

A few examples were identified where workers did not follow established controls as expected. On the 241 AP depth verifier size reduction, workers were not wearing extremity dosimeters as required by the RWP, and the health physics technician did not immediately recognize the need to obtain the required control or modify the RWP before proceeding with the work. On the 241 AP pump replacement, a worker exhibited poor contamination control practices while doffing PPE, which could have resulted in a personnel contamination. Health physics technicians outside the zone who were to survey the exiting workers were not engaged with the doffing evolution and did not observe or question the poor doffing technique. Similar doffing-related contamination control issues were observed during pit preparation work conducted at the 244 CR vault/pit. Lastly, on the 241AP evaporator slurry sample, a lapel sampler on a worker was never turned on as required; therefore the survey record shows results for only two of the three workers who entered the airborne radioactivity area.

Summary

Some aspects of Tank Farm work efforts were effective, particularly for activities in which higher vapor concentrations were expected. Work was generally well defined in work packages and technical procedures. Hazard identification and analysis in JHAs and JSAs were not always sufficiently detailed, and in some cases, predominant hazards of the work were not adequately covered. Identification and implementation of controls were weak, with significant reliance on individual expertise and interpretation to protect workers from radiological and chemical hazards. Consequently, in some cases workers were not aware of appropriate controls. In other cases, workers did not appropriately implement identified controls while conducting work. Although the work control processes clearly establish requirements for work planning, implementation of these processes is weak and warrants additional management attention.

C.2.3 Communication to Workers

Recent Initiatives

CH2M HILL has recently introduced several mechanisms to improve communication channels between management and Tank Farm workers regarding tank vapor issues. In 2003, the company implemented a Tank Chemical Vapor Project formalizing and scheduling the various activities addressing tank vapors. The company has communicated details regarding tank vapors directly to workers through numerous channels, including articles in the company newsletter, "Winds of Change," "all-employee messages," tailgate safety meetings, and two brochures on vapor issues mailed directly to employees' homes. Management has increased emphasis on vapor hazard awareness during safety meetings and pre-job briefings, and workers interviewed by OA indicated that these methods have been beneficial. An independent toxicologist was hired to answer worker questions about the health effects of vapor exposures, and other health and safety specialists recommended by the bargaining unit were invited to the site to perform independent assessments of vapor exposure issues. Management has also implemented its ALARA approach to chemical exposures to address worker concerns and has used the ALARA terminology, in part because workers are familiar with the ALARA concept in the radiological arena.

CH2M HILL has also utilized the Employee Response Team (ERT) to serve as an ombudsman to assist management and employees in the resolution of concerns. While the ERT was developed for resolution of any employee concerns, the ERT has helped some employees resolve concerns specifically related to chemical vapor exposures.

CH2M HILL also created the Chemical Vapor Solutions Team (CVST), co-chaired by management and bargaining unit representatives, to provide a forum for management and Tank Farm workers to work together to address chemical vapor exposure issues and to ensure that employee concerns are heard and addressed. Overall, the members have worked effectively in proposing measures for hazard identification and control and in providing feedback to responsible persons. The CVST has provided information on vapor exposure issues to the workforce through tailgate meetings, newsletters, and a CVST web site. An element of the CVST charter states that the CVST will "*Obtain, document and communicate responses to questions from employees regarding*

Tank Farm chemical odor and vapor concerns, including but not limited to characterization, toxicology, monitoring and hazard controls." Questions received by the CVST are posted on the CVST web site and are provided to line managers to be answered. Answers from line management are provided to senior CH2M HILL management and legal staff for review and then posted on the web site.

As part of the improvement in communications, CH2M HILL developed an eight-hour Chemical Hazards Awareness training course to provide basic fundamentals training for Tank Farm workers. The lesson plan provides a history of tank vapor problems, descriptions of common chemicals present in the vapors, potential health effects from exposure, and appropriate methods to control and respond to chemical exposures. Questions from students regarding chemical vapors that are beyond the knowledge of the instructor are documented on a PER and/or submitted to the CVST for resolution. Worker feedback to the course has been generally positive.

Worker Perceptions and Concerns

In order to gain a perception of worker attitudes, OA requested interviews with a majority of the CH2M HILL and Fluor Federal Services workers who had received medical evaluation due to vapor exposures since January 2002. OA also interviewed members of the CVST and ERT as well as union representatives. These workers were aware of the various channels to raise safety concerns, and most were comfortable with raising safety concerns through their supervisor or other available channels if necessary, with the Fluor Federal Services workers expressing the most trust in the management chain for this. Although a few of the requested CH2M HILL workers refused to talk to OA, most were comfortable with the interview process.

Reports of worker exposures to chemical vapors have increased over the last few years because of a combination of factors, including lower thresholds for reporting vapor exposures and increased worker awareness of vapor issues. Some Tank Farm workers remain concerned about the health risks associated with chemical vapor exposures, and their concern increases as reported exposure events become more frequent. Workers fear that their exposures may be higher than indicated by industrial hygiene monitoring because the acute symptoms that some workers are experiencing are more severe than would be expected based on monitoring results. Continuing events involving acute symptoms also contribute to worker distrust in current tank vapor characterization measurements performed by industrial hygiene as well as management's assertions that no exposure limits have been exceeded. Several CH2M HILL workers interviewed by OA did not trust the industrial hygiene program justifications for lack of respirator requirements for Tank Farm jobs but were not comfortable about use of voluntary respiratory protection because of negative peer pressure and the perception by other workers that it was a sign of weakness. In addition, several CH2M HILL interviewees stated that the process and paperwork to obtain voluntary respiratory protection was too much trouble and too time consuming. Only one of the interviewed CH2M HILL employees had used voluntary respiratory protection. Only one of five construction employees had ever heard that voluntary respiratory protection was available, and none had ever used it.

Management statements that workers need not be concerned about long-term effects have not been convincing in view of worker uncertainties about the concentrations and identity of toxic and carcinogenic materials in the vapors. Workers expressed particular concern that established controls have not been effective in reducing the frequency of vapor exposures. The continuing exposure trend, distrust in the current tank characterization, allegations contained in the GAP report, and other unrelated factors, including major organizational restructuring, outsourcing of work, and reductions in force, have contributed to the loss of trust in management.

In addition, there are problems with some of the above communication channels that further hinder improvement in worker trust in management. Although the CVST has been a positive measure in worker communication, some deficiencies hinder its full potential. The CVST does not maintain a record of question or answer dates, and there is no formal procedure or tracking system to assure that questions are answered in a timely manner or that the specific employee asking a question receives an answer. Some employees said that they did not have ready access to computers and were not aware that questions and answers were posted on the CVST web site. Answers have been posted for only about half of the questions on the web site. There are also deficiencies with the Chemical Hazards Awareness training. In some cases, the training material was not current with actual practices in the field, and line management responses to questions raised in class have not been timely. These

issues caused an indefinite suspension of the training in March 2004 until the inaccuracies and communication problems are resolved.

In some cases, workers are confused about the required responses to vapor odors. The AOP for "Response to Reported Odors or Vapor Exposures," TF-AOP-15, is applicable to all CH2M HILL personnel and subcontractors doing work in the Tank Farm. The AOP provides entry conditions and provides a subjective list of six criteria for the odors to meet entry conditions. The AOP references the standing JHA for general Tank Farm hazards (TF-SJHA-0001) as the safety guideline for this procedure. This JHA lists chemical spills/vapor exposures as potential emergency or abnormal events, and lists some specific controls. However, the additional text for this hazard says to refer to AOPs or emergency response procedures as appropriate, but the JHA does not list all worker actions from the AOP for vapor exposure. Consequently, not all workers would know the specific AOP actions necessary to respond to a vapor event from this JHA. In the fact-finding meetings for the exposure events of March 16 and 17, 2004, workers were confused about actions related to response to vapor odors, further indicating that communications regarding management expectations have not been successful.

Summary

A fundamental problem expressed by the workers is that management makes the assertion that the waste tanks and vapor emissions are well characterized; however, management cannot identify the specific chemicals causing the symptoms in the exposure events. Therefore, management assertions that there are no long-term health effects and that there are no exposures over limits are not perceived as credible if the chemicals causing the symptoms are unknown.

Following the exposures in late March 2004, management implemented a new policy requiring the use of respiratory equipment during all work in the Tank Farms. To facilitate communications regarding this policy, management increased participation in weekly tailgate meetings and began periodic distribution of question and answer packets to provide more accurate and timely answers to workers' questions. Management actions such as these improve the communication problems with workers; however, increased management emphasis on communication of the unknowns with regard to vapors is needed to further restore worker trust.

C.2.4 Engineered Controls

Overview

When the single SSTs were originally designed and installed, vapor releases were not recognized as a significant worker safety hazard. Thus, the tanks and associated support systems were not designed with the specific purpose of preventing or minimizing vapor exposures. The SST passive ventilation approach was designed such that gases and vapors escaped the tank with no engineered filtering, treatment, forced dilution, or dilution through elevation. In fact, the exhaust point of the breather exhaust lines for many SSTs was at about five feet above ground level, at about the same level as the worker's breathing zone. This situation probably contributed to some of the vapor exposure events. In addition, the SSTs were not designed to preclude vapor leaks and there were a number of places, such as valve stems and electrical cabinets, where fugitive vapors leaked from the tanks at ground level and could cause a vapor exposure event.

DSTs also were not specifically designed with the goal of precluding vapor exposures. However, DSTs were designed with active ventilation systems primarily intended to filter out radioactive particulates and prevent heat and hydrogen buildup in the tank. These DSTs with active ventilation systems have inherent advantages over the SSTs from the standpoint of vapor emissions because the tank vapor spaces are maintained below atmospheric pressure, such that leak paths are inward and fugitive emissions are minimized. In addition, the exhaust stacks' release points are elevated, and thus vapors will be diluted before reaching worker breather zones; the amount of dilution depends on the wind patterns and atmospheric conditions.

Over the past fifteen years, the concern about noxious odors and vapor exposure events has received significant attention, and several attempts were made to install engineered controls to mitigate the vapor hazards, primarily on SSTs, which have been the primary focus of engineering control modifications. Some of these engineered controls were determined to be ineffective for various reasons and were removed. Others currently being used on selected tanks have experienced varying levels of success.

To evaluate the engineered controls, OA interviewed engineering managers, held in-depth technical discussions with technical staff, performed walkdowns of existing systems, and reviewed various documents, including modification packages, design

documents, facility operating, testing, maintenance, and conduct of engineering procedures, and the unreviewed safety question (USQ) processes. OA evaluated engineered controls for DSTs and SSTs, with emphasis on design modifications and tanks that have a history of vapor emissions. A number of other modifications have been made over the years, such as replacement in the early 1990s of active ventilation with passive HEPA filters on SST tank exhausts that were not designed to capture vapors and thus were not evaluated as part of the review of vapor exposure issue.

OA evaluated three aspects of engineered controls:

- Effectiveness of current engineered controls and those that have been attempted and abandoned
- Appropriateness of approaches for selecting and designing future modifications
- Effectiveness of engineering processes.

Current Engineered Controls

Engineered controls are only one part of the vapor protection strategy. ORP and CH2M HILL recognize that engineered controls do not, by themselves, preclude Tank Farm workers from being exposed to tank vapor leaks or releases. As discussed earlier, the protection strategy also relies on administrative controls and PPE. Consequently, OA examined the current engineered controls from the perspective of their role in the overall strategy and their effectiveness in performing their intended function, including testing, maintenance, and operational interfaces.

At the time of this review, the SSTs had various engineered controls in place to reduce worker vapor exposure, including:

- **Tank structure.** Maintaining tank integrity is fundamental to vapor control.
- **Tank sealing.** Tank sealing began primarily to prevent water intrusion after interim stabilization in the late 1970s/early 1980s and shifted around 2000 to address ground-level fugitive vapor release pathways. Sealing methods included foaming and taping potential release pathways; replacing pit covers and installing special gaskets on their seals; designing and installing special seals on the various valve operator stems that penetrated the pit covers; and providing special components to prevent leakage in electrical conduits between the tank pits and external cabinet and panels.
- **Breather stack extension on C-103.** SST C-103 has been identified as the source of many vapor exposure incidents and is considered by Tank Farm personnel to be one of the most problematic tanks. After two other unsuccessful engineered controls were attempted in the 1990s, an extension to the outlet of the breather filter on the Tank C-103 was installed to raise the exhaust point to 15 feet.
- **Active ventilation for 13 SSTs at the SX Tank Farm.** One set of SSTs for the SX Tank Farm was designed with an active ventilation system for use with high-temperature wastes.
- **Portable exhausters.** Portable exhausters are used on SSTs during major waste disturbing activities. The portable exhausters are used to remove vapors through an elevated stack and to keep tanks at a slight negative pressure, as well as to remove generated heat.

The team reviewed the effectiveness of the SST engineered controls. The tank sealing modifications, in general, were effective in reducing fugitive vapor release. CH2M HILL has developed plans for periodically monitoring these modifications and, when necessary, new components are designated for sealing, or existing seals are replaced.

The extended breather stack on Tank C-103 provides for some level of dilution before vapors from the stack reach the breathing zone. Similarly, although their primary purpose is to remove decay heat, the active ventilation systems on some SX SSTs mitigate vapor exposure potential by preventing fugitive emissions, by providing dilution in the tank headspace which prevents fugitive emissions, and by providing dilution as a result of the elevated release point. However, only a small number of the SSTs have these controls. In addition, the tanks with active ventilation are subject to the same concerns about excessive vacuum as the DSTs (see discussion below and Finding #C-9), which resulted in the SX tank active ventilation being shut down during this investigation after the concern was raised.

The OA team identified a weakness in configuration control for some SSTs. The tank sealing efforts were not treated as modifications to the tank

configurations, which they were, and, therefore, they did not undergo all of the applicable rigorous, formal, documented procedural steps necessary to assure that complete, valid technical considerations were being performed and that configuration control was maintained. Such sealing on tanks with active ventilation increases tank vacuum, but the potential vacuum threat to these tanks' integrity, as well as the ability to remain below the technical safety requirement (TSR)-required hydrogen concentration limits with reduced inleakage, were not adequately evaluated. Several years ago, a potential inadequacy in the safety analysis was declared because of these hydrogen buildup concerns, which were addressed by removing some of the sealing.

In addition, measurement of the effectiveness of the C-103 stack extension was limited. CH2M HILL had an appropriate goal of moving exhaust out of the direct breathing zone of workers and performed some calculations to quantify the potential benefit of the modification in terms of vapor dilution under average meteorological conditions. However, they did not re-evaluate lessons learned from previous attempts to resolve vapor emission from the tank and did not develop an effective test plan to ascertain the actual effectiveness of the modification. The testing was not complete, in that it did not evaluate effectiveness under other than average meteorological conditions and was fundamentally flawed, in that the initial readings taken without the stack indicated no emissions, which would be characteristic of the tank being in the inhale mode for which no emissions would be expected. Therefore, the readings had no bearing on the concern, and as a result, the effectiveness of the stack was never demonstrated.

At the time of this review, the DSTs had various engineered controls in place to reduce worker vapor exposure, including:

- **Tank structure.** Maintaining tank integrity is fundamental to vapor control.

- **Active tank exhaust ventilation.** All DSTs have active ventilation that helps to prevent fugitive ground-level tank emissions, reduces headspace vapor concentrations, and exhausts vapors through a stack above worker breathing space.

- **AY/AZ Tank Farm condensers.** Certain tanks have condensers in the exhaust ventilation path to reduce some vapor concentrations (e.g., ammonia).

- **High-efficiency gas adsorbers (HEGAs).** One Tank Farm exhaust ventilation (AY/AZ Tank Farm) includes charcoal bed HEGAs, which are installed to address State of Washington concerns with arsenic, ammonia, and volatile organic compound (VOC) emissions. Although the HEGAs were designed to remove arsenic, they were not designed for efficient removal of the other vapors of concern with regard to worker exposure.

- **Continuous air monitoring (CAM) cabinet modifications.** CAM cabinets were identified as a source of vapor exposure in DSTs. The cabinets were modified to allow manual starting of the cabinet exhaust fans to remove vapors prior to opening the cabinet doors.

Historically, DSTs have been viewed as less of a problem from the vapor exposure perspective because all DSTs have active ventilation. With some exceptions, the ventilation systems have reduced fugitive emissions and provided dilution. The condensers and HEGAs on some of the DSTs have also provided an additional degree of protection for some types of vapors.

The modifications to the CAM cabinets addressed a recognized source of emissions. The CAM systems monitor radiation in the ventilation system exhaust stack. Leakage from the sampling components inside the CAM cabinets would collect inside the cabinets and cause exposures to workers whenever the cabinet doors were opened. To address this source, a push button was installed on the cabinets to allow manual starting of the cabinet cooling fan to purge vapors from the cabinet prior to opening the doors.

Although engineered controls are in place, their reliability and effectiveness are hindered by weaknesses in design, testing, maintenance, and configuration control. The most significant weakness involves potential threats to tank integrity from excessive vacuum as discussed below.

The most important engineered feature for controlling tank vapor releases is the tanks themselves. Failure of any of the major structural components in a tank because of exceeding vacuum limits would have the potential for producing immediate worker vapor exposures and could also result in an uncontrolled release of tank contents to the environment. Recovery from such a condition could also be extremely problematic, with high potential for additional worker vapor exposures. OA identified the following specific conditions with the potential to cause excessive vacuum in both the SSTs and the DSTs:

- Contrary to American Society of Mechanical Engineers code requirements and commonly accepted good engineering practice, most actively ventilated tanks (both SSTs and DSTs) did not have specifically engineered relief devices. On those that had such devices, they had not been demonstrated as adequate for design considerations.

- Other installed engineered devices that might have provided some vacuum relief protection had intermediate isolation valves between the devices and the tanks, which is also contrary to code requirements and commonly accepted good engineering practice.

- HEPA filters were also installed in-line between these other engineered devices and the tanks. Differential pressures across these filters would raise the effective relief point of these devices, potentially beyond tank limits.

- Numerous modifications were performed without adequate consideration of the potential vacuum threats they could pose to the tanks. Examples were:

  – Active tank ventilation systems were installed without adequate analyses of their vacuum producing capabilities versus allowable tank vacuums, some of these with capacities well beyond the tanks' design limits. At least one system designed by an outside architect/ engineer called for vacuum relief devices, but they were not installed.

  – Vacuum retrieval systems were installed without consideration of their additional vacuum-producing capabilities.

  – Sealing of potential tank leakage paths of both SSTs and DSTs was performed.

  – Air inlet orifices were reduced in size to increase tank vacuum because of problems with uncontrolled leakage.

- Relief capabilities were assumed for originally-installed vacuum relief loop seals, which they did not have.

- Relief capabilities were assumed for random tank leakage, which was not a legitimate, reliable engineered tank protection feature.

- In some cases, tank weak link structural analyses had not addressed all of the potential weak links for various tank fluid levels. Tank vacuum and level limits that had been imposed on SSTs addressed only pullup of the tank bottoms, whereas analyses indicated that, in some cases, the tanks' sides were the limiting components for vacuum. Therefore, the imposed limits were not necessarily conservative. These analyses were revised after this concern was raised by OA, and they showed higher limits for the tank sides, but these analyses were based on optimistic, unverified assumptions about liner corrosion rates rather than worst credible cases and on vacuum relief for the tank sides, which would not necessarily occur. Also, it was learned that during the initial liquid transfer activities (1998-1999) from Tank C-106, the minimum allowable depth limit used to prevent bottom uplift was almost violated.

As a result of these discoveries, the contractor generated "Significant" PER-2004-1710, and all activities with the potential to challenge the tanks' integrity were suspended, except for routine operator rounds, pending tank-by-tank operational evaluations.

Finding #C-9: DSTs and SSTs with active exhaust ventilation systems at the River Protection Project Tank Farms are not provided with adequate vacuum relief devices or other vacuum protection measures, such as positive administrative controls on critical valves, to preclude potential excessive vacuum conditions that could seriously damage the tanks.

Other deficiencies in design and testing include:

- HEGAs frequently fail their performance tests. CH2M HILL has not investigated the causes of the failures and has not ensured that the upstream moisture removal components (the recirculation system, the condenser system, and the high efficiency mist eliminator system) are performing properly as designed. In addition, there has been no rigorous sampling for the effectiveness of the HEGAs in removing ammonia and VOCs and no effort to relate the sampling to efficiency tests.

- The CAM cabinet modification failed to recognize that the cabinet ventilation outlet was located on the side of the cabinet at approximately head level, and therefore, for certain wind directions, purged vapors could be blown directly into the worker's face. Complaints of such exposures had been reported.

For DSTs and SSTs with engineering controls that incorporate elevated release points, these controls reduce the likelihood of worker exposure by reducing concentrations of pollutants in the breathing zones by dilution. However, the vapors are not removed and the effectiveness of this approach varies with the meteorological conditions. The benefits of dilution are more pronounced in unstable meteorological conditions (typically during the daytime or high winds) and less pronounced when meteorological conditions are stable (typically at night and early morning, because of ground-based temperature inversions and shallow mixing layers, and occasionally during stationary high-pressure systems). In addition, air patterns are subject to random variations in direction and intensity (gusts) that can blow vapors toward workers regardless of the stack height. Therefore, elevated stacks provide a significant benefit but cannot provide full assurance that all exposures will be precluded.

Overall, the engineered controls reduce the potential for worker exposure at many Tank Farm locations, and the modifications have addressed some known problems. However, some weaknesses in design, testing, and configuration management have reduced their effectiveness. While the current engineered controls for the SSTs and DSTs reduce exposure potential by eliminating release pathways or diluting release concentration, they do not eliminate the vapors.

Future Modifications

As part of their approach to addressing the vapor concerns, ORP and CH2M HILL are in various stages of implementing additional engineered controls, and are considering and evaluating a number of other options. OA examined the engineered controls options that have been approved for installation or further analysis by CH2M HILL and/or ORP management.

Some CH2M HILL plans to evaluate and implement further engineered controls were developed as part of the corrective actions specified in the September 2003 PER 2003-3497, *Approach to Dealing With Chemical Hazards in the Workplace*. Other improvements were developed as part of an effort to replace ventilation systems for the AW and AN Tank Farms that were approaching their design lifetime.

Three sets of engineered controls planned for implementation include: (1) addition of stacks to breather filters on nine additional SSTs (ten new stacks total, with one – C-103 – complete) to raise the exhaust to 15 feet, (2) replacement of the AW and AN Tank Farm ventilation system to include taller stacks, improved fan seals, vacuum pumps external to CAM cabinets, and separate ventilation trains, which will result in improved ventilation isolation control, and (3) extension of the AP ventilation stack. Although CH2M HILL has not formally established schedules or milestones for implementing these improvements, they currently estimate that these modifications will be complete in less than one year.

These three sets of controls will provide benefits primarily in the localized to the areas near the tanks. The improved ventilation fan seals and more complete train separation should prevent fugitive emission from known emission points in the current AN and AW ventilation systems. Further, the stack additions and extensions will reduce concentrations of pollutants in the breathing zones (subject to the same limitations and variation with meteorological conditions as discussed previously for all elevated-stack, dilution-based approaches).

However, the plan to add stacks to ten SST breather filter exhausts has not undergone a formal and rigorous engineering analysis to support selection of the ten best tanks to modify. To initially identify the tanks, CH2M HILL appropriately solicited worker input. However, CH2M HILL did not complement this input with a rigorous analysis of current tank constituents, breathing rates, and other such factors to provide a solid technical basis for selecting the tanks. Further, CH2M HILL did not rigorously evaluate the potential unintended consequences (e.g., changes in passive ventilation patterns through interconnected tanks), and initiate these analyses immediately when the concern was raised.

CH2M HILL is currently evaluating the potential benefits of another type of engineered control—scrubbers for permanent and portable ventilators. Scrubbers were one of the engineered controls recommended in a CH2M HILL evaluation completed in January 2004. CH2M HILL plans to complete an evaluation of the feasibility of installing scrubbers in

June 2004. Scrubbers would have the benefit of removing most of the ammonia from the ventilator emissions. However, the January 2004 study indicated that they would not be effective in removing VOCs.

Although the CH2M HILL initiatives to improve engineered controls should result in some reductions in vapor exposures in the short term and potentially more reductions in the longer term if scrubbers are installed, CH2M HILL has not performed a comprehensive engineering evaluation of these and other potential alternative solutions to the chemical vapor issues. The stated objective of corrective actions for the vapor emission PER is to achieve ALARA. However, ALARA has not been defined such that the engineered controls in place, planned, and being studied can be evaluated against specific criteria.

Furthermore, CH2M HILL has not formally evaluated a comprehensive set of alternatives to support the current corrective action plan. Alternatives that have not been formally evaluated include charcoal filters, dilution fans with stacks for the SSTs, catalytic converters, active ventilation for SSTs (individual or ganged), and incorporation of improvements specified for the AN and AW ventilation systems (e.g., better seals and separate stacks) at other Tank Farms. Although some of these alternatives have been considered in previous engineering evaluations and environmental permits, CH2M HILL has not yet comprehensively considered the range of potential options/controls, and has not considered lessons learned from earlier studies and unsuccessful modifications. For example, CH2M HILL is not evaluating some options, such as charcoal filters and dilution fans with stacks for the SSTs, in part because they cite previous modifications using these options that were unsuccessful (see following section). However, OA's review of the design packages for these modifications indicated that they were potentially good mitigation approaches that likely failed because of poor engineering, lack of attention to detail, poor follow-up after installation to address refinements, poor operational support, poor testing, and poor maintenance, etc., not necessarily because the technology was not viable. Effective engineering at the times these were installed (in the late 1980s and 1990s) should have evaluated the causes of the failures and taken appropriate corrective actions. The recent dismissal of these options based on cursory evaluations without a full understanding of the causes of the failures indicates recurring deficiencies in the engineering approach and processes and in the integration of the supporting disciplines.

Overall, the planned modifications of selected systems are appropriate to reduce the likelihood of vapor exposures. However, the planned actions are limited in scope and provide only an incremental decrease in risks. CH2M HILL is making progress on the analysis of the benefits of using scrubbers but has not systematically considered the full range of other options.

Engineering Processes

OA evaluated CH2M HILL engineering processes for developing, reviewing, and instituting engineered controls. Specifically, OA reviewed selected aspects of design processes, maintenance and testing of engineered controls, configuration control, and integration of controls into operating procedures. The current engineering processes were reviewed to provide insights on actions that ORP and CH2M HILL should consider to increase the reliability of current controls and increase the likelihood of success of controls being installed or evaluated for future installation. Modifications were also reviewed to provide perspectives on the historical reasons that some of them were unsuccessful, so that lessons learned can be applied.

Over the past 15 years, numerous engineered vapor controls have been instituted in the Tank Farms. Some have been generally effective and adequately engineered. However, in a number of cases, the engineering and the supporting disciplines were either inadequate or incomplete, or had the potential to create new additional concerns. As discussed in the examples below, weaknesses in the engineering processes of CH2M HILL and predecessor site contractors (CH2M HILL took over the contract in 1999) were a contributing factor. CH2M HILL management recognized approximately two years ago that technical rigor must be improved and has implemented a number of longer-term actions to improve the discipline for designs, calculations, and associated documentation. Most of these examples pre-date these initiatives. The AW/AN example, where CH2M HILL staff removed the vacuum relief, indicates that continued vigilance is needed. These weaknesses contributed to situations where the engineered controls did not perform adequately and, in some cases, appeared to have actually increased the potential for vapor exposure.

- **AY/AZ Tank Farm condenser system.** Plugging of the condensate pot drain line seal for the AY/AZ Tank Farm is a recurring problem requiring maintenance. Repair of this subsystem caused the

active ventilation at the AY/AZ Tank Farm to be shut down for an extended period, which led to several vapor exposures during the investigation (see Section C.2.2). The design of the condenser did not permit easy flushing because fouling was not anticipated in the design phase.

- **Carbitrol passive vapor treatment system.** In 1989, the Carbitrol passive vapor treatment system was installed downstream of the breather filter of tank C-103. This was a passive system that used two carbon adsorbers to remove organics and ammonia. Although this system had promise for reducing vapors, numerous technical difficulties were encountered with its operation, apparently because of moisture accumulation in the adsorption media. The moisture accumulation occurred, at least in part, due to the system's piping not being installed in accordance with the design, and heat tracing on components upstream of the system that was not always functional. This moisture tended to plug the adsorber material to the point of creating high tank breathing resistance through this pathway, which tended to cause the tank to breathe preferentially through the myriad of ground-level fugitive leak paths. This system was determined to be ineffective and was removed.

- **Vapor mixing system.** The vapor mixing system was installed on tank C-103 in 1995. It utilized a blower to force fresh air up through a stack and a smaller venturi draw tube from the tank breather line in the stack to pull the tank vapors into the stack where they were diluted by the fresh air flowing in the stack before being discharged. Although possessing much potential, this system experienced numerous technical problems which undermined its operability, including unreliable electrical power, an ineffective stack cap design (which directed flow back down to the ground), and insufficient draw from the venturi draw tube. The system was abandoned in 1999 after numerous attempts to resolve the venturi draw were unsuccessful. This engineered control appeared to be a valid approach, inadequate engineering reduced the effectiveness of the design (e.g., location of the draw tube on the high-pressure side of the dilution fan).

- **DST exhauster fan shaft leakage.** The original active ventilation systems on some of the DSTs contained two parallel exhaust fans, one normally operating and the other idle. Both fans discharged into a common exhaust stack. With this design, the idle fan was pressurized by the discharge of the operating fan, which created a potential ground-level leakage source at the idle fan shaft. Although this was a known leakage source, no engineered controls, such as shaft exhausters to the operating fan, which is a standard engineered approach to this phenomenon, had been attempted. CH2M HILL is currently addressing these problems by replacing shaft seals. The shaft seal for AW Tank Farm train A shaft was replaced with an improved seal in 2003, and further replacements are planned.

Weaknesses in engineered controls for the DST CAM cabinet ventilation modification, C-103 tank vent stack addition, HEGAs, and the tank vacuum protection were discussed previously and also indicate historical or current problems with engineering processes. For example, although HEGAs are being considered as a potential option for controlling vapors at other Tank Farms, CH2M HILL has not yet investigated or evaluated the design/performance problems with the presently installed system with HEGAs to enable an informed decision about the practicality of using them for vapor removal for other Tank Farms. CH2M HILL is also actively evaluating the use of scrubbers.

Finding #C-10: The conceptualization, analysis, detailed engineering, and execution of engineering measures have not been adequate to provide fully effective engineered vapor controls for the Tank Farms, as exemplified by recent modifications to the AY/AZ Tank Farms and the CAM cabinets.

For engineered controls to effectively achieve their intended purpose, they must be supported by operations, maintenance, testing, procedures, and practices. The support in these disciplines was effective with regard to TSR-related requirements. However, OA identified the following areas where the effectiveness of non-TSR engineered controls was impacted by weaknesses in these other disciplines:

- There is a reduction in the reliability and availability of Tank Farm ventilation because of maintenance issues, such as lack of spare parts. The reliability of the active exhaust ventilation systems is an important concern since during the period of time when a DST Tank Farm ventilation system is out

of service, fugitive emission paths are possible. Several upgrades to the DST active ventilation systems to replace worn-out equipment have been completed or are near completion. Having readily available spare parts permits Maintenance to rapidly complete many ventilation repairs. A spare parts process procedure with milestones has been approved and is being implemented.

- The recirculation fan for AY 102 had been out of service for three years, as recognized in a 2002 CH2M HILL management assessment and subsequent quarterly system health reports. The recirculation system is used to remove heat from the tank and it also removes some vapors, including water vapor. Lack of an operational recirculation system places potentially excessive demands on downstream components. Therefore, when this system is out of service, higher vapor and moisture concentrations are presented to downstream components, and potentially higher vapor concentrations are released out of the stack. These higher concentrations at the HEGA filters could be a significant factor in the excessive failure rate that has been experienced with these filters.

- In industrial facilities where incorrect operation of equipment could endanger personnel or vital equipment, common operating practice is to institute physical operational controls, such as locks or seals. For tanks with active ventilation (both SSTs and DSTs), the tank inlet vent paths contain manual isolation valves, which if throttled or closed without proper engineering evaluation could cause tank vacuum limits to be quickly exceeded. However, no physical operational controls had been placed on these critical valves.

- As previously described, actively ventilated tanks had no specifically engineered relief devices, but some did have various types of pressure control devices or fan trip devices. However, routine testing and/or operational surveillances of these devices were not being performed to verify that they would function as designed to prevent excessive tank vacuums.

A few deficiencies in configuration control were also identified. As discussed earlier, CH2M HILL is not treating tank sealing as a modification. Other configuration control deficiencies are described in the following paragraphs.

During this investigation, OA identified a configuration control concern with CH2M HILL's USQ practices. 10 CFR 830 requires that any changes to procedures, "as described in the documented safety analysis," must undergo a USQ evaluation. The team identified seven procedure changes from a sampling of nineteen that had been incorrectly screened out of the evaluation process by using incorrect, non-conservative screening criteria. Six of the seven incorrect screenings had used non-conservative qualifiers to the CFR's criterion. One screening's interpretation was that only procedure changes that entailed a different procedure *type* from those *types* described in the documented safety analysis required a USQ evaluation; thus, since that change was to a maintenance procedure, which was a procedure type described in the documented safety analysis, it did not require an evaluation. Another screened-out change to a maintenance procedure was for the opposite reason; it reasoned that since maintenance procedures were *not* described in the documented safety analysis, either explicitly or implicitly (which, in fact, they were), no evaluation was required. The other procedure changes were screened out because they would not require a change to be made in the documented safety analysis, which was also not the CFR criterion.

OA's review of 44 modification packages (engineering change notices) identified one significant documentation weakness. In almost every case, the descriptions provided in the documentation were inadequate to allow a technically qualified reader to clearly understand what was to be accomplished, why it was to be accomplished, how it was to be accomplished, or what the expected results were. CH2M HILL personnel acknowledged this weakness, and indicated that it had been self-identified as far back as two years ago and most recently in January 2004, and that actions were being taken, such as additional training for responsible engineers, formalizing expectations, upgrading procedures, and establishing senior reviews. The bulk of the engineering change notices that were reviewed pre-dated these initiatives, as the focus was on ventilation system modifications made in the late 1990s to 2002.

The engineering organization does not have sufficient formal processes that ensure that engineering activities consistently and rigorously consider the potential effects of engineering actions, such as modifications, on worker vapor exposure as a routine part of its design processes. A hypothetical example would be a modification to the control logic of tank exhaust fans that could leave both fans operating for

certain conditions (where before only one at a time could operate). Such a modification could have the potential to exceed tank vacuum limits. Presently, consideration of vapor issues in engineering activities relies on individual expertise or initiatives rather than on rigorous and systematic processes. OA reviewed dozens of recent modification packages and determined that vapor mitigation was not explicitly considered in any of the packages, although several packages had the potential for such impacts.

Several programmatic weaknesses contributed to the deficiencies in engineering processes and controls, including:

- Insufficient attention to detail in engineering, construction, maintenance, operations, and testing
- Not incorporating appropriate surveillance and testing requirements as part of system design
- Insufficient consideration of possible impacts of modifications on connected/affected systems and standard engineering safety considerations (e.g., vacuum protection)
- Poor documentation of system design and testing
- Insufficient application of lessons learned.

Finding #C-11: Engineering processes have not ensured that engineering activities specifically consider potential worker vapor exposures or phenomena that could threaten the integrity of the tanks.

Summary

The current engineered controls reduce the potential for worker exposure at many Tank Farm locations, and the modifications have addressed some known problems. ORP and CH2M HILL recognize the need to enhance engineered controls, and some enhancements are underway that will reduce the risk of vapor exposures. While the current engineered controls for the SSTs and DSTs reduce exposure potential by eliminating release pathways or diluting release concentration, they do not eliminate the vapors.

However, weaknesses in design, testing, maintenance, and configuration management reduce the effectiveness of the current controls. Past and current weaknesses in engineering processes are a contributing factor. ORP and CH2M HILL are taking actions to address some of these weaknesses, but more rigor is needed.

C.2.5 CH2M HILL Injury and Illness Investigation and Reporting

The OA investigation team reviewed the documentation contained in injury and illness case files and discussed case details and investigation and reporting processes with the manager responsible for implementing the injury and illness program and case management. About 90 cases were reviewed to determine compliance with CH2M HILL procedures and OSHA and DOE reporting requirements, including case files for 45 individuals in 31 vapor-related incidents listed in the GAP report, 25 vapor exposure incidents reported between August 2003 and March 2004, and 20 non-vapor exposure-related injuries occurring during the last quarter of CY 2002. The team also evaluated the rigor and effectiveness of the CH2M HILL investigations of the vapor exposure incidents cited in the GAP report and the adequacy of corrective and preventive actions.

No widespread or significant underreporting of injuries and illnesses was identified. In several instances, cases may have been overly conservatively classified as non-reportable "first aid" cases when there was no evidence that first aid, as defined by OSHA, had been provided. With minor exceptions, CH2M HILL's procedures for evaluating, classifying, and reporting injuries and illnesses to OSHA and CAIRs were adequate to implement an effective program.

Notwithstanding the generally appropriate decision-making on classification and reportability, OA did identify three cases where reportability requirements had not been met. In addition, it was not possible to clearly establish compliance in some cases because of incomplete and conflicting information in the case files. Case files had weaknesses in documentation, such as inadequate information on the record-of-visit forms from Hanford Environmental Health Foundation (HEHF), insufficient documentation of personal physician and emergency room medical reports, and inadequate documentation or attribution of the basis for injury and illness classification and reporting decisions.

In vapor exposure case #55687, work restrictions were specified by HEHF on several record-of-visit reports, but the case was not classified as recordable. In vapor exposure case #55650, the case was identified as recordable and was reported because prescription drugs were dispensed, but it was not reported as a restricted workday case, although there were work restrictions specified by HEHF on the record-of-visit. These two cases were first identified by a March 2004 ORP assessment (performed with the help of a DOE expert from another site), and these classifications have been corrected and reports to CAIRS revised.

Inappropriate documentation and classification were also apparent in case #55942. A record-of-visit form dated January 12, 2004, certified by a private physician, addressed a vapor exposure from a year earlier and indicated that the worker had been off work for approximately a month (an OSHA and DOE reportable condition). However, the case was classified on January 21 as first aid only. This case was later reclassified as an OSHA recordable lost workday case on March 2, 2004, after notification that the worker had filed a worker's compensation claim with a supporting medical report from a personal physician.

In another exposure event listed in the GAP report, a PER was generated indicating a potential link between symptoms and a vapor exposure that resulted in a worker being transported to the onsite clinic and an emergency room, but CH2M HILL did not establish a case file as required by procedure. In this instance, the case would not have met reportability thresholds, but CH2M HILL procedures were not followed.

Examples of administrative and documentation errors in the file included log entries that failed to provide sufficient information on what actions were taken and when, missing medical reports from emergency rooms or personal physicians (and no evidence of attempts by CH2M HILL to obtain them), associated PERs not in the case file, and deficiencies in HEHF record-of-visit forms that were not resolved by CH2M HILL. Deficiencies in these forms included unrelated prior work restrictions, specification of over-the-counter medications without identifying dosage or whether they were dispensed due to stated existing conditions or symptoms from an exposure, and typographical errors related to incident dates.

Investigating injury and illness causes and establishing recurrence controls are governed by Operations event investigation and site PER procedures. Line and safety support management are responsible for these corrective action dispositions of vapor exposure events. As discussed in Section C.2.6, PER evaluations and resolutions of vapor exposures were not always thorough and complete. In addition, an event report form required to be completed by the worker and supervisor by the injury and illness reporting procedure has not been consistently or fully completed and contains numerous corrective action elements that are not in consonance with the formal CH2M HILL corrective action process. For example, the event report requires the determination of root causes, and recommended actions and decisions concerning unsafe conditions and behavior, none of which are dispositioned on this form or incorporated into the PERs associated with the event. These elements are not helpful to case management and corrective/preventive actions are not within the purview of safety department case managers.

Management's expectations and company policy on reporting of Tank Farm odors and exposures are not completely understood by some workers. Despite communication of this information through several venues during the past year, questions raised as a result of an exposure event occurring during this investigation prompted yet another letter to all workers clarifying reporting requirements and the action thresholds of the AOP for responses to reported odors or vapor exposures.

Although a variety of graphical presentation and analysis of injury and illness data is performed, primarily the basic performance indicators of lost workday and recordable case rates and averages, there does not appear to be effective analysis or directed corrective actions. For example, the recordable injury rates for both the Closure Project and for Waste Feed Operations have been rated as "red" for every month for the past year, without any improvement over that time period. There are no procedures or specified requirements for trend analysis of injury and illness data except for the required lost workday and recordable performance indicators.

In summary, injury and illness evaluation and reporting processes are generally adequate and there are no indications of significant or pervasive underreporting of injuries and illnesses. However, CH2M HILL has not established and maintained a sufficiently rigorous system of records to support injury and illness reporting, which is an important worker health and safety element subject to OSHA and DOE regulations and requirements.

Finding #C-12: CH2M HILL has not properly classified and reported some injury and illness cases, and CH2M HILL injury and illness reporting programs and quality assurance processes are not sufficiently rigorous, contributing to errors and omissions in documentation and case management of reported injury and illnesses.

C.2.6 CH2M HILL Feedback Mechanisms

OA reviewed selected aspects of CH2M HILL feedback mechanisms, including assessments, the employee concerns program, and issues management. The primary focus of the review was on the application of feedback mechanisms to vapor exposure issues.

Assessments

Because of longstanding and continuing management and employee concerns and incidents related to vapor exposures, various organizations have been conducting numerous internal assessment activities to resolve vapor issues and support the dispositions of PERs. Industrial Hygiene section leaders in Waste Feed Operations and Closure Projects have conducted routine field implementation reviews that are documented on management observation checklists and sometimes on PERs. These management walkdowns have identified and initiated resolutions for many deficient conditions and activities. An internal independent assessment of the implementation of the industrial hygiene vapor monitoring program conducted in September and October of 2003 was thorough and identified substantial issues and opportunities for improvement for which corrective actions are complete or in progress.

However, given the importance and attention directed at the ongoing issues related to vapor exposures, few formal self-assessment activities related to vapor exposures and related industrial hygiene and engineering programs over the last few years have been planned and conducted as part of the formal management assessment program. Further, with the exception of the recent vapor monitoring program assessment, the assessments that were performed lacked sufficient rigor. For instance, an extensive January 2002 assessment of the worker protection program at the Tank Farms only determined whether processes were in place and did not evaluate their adequacy or effective/compliant implementation. No deficiencies, weaknesses, or observations were identified for any of the 81 criteria assessed. A November 2001 assessment of the injury and illness reporting program evaluated 29 criteria and identified only one opportunity for improvement. The adequacy of implementation of program requirements was not determined, and the assessment did not identify weaknesses in the quality of records and documentation, or errors in reportability decisions identified in this or other recent investigations and external reviews (see Section C.2.5). The one improvement opportunity identified was that only one person was trained to implement the injury and illness reporting program – a condition that still exists.

Several assessments of a variety of vapor-related issues have been conducted over the last two years by external organizations, many initiated by CH2M HILL after an increase in the frequency of reported exposures was identified by CH2M HILL. The reviews were performed by health and safety professionals contracted by CH2M HILL; a Paper, Allied-Industrial, Chemical & Energy Workers Union International (PACE) health and safety specialist; Dupont Safety Resources; NIOSH; and the State of Washington. A report and recommendations for improvement were developed for each review except for recently-completed NIOSH and State reviews for which formal reports have not yet been issued. Collectively, these reviews provide a comprehensive assessment of programs and practices for the identification and control of hazards associated with chemical vapor exposures in the Hanford Tank Farms. About 70 recommendations were made for improvements in such areas as engineered controls, characterization of gases in tank headspaces, measurements of vapors in work areas, personal exposure monitoring, respiratory protection, exposure databases, and training and worker involvement. Many of these recommendations were only recently received by CH2M HILL and thus have not yet been fully implemented. As discussed below, some other recommendations that were received earlier have not been addressed in a timely manner.

The recommendations from reviews in 2003 and 2004 were properly entered into the CH2M HILL corrective action system. A PER was generated for each review, including the assignment of responsibilities and due dates. A root cause analysis was performed of chemical hazards in the workplace, based on the results of these reviews and other vapor issues (see PER 3497). A project manager was assigned and a Mission Execution Schedule was developed.

PERs were not prepared for the recommendation in the 2002 review, which focused on exposure controls and health risks. The consultant who performed the March 2002 review recommended that CH2M HILL establish chemical worker training, pilot a proposed monitoring strategy, establish a database of monitoring results, create a joint labor-management committee to address concerns, and institute voluntary use of half-face respirators. Steps have been taken to implement all of these recommendations. Chemical Hazard Awareness training is being provided to Tank Farm workers, the CVST has been established as a forum through which labor and management can jointly address vapor issues, and voluntary use of respirators has been authorized. However, implementation of some recommendations was not timely or fully effective. In particular, the proposed monitoring strategy, which included use of personal monitoring, was piloted in March 2002 but not approved for general use in the Tank Farms until March 2004, after ORP and CH2M HILL assessments found that the CH2M HILL exposure monitoring strategy did not fully meet the requirements of DOE Order 440.1A. A revised strategy was recently approved for use but has not yet been fully implemented. In addition, a database of exposure monitoring results is under development by CH2M HILL but is not yet implemented.

CH2M HILL has effectively involved workers in the identification and correction of vapor issues. Recommendations solicited from bargaining unit employees in October 2003 were documented in a PER and added to the Mission Execution Schedule. As discussed elsewhere in this report, a CVST was chartered to provide a continuing forum for involvement in this area by bargaining unit employees.

Although some corrective actions have been completed and others are in progress, the number of recent exposure events demonstrates the need for timely completion of planned enhancements and timely evaluation of the deficiencies and potential enhancements identified in this OA investigation. A January 2004 midpoint assessment of the actions in response to the root cause analysis indicated that substantial progress was being made based upon a reduced frequency of exposures that was evident at that time. Since that time, additional exposure events prompted ORP and CH2M HILL to take additional interim actions (as discussed previously).

The CH2M HILL self-assessment program has lacked the frequency, scope, rigor, and self-critical approach needed to identify the program and implementation deficiencies in industrial hygiene, work control, and engineering programs as detailed in Sections C.2.1, C.2.2, and C.2.4. However, CH2M HILL has used external expertise to perform assessments, which have identified numerous deficiencies and areas for improvement. The use of external expertise has also provided a degree of independence that can enhance credibility with workers and external organizations. In addition, CH2M HILL has recently initiated appropriate actions to address weaknesses in its self-assessment program.

CH2M HILL Employee Concerns Programs

Investigation packages for 16 formal employee concerns related to vapors reported between February 2002 and February 2004 were reviewed for compliance with CH2M HILL policies and procedures and the requirements and guidance in DOE Order 442.1. Closed packages were generally adequate, with a completed concern form indicating closure basis and a chronological log of case-related activities, including final resolution. In general, the investigations, interviews, and document reviews performed by the employee concerns case manager were thorough and appropriate.

However, several dispositions did not fully address all aspects of the concerns, and inadequacies in the interfaces with RL and HEHF as well as internal process weaknesses were identified. In one case, weaknesses in the communication among RL, HEHF, and CH2M HILL resulted in a potentially inadequate disposition of a case. Case #20003-0105, with four issues, was transferred from RL to CH2M HILL. In a case transfer, RL closes their file and does not require feedback from CH2M HILL. In this instance, the concerned individual requested confidentiality, and RL did not pursue the concerns adequately to acquire the necessary details for CH2M HILL to do an effective investigation. Further, RL did not transfer the case until six weeks after receipt. CH2M HILL responded to RL informally (e.g., via electronic mail) that there was insufficient information, the issues were not within the contractor's jurisdiction, and they were being closed. CH2M HILL recommended that RL transfer one issue, an allegation that HEHF was not providing adequate data to patients, was not reporting exposures, and was not protecting workers, to HEHF. RL rejected CH2M HILL's response (via electronic mail) and did not address the transfer of the HEHF-related concern. CH2M HILL subsequently "transferred" the issue to HEHF by electronic mail, although there is no established process or protocol for transferring

concerns between contractors. CH2M HILL then closed the issue and conducted no follow-up with HEHF. RL did not follow up with either contractor on the resolution of these concerns. HEHF made attempts internally to address the concerns, but lacked sufficient information, and no actions resulted from their review. (See Appendix D for discussion of interface issues in the occupational medicine program.)

Case #2003-134, referred by RL (in a referral, RL retains ultimate control of the case and expects a response from CH2M HILL), involved an exposure of a worker on November 13, 2003, while doing routine work shortly after the engineering organization started a test at 241BY by closing breather filters. The resolution in the concern package and the two PERs written for this incident described the reactive actions taken after the event related to monitoring and controls, but failed to address why the test did not consider the potential additional hazards and invoke compensatory measures for work activities occurring in areas affected by the test conditions.

Employee concern investigation packages exhibited a number of administrative deficiencies that indicate insufficient rigor in maintaining complete and accurate files, and present vulnerabilities to an otherwise effective program. In many cases, the employee concerns office is not identifying the concern statement as the employee's verbatim statement of their concern. Many concerns as expressed by workers are lengthy and imprecise. The case investigator distills the expressed concern into a concise phrase or sentence based on a review of the written or verbal presentation from the concerned individual, including initial interviews. Although this abbreviated concern statement facilitates the investigation and closure of the issue(s), it may not capture the nuances or full extent of the concern. There is no indication or documentation in the files that concerned individuals concur with the accuracy or completeness of the abridged concern statement.

In several cases, it appeared the employee concerns office dispositions may be technically or legally correct based on the wording used by the concerned individuals or the extracted concern statement, but are not fully addressing all of the underlying issue(s). For example, the disposition of case #03-0129 addressed only parts of a complex issue that had implications to stop-work processes, personnel conflicts, and ongoing conflicts between construction and health physics technicians.

A February 2002 concern (#02-003) described failures of management to resolve vapor exposure issues related to major tank S-111 operational evolutions and in developing a satisfactory monitoring plan. The investigation report describes the technical resolutions involving an independent industrial hygiene review, but did not address the issue from the standpoint of management failures, why it took an employee concern to get the issue finally resolved, whether appropriate work controls were in place to protect workers, and whether ongoing actions would have adequately resolved the concerns without jeopardizing worker safety.

Although the documentation in completed packages appeared to be complete and well organized, the information contained in the reviewed packages that were still open was incomplete and did not reflect a controlled process. For example, the "intake" process form was not completed in open investigation files – the concern form was not filled in except for some unsigned handwritten notes, confidentiality decision blocks were not checked, the assigned investigators were not noted, and the intake person was not identified. In some cases there was no chronological log established even though the concern had been communicated to the office, intake information had been taken, several interviews had been conducted, and research had been performed. In some packages, pertinent information was missing or the concerns office staff had to locate additional folders to compile all the evidence for this review. The employee concerns procedure does not address protocols for retaining controls and records management for cases that are transferred to the legal department or to other organizations, such as the HEHF case described above.

Issues Management

As discussed in various sections of this report, a myriad of Tank Farm vapor and vapor exposure issues have been identified and addressed over the years by CH2M HILL and previous contractors. Many different mechanisms have been used to identify, evaluate, and disposition these issues. Many independent reviews of various aspects of the vapor issues have been conducted. CH2M HILL has issued and dispositioned hundreds of PERs that identify individual and specific deficiencies, events, and concerns, and others that identified broader, systemic vapor-related issues. Much work has been done to identify and characterize vapor hazards, and many initiatives have resulted in improvements in engineering, administrative, and PPE controls for the vapor hazards. Multi-discipline teams of subject matter experts and workers have been formed and forums have been created to collect and

respond to concerns and suggestions for minimizing vapor exposures and answering worker questions on technical matters and improvement initiatives. Numerous communiqués from senior management and environment, safety, and health (ES&H) to all Tank Farm workers and through the monthly Tank Farm newsletter also serve to communicate management expectations, vapor-related policies, and ongoing improvement initiatives. Approximately 150 vapor project enhancement recommendations have been catalogued from various assessment and studies performed in 2003 and documented on PERs for disposition.

Notwithstanding the many improvements and actions taken to address tank vapor issues, many systemic deficiencies in the implementation of corrective actions and issues management processes are apparent and are impeding efforts to prevent tank vapor exposures. Of the over 60 vapor exposure incidents reviewed by the investigation team, only two were subject to formal event investigations, and only one event investigation team report related to vapor exposures was issued for each of the years 2001, 2002, and 2003. Many of the reported vapor exposures have occurred during routine survey and maintenance operations that are not considered for post-job reviews, and there is little evidence that the post-job review process has been used to aid in the development of preventive measures for vapor exposures. The formal lessons-learned process has also not been used to communicate vapor exposure event lessons. Only one of the 161 formal lessons learned issued by CH2M HILL since January 1, 2002, involves vapor exposures—a bulletin issued January 9, 2004, regarding the application of ALARA principles to all safety programs, with several mentions of vapor exposures and industrial hygiene.

Although CH2M HILL has implemented a robust and comprehensive corrective action process, the resulting large number and variety of concerns, deficiencies, and recommendations documented on PERs present a continuing challenge in achieving consistent and appropriate classifications, evaluations, and dispositions. The vast majority of PERs related to exposure events have been classified as trend only after an initial review of the reported issue, with no further actions required. A number of the PERs with actions written in response to events did not fully evaluate and address all aspects of the event, especially with regard to work planning and control elements (see Section C.2.2).

PER 2003-3553 describes an event where an industrial hygiene technician was exposed to vapors in excess of the HASP limits and experienced symptoms while conducting routine Tank Farm monitoring. This PER and the related event investigation report provide an illustration of numerous weaknesses in the evaluation and disposition of vapor events. The causal analysis section of the PER indicates that respiratory protection was not required for industrial hygiene monitoring of an AMZ unless airborne concentrations of VOCs and ammonia exceed HASP limits. However, the document or source of required controls for this work activity are not identified, and the adequacy of the controls are not addressed. The description of the event on the PER does not address whether the exposed person was in compliance with controls or whether the specified controls were adequate. The extent of condition/safety significance and generic implications discussion does not address those elements and cites only the actions taken after the event. The causal analysis on the PER does not clearly identify root or contributing causes. Further, no corrective actions other than immediate actions already taken are specified, nor is there a statement that previous actions were deemed sufficient. There is no evaluation or disposition of other aspects of this event identified in the causal analysis section of the PER, such as assumptions made by the exposed individual regarding the need for respiratory protection or the appropriateness of the response to smelling extremely strong odors. Further, a formal event investigation performed to address both this exposure and another exposure occurring earlier in the day during the same evolution (at different locations) identified three areas for improvement, but none of the three PERs written for these recommendations identified any additional actions.

Corrective actions to address vapor issues have not always been completed in a timely manner. As discussed above, recommended actions from a March 2002 review for establishing an exposure monitoring program and exposure monitoring results database have still not been implemented. Section C.2.1 discusses inadequate corrective actions to vapor monitoring instrument processes and performance identified by prior external reviewers and self-assessments, including issues documented in PERs in 2003. Section C.2.4 discusses examples of inadequate and untimely corrective actions over the years for evaluating and implementing effective engineered controls and inadequate follow-up on the effectiveness and maintenance of installed controls. A February 2002

PER (2002-0887) directed several trial projects and engineering feasibility studies that were not brought to resolution before closure of the PER. The extension of piloted and successful engineered control improvements, such as extending the vent stacks on SSTs, has not been aggressively pursued.

Although there may be differences in various characteristics and details, the issues identified in a 1992 Type B investigation of recurring worker exposure events and many of the resultant judgments of need continue to exist over a decade later. At that time, one disability had been reported to be associated with tank vapor exposures, and a series of investigations and analyses had failed to prevent recurrence of the problem. The scope of that investigation covered 16 events from 1987 to 1992. That investigation concluded that causes of the exposures included the lack of a properly developed industrial hygiene program, lack of a technically adequate filtration system, failure to ensure that all corrective actions to previous events were adequately implemented, failure to characterize the work environment, and failure to develop appropriate engineered controls. Contributing causes were weaknesses in risk assessment, data collection and analysis, and communications.

Long-term experience at the Tank Farms and some basic technical assumptions and attitudes developed over the years may contribute to reduced rigor in the evaluation and response to vapor exposure incidents and issues related to tank vapors. For example, during this investigation CH2M HILL managers expressed their belief that the tanks were adequately characterized, that industrial hygiene monitoring confirmed low levels of exposures, that there have been no known "overexposures" to hazardous materials, and that no one has experienced long-term physical effects from incidental exposures. As discussed in Section C.2.1, the technical basis for these assumptions and beliefs is not sufficiently comprehensive, and there are some unanalyzed vulnerabilities, particularly in the industrial hygiene program.

Finding #C-13: CH2M HILL's corrective action program has not been effective in defining and investigating issues related to Tank Farm vapor releases and exposure incidents or in establishing actions that effectively prevent recurrence of personnel vapor exposures and provide assurance that vapor exposures do not have long-term effects on worker health.

Summary

In the past two years, CH2M HILL has devoted significant attention and resources to assessing and addressing vapor exposure issues. Given the scope and volume of tank vapor-related issues and the dynamic nature of ongoing studies and initiatives and recently completed actions, it is not possible to establish definitively the adequacy of current actions or to predict the success of these efforts. However, at the time of this investigation, notwithstanding the initiatives and corrective/preventive actions cited above, the fundamental vapor exposure issues at the Tank Farms have not been adequately resolved, contributing to ORP and CH2M HILL decisions to implement a set of interim actions in April 2004. Recent and ongoing improvements are being implemented to apply project management tools to address vapor issues and to address these issues collectively. However, over the last several years individual vapor exposure events and conditions and systemic issues have not been consistently and completely evaluated and resolved in a timely manner by CH2M HILL.

C.2.7 Office of River Protection Oversight

Oversight of vapor issues at the ORP is accomplished by two organizations: (1) the line organization headed by an Assistant Manager for the Tank Farm Project (TFP), and (2) the Environmental Safety and Quality (ESQ) support organization. ESQ and TFP Facility Representative (FR) assessments and surveillances cover a wide range of ES&H programs and issues and are generally of good quality.

The TFP has a mature FR program, including eight fully qualified FRs. Results of FR observations are communicated in weekly and quarterly reports to the contractor. The TFP Operations Division Director and FRs meet with the contractor monthly to discuss the weekly FR reports and track associated corrective actions. Corrective actions are tracked in the CH2M HILL PER program. An ORP Manual 420.2, *Facility Representative Program*, defines the expectations of the FR program, and day-to-day FR actions are described in FR instructions. The FR instructions provide good information but do not reflect the current organization or accurately describe the current FR reporting process.

The ORP ESQ organization has an integrated assessment program procedure that was implemented

last year. Specified minimum required assessments (based on an ESQ review of rules, DOE orders, etc.) are being accomplished, and results are communicated formally to the contractor. Corrective actions are tracked to closure. ESQ conducted one reactive assessment of the CH2M HILL industrial hygiene program in October 2003, with support from an industrial hygienist from RL. Weaknesses identified by the ORP assessment are generally consistent with those identified by the OA industrial hygiene team. ORP did not communicate any findings requiring corrective action to CH2M HILL as a result of the assessment. CH2M HILL formally responded with a corrective action plan for the identified programmatic weaknesses.

ORP currently does not have sufficient industrial hygiene expertise to adequately perform its line management oversight responsibilities, including industrial hygiene assessments and routine evaluations. ORP has a single industrial hygienist on staff, but that individual is on long-term educational leave while completing a PhD in industrial hygiene (he has not been available since August 2001 and is not scheduled to return until January 2005). ORP has recently arranged for temporary industrial hygiene assistance from RL (per a memorandum of agreement), DOE Headquarters Office of Environment, Safety and Health, and Oak Ridge Operations Office. However, DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*, requires DOE elements to use qualified worker protection staff to direct and manage the worker protection program and requires industrial hygiene programs to have professionally and technically qualified industrial hygienists to manage and implement the program. Although the recent reactive reviews and interim actions to obtain industrial hygiene support from other DOE organizations are appropriate, ORP has not devoted sufficient attention and resources to performing effective line management oversight of the industrial hygiene program, issues, and ongoing corrective actions (see Section C.2.6) at the Tank Farm. Insufficient industrial hygiene expertise on the ORP staff is a particular concern in light of the longstanding and recurring vapor exposures and the need for ORP to understand and evaluate the complex and interrelated industrial hygiene issues raised by various CH2M HILL and external reviews.

Finding #C-14: ORP has not adequately addressed weaknesses in its oversight of the CH2M HILL industrial hygiene program and has not ensured timely corrective actions for identified issues.

ORP has recently conducted oversight assessments of occupational injury and illness reporting processes for both of its contractors: CH2M HILL and Bechtel National, Incorporated (BNI). The recent assessments stemmed from an employee concern about injury and illness reporting that prompted ORP to direct an FR to review injury and illness reporting. Based on the FR results, ORP subsequently arranged for assistance from an individual from another DOE organization, who has considerable OSHA expertise, to further assess BNI and CH2M HILL injury and illness reporting. These assessments were of good quality, and identified multiple findings and observations. ORP transmitted the final report and recommendations to CH2M HILL on April 5, 2004, with appropriate directions to address the issues, to review and correct discrepancies back to the start of January 2002, and to support an eight-hour training class by a certified OSHA instructor within the next six months.

Although there are no specific ES&H deliverables for award fee in the CH2M HILL contract, there are appropriate contract provisions for holding the contractor accountable for ES&H requirements. Clauses H-1 and H-2 describe the incremental and provisional payment of fee associated with a number of performance-based incentives. Section C, Statement of Work, describes environment, safety, health and quality requirements during the conduct of work. Clause H-31 provides requirements for subcontractors. Clause I-110 details the Conditional Payment of Fee as prescribed in 48 CFR 970.1504-5(c). The Conditional Payment of Fee clause was exercised by ORP in FY 2001 for a $2 million reduction in award fee for deficiencies in meeting the implementation requirements of integrated safety management, quality assurance, and the authorization basis. ORP management indicated that CH2M HILL addressed these problems and indicated satisfaction with CH2M HILL ES&H performance and thus did not exercise award fee reductions in FY 2002 or FY 2003.

ORP has effective mechanisms in place to provide oversight of the CH2M HILL employee concerns program. ORP members participated in the RL surveillance (July 2003) of the CH2M HILL employee concerns program. ORP also interfaces with the RL

and CH2M HILL employee concerns programs and receives monthly reports from RL about the nature of the concerns and the status of RL and CH2M HILL actions with regard to employee concerns.

ORP does not manage a separate DOE employee concerns program but utilizes the RL employee concerns program (see Section C.2.8). RL and ORP interfaces are defined in the RL employee concerns program procedure.

In summary, ORP has been engaged in the various assessments of vapor issues, has a mature FR program, and has performed some quality assessments. However, weaknesses in oversight of industrial hygiene are evident, in part because of the lack of industrial hygiene expertise on staff. Also, ORP has not always sufficiently focused on ensuring timely and comprehensive corrective actions for the issues identified in internal and external reviews.

C.2.8 RL Employee Concerns Program

ORP relies on RL to provide a DOE employee concerns program. RL and ORP interfaces are defined in the RL employee concerns procedure. Posters are in place on numerous ORP and CH2M HILL bulletin boards listing contact information. The RL employee concerns procedures are in accordance with DOE Order 442.1A. Oversight assessments of the contractor's employee concerns programs are being accomplished (i.e., CH2M HILL in July 2003). The requirement for a yearly self-assessment of the RL employee concerns program was last accomplished in December 2003 and is on the integrated assessment schedule for December 2004. RL has not conducted an oversight review of HEHF. Such a review had been planned was placed "on hold" pending award of the new contract. An oversight review of Bechtel Hanford, Incorporated is also "on hold" pending resolution of the contract protest.

Twelve case files were reviewed for conformance to requirements in DOE Order 442.1A and the RL employee concerns procedure. Concerns investigated by RL or referred by RL to a contractor for investigation are generally processed in an acceptable manner, and include proper communication with the concerned individual. Two cases studied were misprioritized as "routine" when an "other than serious concern" was appropriate. The "other than serious concern" prioritization is for those concerns having ES&H components, and guidance for this prioritization is that the investigation is to be conducted within 20 working days. Other than guidance for prioritizing screening, DOE Order 442.1A does not specify case processing durations. However, two cases referred to CH2M HILL took six and fourteen months, respectively, to close. Another case referred to CH2M HILL has been in process for 20 months, and remains open today. One vapor case that was transferred to CH2M HILL for investigation (5 weeks after receipt at RL) was subsequently closed without investigation by the CH2M HILL employee concerns program because of "…insufficient information for CHG to investigate."

C.3 Conclusions

While there are no known instances of exposures above regulatory limits, the longstanding deficiencies in the characterization of the Tank Farm vapors and industrial hygiene program are such that the site cannot adequately assure that all exposures are below regulatory limits. Regardless, exposure to even low concentrations may have caused symptoms to workers and, thus, needs to be addressed.

The recent actions by ORP and CH2M HILL (including requiring supplied air for certain activities) protect workers from vapor exposures. Such conservative measures are appropriate until ORP and CH2M HILL develop a documented protection strategy and translate that strategy into a technically defensible set of engineered controls, administrative controls, and personal protective equipment. Development of such a strategy needs to reflect a conservative approach to exposure limits because the synergistic effects of the more than 1200 identified chemicals in the tank wastes cannot be explicitly determined.

Improvements in the industrial hygiene program are needed to ensure that hazardous materials are identified and monitored, and that concentrations in the breathing zone are adequately measured. Improvements in engineered controls, engineering processes, and work planning (including hazards analysis and controls) are also needed to ensure that workers are adequately protected against vapors. ORP and CH2M HILL also need to further improve communications to workers, including providing information about residual risks, and to make respirators easily accessible to workers who choose to use them as part of a voluntary respirator program (assuming that the current interim measures are changed in the future based on sufficient analysis, and that a voluntary program is used in the future).

There are no indications of significant or pervasive underreporting of injuries and illnesses by CH2M HILL. However, there are weaknesses in documentation and quality assurance that result in errors and insufficient records.

Vapor issues at the Tank Farms have been the subject of numerous assessments in the past few years, including this OA investigation. Collectively, these assessments provide OPR and CH2M HILL with a good understanding of the issues and the weaknesses in the current safety and health programs at the Tank Farms. However, corrective action management and some aspects of ORP industrial hygiene oversight need to be improved to ensure that longstanding and recurring deficiencies are adequately addressed in several areas, including tank characterization, industrial hygiene, engineered controls, engineering processes, and communications to workers.

C.4 Recommendations

The recommendations below apply to ORP and/or CH2M HILL.

Industrial Hygiene

1. Develop a comprehensive strategy for characterization of tank vapor headspaces that can be used as a living document for developing industrial hygiene exposure assessments and sampling and monitoring plans.
    - Develop, document, and implement a strategy for sampling and monitoring waste tank headspaces.
    - Establish a mechanism for periodically reviewing and updating the chemical composition of waste tanks.
    - Periodically perform toxicological evaluation of chemicals identified in headspaces.
    - Consolidate the existing chemical vapor space databases.
    - Implement the CH2M HILL recommendations recently identified during the re-evaluation of the industrial hygiene technical basis.
2. Develop and implement an exposure assessment strategy consistent with the requirements of DOE Order 440.1A and industry good practices.
    - Establish a risk-based sampling and monitoring plan.
    - Increase the frequency and rigor of personal monitoring for chemical contaminants.
    - Expedite the implementation of the CH2M HILL exposure assessment strategy.
3. Establish technical basis documents for administrative controls identified in the HASP.
    - Document a basis for action levels for industrial hygiene monitoring (e.g., organic vapors, ammonia)
    - Document the process for establishing, removing, and monitoring for AMZs.
    - Provide workers with training on the above.
4. Develop and implement improvements to direct and non-direct instrumentation programs.
    - Define limitations of instrumentation with respect to the wide range of chemicals and chemical concentrations in the tank farms.
    - Procure the appropriate instrumentation and calibration equipment to ensure adequate monitoring and sampling of tank effluents, areas, sources, and personal exposures.
    - Develop calibration and usage procedures for instrumentation in use.
    - Train technicians on the above.
5. Assess the effectiveness of the instrument data record-keeping systems; modify records, procedures, and practices, and train accordingly.
6. Develop and implement a formal training and qualification program for industrial hygienists and industrial hygiene technicians.

7. Evaluate the effectiveness of the CH2M HILL respiratory protection program with respect to:

    - Training and qualification of respirator issuers
    - Definition of roles and responsibilities for the administration of the respiratory protection program
    - Adequacy of respirator cartridges for known chemical contaminants in the tank farms
    - Facilitation of the voluntary respiratory protection policy.

8. Implement specific, conservative worker exposure limits for vapors to include adopting or establishing local control limits.

    - Implement specific, conservative worker exposure limits for vapors.
    - Establish local control limits that are well below existing recommended or regulatory limits where such limits exist.
    - Establish local control limits (e.g., limits of detection) where regulatory or recommended limits do not exist and it is practical to do so.
    - Where such limits are not practical, clearly communicate to workers that some residual risks remain, and use conservative respiratory controls.

9. Expand the corrective actions identified in the Industrial Hygiene Improvement Plan to incorporate all of the industrial hygiene deficiencies identified in this report.

    - Prioritize and risk-rank the corrective actions in the expanded CH2M HILL Industrial Hygiene Improvement Plan to ensure expeditious corrective action implementation in the areas of tank vapor characterization; exposure assessments; industrial hygiene instrumentation; training and qualification of industrial hygiene technicians; industrial hygiene procedure development and implementation; and improvements to the respiratory protection program.
    - Ensure that sufficient industrial hygiene resources are allocated to achieve the milestones identified in the improvement plan.

Work Control Recommendations

10. Review existing JHAs/JSAs for current and planned work packages within Tank Farms and facilities to ensure that vapor hazards and controls are adequately addressed.

    - Develop industrial hygiene controls that are more tailored to specific vapor emission concerns.
    - Ensure that standing JHAs for operating procedures or maintenance activities are consistent with routine expectations, and ensure that response actions for conditions that could result in exposure to vapor emissions are clear to workers.
    - Ensure that job-specific JHAs include appropriate reference to potential hazards associated with vapor emissions.
    - Ensure that JHAs include reference to established AMZ requirements (i.e., aggressive industrial hygiene job coverage and DRI survey performance), and as work tasks become more invasive or where extensive use of administrative controls and PPE are needed, incorporate these requirements into applicable work instructions.

11. Improve the level of rigor, formality, and specificity associated with implementation of controls.

    - Minimize the use of standing orders to convey controls to personnel in lieu of procedures, JHAs, or work instructions, consistent with the Conduct of Operations Manual.
    - Ensure that an adequate technical basis is established and followed such that controls are consistent for work with similar hazard potential across all tank farms.
    - Subdivide broad RWPs into more discrete RWPs with more narrow and realistic

numerical ranges on expected radiological conditions and suspension limits, based on actual survey data or anticipated conditions applicable to the work.

- Attach actual radiological survey results to RWPs where possible.

12. Revise the JHA program to include specific site hazards, such as vapor emissions, lead, etc.

    - Revise the Hazard Review Template (HRT) to capture specific hazards and controls related to vapor emissions.

    - Conduct periodic reviews of completed JHAs to determine whether specific hazards are being identified that could be included in the HRT question set.

    - Encourage additional feedback from industrial hygiene subject matter experts regarding specific hazards and controls related to bare lead sheets that could be included in the HRT.

13. Improve the adequacy and accuracy of hazards analysis activities in support of work planning.

    - Ensure that work instructions and permits are sufficiently detailed such that work can only be performed within the constraints anticipated during the work planning. Eliminate subjectivity to the extent practical and necessary.

    - Direct work planners to perform periodic walkdowns of work activities in the field to ensure that they are being performed as expected. Document results of walkdowns and findings.

    - Ensure that JHA hazards and controls are tailored to individual work activities rather than the entire job such that there is linkage between the hazard and the specific work evolution where the hazard may be encountered.

    - In the absence of specific characterization data, assume the worst-case scenario when developing controls.

    - Obtain actual survey and sampling data for systems being breached, whenever practical.

14. Develop and implement a work control mechanism or process to ensure that appropriate JHA/JSA and RWP hazard controls are implemented for all work activities.

    - Improve the work control processes to ensure that for any work activity the appropriate hazard controls in work packages can be easily and consistently identified by workers.

    - Increase the level of detail in work instructions to a point where it is clear which hazards and controls apply to which work evolutions.
    - Where possible, incorporate controls directly into individual work instructions.

    - Conduct periodic walkdowns, by work planners of work activities in the field, to ensure that they are being performed as expected. Document results of walkdowns and findings.

    - In the absence of specific characterization data (radiological and/or chemical), assume the worst-case scenario when developing controls. Actual survey or sampling data should be obtained for tank intrusive actions whenever practical.

15. Implement more effective accountability mechanisms for workers within the confines of Tank Farms.

    - Evaluate the feasibility of modifying the emergency communication system (public address) in the 200 East and West areas to provide the capability for Tank Farm operations personnel to use it in abnormal situations, such as a Tank Farm evacuation due to vapor releases.

    - Implement a system whereby workers entering the Tank Farm are accounted for by name in the event the Tank Farm is evacuated.

    - Implement local sounding alarms that would signal workers to exit the Tank Farms. Make this alarm locally controlled from the Tank Farm and from the work control centers.

Communications

16. Continue to ensure frequent communications between the CH2M HILL leadership team and workers regarding vapor issues.

    - Modify the Chemical Hazards Awareness training class to include a question and answer session with a senior tank farm manager at the end of each presentation to demonstrate management involvement and to ensure timely answers to questions regarding operation of the Tank Farms.

    - Develop and disseminate information regarding what is not known about tank vapors and associated exposures. Address such topics as potential unknown or unexpected chemical interactions and vapor emissions during tank cleanup and closure operations.

    - Develop and disseminate information regarding the increased risk of being a Hazardous Waste Operations (HAZWOPER) worker and working with chemical vapors, similar to risk discussions related to being radiation workers and being exposed to radiation. If the risk information is available, include relative risk comparisons of HAZWOPER workers to workers in other hazardous occupations, such as the chemical, construction, mining, and law enforcement industries.

Engineering Processes

17. Ensure a project management approach to the engineering aspects of the resolution of vapor issues, with clear objectives, responsibilities, and milestones and a comprehensive assessment of all potential mitigation methods.

18. Explicitly define the goals for engineered controls to prevent or mitigate the release of vapors to provide a basis for evaluations and decisions about the adequacy of engineered controls, including effectiveness relative to the ALARA policy.

19. Determine the causes of past unsuccessful engineered controls and current engineering process deficiencies, and incorporate lessons learned into new engineered controls and engineering processes.

20. Improve the engineering processes to ensure that complete and appropriate engineering, installation, testing, surveillance, maintenance, and configuration control are performed for the full spectrum of anticipated conditions (including conditions not addressed by the documented safety analysis but relevant to worker vapor exposures), and that various conditions that could degrade performance of engineered controls are identified.

21. Evaluate a potential upgrade for engineered controls for CAM cabinet exhaust ventilation (e.g., a time delay) and a gland seal exhauster on the exhaust fan seals for those systems that share a common stack.

22. Evaluate the following potential longer-term vapor control options for SSTs:

    - Further evaluate the potential sources of vapor releases to support evaluation of the effectiveness of engineered controls, to include sampling the source terms during various conditions.

    - Evaluate installing ganged active exhaust ventilation on entire SST Tank Farms when performing retrieval operations versus the current method of installing and moving portable ventilation skids between individual SSTs.

    - Revisit the feasibility of adding a diffusion flow system tied to the breather filter exhaust stacks, with the stack connection on the low pressure side of the purge fan.

23. Because of the very high potential risks associated with vacuum conditions in the tanks, perform a formal engineering baseline evaluation of all tanks to determine their current status with regard to vacuum threats, and install vacuum protection where required (by code or good engineering practice). Further, change engineering procedures to include formal specific requirements for consideration of all changes to the facility or procedures with respect to their potential impact on the protection of tanks from vacuum. Utilize the baseline evaluation as the starting point for the evaluation of such changes, and revise the baseline, as appropriate, as facility and/or procedure changes are made.

24. Change engineering procedures to add formal, specific requirements for consideration of all changes to the facility or procedures with respect to their potential impact on the exposure of workers to vapors from the Tank Farms.

Injury and Illness Investigation and Reporting

25. Strengthen the injury and illness investigation and reporting processes and re-verify the accuracy of prior classification and reporting decisions.

    - Formalize the expectations for the content and format of medical information from service providers, including local emergency rooms.

    - Ensure that case files include detailed documentation of decisions and evidence or clear attribution for information supporting decisions, and ensure that DOE 5484.3 reporting forms accurately reflect when revisions were made.

    - Conduct a review and upgrading of completed case management files for at least the prior two years to ensure that cases were properly classified and reported and that files contain appropriate information to support classification decisions and changes.

    - Tailor the event report form and process to provide only information essential to support injury and illness reporting, with case file linkage to associated issues management documents.

Feedback Mechanisms

26. Strengthen the employee concerns program to improve evaluation and disposition of concerns.

    - Establish procedures and protocols for transfers of concerns to other organizations that ensure appropriate controls and feedback on ultimate resolutions.

    - Ensure that files are continually maintained and updated from the intake process to final disposition and closure.

    - Establish processes to ensure that the full extent of concerns are accurately established, confirmed with concerned individuals when possible, and fully addressed before closure.

27. Strengthen management assessment processes and performance to ensure that the processes and performance for safety programs and functional areas are routinely and rigorously evaluated.

    - Ensure that rigorous self-assessments of all safety-related functional areas and elements are planned, scheduled, and conducted on a frequency appropriate to risk and other relevant factors.

    - Provide additional training, guidance, and oversight to line and support organizations to enhance assessment skills and techniques and drive improvement in the effectiveness of safety program evaluations.

28. Strengthen issues management processes to ensure that safety issues are properly evaluated and are resolved with appropriate, timely, and effective corrective and preventive actions that address identified causes.

    - Apply successful techniques from the current Corrective Action Review Board to a sample of lower-level PERs, including the Performance Improvement Evaluation category, to audit performance and drive improvement in the quality of problem descriptions, causal analysis, significance and extent-of-condition reviews, corrective action plans, and closure justifications.

    - Provide additional training for personnel responsible for PER causal evaluations and corrective action plans, and hold responsible managers accountable for effective implementation of the corrective action program.

    - Lower the threshold for entering the formal event investigation process, especially for injury and illness events, and take better advantage of analytical tools to clearly establish relevant facts and support the determination of effective corrective and preventive actions.

APPENDIX D
OCCUPATIONAL MEDICINE PROGRAM

D.1 Background

Hanford Site Occupational Medicine Program

The Hanford Site has one primary occupational medicine program that serves all Hanford Site contractors except Bechtel National, Incorporated (BNI), which was authorized by U.S. Department of Energy (DOE) to subcontract to its own occupational medical provider. Under contract to the DOE Richland Operations Office (RL), the Hanford Environmental Health Foundation (HEHF) manages and operates the primary occupational medicine program, including the main clinic in Richland and a satellite facility in the 200 Area. HEHF is a non-profit corporation that has managed the Hanford Site occupational medicine program since 1965. In September 2003, HEHF underwent a restructuring and downsizing of staff, in part to reduce costs.

In 2003, the occupational medicine program contract was up for recompetition, and another company (AdvanceMed) was awarded the contract on January 6, 2004. The new contractor was scheduled to take over operations in March 2004. However, HEHF and other bidders filed protests, and HEHF is continuing to manage the occupational medicine program under contract extensions while awaiting a final ruling from the General Accounting Office (expected by end of April 2004).

The occupational medicine program provides a number of medical services for Hanford Site workers. It operates their clinics (open day shift on week days) that are used for treating Hanford Site workers who become ill or are injured, provides medical surveillance for regulatory mandated examinations, provides fitness-for-duty determinations, and performs general case management and follow-up for all work-related medical cases. Workers who are injured or ill on back shifts or weekends would normally be sent to local hospital emergency rooms and advised to return to HEHF for any follow-up care as necessary. HEHF has a physician on call for off shifts and weekends. The clinic also performs various routine and scheduled medical exams, such as routine physical examinations in a voluntary wellness program, a special examination program created to medically follow workers concerned about past potential exposures, and behavioral health services for workers and their immediate family under a formal employee assistance program. HEHF also coordinates other occupational medical services for workers with injuries and illnesses, including referrals to specialists and additional laboratory diagnostic testing, as needed, and works with contractors to evaluate work stations, work restrictions, and accommodations in their work environment.

The occupational medicine program performs various functions as required by DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*. For example, the occupational medicine program provides medical treatment, keeps health records for Hanford Site workers, and has responsibility for performing, tracking, and coordinating medical issues, including trending of health issues for all site contractors.

Occupational Medicine Program Interfaces

Hanford Site prime contractors (except for BNI) use the sitewide occupational medicine program. The CH2M HILL contract requires HEHF be used as the occupational medical provider. Other site prime contractors have an option in their contracts to choose their provider, with DOE concurrence. Each contractor obtains occupational medicine program services and sends employees to the clinic as necessary. For example, CH2M HILL has case managers and health advocates who coordinate and assist employees in arranging visits and treatment at HEHF or emergency treatment facilities.

Management of the contract and funding for the occupational medicine program is provided by RL using a chargeback mechanism to the prime contractors for certain occupational medicine program services. Memoranda of agreement (MOAs) describe the broad responsibilities and relationships between RL and the Office of River Protection (ORP).

RL has the responsibility for providing various infrastructure services to the Hanford Site, including the occupational medicine program. As such, RL has responsibility for the occupational medical provider

contract and for ongoing oversight of the occupational medicine program. Both RL and ORP have responsibility for ensuring that appropriate agreements are in place and adequately defining the processes by which contractors interface with one another on important safety and health related activities.

GAP Allegations

The Government Accountability Project (GAP) report includes several allegations about the occupational medicine program at the Hanford Site. These allegations generally fall into the following categories: inappropriately changing records, undue pressure by HEHF management to minimize the number of recordable injuries and diagnoses, insufficient medical restrictions, collusion between HEHF and site contractors about medical information and records used in workers' compensation claims, inappropriate limitations on medical visits (e.g., workers are only permitted to see certain doctors and cannot bring family or representatives), dismissive approach to vapor exposures (e.g., explaining away worker exposure symptoms as psychological or allergic reactions), unjustified psychological referrals, insufficient health care studies, different medical treatment of employees depending on their administrative categories, and inappropriate storage and sharing of patient records.

Hanford Site Response

RL and HEHF have disputed the factual aspects of GAP allegations and their associated implications. HEHF has specifically denied any wrongdoing and states that they were not party to any effort to inappropriately adjust, destroy, or falsify health records.

The Inspector General extracted the GAP allegations relevant to HEHF and transmitted them to RL and HEHF in September 25, 2003, requiring RL and HEHF to investigate the allegations. RL determined that it needed external expertise to investigate medical matters and arranged for the U.S. Public Health Service (PHS) to conduct two reviews through an interagency agreement. The PHS and RL surveillance team reports did not substantiate the GAP allegations and did not identify any major deficiencies with HEHF medical services related to the specific allegations.

OA Investigation Conduct and Scope

The Office of Independent Oversight and Performance Assurance (OA) examined the GAP allegations and determined that they fall into the following areas:

- Contracts and interfaces
- HEHF management systems
- Clinical evaluation, diagnosis, treatment, and medical records.

Therefore, OA reviewed the relevant HEHF processes in the above areas. In addition, OA reviewed RL line management oversight of HEHF activities and interfaces.

OA interviewed RL, ORP, and HEHF personnel, including managers, medical providers, worker advocates, and workers, and observed various working meetings, such as the Chemical Vapor Solutions Team. OA reviewed site contractor prime contracts, contractor Performance Evaluation Plans (PEPs), MOAs, medical and contractor policies and protocols, contractor medical records, a sample of patient satisfaction surveys, employee concerns, survey assessments, and incident reports.

D.2 Results

D.2.1 Contracts and Interfaces

The RL contract with HEHF, DE-AC06-98RL13686, appropriately establishes the requirements for an occupational medicine program. DOE Order 440.1A, which includes DOE occupational medicine program requirements, is contained in Section J.7, List of Applicable Directives, of the HEHF contract. Section C, Statement of Work, of the contract provides a broad set of expectations for occupational medical services, such as: "provide timely and effective occupational medical services to the Hanford workforce," and "assist site contractor and DOE management in protecting employees from health hazards." However, RL has not established supplemental directives or other formal agreements that establish specific expectations for how HEHF is to interface with site contractors and specifically how to address health concerns of Tank Farm workers.

Occupational medicine program requirements for other site contractors that use HEHF services are established through the prime contracts with the responsible DOE office: RL for Bechtel Hanford, Incorporated (BHI), Fluor Hanford, Incorporated (FHI), and Pacific Northwest National Laboratory (soon to be the Office of Science) and ORP for CH2M HILL.

However, these contracts did not establish specific expectations for how site contractors were to integrate their efforts with the Hanford onsite occupational medical provider. For example, the ORP/CH2M HILL contract requires CH2M HILL to obtain occupational medicine program services from HEHF and to reach agreement on how these services would be delivered in compliance with DOE Order 440.1A, Chapter 19. However, there are no supplemental directives or formal agreements in place to describe how the contractor would interface its activities with HEHF for obtaining such services. Similarly, FHI chose to use HEHF as its onsite occupational medical provider, but there are no agreements in place that established specific expectations on how these services would be obtained.

Annual PEPs and the Performance Fee Determination process were used by RL to establish performance expectations for HEHF and to hold HEHF accountable for meeting those expectations. With one exception, PEPs were not used to focus HEHF management attention on aggressively pursuing and resolving worker health concerns at the Tank Farms.

The exception was the inclusion of an evaluation criterion in the FY 2003 PEP for a population health management program, which called for a three-year study on Tank Farm workers to identify early medical problems. The 2003 portion of the study concluded that time and continuing study of these workers is needed to categorically determine that there is no evidence of medical problems associated with Tank Farm exposures. HEHF also recommended that Tank Farm workers have additional medical follow-up post exposure, that evaluations be actively case managed, and that they continue the cross-sectional study until Tank Farm work is completed to determine any long-term worker health effects. However, the population health management program was dropped from PEP evaluation criteria in fiscal year (FY) 2004 because of uncertainties resulting from recompetition of the HEHF contract.

Performance incentives have been established by RL and ORP as a means of holding prime site contractors accountable for performance. However, the performance incentives for the FHI, BHI, and CH2M HILL contracts did not establish expectations for integration of efforts with HEHF for obtaining occupational medical services and for addressing worker health concerns.

RL and ORP have MOAs that clearly establish their respective roles and responsibilities for conducting activities at the Hanford Site. The MOA between RL and ORP for health and safety support specifically assigns responsibility for the occupational medicine contractor to RL. A second MOA assigns the role of landlord for site services to RL and requires RL and ORP to develop and formalize, as necessary, interface agreements between the two parties. The MOA also spells out the required content for each interface agreement document, including responsibilities, requirements, and approvals by individuals with assigned approval authority. Although these MOAs are intended to provide the basis for establishing interface agreements between the two organizations and their respective contractors, RL and ORP have not developed and implemented such agreements to address occupational medical and associated worker health issues.

Several groups, such as the Hanford Occupational Health Process group and the Chemical Vapor Solutions Team, have been established by site contractors to address particular health-related needs. For example, the Hanford Occupational Health Process group has been established to provide guidance and oversight of the employee job task analysis process. The Chemical Vapor Solutions Team is a management/worker forum established by CH2M HILL to address Tank Farm vapor issues that now includes HEHF. Although these groups represent positive actions by site contractors to address particular needs, formal interface agreements have not been established between HEHF and site contractors to address more serious issues, such as providing information for reportability determinations and assuring the timely flow of industrial hygiene exposure information to the occupational medicine contractor.

The MOA for health and safety support states that RL will coordinate technical issues associated with the occupational medicine contractor with ORP's Assistant Manager for Environmental, Safety, Health, and Quality. However, mechanisms for coordinating technical issues and addressing worker exposure issues have not been established. Furthermore, at a time when allegations were being raised by GAP and workers at the Hanford Site, RL did not take action to bring all parties (HEHF and contractors) together in a common forum to address these issues.

Health-related issues have gone unresolved, in part, because of ineffective interfaces between HEHF and site contractors, which result from the lack of interface agreements that define roles, responsibilities, and processes for addressing such issues. For example, DOE Order 440.1A, Chapter 19 requires contractors to supply, to the provider of medical services, summaries of potential worksite exposures of

employees prior to mandatory health examinations. Several instances were found where important industrial hygiene exposure information was not provided to HEHF in a timely manner. Several examples were identified where HEHF did not receive health-related information (i.e., industrial hygiene monitoring samples) for an unreasonably long time (three months to two years). According to the FHI data entry person, approximately 25 percent of the input data contains errors that require follow-up by the data entry clerk or returning it to CH2M HILL Industrial Hygiene for correction. These delays were substantiated by reviewing employee medical charts at HEHF, where exposure results were not available for as much as two years.

The lack of effective working interface agreements between HEHF and site contractors is also evident in the record of visit (ROV) forms. As discussed in Section D.2.3 and Appendix E, information provided from HEHF on ROVs is not always sufficient to meet the needs of the site contractor to provide for proper decisions about recordable injury and illness events. In the absence of agreements, there is no clear expectation for what information the site contractors need or how the occupational medicine program is to provide that information.

Finding #D-1: RL has not adequately coordinated with ORP, the Pacific Northwest Site Office, and site contractors to ensure that effective interface agreements are in place between the occupational medicine program contractor and site contractors to ensure compliance with DOE occupational medicine program requirements.

D.2.2 HEHF Management Systems

Both the RL contract (DOE Order 414.1A) and the Joint Commission for Accreditation of Health Care Organizations (JCAHCO) establish expectations for the occupational medical contractor to obtain feedback on ways to improve organizational performance through self-assessments and patient satisfaction surveys.

HEHF uses many methods to collect feedback from staff, contractors, and patients, such as meetings with the President and Chief Executive Officer, "all staff" forums, focus groups with contractors, and patient/staff surveys. These processes provide feedback about the quality of health care, workplace health and safety, workplace restrictions, and other such issues. However, the information gathered is not analyzed, translated into specific action, and implemented and used to improve organizational performance. HEHF uses an automated quality improvement software system to generate monthly reports based on patient surveys. These surveys offer an excellent mechanism for obtaining patient feedback, including anonymous patient surveys. However, in most instances, the results from these surveys have not been thoroughly analyzed and used to address worker health issues.

HEHF also generates a second quality-based report that contains the results of physician peer reviews. However, the Clinic Director who has administrative responsibility for the medical staff has not been able to review these reports because of a restrictive company policy on credentialing, which inappropriately precludes his ability to monitor provider performance and provide constructive feedback. This policy has been revised, but not issued or implemented.

HEHF has an operational policy for reporting incidents that employees can use to identify incidents related to HEHF medical affairs, safety, security, and facilities. These medical incident reports are reviewed by the Clinic Director and corrective actions taken in many instances; however, the information from these reports is not analyzed and trended and used to address underlying issues within HEHF.

HEHF has a *Plan for Enhancing Organizational Performance through Process Improvement* (dated March 2003), which describes the roles of staff, supervisors, managers, senior management, and the Board of Directors and the process for achieving continuous improvement. The approach described in this plan has the potential for addressing many of the internal HEHF and worker concerns; however, the plan has not been fully implemented.

At the time of the investigation, HEHF continues to face a number of significant personnel and management challenges. Personnel problems and interpersonal conflicts among the HEHF medical staff have been exacerbated by the September 2003 restructuring and downsizing of staff as well as the turnover in the Medical Director position, a pending union contract with health care assistants, uncertainty associated with the HEHF contract, and an organizational culture that has historically tended to avoid conflict. Some of these issues have been documented as HEHF employee concerns and addressed. However, conflicts with staff persist, and some management actions to correct these problems have not been effective.

HEHF management communications have not been effective in clarifying policy or providing clear direction in a number of cases. These communication problems have been exacerbated through overuse of email to communicate policy and direction; these email messages have often been unclear or misunderstood, contributing to confusion and additional conflict. A draft report, prepared by PHS and the National Archives and Records Administration as part of validating the HEHF response to GAP allegations, also identified poor communications between HEHF staff and management, poor communications between HEHF and patients, and inadequate communication of HEHF company policies, the basis for those policies, work restrictions for patient/clients, and the basis for restrictions placed on patient/clients.

Required coordination and communication between HEHF and site contractors has not been adequately addressed by HEHF procedures. As a result, there are weaknesses in the transfer of industrial hygiene exposure data to medical providers. In addition, HEHF and site contractors are not interfacing sufficiently to ensure that the occupational medicine program is optimally used to assist in injury/illness determinations or the communication of health evaluations to managers responsible for the mitigation of hazards. In a letter dated February 9, 2004, the President/Chief Executive Officer of HEHF requested a meeting with the CH2M HILL General Manager to agree upon ways to implement the recommendations contained in the October 2003 DuPont report and address employee concerns with vapor issues. No response to that communication was received (see Finding #D-1).

Overall, HEHF management has some effective processes in place for gathering patient feedback. However, there are weaknesses in communication and interfaces. Although senior HEHF management is acutely aware of these problems, efforts to overcome these problems to date have been fragmented and inadequate. Furthermore, HEHF management has not developed a plan for addressing these issues and for communicating management expectations for addressing internal staff and administrative issues (see Finding #D-2).

D.2.3 Clinical Evaluation, Diagnosis, Treatment, and Medical Records

The HEHF site medical program is based on DOE Order 440.1A Chapter 19 medical program requirements. HEHF established a formal written program that details the methods and procedures used to implement the medical services provided to site contractors, as required by the DOE order. The HEHF policies, procedures, and protocols adequately define how the HEHF medical program is to be implemented.

Vapor Exposure Cases

In response to workplace exposure incidents, HEHF developed a protocol entitled "Exposure and Unusual Event Service." The protocol has been in effect since 1996 and has been updated five times since then. It provides reasonable guidance to the medical providers at both HEHF and Kadlec Hospital (the local hospital) for evaluating, testing, and follow-up on employees post exposure.

The medical records of all vapor exposed workers identified during the DOE Inspector General's investigation were carefully reviewed (53 patient records) by the OA team. In all cases, the incident history and physical examination was properly conducted, and findings were recorded in the medical record. At the time of examination, all cases were documented as work-related. Laboratory and other medical tests, a part of the vapor exposure exam protocol, were accomplished (unless declined by the employee) and properly included in the medical record.

Diagnoses varied with the individual patient, the nature of the vapor exposure, and the system affected. Typical symptoms included weepy, stinging eyes; scratchy throat; metallic taste in the mouth; raspy voice; headache; and skin irritation in some patients. Symptomatic treatment was provided, and many patients were symptom free within a day, most within three to five days. A few workers experienced lingering symptoms, usually respiratory in character. One patient, whose respiratory tract symptoms lingered well beyond the average duration for the exposed worker group, was suspected of having an underlying allergic rhinitis, which could be a potential underlying cause for prolonged symptoms. HEHF arranged an appointment with an allergy specialist to evaluate this differential diagnostic possibility, but according to the record notes, the patient did not keep the appointment.

Medical follow-up, including outside specialist consultations, was always afforded to vapor-exposed patients until recovery was complete. Laboratory test results were reported to the workers by mail or phone calls days later. The medical care provided to injured or vapor exposed workers by HEHF was of high quality. More periodic follow-up to include all vapor exposure cases is desirable, and follow-up should be a standard part of the protocol.

Medical Diagnosis and Patient Treatment

OA thoroughly examined more than 75 workers' medical records, including all records of the 53 vapor-exposed workers from 2002 to date and selected other cases. The review revealed no evidence of diagnosis or disposition alteration without detailed explanation in a properly constructed and dated addendum.

HEHF health care providers are not responsible for determining whether worker incidents are work-related. They record the patient's version of the injury/exposure incident, conduct a physical examination supplemented by laboratory studies, record their findings, and treat appropriately. The contractor case manager, not the HEHF medical provider, makes the final determination of whether an injury is occupationally related. In some cases, this final determination may vary from information on the medical ROV. OA's review of the medical records shows the allegation of differing medical treatment for different categories of workers to be unsubstantiated. This perception could occur because some vapor-exposed workers elected to abstain from some of the surveillance protocol tests because the protocols seemed not to apply to their particular symptom complexes. The fact that some employees choose to abstain is an undesirable variant to the study protocol but not an indicator of differing treatment.

Recognizing that occupational medicine is practiced within a corporate interest climate, the pursuit of accurate information and diagnosis is an imperative to protect the company, the examiner, and the worker. HEHF decided to consolidate all vapor exposure and other injury and illness follow-up examinations with one medical provider, who is the acting medical director. This individual was also the author of the email messages referred to in the GAP report, some of which provided unclear direction that could be interpreted as advocating a non-conservative approach to records management such that recordable incidents are minimized. It appears from HEHF staff interviews that the instruction in the email was intended to ensure that the terminology used on an ROV did not automatically produce a recordable case before the correct diagnosis was actually established. Notwithstanding the poor communications, OA's detailed review of the records indicates that the records were accurate and properly managed in all cases reviewed. Additionally, this physician possesses the best occupational medicine training and credentials of the clinical staff, including board certification in occupational medicine and a masters degree in public health. The consolidation of all vapor-exposure cases under this provider was intended to achieve consistency in handling and documentation. In these circumstances, the practice of having a designated provider treat vapor-related exposures and the associated limits on which provider the patients would see has merit and is an acceptable clinical practice, particularly when the physician designated possesses the best occupational medicine credentials and experience at HEHF.

Providing patient privacy during actual physical examination is normal practice in medical facilities across the nation. Privacy is the foundation for this restriction, recognizing that the patient may be disrobed and perhaps will be responding with personal information to the examiner's questions. Discussion with others, with patient permission, following the examination is preferred. The perception by some that this policy is designed to limit patient rights is not substantiated.

Allegations of improperly altered or even destroyed medical records at HEHF were not substantiated. This perception appears to be fueled by observations of worksheet disposal following transfer of its information to the formal medical record. Following the close examination of all elements of the medical records of over 75 workers, no improprieties in medical record keeping were found. The HEHF medical records system is sound and of high quality. The sheer size of some of the controversial case record files is such that extraction of pertinent information to a manageable "case file" is an administrative necessity for efficiency.

OA's investigation showed no evidence of breaches of patient confidentiality. Medical records are handled in a professional manner at HEHF. The records room staff at HEHF were observed to be professional, fastidious, and conscientious records librarians and custodians.

Psychological Referrals

No vapor exposure incident workers were sent for psychological evaluation because of vapor-related symptoms. Two workers, who had experienced vapor exposures in the past, were seen by Behavioral Health Service (BHS) psychologists for work-related stress involving conflict with their supervisors, but the referrals were not related to any previous vapor-exposure incident.

The HEHF protocol for exposures/unusual events allows for referral to BHS depending on the type of exposure and clinical findings. BHS would be recommended in the event that an exposed worker

exhibited a neurological deficit or other adverse behavioral symptoms. In the medical charts reviewed by OA, no workers were referred to BHS for a neurological assessment as a result of a vapor exposure.

OA reviewed other instances in which employees may be referred to BHS and determined that they are appropriate and do not substantiate allegations of inappropriate referrals. There are four causes when an employee is required to report to BHS. The first cause is related to medical surveillance issues when an employee must have a periodic psychological assessment (human reliability program) or is to be certified (e.g., substance testing) to operate commercial vehicles. The second cause is when an employee has missed five consecutive days of work because of a behavioral/mental health issue. The third cause is a site contractor Human Resources referral, which could occur for various causes, such as when an employee has had a performance problem, is under the influence of a substance and the behavior is witnessed by two managers, is caught selling an illegal substance, is involved in an altercation, or threatens another individual. The fourth cause, also a fitness-for-duty issue, is if a person has a positive post-accident drug screen or a positive random drug screen.

If an employee is referred to BHS for cause, it is always based on a site contractor Human Resources referral. Human Resources will request an immediate assessment of the patient's behavioral status. At such a time, if an employee discloses a substance abuse problem, he/she is referred to an in-house treatment facility. Following in-house treatment and prior to returning to work, the employee must sign an agreement that he/she will submit to monthly monitoring and random drug screening for one year. Agreements are binding, and if an employee fails to meet either obligation, he/she is considered not to be fit for duty. Patients may also be referred to BHS on a voluntary basis in some circumstances.

At the time of periodic examinations, patients are given a form entitled "Health Life Index." Patients are asked to check the boxes that apply to them, and these are reviewed and rated. If the score is over 300, the patient is offered a referral to BHS. Both the form and the referral are completely voluntary.

During one period, the HEHF acting medical director and behavioral psychologist were considering developing a protocol for chronic pain management. The motive for this endeavor was to help employees suffering from chronic pain to manage their disability more effectively. Patient participation in the program was to be strictly voluntary. Email was distributed to HEHF providers and provided to GAP, defining possible criteria that could be used in assessing a patient's possible need for BHS. The protocol was never finalized. To date, there is no informal or formal policy for referring an employee to BHS for repeated complaints of pain or injury.

Communications Between HEHF Medical Providers and Site Contractors

With some isolated exceptions (i.e., three cases of incomplete treatment information being recorded on the ROV, which is discussed later), HEHF records reviewed on this investigation showed no evidence of providers yielding to outside pressure from site contractors to adjust ROV terminology to minimize OSHA recordable events.

There is appropriate and necessary communication between HEHF staff and contractor case managers to accommodate workable restrictions in the workplace for individual workers, both protecting worker health and preserving worker employment. No evidence was found to support the allegation that providers developed ineffective work restrictions. Some restrictions included exposure level limitations, which in effect would require an individual worker to wear personal protective equipment (PPE) during work assignments. Given this degree of restriction, the contractor would be obligated to furnish easily accessible PPE for this worker in job situations where his/her exposure level limitation would likely be exceeded.

Staffing and Accreditation

The HEHF professional staff consists of four physicians, four physicians assistants, and two occupational health nurses who perform clinical activities under the guidance of a physician. Two of these physicians are board certified in occupational medicine. All are properly credentialed and licensed to practice medicine or nursing in the state of Washington. HEHF was inspected by JCAHCO in 2002. The accrediting team awarded HEHF a high score and granted accreditation for three years.

The lack of a permanent medical director has contributed to insufficient leadership and communication of expectations to the clinical staff. The individual serving as the acting medical director has served in this position for just over one year. He has eight years' experience in managing clinical activity at HEHF and continues to also perform this function. This dual set of responsibilities is a challenge and dilutes his

attention to medical director responsibilities and initiatives. He openly admits his preference for managing clinical occupational medical activity, rather than being a medical director.

The lack of a full-time medical director adversely affected disemination of information (to Tank Farm workers in particular) about the acute effects of vapor exposures being seen by HEHF providers, the long-term unknown effects, and the importance of follow-up surveillance testing. Candid, repetitive discussions with targeted groups, led by respected medical authority, could help relieve anxiety and concern among Tank Farm workers. There is documented evidence that HEHF senior management appealed to CH2M HILL on more than one occasion to work together to improve worker confidence in the Hanford Site's chemical exposure program. The communications suggested development of a joint long-term plan for understanding and alleviating employee concerns regarding vapor exposures. A response from CH2M HILL was never received, and RL was not informed.

Long-term Health Impacts

Despite the management challenges, HEHF staff has demonstrated genuine concern for and attention to Hanford Tank Farm workers' vapor exposures. These patients are all being followed in the Medical Surveillance Study. Additional medical follow-ups are being conducted where indicated, and at specified intervals in addition to the next annual physical examination. This Medical Surveillance Study of vapor-exposed workers was begun in 2002 using data from 2000 and 2001. The data collected included physical examination and laboratory and pulmonary baseline information, which may prove useful in addressing the long-term effects of exposure and health concerns of Tank Farm workers.

At this early date, the study has not reached any conclusions. However, in the 2003 Medical Surveillance report, several recommendations for program improvement were presented. One of the recommendations was that all exposed workers have additional follow-up at HEHF with a physician and be placed in the case management category. While this has been accomplished in some cases, as yet, processes are not sufficiently rigorous to ensure that such follow-up is always being done, particularly if the vapor exposed worker has become asymptomatic in a few days. There is a need for reliable follow-up review, examination of industrial hygiene chemical identification and measurement data during the follow-up visit, and thorough progress notes on laboratory value changes on all exposure cases.

Workers from CH2M HILL have voiced increasing concerns about vapor smells from the Tank Farms. The toxicological and biological effects on the body that may develop resulting from exposures to vapors found at the Hanford Tank Farms will vary depending on the actual chemicals involved in a particular tank and the quantity of the vapor exposure. The effects will also vary depending on each worker's general health and biological systems' functioning at the time of exposure. Following some exposures, Industrial Hygiene has collected information about the offending chemicals and/or has measurement data (see Appendix C for a discussion of weaknesses in industrial hygiene measurements). This specific information needs to be available on the worker's medical record for follow-up visit review by a physician. At present, Industrial Hygiene and HEHF have not transferred information in a timely manner or not at all (see Finding #D-2).

Medical Record Storage and Quality

HEHF maintains a system for collection, processing, maintenance, storage, retrieval, and distribution of patient medical records. There are approximately 14,600 active files, 4,000 inactive microfiche files, and numerous active microfiche reel files within the HEHF records area. Hard-copy inactive medical records originating prior to 1962 are stored at the Federal Repository in Seattle, Washington, along with copies of the microfiche reels.

HEHF must comply with the DOE Record Inventory Disposition Schedule (RIDS), an initiative managed by the DOE Chief Information Officer. The Federal Records Act requires all agencies to have a complete inventory of records such that the agency knows what was destroyed in case of a catastrophic event, and has predetermined a priority of retrieval for any remaining damaged records. HEHF self-disclosed that they have not submitted a RIDS report since 1995. Records personnel notified the RL Records Officer on October 27, 2003, of their non-compliance. Actions were discussed with RL, and actions are under way to come into compliance with the Federal Records Act and good business practices set forth by the Chief Information Officer.

During business hours, HEHF medical records are stored in a locked area that is only accessible to health care providers and records personnel. Entry into this area requires a badge swipe or private escort. After-

hours, the medical record cabinets are locked. Each record is bar coded so that when it is released outside the confines of the medical records area or removed from storage by records personnel, it can be easily tracked by individual and by location.

Each medical record has a green face sheet that serves to highlight a patient's allergies, current medications, chronic health conditions, and outcomes of past health examinations. Within each individual section, documents are arranged in chronological order, with the latest visit or test result appearing on top of past entries. HEHF medical providers are required to initial lab work, x-ray, pulmonary function test, electrocardiogram, physical examination forms, or other correspondence to document their review and follow-up of abnormal results.

A sample of 75 medical records that included files on current and former workers was reviewed. The largest number of CH2M HILL records reviewed pertained to patients reporting a vapor exposure (53). A selection of non-vapor-exposure records representing Hanford prime contractors (20) was also reviewed. A review of beryllium surveillance records (2) was also performed. The beryllium records were reviewed following allegations that a worker's diagnosis was inappropriately changed by HEHF when in fact, changes in laboratory values were the reason for the modified diagnosis.

Overall, the records reviewed were well maintained and in good condition. Occasionally a record was divided into two folders because of the huge volume of documents. Divided records were easily identified by markings on the outside cover. To make larger charts more manageable, HEHF personnel put early medical data on microfiche, which is attached to the inside of the folder. When requested, HEHF personnel could easily retrieve the microfiche records.

With few exceptions, record contents were in chronological order. The most frequent inconsistency in record organization involved the placement of reports from Kadlec Hospital following the treatment of a vapor exposure. Hospital reports were found either in the correspondence, laboratory, or progress notes sections. Only one instance was identified where treatment notes from Kadlec, following a vapor-related incident, were not communicated in writing to HEHF. In that case, a letter addressed to the patient from an HEHF medical provider was present in the chart, detailing the outcomes of the examination conducted at Kadlec and indicating that an emergency room record once existed.

In the exposure records reviewed, the Exposure and Unusual Event Service protocol was not followed when an employee reported an exposure 24 hours post-event and was also asymptomatic at the time of examination. Further, it was also not followed when an employee only wanted to document the vapor incident in their medical record and declined an examination. The Exposure and Unusual Event Service laboratory panel consists of a chemistry profile (electrolytes, liver enzymes, lipid panel), complete blood count, and microscopic urinalysis. Following analysis, the blood and urine specimens are preserved for 30 days so more definitive testing can be done if the chemical agent of exposure is subsequently identified. Because the chemical agent is usually unknown when employees present themselves to HEHF or Kadlec, the laboratory work generated evaluates likely target organs and other systems that may be affected by a chemical vapor exposure.

In reviewing the vapor-related incidents, it was apparent that there has been a more consistent approach since 2002 in performing the Exposure and Unusual Event Service protocol at HEHF and Kadlec. Providers were more apt to clearly document patient assessment, tests conducted, and instructions for follow-up. Progress notes were in the "SOAP" format, the employee's account of the vapor exposure incident and associated health complaints (Subjective), physical examination and lab work (Objective), medical diagnosis (Assessment), and treatment (Plan). However, reports of exposure or air monitoring data collected on the day of the vapor incident were rarely found in the medical charts. There were no references in the provider's notes of discussions with industrial hygiene personnel or a description of the PPE worn at the time of the vapor exposure.

There was a fairly frequent trend of documenting an assessment as "Exam WNL" (within normal limits) when an employee reported symptoms but the provider found no obvious physical findings. It is accepted medical practice to use the "WNL" terminology when patients exhibit no abnormal physical findings. However, the use of this terminology may create a misperception among Tank Farm workers that medical personnel are discounting their symptoms. Some assessments read "Vapor Exposure, Normal Exam." HEHF providers were very consistent in their follow-up of examination results with the patient post-exposure. Providers documented by progress note or letter that the patient had been informed of all test results related to the vapor exposure.

The treatment plans developed depended on a provider's objective findings. If an employee complained of headache pain post vapor exposure,

he/she was treated with over-the-counter (OTC) medications. HEHF providers were very consistent in documenting instructions for employees to return as needed, consulting a private medical physician if symptoms persisted, providing instructions on workers' compensation rights, and noting a return-to-work status.

If employees inform HEHF that they want to pursue compensation, they are given a Workers' Compensation Advisory Form. Employees must document their desire to pursue compensation, the injury/illness incurred, a request to see their private physician, and an acknowledgement of the two-year time frame to claim injury. Once employees sign the form, it is mailed to their private physicians. The private physician provides the necessary prerequisite forms the state needs to determine if the work-related injury/illness is compensable. The state precludes the employer from managing workers' compensation claims; this service is provided by a third-party administrator, Contract Claims Services Incorporated. Compensability is decided by the State of Washington Labor and Industry Board.

Records of Visit

When a worker is treated at HEHF, the method of communicating the outcome of the visit to their manager and contractor safety representative is through a ROV. The ROV is an HEHF computer-generated form that documents the patient's statement of visit; patient's account of injury or illness including date and time; work-relatedness; medications administered at the time of treatment; medical referral; return-to-work status; and work restrictions and/accommodations. HEHF creates a ROV for work-related and non-work related incidents and continuance of restrictions. For non-work related incidents, the ROV is a return-to-work slip documenting that the employee is medically fit for duty following an absence of more than five consecutive days.

Prior to creating the ROV, patients are asked by the HEHF clinic receptionist to write their reason for visit and if it is work related or not. The patient information is transcribed in the patient's own words, into the computer-generated ROV. In the past, once the ROV was created the HEHF administrators discarded the original document that patients filled out. Several months ago, HEHF started retaining the original document as part of the permanent record.

The provider completes the ROV by adding return-to-work status, treatment plan, follow-up if needed, and work restrictions/accommodations. If a work restriction is required for the employee's return to work, a discontinue or reassessment date is noted. The clinic receptionist adds the provider's information to the ROV and prints patient and supervisor copies. The patient then reads the printed information, and acknowledges accuracy by signature. Upon return to work, the patient delivers the ROV to his/her supervisor. If the ROV is work-related, a third copy is emailed to the contractor safety representative.

There is certain information on the ROV that is generated only by the employee/patient. The patient's statement of injury/illness and claim of work-relatedness is strictly self-determined information. In fact, if a patient fails to check the box claiming that the visit to medical is work-related, it is perceived by HEHF "as not." In reviewing medical records there were several instances where this information was left blank by the patient and consequently the corresponding ROV reflected "Not Work Related."

When HEHF updated an existing ROV, it usually resulted from a patient returning for follow-up care or when new information was communicated from the contractor or workers' compensation. The old ROV was stamped to direct attention to the newly created ROV. The new ROV was also stamped acknowledging the date of the ROV it superseded, with new information highlighted in yellow. There were several records where a new ROV reflected a non-work related injury being changed to work-related. In addition, an accompanying entry describing why the change occurred was usually documented in the provider's progress notes.

HEHF was very consistent in their method of adding addendums to existing ROVs and documenting changes in the provider's progress notes as well. There was no sign in any of the charts reviewed that old information was discarded in favor of new. If changes to information occurred, the word "Addendum" appeared prior to the progress note. If any information was "lined through," it was still easily discernible and there was no use of "white out" preparations or other masking material. In all the charts reviewed, there was only one severely crumpled and mended record. It was a progress note that got caught in the copier when the record was being duplicated per written request of the patient. Records personnel mended the still legible document with tape and retained it in the file.

The ROV does not establish a work-related injury/illness as an Occupational Safety and Health Administration (OSHA) recordable. Also, it does not establish whether the injury/illness is compensible under state workers' compensation laws. The contractor's safety recordkeeper makes the decision whether or

not an injury/illness is OSHA recordable upon an investigation of the alleged work-related incident, which includes written reports from the worker, the supervisor, and any witnesses. However, the contractor's determination of OSHA recordability is partially dependent on information generated by HEHF. For example, if Safety classifies an injury/illness as work-related and HEHF reports the occurrence of a fracture, a laceration requiring suturing, unconsciousness, the need for restricted duty, a controlled medication prescribed, or lost time because the employee is sent home or hospitalized beyond the day of injury, it becomes a recordable case. The safety recordkeeper must have a clear knowledge of all treatment rendered by HEHF or local hospital and outcomes to make an accurate entry in the OSHA 300 log.

In comparing the information recorded on the ROV to that in the providers' progress notes, there were a few discrepancies. In three records, a provider prescribed an OTC medication at prescription strength, but the corresponding ROV reflected only "OTC." In the first case, Ibuprofen was prescribed at "200 mg *iii* tablets tid #20" (3 tablets, three times per day, 20 tablets provided). The second case was the same medication, but 30 tablets were provided. The third case was Naproxen 200 mg *ii* tablets bid (2 tablets twice per day). The three ROVs contained incomplete information and because the employees were returned to work without restriction, there were no other factors that would make the cases recordable under OSHA requirements. As a result, these cases may have been improperly recorded. In one of the three cases, the injury was later identified as recordable because it turned into a lost-time injury. The three ROV discrepancies represent a small number of the 75 records sampled, but reflect management ineffectiveness in records quality assurance review.

Finding #D-2: HEHF management has not ensured that administrative processes are effectively implemented for clearly communicating policy, implementing the results of surveys as part of the HEHF quality process improvement initiative, and ensuring that ROVs provide complete information to site contractors to preclude a few cases of misreporting of recordable injuries.

D.2.4 RL Oversight

Except for the PEP and Award Fee Determination process, RL has not conducted assessments of the occupational medicine program since 2002. RL oversight of the occupational medicine program has been limited to participation in the performance evaluation and fee determination process, review of HEHF invoices, and approval of HEHF subcontracts. Until the decision was made to recompete the HEHF contract, the RL Contracting Officer and HEHF Program Manager met monthly with HEHF to discuss topics of mutual interest that provided RL the opportunity to raise and address issues. However, those meetings were discontinued to avoid the perception of unfair advantage on the contract recompetition. Furthermore, although the RL HEHF Program Manager was aware that there were concerns with vapors at the Tank Farms, RL was not actively engaged and taking formal action to address medical interface aspects of these issues.

The occupational medicine program resides within the RL Infrastructure, Property Office and is one of many services provided to the Hanford Site by RL. The RL HEHF Program Manager has multiple roles and responsibilities, including serving as the HEHF Contracting Officer, serving as property officer for the Hanford Site, managing the transfer of assets to the local Community Reuse Organization, and serving as Contracting Officer for disposal of personal property. As such, the Program Manager devoted limited attention to oversight of the occupational medicine program and HEHF activities.

Recognizing their limited expertise in occupational medicine/occupational health, RL established an Interagency Agreement with the Department of Health and Human Services/PHS in 2002. PHS helped RL develop language for bidding the occupational medicine program contract and to validate the HEHF response to concerns raised in the September 25, 2003, letter from the Office of the Inspector General related to GAP allegations against HEHF. However, RL has not used PHS for conducting oversight of the occupational medical program or for other evaluations of Tank Farm worker issues. Some limited support was provided by the RL environment, safety, and health organization in evaluating HEHF performance as part of the Award Fee Determination process. However, resources from the environment, safety, and health organization were not employed to conduct routine oversight activities of HEHF and the occupational medical program.

D.3 Conclusions

Based on a detailed review of medical records of 75 workers, including the 53 identified in the GAP report,

as well as numerous interviews with HEHF medical staff and tank workers and reviews of HEHF administrative procedures and protocols, the OA team did not substantiate any of the health-related GAP allegations, except for several isolated instances of incomplete treatment information being provided to contractor record-keeping case managers. The OA team also found the clinical practices and protocols to be consistent with standard occupational medical practices. Medical records are detailed and well organized, and are controlled by strict record-keeping practices. The medical staff has excellent professional credentials, and it was apparent that quality worker health care was a priority of the organization.

HEHF has many of the basic survey tools needed to obtain feedback from staff, contractors, and patients concerning the quality of health care and offer an excellent feedback mechanism for improving overall health services. However, the tools have not been formalized and used by management to improve organizational performance. HEHF has not developed the necessary administrative protocols for properly completing ROVs, for communicating policy and expectations to the professional staff, and for integrating exposure information into the medical record. This is evidenced by examples of incomplete information about OTC medications provided on ROVs, contributing to possible instances of misreporting of events and the delay of reviewing exposure information for as long as two years.

The unique relationship of HEHF to multiple prime contractors at Hanford requires that specific interfaces be in place and be used to exchange health related information such as the transfer of industrial hygiene exposure data to medical charts and injury/illness incident treatment information to safety case managers; these interfaces have not always been effective in ensuring timely and effective data exchange in past years. Furthermore, interfaces among HEHF and ORP and CH2M HILL were not adequate to ensure that HEHF was sufficiently involved in the ongoing development of solutions to the vapor exposures and recent OSHA record-keeping issues, even though several consultant reports called for greater medical program participation and increased efforts to better communicate medical information to workers affected by vapor issues.

The occupational medicine program is managed by RL as a site service rather than a worker protection program, as described by DOE directives and contractor requirements, and thus has not received sufficient programmatic management attention. RL has not established expectations to focus the occupational medicine program on critical activities, such as the population health management program (which is an important program for monitoring potentially exposed workers for long-term health impacts and enhanced communication projects to dispel worker concerns). In addition, RL staff have not been sufficiently engaged in ensuring that interface agreements are in place for the integration of HEHF into site safety and health management activities. Occupational medicine program personnel must work closely with contractor line management and safety officials to solve problems, collect relevant health related data, communicate health information and track and trend the health of the workforce so that management can be confident that safety and health programs are effective. RL, ORP, and the Pacific Northwest Site Office have not ensured that individual interfaces at the prime contract level are established to address the complete scope and intent of the DOE occupational medical directive and contractor requirements.

D.4 Recommendations

Richland Operations Office

1. Communicate clear expectations to the occupational medical contractor and Hanford site contractors for integrating activities in support of the site occupational medicine program by incorporating language into existing contracts and contractor performance evaluation plans that clearly establish DOE's expectations for integrating Hanford site occupational medical program activities. Coordinate the establishment and communication of these expectations to site contractors with ORP and Pacific Northwest Site Office to ensure consistency. Include the population health management program within the Hanford onsite medical provider's performance evaluation plan as a means for evaluating long-term worker health effects.

2. Ensure that formal interface agreements are established between the occupational medical contractor and Hanford site contractors for integrating activities and addressing issues related to the site occupational medicine program. Include roles and responsibilities, requirements, expectations, and management approvals for each interface agreement. Address processes to ensure

the timely flow of industrial hygiene exposure information to the occupational medical contractor, use of ROVs for providing accurate employee information to contractors, and processes for communicating occupational medical protocols, procedures, and health outcomes to the workforce. Coordinate the establishment of these interface agreements with ORP and the Pacific Northwest Site Office.

3. Strengthen oversight of the occupational medicine program to include regular formal assessments of the occupational medicine program as well as frequent routine walk-throughs as part of oversight. Meet regularly with occupational medicine program contractor management to ensure program issues are being addressed in a timely and effective manner. Provide personnel with occupational medical and/or health expertise as needed to support oversight activities.

Occupational Medical Contractor

1. Develop formal plans for addressing internal staff and administrative issues. Include developing protocols for completing ROVs; quality review of health examiners progress notes, including exposure data; examination records, and laboratory reviews to ensure greater consistency and adherence to protocols.

2. Revise the occupational medical contractor ROV, develop a protocol for its use, and train staff to: provide sufficient information with regard to medical recommendations and directions given to the patient; name the medications administered, prescribed, or recommended to the patient and indicate whether a prescription dose was provided; and develop and document specific work restrictions that are tailored to the diagnosis and the employee's job task analysis.

3. Ensure medical surveillance of Tank Farm workers study protocol is followed by all providers so the data collected is consistent for all workers. Consider implementing a standard six-month follow-up review of vapor exposed patients by an occupational medical contractor physician.

4. Provide frequent enhanced communication to Tank Farm management, workers, and committees in order to stem rumors, provide physician answers to questions concerning vapor incidents, and coordinate actions from vapor related audits and assessments.

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APPENDIX E
INJURY AND ILLNESS INVESTIGATION AND REPORTING

E.1 Background

Injury and Illness Investigation and Reporting Requirements

U.S. Department of Energy (DOE) contractors are required to develop and implement a written worker protection program to meet the requirements in the contractor requirements document (CRD) for DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*. This CRD has specific requirements for investigating and reporting injuries and illnesses, and analyzing related data for trends and lessons learned.

The CRD for DOE Order 440.1A also requires establishment of an occupational medicine program. As discussed in Appendix D, most Hanford Site contractors use the sitewide occupational medicine program to meet this requirement. The occupational medicine program has some designated responsibilities, including informing contractor management of appropriate employee work restrictions, and reviewing all monitored care of ill and injured employees, to maximize their recovery and safe return to work and to minimize lost time and associated costs.

DOE contractors are also required to develop and implement programs to meet the requirements in the CRD for DOE Notice 231.1 and in 29 CFR 1904 for recording, maintaining accessible, reporting, and posting records and statistics related to occupational fatalities, injuries, and illnesses occurring among their employees. Contractors are required to maintain individual occupational injury and illness case files, including both first aid and more serious cases. Contractors are also required to use Occupational Safety and Health Administration (OSHA) 300, *Log of Work-Related Injuries and Illnesses*, and OSHA 300-A, *Summary of Work-Related Injuries and Illnesses*, to log and summarize all occupational injuries and illnesses occurring to their employees that meet the criteria for OSHA recordable cases. The criteria for OSHA recordable injury and illness cases are contained in 29 CFR 1904, Subpart C. Various OSHA documents provide additional guidance for interpreting the reporting criteria, including OSHA published responses to frequently asked questions, record-keeping policies and procedures manual, record-keeping letters of interpretation, and various OSHA web pages. Contractors are also required to complete a Computerized Accident/Incident Reporting System (CAIRS) report, DOE Form 5484.3, *Individual Accident/Incident Report*, within seven days of receiving information that an OSHA recordable injury or illness has occurred and to submit to DOE field elements and Headquarters a copy of the new or revised CAIRS report following the end of each calendar quarter.

Hanford Site Organizations

Major site operating contractors at the Hanford Site include CH2M HILL, Fluor Hanford, Incorporated (FHI), Bechtel Hanford, Incorporated (BHI), Bechtel National, Incorporated (BNI), and Pacific Northwest National Laboratory (PNNL). Each contractor manages its own occupational injury and illness (OII) investigation and reporting program. The quality of the injury and illness data and the adequacy of investigations and reporting are the responsibility of the individual contractors. FHI, CH2M HILL, BHI, and PNNL use the sitewide occupational medical program, which is currently managed by Hanford Environmental Health Foundation (HEHF). BNI uses another health care provider organization, Work Care. DOE organizations at the Hanford Site – DOE Richland Operations Office (RL), DOE Office of River Protection (ORP), and Pacific Northwest Site Office (PNSO) – are responsible for providing line management oversight of their respective contractors (i.e., RL for FHI, BHI, and HEHF; ORP for CH2M HILL and BNI; and PNSO, in support of RL, for PNNL).

GAP Allegations

In addition to the allegations already discussed in Appendices C and D, the Government Accountability Project (GAP) report contains a general allegation that DOE contractors falsify injury and illness investigations and reporting.

OA Investigation Conduct and Scope

In addition to the reviews of CH2M HILL and the sitewide occupational medicine program discussed in Appendices C and D, respectively, the Office of Independent Oversight and Performance Assurance (OA) evaluated the effectiveness of injury and illness reporting for four other prime site contractors: FHI, BHI, BNI, and PNNL, with a focus on the adequacy and accuracy of injury and illness records and reporting. For each of the evaluated contractors, OA interviewed selected managers, reviewed injury and illness investigation and reporting policies and practices, and examined a sample of case investigations and records for calendar years (CYs) 2002 and 2003. OA examined the key documents associated with OII reporting, including event descriptions, investigation reports including cause(s) and needed corrective action(s) determinations, medical work restriction recommendations, work restriction agreements, initial and follow-up medical reports, return-to-work authorizations, OSHA 300 logs, OSHA 300-A summaries, applicable CAIRS reports, workers' compensation claims, and correspondence associated with case files. This review also assessed the adequacy of medical records and reports developed by HEHF and Work Care in support of injury and illness reporting processes for site contractors. Further, OA reviewed RL and PNSO oversight of their respective contractors (ORP oversight is discussed in Appendix C).

E.2 Results

Program descriptions and the performance of all evaluated organizations (Note: CH2M HILL is discussed in Appendix C) show that the primary purpose of OII programs was to assist injured workers in maximizing their recovery and in minimizing the time it takes for a medically approved safe return to work. All OII programs reviewed have clear requirements that provide the foundation for their OII program. For example, all site contractors have clear requirements to investigate and report OII events and determine apparent causes and needed corrective actions, using a graded approach based on significance and severity.

E.2.1 FHI

FHI's OII program is described in their occupational safety and health procedure HNF-PRO-077, *Reporting, Investigating, Managing Events*. Fluor Corporate performed a health and safety assessment of FHI activities in September 2003 and concluded that OII case management met standards. Fluor Corporate recommended establishment of a third-party review process for OSHA recordable decisions that may be the subject of DOE non-concurrence.

FHI's OSHA 300 logs, OSHA 300-A summaries, and DOE's CAIRS accident log for CYs 2002 and 2003 and were compared to identify inconsistencies, potential inaccuracies, and classification downgrades that needed additional follow-up case file review. Summaries of FHI first aid cases for the same period were also reviewed to select a sample for further review of the adequacy of OSHA recordable determinations.

OA conducted detailed reviews of 51 OII case files and their associated logs and reports, including OSHA recordable, reclassified non-OSHA recordable, and first aid cases against OSHA, DOE, and FHI program requirements. Of the 51 case files reviewed, OA determined that three were insufficient to justify the determinations made, two of which should have been categorized as OSHA recordable.

The majority of OII case files contained HEHF initial and follow-up records of visits (ROVs), the "Event Report," workers' compensation correspondence, and case management notes and correspondence, the latter principally associated with determining whether the cases were OSHA recordable and the categorization of and basis for the number of lost workdays away and/or restricted workdays. A few OII case files contained event critique evaluations, summaries of medical evaluations of workers involved in group exposure to chemical vapors (not Tank Farm), and industrial hygiene post-event survey results. However, many reviewed files did not contain sufficient information to support an independent conclusion about whether an event was OSHA recordable.

The initial review of contractor records of CY 2002 OSHA 300 logs, the OSHA 300-A summary report, and the web-based DOE CAIRS accident log determined that about 10 percent of the OSHA 300 logs were inconsistent with corresponding DOE CAIRS accident logs. However, when the current versions of those records were compared (those containing the periodic updates required by OSHA and DOE), all the inconsistencies had been resolved. FHI's success in establishing consistency between these records is attributed in large measure to their authority to electronically upload initial and revised CAIRS report data as new information associated with individual OII cases becomes available, and to their efforts to promptly correct data manipulation software deficiencies as they are discovered.

Several CAIRS reports lacked valid input regarding the time when work was started. As a result, the case files appeared to demonstrate that the workers involved in those OII events worked in excess of 16 hours during the day of the accident. FHI intends to revise these reports to reflect the correct data input. Several of the reviewed CAIRS and Event Reports summarized the event investigation, but failed to discuss corrective action plans for some apparent event root and/or contributing causes and the dissemination of lessons learned.

The reviewed files did not contain, nor does the program require, any documented worker-supervisor agreement on the interpretation of the HEHF-defined work restrictions. However, given the importance of mutual understanding of work restrictions and the need to accurately assess whether the work restriction is OSHA recordable, documentation of the understanding of the work restriction beyond the ROV would be beneficial.

One of the three challenged OII case determinations involved a Hanford fire department supervisor who tripped, fell, and aggravated a previous non-occupational shoulder injury while carrying his fire department personal protective equipment and self-contained breathing apparatus frame back to his assigned vehicle, following a work-related training activity. The initial HEHF ROV documented work restriction stated "no lifting, pushing, pulling over 15 pounds with right arm-suggest office only," and was subsequently revised to 25 pounds in a follow-up ROV. The employee job task analysis (EJTA) for the supervisor's position, which was not originally part of the presented case file, lists his essential functions as fire fighting and hazardous material emergency response, and lists his physical job demands to include occasional (up to one third of the time) climbing (hands and legs), lifting greater than 25 but less than 55 pounds, etc. Despite these job requirements listed in the EJTA, FHI maintains that fire fighting and hazardous material duties for this supervisor are emergency functions that do not meet OSHA's definition of routine weekly work activities, in part because the Hanford fire department and this supervisor reportedly do not routinely need to respond to fires or hazardous material spills, and that the work restrictions did not preclude the supervisor's performance of his essentially routine management and administrative tasks. Based on the records reviewed and the discussions held, this case may be legitimately exempt from reporting as OSHA recordable, but also does not appear to be a reasonable use of the recording exemption described in 29 CFR 1904.7(b)(4)(ii).

The second of the three remaining challenged determinations involved a worker who experienced an occupationally related and confirmed minor insoluble plutonium uptake and deposition in the lungs. The worker was treated with diethylenetriaminepentaacetate (DTPA), a prescribed medical treatment, developed a headache following treatment with DTPA, and received a prescribed medicine for the treatment of the headache. FHI management maintains that the OII case is not OSHA recordable because HEHF did not believe the DTPA treatment was necessary due to the minor nature and insolubility of the uptake, that plutonium was not found in the blood, and that HEHF gave the medically prescribed DTPA to the worker at the worker's request as a precautionary measure. However, the doctor in charge of HEHF indicated in a document in the case files that "the worker was offered the choice to utilize the chelating agent just to make certain that if any Pu [plutonium] translocated to the blood, the dose could be attenuated." FHI management cites the OSHA recordable exception outlined in 29 CFR 1904.5(b)(2)iii, which provides a reporting exception for an injury or illness resulting from worker voluntary participation in such medical activities as blood donations and flu shots. Further, FHI management maintains that the medical prescription for treatment of the worker's headache did not make the case OSHA recordable, because the DTPA treatment was a worker voluntary participation in a medical activity and therefore not an occupational injury or illness condition for which the prescription of medication would otherwise make the case OSHA recordable. The cited basis for this interpretation is OSHA's "Frequently Asked Questions for OSHA's Injury and Illness Recordkeeping Rule" web site, and the suggested parallel to the OSHA response to Question 7-15, indicating a case involving oxygen administered as a purely precautionary measure to an employee who does not exhibit symptoms of an injury or illness, does not make the case recordable. The case file does not discuss the 50 year committed effective radiological dose to the lungs from the plutonium body burden, and there was no document in the case file that addressed this issue with regard to OSHA recording. Based on the records reviewed, this case appears to be OSHA recordable because the DTPA was medically prescribed and would not have even been considered as a potential injury or illness mitigation had the occupational exposure not occurred. Both the OSHA 300 log and CAIRS reports should be revised/created to reflect this change in classification.

The last of the remaining challenged determinations involved an OII case of an electrician that was originally

classified as involving a work restriction. The HEHF initial ROV states a medical work restriction of "limited use of left arm, should keep arm in sling unless doing mobility exercises." However, several days later, in response to questions from FHI, HEHF documented that despite what the ROV said, they actually told the worker to limit his use of his arm to that tolerated by pain. Further, an email in the case file indicated the worker reported that the injury had not prevented performing normal work activities; therefore, the contractor reclassified the case as non-OSHA recordable. 29 CFR 1904.7(b)(4)(viii) states "if a physician or other health care professional recommends a job restriction meeting OSHA's definition, but the employee does all of his or her routine job functions anyway…you must still record the injury or illness on the OSHA 300 log as a restricted work case." By this OSHA interpretation of the rules, as a minimum, the days following the initial ROV up to the time of receipt of HEHF's email relaxing the work restriction should be treated as OSHA recordable. Until this issue is further resolved, the OSHA 300 log and a CAIRS report should be revised/developed to reflect OSHA recordable and restricted days of work.

GAP report, Appendix B, Possible Exposure Case #41 correlates with FHI first aid cases 16042, 16044, and 16045 involving a June 8, 2003, exposure to chlorine vapor by a three-man team that was investigating, without respiratory protection, reports of chlorine odor in the 105 KW Basin. A subsequent event critique concluded that oversized chlorine tablets had been placed in the water reservoir of an evaporative cooler to sanitize and inhibit biological growth as part of a routine warm-weather preparation activity, but that the cooler was shut down because of a bad bearing, allowing the tablets to dissolve without an effective mechanism to dissipate the evolved vapors. When the cooler was later run, the concentrated chlorine vapor was swept into the basin area. After the investigating team identified the evaporative cooler as the likely source of the chlorine odor, each member of the investigating team reported a metallic taste in their mouth, and one member of the team experienced breathing difficulty. The Hanford fire department was called for medical assistance and subsequent investigation of the cause of the exposures. The members of the three-man team were each examined at the Kadlec Hospital for complications and were cleared for return to work without restrictions, with direction to seek additional medical review if symptoms did not further improve. Five other individuals on the previous shift who had initially reported the odors were also contacted and recommended to get medical examination, but only three went for examination. A subsequent HEHF documented review of medical records indicated that all six had normal laboratory results. Reviewed case and medical files showed that two of the six also received medical treatment and/or advice for conditions unrelated to the exposure to chlorine vapors.

Documented corrective actions for the chlorine exposure event address several concerns, including the immediate cause of the generation of vapors. However, the corrective actions did not address several apparent problems that surfaced in the critique, including conservatism in event response; premature resumption of work; inadequacies in portable chlorine monitor instrumentation calibration, use, and training; inadequacies in facility configuration control; and responsiveness to employee concerns.

Overall, FHI's program for recording and reporting OIIs met the requirements of DOE, OSHA, and their internal procedures. The reviewed OII case files were generally of good quality and consistent with requirements. However, a few cases were incorrectly categorized as not recordable, and some cases were missing information, indicating a need for enhanced quality assurance (see Finding #E-1).

E.2.2 BHI

BHI's OII program is described in their safety and health procedure, BHI-SH-02, "Accident/Incident Investigation and Reporting Requirements," with additional details for implementation defined in their desktop instruction titled "Medical Case Management." BHI also coordinates and provides oversight for injury/illness record-keeping by their subcontractors, with BHI maintaining the official records. The accuracy of CAIRS data to be provided to DOE is reviewed by safety representatives of BHI and their subcontractors in a quarterly meeting.

BHI and their subcontractors' OSHA 300 logs, OSHA 300-A summaries, and DOE's CAIRS accident logs for CYs 2002 and 2003 were compared to identify inconsistencies, potential inaccuracies, and classification downgrades that needed additional follow-up case file review. As a result, detailed reviews of 14 OSHA recordable OII case files for CYs 2002 and 2003 were conducted to confirm the accuracy and consistency of the associated reports and logs. Also, detailed reviews of 73 BHI OII cases categorized as non-OSHA recordable for the period January 2002 to March 2004 were conducted to determine the accuracy of the

determination of whether or not the cases were OSHA recordable.

In general, most reviewed cases appeared to be appropriately categorized, investigated, and reported. Some questionable and/or incorrect categorization and reporting are discussed in the following paragraphs.

Two examples of apparent failure to record and report OSHA recordable events were identified with one OII case. The OII case involved a decontamination and decommissioning worker who was occupationally injured, where the HEHF initial visit ROV indicated "Return to Work Without Restrictions." A second OII event occurred that significantly aggravated the original injury. The subsequent incident report explained that, over the period of several months, the original injury improved but reportedly never fully recovered, and that the employee's private medical provider referred the employee to an orthopedic specialist who administered a course of treatment, which was approved by BHI's workers' compensation third-party administrator. Two HEHF ROVs for the injury aggravation, with the same date and time of service, indicate "Return to Work with Restrictions of Light Duty, Limited Walking, Should Use Crutches, Recommend Sit Down Work," but one shows treatment with prescription medications and the other does not. One of the ROVs was also incorrectly annotated (with a CAIRS report number that applies to another OII case). An *Employee Restriction Assessment Form* for the latter OII event indicated the restriction was being accommodated. No documentation was found in the files officially recording either event as CAIRS or OSHA recordable and providing a restricted workdays count. Further, no documents were provided that explained why the two OII cases were not both recorded, despite the fact that each met OSHA recording criteria. It appears that OSHA 300 and CAIRS reports need to be revised/created for both OII cases.

Another OII case was listed as non-OSHA recordable, but contained an HEHF ROV indicating a diagnosis of beryllium sensitivity, with a permanent work restriction for work environments with an eight-hour time-weighted-average beryllium concentration exceeding 0.01 μg/gm. The OII program files did not contain any documentation of the 10 CFR 850.34(g) required OSHA 300 log entries or DOE CAIRS report corresponding to this OSHA recordable OII.

One OSHA recordable OII case addressed an injury resulting in a medically directed restriction of minimal use of the employee's right upper extremity. The employee was placed on light duty, but the associated CAIRS report indicates he could "still perform all of his functions but at a pace suited to his personal limitations." However, after three additional medical evaluations over a period of six days and with no change in the documented work restriction, it was concluded that the work restriction could not be accommodated, and the employee was sent home with lost workdays away exceeding 180. In retrospect, the case file raises a question of whether the restriction was really able to be accommodated for the initial six days and whether those days should now be categorized as restrcted workdays on the OSHA 300 log and in the CAIRS report. The OII case file does not provide sufficient information to resolve this issue.

One injury case labeled "Non-Work Related" involved a construction engineer who was stung by an insect while observing electrical utilities performing power line maintenance while located south of the 300 Area South Process Pond, apparently during normal work hours. The employee developed a significant reaction that ultimately required treatment by his personal physician. The case file does not explain why the injury is not OSHA recordable.

One 2004 first aid case file contained an HEHF initial ROV listing medications as over-the-counter (OTC). However, BHI's occupational medical specialist was subsequently informed by the workers' compensation third-party administrator that they determined during their claim investigation that the medical provider's notes documented that prescription medication was given on the first appointment. The OII case was appropriately reclassified by BHI as OSHA recordable, and BHI reportedly initiated an investigation of the CAIRS reporting process.

Another OSHA recordable OII case file contained a CAIRS report indicating that OTC medication at prescription strength was provided during a follow-up examination; however, the associated HEHF follow-up ROV only indicated that the medication provided was OTC. OA determined that the associated HEHF medical files indicated OTC medications at a dosage that could reasonably be argued was OTC strength. Therefore, this is not an example of inaccurate information being recorded on an ROV. However, the OII case was still recordable because of an earlier ROV, patient information leaflet, and an email to management from the Safety Department case manager indicating that prescription drugs were dispensed or administered for the worker's injury during the initial HEHF visit.

The review of current BHI OSHA 300 and DOE's web-based CAIRS accident logs for CYs 2002 and 2003 identified only one of nineteen corresponding

records had inconsistent workdays that affected that year's cumulative workdays lost to restriction. The effect of the inconsistency was less than five percent. The occupational medical specialist indicated that revisions have been submitted, but are not always reflected in subsequent queries of DOE's database. Also, a number of typographical, transcription, omission, and logic errors were found in reviewed OSHA 300 logs and CAIRS reports, but no significant factual errors were identified. BHI had already identified a number of similar minor errors in these records and had either corrected or planned to correct these errors in revisions planned in April 2004.

Reviewed BHI OII case files contained HEHF initial and follow-up ROVs, and associated notes, statements, investigation reports and summaries, Employee Restriction Assessment forms, outside medical provider correspondence, and workers' compensation claim correspondence. The included incident report form and short-form email summary of investigation results demonstrated a reasonable, graded approach to investigations and timely communication of lessons learned, but were not consistently available in all injury/illness case files. For OSHA recordable cases, the associated CAIRS report was usually included and was found to be consistent with other OII case-related investigation documents included in the file. The majority of corrective actions for injury/illness cases that were reviewed appeared to be appropriate to the associated circumstances and usually involved actions already taken and/or instructions that had already been given to the individual and workers in similar disciplines; however, corrective actions not closed at the time of the investigation or CAIRS report development were assigned to the employee's immediate supervisor without clear evidence in the case file of tracking or closure. The Employee Restriction Assessment form was frequently included in work restriction cases, but not in all cases. Case files reviewed did not contain a definitive narrative on why the OII case was determined to be OSHA recordable or not, but investigation narratives occasionally did describe an opinion on OII category and whether or not the cases were OSHA recordable.

HEHF ROVs in some of the reviewed OII case files lacked information and specificity to meet the needs of the contractor staff charged with determining OSHA recordable cases and injury/illness categories; for instance, "Follow Verbal Recommendations as Provided," without indication whether those recommendations were pertinent to the work environment; "Meds Given or Administered," without indication whether prescription strength or OTC; "OTC" listed without indicating whether prescription dosage was recommended; "See Private Physician, Return to HEHF," without follow-up date or follow-up ROV; and "Return to Work with Restrictions," without restriction specificity or with some general restriction statement relating to the patient's tolerance of pain, neither of which is directly interpretable in terms of the workers' routine work activities. Further, the ROV forms did not always provide sufficient injury/illness diagnosis information needed to categorize the OII per OSHA 300 and/or CAIRS forms injury and illness categories, such as skin disorder, respiratory condition, poisoning, dust diseases of lung, respiratory condition due to toxic agents, and disorder due to physical agents, the medical provider recording of which would enhance the likelihood of accurate OSHA and CAIRS reporting. In addition, ROVs for OII program-required HEHF visits following examination and/or treatment by a private health care provider did not always ensure adequate communication of information to the contractor, which is needed to determine whether the OII case is OSHA recordable and how to interpret the private health care provider's recommended work restrictions.

In general, BHI's program for recording and reporting OIIs was adequate to meet the requirements of DOE, OSHA, and their internal procedures. The reviewed OII case files were generally complete, of good quality, and consistent with requirements. However, categorization of a few cases was questionable and/or incorrect (see Finding #E-1).

E.2.3 BNI

BNI's OII recording and reporting program is principally described in Bechtel's Core Process description titled *Injury/Illness Notification, Investigation & Reporting*, and in the Waste Treatment Plant procedures titled *Reporting Occurrences in Accordance with DOE M 231.1-1, Reporting Occupational Injuries and Illnesses* and *Environment, Safety, and Health reporting in Accordance with DOE Order 231.1A.*

BNI recently developed a trending report from their injury/illness data that highlighted the most significant causes of injuries, but did not identify any trend. The results of the analysis were forwarded to the integrated safety management system manager for consideration and action as deemed necessary. Additional review

and evaluation of this data are warranted to develop the best strategy to improve performance.

BNI conducted two Safety Assurance assessments in 2003 that examined OII recording and reporting program elements. The June 2003 OSHA and safety record-keeping assessment determined that three separate but similar forms for recording OII occurrences were being used, that the quality of data provided and subsequently entered into the Safety Data System for the occurrences needed improvement, that injury/illness reports are not always promptly completed, that completion of corrective action was not being tracked by Safety Assurance, that compliance with OSHA requirements for records and logs was satisfactory, and that files were generally complete (with the exception that some forms were not included in all files). Recommendations for improvement were appropriate to the concerns identified.

The October 2003 Accident Investigation Assessment determined that first aid cases at the construction site were currently being investigated by a recently developed process (not yet described in their program documents) in which the supervisor and Safety Assurance lead reviewed the injury with the employee, determined cause(s), and initiated corrective action(s), as necessary, with a simple narrative report describing the circumstances, causes, and corrective actions; corrective actions were then distributed to the Construction Project Manager and Safety Assurance staff for information/action. The assessment determined that OSHA recordable cases were being investigated as specified in the procedure for *Reporting Occupational Injuries and Illnesses*, and that tracking of corrective action completion was now being tracked by Safety Assurance, as recommended by the earlier assessment, in the Site's Safety Action Tracking System. No findings or recommendations were developed.

In March 2004, ORP directed a for-cause assessment of their contractor-implemented OSHA injury/illness record-keeping practices and records, including the OII recording and reporting programs of BNI and their subcontractors for the Waste Treatment and Immobilization Plant Construction Project during the last half of 2003. The assessment team included a DOE expert in OSHA recording requirements from the Oak Ridge Operations Office and found weaknesses in OSHA record-keeping, procedures, and processes; oversight of subcontractor record-keeping; inadequate injury/illness safety records; and minimal analysis of injuries and illnesses. The team identified five cases recorded as first aid that should have been recorded and reported as OSHA recordable with restricted workday activity; four cases that should have been recorded as OSHA recordable; four OSHA recordable cases for which there was insufficient documentation to determine the actual number of days away from work and/or restricted workday activities; thirteen cases for which the accuracy of classification could not be determined from available documents; and two subcontractor cases that were not recorded in the subcontractors OSHA 300 log, but should have been included by BNI in CAIRS reports submitted to DOE. Given the quality, comprehensive scope, significance of findings, and time period addressed by the ORP inspection and report, the OA investigation was limited to BNI's OII recordkeeping and reporting practices in CY 2002.

This OA review compared BNI and their service and construction subcontractor 's CY 2002 OSHA 300 logs and quarterly-submitted CAIRS reports involving 27 OII cases. The initial review identified about 40 percent of the corresponding records with inconsistent data, including OSHA recordable cases apparently not reported in CAIRS; assignment of "Other recordable cases" versus "Job transfer or restriction" category to OSHA recordable cases with listed days of restriction; "On job transfer or restriction (days)" not recorded when the OSHA recordable case was appropriately categorized as "Job transfer or restriction;" restricted days listed in the current electronic version of the CY 2002 OSHA 300 log different than reported in the quarterly-submitted CAIRS report, without any revision listed in the following quarter submittals; an injury/illness listing in the OSHA 300 log inconsistent with that listed on the CAIRS report; an apparent day of transfer not categorized as such; and many CAIRS reports that did not list company or investigation type. A number of these problems were subsequently identified during contractor and DOE reviews, and the associated reports were revised; however, some recording inconsistencies remained.

The majority of OSHA recordable corrective actions appeared to be appropriate to the associated OII event circumstances and usually involved actions already taken and/or instructions that had already been given to the individual and workers in similar disciplines; however, one corrective action required consideration of use of face shields when the injury occurred while a face shield was being worn.

OII case files reviewed did not always contain Injury, Illness or Incident report forms to capture the event, investigation, and corrective action information. The medical provider (Work Care) uses their *Daily*

Services Log for Bechtel RPP/WTP form to record much of the information that HEHF records on their ROV form. The Work Care form has reportedly evolved over time to meet the needs of the staff; however, no injury/illness codes are provided for skin disorder, respiratory condition, poisoning, or other such conditions, which are types of injury/illnesses categories deemed OSHA recordable, the recording of which would enhance the likelihood of accurate OSHA reporting. The lack of additional narrative information in the form was not seen by Work Care or BNI as a problem, because the medical service provider and the Safety Assurance staff responsible for OSHA recording and reporting are co-located, facilitating easy access to informal discussion of needed details of OII case diagnosis, treatment, and work restriction. Further, for OSHA recordable cases, the Bechtel injury or illness report and subsequent investigation report should formally document the pertinent medical information. For the records reviewed, the nature of the work restrictions frequently needed greater specificity to support assessment of whether the restriction prevents performance of any of the routine activities of the worker's job. Such a determination is needed to determine whether the restriction qualifies as OSHA recordable. The latter concern is again ameliorated by the fact of close proximity of the offices of the Safety Assurance staff to the Work Care staff, enabling discussion of the nature of the restriction in the context of the worker's job task analysis. No case file reviewed contained a narrative on how the determination of whether OSHA recordable and the appropriate injury/illness category were made. Finally, many examples of the record quality concerns that were identified in the recent ORP inspection and earlier BNI assessment were also present in the CY 2002 case files reviewed.

In general, BNI's documented program for meeting DOE and OSHA requirements for recording and reporting OIIs is adequate; however, the program has not been consistently implemented and needs revision to reflect how it should be implemented in the future. The OII case files, OSHA 300 logs, and CAIRS reports that ORP inspected and OA reviewed do not reflect the quality of records expected, contain a significant number of errors, and need to be reviewed and revised appropriately (see Finding #E-1).

E.2.4 PNNL

PNNL's OII program is defined in their Standards Based Management System Subject Area document titled "Injury or Illness." Specific requirements for the Safety and Health Department implementation of their associated responsibilities are contained in procedure MA-858-SHP-4.02, "Accident Investigation, Recordkeeping, and Recording." PNNL requires peer review and approval of investigation reports before they are deemed complete. The "Injury or Illness" document also attempts to establish a uniform basis for interpretation of work restriction phrases, such as "patient defined," that are frequently encountered in HEHF ROVs. PNNL's Safety and Health Management Information System (SHIMS) effectively supports the implementation of their OII program, facilitates the development, review, and approval of a comprehensive OII event investigation report, and provides a robust database for collection of OII records and the generation of required reports and logs.

A number of administrative aspects of the program need to be improved. For instance, the "Injury or Illness" document definition of "days away from work" is not consistent with OSHA guidance (however, the Safety and Health staff appear to appropriately count restricted days and days away). The Standards Based Management System Subject Area document *Safety Rights and Responsibilities* still references the obsolete OSHA 200 form. There is no requirement to communicate the "Return to Work Plan" to the OSHA records technician in support of the determination of whether the work restriction qualifies as OSHA recordable. Also, PNNL has only recently been given authority to electronically upload CAIRS data to the DOE CAIRS accident log database. Timely resolution of the inconsistencies between DOE's and PNNL's OII databases that were identified during this investigation should occur once this new authority is exercised. Further, corrective action for the problems identified in PNNL's OII program during the November 2003 OA safety management inspection have still not been completed. However, the January 2004 *Worker Safety & Health Program Improvement Plan* has a performance objective with a September 2004 due date to "improve the process and performance for investigating and documenting preventative actions for injuries and illnesses," which includes relevant sub-objectives.

PNNL OII data and results of trending are available on their web site for management review. Further, a recent *Evaluation of PNNL's F&O Recordable Event Occurrence Trends* report for the period 2000 through the second half of 2002 was developed and presented to the Voluntary Protection Program committee with recommendations for improvement initiatives to address

trend concerns, demonstrating the use of trending of OII data and development of lessons learned.

PNNL's OSHA 300 logs, OSHA 300-A summaries, and DOE's CAIRS accident logs for CYs 2002 and 2003 were compared to identify inconsistencies, potential inaccuracies, and classification downgrades that needed additional follow-up case file review. Summaries of PNNL's first aid cases for the same period were also reviewed to select a sample for follow-up case file review for accuracy of OSHA recordable determinations.

Twenty-eight OII case files and their associated logs and reports for CYs 2002 and 2003, including OSHA recordable, reclassified non-OSHA recordable, and first aid cases, received detailed reviews against OSHA, DOE, and PNNL program requirements. The OII case files reviewed contained HEHF initial and follow-up ROVs; a SHIMS-generated Injury/Illness Investigation Details report; a Return to Work Plan for some but not all of the cases involving restrictions; various correspondence related to case status and classification; workers' compensation claim correspondence; and applicable CAIRS reports and their revisions. The Injury Investigation Details report frequently included an auditable narrative of the process, rationale, and timing of various activities that lead to the determination of the OII case classification as first aid or OSHA recordable. Not all investigations had been completed and peer reviewed in a timely manner. The majority of case files reviewed were of high quality, contained few errors, and were appropriately characterized, recorded, and reported; however, two apparent OSHA recordable cases had not yet been characterized as such.

The first OII case to be reclassified as OSHA recordable involved an employee who fell at work and was injured in 2002. The employee sought treatment and was given anti-inflammatory medications by the employee's private health care provider, and the case originally was treated as a first aid case. During this review, the OSHA recording technician recognized that this case file, which had been identified by OA for follow-up, did not contain sufficient information to confirm that no medically directed work restriction had been established. Based on the technician's follow-up, it was learned that after the injury, portions of several days were not worked in accordance with the direction of the employee's health care provider, making the OII case OSHA recordable.

The second OII case that needed to be reclassified as OSHA recordable and may involve restricted workdays involved a 2003 occupational repetitive motion musculoskeletal-injured employee, who received prescription medication from the employee's private health care provider and a recommendation to self-limit the use of the left hand and arm, the facts of which were documented in the OII first aid case files. However, a subsequent HEHF initial ROV indicated that no treatment was given, which was accurate with regard to HEHF's activities. The employee had moved the computer mouse to the left side of the employee's keyboard in response to an earlier employee's private health care provider recommendation to limit the use of the right hand. Apparently, the earlier note of treatment with prescription medicine, which made the case an OSHA recordable injury, was missed. Currently the OII case investigation is incomplete despite the passage of nine months, and the determination of whether restrcted workdays are involved remains to be determined by PNNL. As a minimum, the OII case should be reclassified as OSHA recordable and a CAIRS report should be developed.

The basis for classifying one other case from January 25, 2003, as non-OSHA recordable could not be discerned from the first aid case files. A worker filed a workers' compensation claim for reported exposure to asbestos during his employment. The worker reportedly sought evaluation from his private health care provider, but the nature of the diagnosis and medical treatment were not documented in the case file and need further PNNL review to provide a documented basis for confirming the accuracy of the initial classification.

Consistency between PNNL OSHA 300 logs and DOE's CAIRS accident log could not be demonstrated. Specifically, OSHA lost workdays and restrcted workdays statistics for 13 cases were not accurately reflected in the DOE CAIRS accident log. PNNL had already submitted accurate initial and/or updated CAIRS reports for eight of the cases that had not been adequately incorporated into DOE's database, and five of the cases required revisions that had not yet been submitted. All but one of the latter five cases had been identified by PNNL for submission of a revision in the next few days. The one exception involved a 2002 OII case with a 2003 CAIRS report number. PNNL requires quarterly verification of the accuracy of this data and submission of accurate hard-copy revisions and initial reports; therefore, expediting PNNL's use of the recently granted authority to electronically upload and correct the DOE database seems to be an obvious solution.

Overall, PNNL's program for recording and reporting OIIs generally meets the requirements of

DOE, OSHA, and their internal procedures. Decisions on which cases were OSHA recordable were generally found to be based on well-documented facts and OSHA interpretations. However, two cases appear to have been miscategorized. Several reviewed investigations were incomplete or had not yet been peer reviewed and approved. Although some SHIMS data inaccuracies or omissions were identified, the quality of records examined was generally very good and consistent with requirements (see Finding #E-1).

E.2.5 DOE Oversight of Contractor Occupational Injury and Illness Recording and Reporting

RL is responsible for oversight of FHI and BHI. RL performed assessments of OII recording and reporting programs implemented by FHI and BHI and their major subcontractors in 1999 and 2003. The most recent assessment of FHI and its major subcontractors identified two findings and three observations, and concluded that overall the FHI program was generally compliant but needed improvement in the completeness and accuracy of injury and illness records. The findings were for insufficient documentation to support reporting decisions in 17 percent of the 156 case files reviewed, and for failure to record seven diagnosed chronic beryllium disease cases in OSHA logs or the CAIRS database. The RL assessment of FHI's program was thorough and effective in identifying deficiencies. The most recent assessment of BHI and its subcontractors identified no findings, and one observation for failure to perform routine self-assessments. RL recently began quarterly comparisons of OSHA logs and CAIRS reports for these two prime contractors and will document the results of these comparisons in assessments planned for later this year.

PNSO (in support of RL) performs oversight of PNNL and has generally provided adequate oversight of injury and illness recording and reporting by PNNL. PNSO assessed PNNL compliance with injury and illness reporting requirements in 2003. The assessment, which was performed and documented as part of routine operational oversight activities, concluded that PNNL was in compliance with reporting requirements. No examples of underreporting were identified.

As discussed in Section C.2.7, ORP recently conducted oversight assessments of OII reporting processes for both of its contractors: CH2M HILL and BNI. The assessments that were conducted were of good quality, and identified multiple findings and observations.

In general, the OA investigation found good consistency between OSHA 300 logs and CAIRS database records for total recordable case rate and lost workday case rate for calendar year 2002. These are the principal performance metrics used by DOE senior management in relation to worker safety performance.

However, consistency between OSHA 300 logs and the CAIRS database for the number of lost and restricted workdays needs improvement. For 55 out of 246 OSHA 300 log recorded cases for calendar year 2002 and part of 2003 that were reviewed by OA, there were discrepancies between the OSHA 300 logs and CAIRS database. These discrepancies included instances of both overreporting and underreporting. Two contributors to these inconsistencies were transcription errors and failure to submit required revisions to the CAIRS database. In general, because of the variability of this performance metric, maintaining consistency between the OSHA 300 logs and CAIRS database requires frequent reconciliation of the data and increased quality assurance. One Hanford contractor had exercised its authority for direct electronic input of information into CAIRS, and had a high degree of consistency between OSHA 300 logs and CAIRS database records. During the final phase of the OA investigation, recent updates to CAIRS, following contractor-submitted updates and revisions had already resolved many of the inconsistencies for calendar year 2002.

DOE, to include RL, ORP, PNSO, and the Office of Environment, Safety and Health, has not adequately implemented the responsibility to maintain the CAIRS report database, as evidenced by the problems with the accuracy of the CAIRS accident logs for each contractor. The time lags in getting these records corrected highlights the need to expedite authorizing contractor electronic access and contractually requiring contractors to maintain the accuracy of the database (see Finding #E 2).

E.3 Conclusions

Program descriptions and the performance of all evaluated organizations demonstrate that the primary purpose of the injury and illness investigation and reporting activities was to assist injured workers in maximizing their recovery and minimizing the time it takes for a medically approved safe return to work.

There were no indications of significant or pervasive underreporting of injuries and illnesses. However, the

overall quality of records was inconsistent, and collectively, about 15 percent of the OSHA recordable decisions made by Hanford contractors were questionable or incorrect. In addition, there are inaccuracies in CAIRS because of various record-keeping and reporting errors. Many of the errors have since been identified by the contractors and revisions have been submitted; however, DOE has not always been timely in making the corrections. Improvements in quality assurance and process enhancements, such as peer reviews and committee reviews of case records and decisions, could improve the accuracy and reliability of injury and illness reporting.

Although improvements are warranted, the number and type of discrepancies identified in this investigation do not negate the overall usefulness of injury and illness metrics as a tool for monitoring safety performance and for focusing attention on problem areas or trends. However, the data on OSHA recordables and in the CAIRS database is not as reliable as it should be, and the CAIRS database has not been updated in a timely manner to reflect new information or the discovery of errors or omissions. Thus, the CAIRS information used by DOE management does not always reflect the most current and accurate information. Many of the problems with the accuracy of CAIRS data can be addressed by having contractors update the database, thus eliminating time lags and transcription errors.

Finding #E-1: FHI, BHI, BNI, and PNNL have not properly classified and reported some injury and illness cases, and their injury and illness reporting programs and quality assurance processes are not sufficiently rigorous, contributing to errors and omissions in documentation and case management of reported injury and illnesses.

Finding #E-2: RL, ORP, PNSO, and the Office of Environment, Safety and Health have not ensured that CAIRS is updated or corrected in a timely manner to reflect new information or the correction of errors, resulting in discrepancies between CAIRS and OSHA logs, and information being provided to DOE management that does not reflect the most current and accurate data.

E.4 Recommendations

1. To resolve continuing problems of inconsistency between OSHA 300 logs and DOE's CAIRS accident logs, accelerate the process of authorizing and contractually requiring each contractor to periodically validate consistency and electronically upload initial and revised CAIRS data to these logs, using the resulting Federal staff resource savings to enhance oversight of the process.

2. To ensure the ability to reconstruct the bases for OSHA recordable determinations and to promote common understanding of work restrictions, OII case files should include a chronological narrative on the basis and timing for various decisions that make the OII case OSHA recordable, and documentation of the specific nature of work restrictions.

3. To ensure that OSHA recordable determinations and medically directed work restrictions are based on Work Care documents that are formally developed and transmitted to BNI, particularly in first aid cases, Work Care and BNI should jointly develop a document, a procedure for its use, and staff training similar to that recommended in Appendix D for a revised occupational medicine program contractor ROV.

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Abbreviations Used in This Report (continued)

FRI	Facility Representative Instruction
FY	Fiscal Year
GAP	Government Accountability Project
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations
HEGA	High Efficiency Gas Adsorber
HEHF	Hanford Environmental Health Foundation
HEPA	High Efficiency Particulate Air
HRT	Hazard Review Template
JCAHCO	Joint Commission for Accreditation of Health Care Organizations
JHA	Job Hazards Analysis
JSA	Job Safety Analysis
MOA	Memorandum of Agreement
NIOSH	National Institute for Occupational Safety and Health
OA	Office of Independent Oversight and Performance Assurance
OII	Occupational Injury and Illness
ORP	DOE Office of River Protection
OSHA	Occupational Safety and Health Administration
OTC	Over the Counter
PACE	Paper, Allied-Industrial, Chemical & Energy Workers International Union
PEL	Permissible Exposure Limit
PEP	Performance Evaluation Plan
PER	Problem Evaluation Request
PID	Photo-ionization Detector
PNNL	Pacific Northwest National Laboratory
PNSO	Pacific Northwest Site Office
ppb	Parts Per Billion
PHS	U.S. Public Health Service
PPE	Personal Protective Equipment
ppm	Parts Per Million
RBA	Radiological Buffer Area
RIDS	Record Inventory Disposition Schedule
RL	DOE Richland Operations Office
ROV	Record of Visit
RWP	Radiation Work Permit
SC	DOE Office of Science
SHIMS	Safety and Health Information Management System
SST	Single-Shell Tank
TEEL	Temporary Emergency Exposure Limit
TFP	Tank Farm Project
TLV	Threshold Limit Value
TSR	Technical Safety Requirement
TWA	Time Weighted Average
TWINS	Tank Waste Information Network System
USQ	Unreviewed Safety Question
VOC	Volatile Organic Compound
VMS	Vapor Mixing System
WSCF	Waste Sampling Characterization Facility
WSRC	Westinghouse Savannah River Company