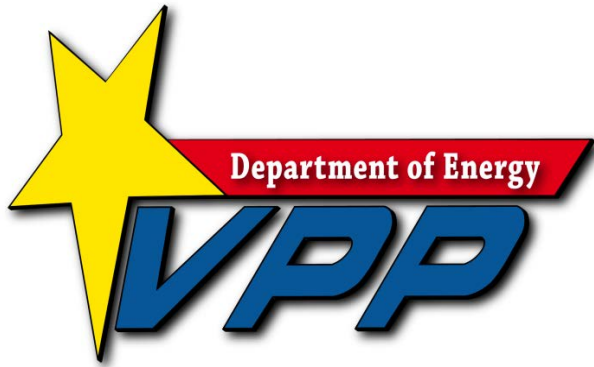




Pacific Northwest National Laboratory Battelle Memorial Institute

**Report from the Department of Energy
Voluntary Protection Program
Onsite Review
October 30-November 8, 2012**



U.S. Department of Energy
Office of Health, Safety and Security
Office of Health and Safety
Office of Worker Safety and Health Assistance
Washington, DC 20585

Foreword

The Department of Energy (DOE) recognizes that true excellence can be encouraged and guided, but not standardized. For this reason, on January 26, 1994, the Department initiated the DOE Voluntary Protection Program (VPP) to encourage and recognize excellence in occupational safety and health protection. This program closely parallels the Occupational Safety and Health Administration (OSHA) VPP. Since its creation by OSHA in 1982, and implementation by DOE in 1994, VPP has demonstrated that cooperative action among Government, industry, and labor can achieve excellence in worker safety and health. The Office of Health, Safety and Security (HSS) assumed responsibility for DOE-VPP in October 2006. HSS is expanding complex-wide contractor participation and coordinating DOE-VPP efforts with other Department functions and initiatives, such as Enforcement, Oversight, and the Integrated Safety Management System.

DOE-VPP outlines areas where DOE contractors and subcontractors can surpass compliance with DOE orders and OSHA standards. The program encourages a *stretch for excellence* through systematic approaches, which emphasize creative solutions through cooperative efforts by managers, employees, and DOE.

Requirements for DOE-VPP participation are based on comprehensive management systems with employees actively involved in assessing, preventing, and controlling the potential health and safety hazards at their sites. DOE-VPP is available to all contractors in the DOE complex and encompasses production facilities, laboratories, and various subcontractors and support organizations.

DOE contractors are not required to apply for participation in DOE-VPP. In keeping with OSHA and DOE-VPP philosophy, *participation is strictly voluntary*. Additionally, any participant may withdraw from the program at any time. DOE-VPP consists of three programs with names and functions similar to those in OSHA's VPP: Star, Merit, and Demonstration. The Star program is the core of DOE-VPP. This program is aimed at truly outstanding protectors of employee safety and health. The Merit program is a steppingstone for participants that have good safety and health programs, but need time and DOE guidance to achieve true Star status. The Demonstration program, expected to be used rarely, allows DOE to recognize achievements in unusual situations about which DOE needs to learn more before determining approval requirements for the Merit or Star program.

By approving an applicant for participation in DOE-VPP, DOE recognizes that the applicant exceeds the basic elements of ongoing, systematic protection of employees at the site. The symbols of this recognition provided by DOE are certificates of approval and the right to use flags showing the program in which the site is participating. The participant may also choose to use the DOE-VPP logo on letterhead or on award items for employee incentive programs.

This report summarizes the results from the evaluation of Battelle at the Pacific Northwest National Laboratory (PNNL) in Richland, Washington, from October 30-November 8, 2012, and provides the Chief Health, Safety and Security Officer with the necessary information to make the final decision regarding PNNL's continued participation in DOE-VPP as a Star site.

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ABBREVIATIONS AND ACRONYMS

ANSI	American National Standards Institute
BLS	Bureau of Labor Statistics
Battelle	Battelle Memorial Institute
CFR	Code of Federal Regulations
CSC	CSC Hanford Occupational Health Services
CSM	Cognizant Space Manager
DART	Days Away, Restricted or Transferred
DOE	Department of Energy
DSOC	Directorate Safety and Operations Council
EHSS	Environment, Health, Safety and Security
EJTA	Employee Job Task Analysis
ELMS	Electronic Learning Management System
EMSL	William R. Wiley Environmental Molecular Sciences Laboratory
ES&H	Environment, Safety and Health
F&O	Facilities and Operations
HAMMER	Volpentest Hazardous Materials Management and Emergency Response Training Center
HDI	How Do I
HF	Hydrofluoric Acid
HSS	Office of Health, Safety and Security
IOPS	Integrated Operations System
LSOC	Laboratory Safety Operations Council
NAICS	North American Industry Classification System
OSHA	Occupational Safety and Health Administration
PNNL	Pacific Northwest National Laboratory
PNSO	Pacific Northwest Site Office
PPE	Personal Protective Equipment
PSL	Physical Sciences Laboratory
ROC	Research Operations Council
RPL	Radiochemical Processing Laboratory
SBMS	Standards Based Management System
SME	Subject Matter Expert
Team	Office of Health, Safety and Security DOE-VPP Team
TIS	Training and Information Services
TOR	Technical Oversight Representative
TRC	Total Recordable Case
VPP	Voluntary Protection Program

EXECUTIVE SUMMARY

Battelle Memorial Institute (Battelle) is the prime contractor for management and operation of the Pacific Northwest National Laboratory (PNNL). Battelle has operated PNNL for the Department of Energy (DOE) and its predecessors since 1965. Located in Richland, Washington, PNNL is one of ten DOE National Laboratories managed by DOE's Office of Science. Funding for work at PNNL comes from a wide variety of sources, including the Department of Energy's Office of Science, the National Nuclear Security Administration, other government agencies, private industry, and academia.

Recognition in DOE Voluntary Protection Program (VPP) requires an onsite review by the Office of Health, Safety and Security DOE-VPP team (Team) to determine whether the applicant is performing at a level deserving DOE-VPP Star recognition. The Team conducted the onsite review of PNNL from October 30-November 8, 2012. The Team had contact with over 250 employees, managers, and supervisors, either formally or during observation of field activities.

Accident and injury rates at PNNL for the past 3 years have been declining, and that trend is continuing through calendar year 2012. PNNL does not offer any incentives tied to accident or injury rates. A continued positive emphasis on safety through a variety of methods is helping PNNL continue to prevent and avoid injuries.

PNNL managers clearly demonstrated an effective commitment to excellence in safety and health, and recognized safety and health as a core business process. They have increased their visibility, credibility, and accessibility to laboratory personnel, and are committing the necessary resources to foster continued improvement. They recognize the continued need to push that commitment down through the management structure to the principle investigators. They support broad involvement of laboratory personnel in safety and health improvements.

Employee involvement has led to a positive health and safety culture at PNNL. PNNL not only promotes employees' health and safety ideas at work, but also off-campus through many hours of community involvement. Managers should continue to empower their employees through their open communications at the VPP Steering Committee and safety meetings, as well as, recognize employees that contributed to the health and safety culture at PNNL.

PNNL continues to employ multiple processes to address hazards and develop controls. Subject matter experts are available and engaged in helping Cognizant Space Managers and laboratory workers define hazards and identify controls. Workers demonstrated their awareness of hazards in their spaces, but some ambiguity existed in the documentation and implementation of controls. PNNL continues to implement new processes designed to improve management of hazardous substances and work activities.

PNNL continues to pursue improvements that strengthen its hazard controls hierarchy and invest in those controls. The Integrated Operations System process needs some improvement providing specific, detailed selection criteria for laser and chemical controls. The Emergency Management and the Occupational Medicine programs have demonstrated strong innovation in support of PNNL employees.

PNNL continues to make improvements to its safety and health training program. Training and Information Services (TIS) has made a concerted effort to consolidate redundant training and be more customer driven. TIS is actively working with managers to streamline training and keep content relevant. TIS is working to support employees by updating classes to make refresher training more interesting, and consolidating classes to reduce demands on employees' time. Training meets or exceeds employees' expectations with no reported inadequacies in either training class content or method of delivery.

Since the last triennial recertification, PNNL has reenergized and expanded its safety and health initiatives into a sustainable focus on operational excellence. These efforts are proving effective. Process improvements begun in 2009 are reaching maturity and gaining acceptance among researchers. PNNL is leveraging its influence with other institutions of higher learning through its intern and visiting scientist programs to affect changes to the safety culture at university laboratories. The Team recommends that PNNL continue in DOE-VPP at the Star level.

TABLE 1
OPPORTUNITIES FOR IMPROVEMENT

Opportunity for Improvement	Page
PNNL should find ways to improve the Safety Conscious Work Environment Survey response rate and share its integrated self-assessment approach with other DOE-VPP participants.	5
PNNL should continue to seek craft personnel input on facility design and modifications, track long-term cost savings and safety improvements from that input, and share the results of this approach with other DOE contractors and Federal staff managing design and construction projects.	10
PNNL should implement a process to document and retrieve the hazard analysis or other decision basis for low-hazard work determinations.	13
PNNL should continue to emphasize the need for continued vigilance in implementing the processes and procedures through HDI and IOPS to CSMs and research personnel alike.	15
PNNL should expand the scope of its ergonomic program to include nonoffice ergonomic hazards and ensure a consistent and effective implementation.	16
PNNL should evaluate the selection of gloves in laboratories to ensure glove selection criteria include the specific chemicals in use, and the manufacturer's specific recommendations.	18
PNNL should update its laser safety program to reflect ANSI Z136.1-2007, <i>American National Standard for Safe Use of Lasers</i> , and include appropriate PPE for ultraviolet skin protection for laser operations.	19
PNNL should ensure EJAs correctly identify all hazards and duties, including the hazards associated with escorting subcontractors during construction and maintenance activities.	21
PNNL should consider developing a course to convey PNNL's requirements and expectations for cryogenic hazards to use in conjunction with specific activities throughout PNNL.	23
PNNL should improve its laser safety training to ensure users gain a clear and consistent understanding of PNNL's requirements for Class 3B and 4 laser use, including PPE requirements for both laser operators and other laboratory personnel not associated with the laser in use.	24

I. INTRODUCTION

Battelle Memorial Institute (Battelle) is the prime contractor for management and operation of the Pacific Northwest National Laboratory (PNNL). Battelle has operated PNNL for the Department of Energy (DOE) and its predecessors since 1965. The DOE Pacific Northwest Site Office (PNSO) provides oversight of Battelle.

Located in Richland, Washington, PNNL is one of ten DOE National Laboratories managed by DOE's Office of Science. Funding for work at PNNL comes from a wide variety of sources, including DOE's Office of Science, the National Nuclear Security Administration, other government agencies, private industry, and academia. PNNL:

- Provides the facilities, unique scientific equipment, and world-renowned scientists/engineers to strengthen U.S. scientific foundations for fundamental research and innovation;
- Prevents and counters acts of terrorism through applied research in information analysis, cyber security, and the nonproliferation of weapons of mass destruction;
- Increases U.S. energy capacity and reduces dependence on imported oil through research of hydrogen and biomass-based fuels; and
- Reduces the effects of energy generation and use on the environment.

PNNL currently has approximately 4,700 staff members and a business volume of \$1.1 billion. At the main campus in Richland, Washington, PNNL has a variety of laboratory facilities. For example, the William R. Wiley Environmental Molecular Sciences Laboratory (EMSL), a DOE Office of Science national scientific user facility, is located on PNNL's Richland campus. Other facilities are the new Biosciences Facility, the Computational Sciences Facility, the Applied Process Engineering Laboratory, the Radiochemical Processing Laboratory (RPL), the Research Aircraft Facility, and the Physical Sciences Laboratory (PSL). PNNL also operates the Marine Research Operations Facility (including the Coastal Security Institute) in Sequim, Washington, and has satellite offices in Seattle and Tacoma, Washington; Portland, Oregon; and Washington, DC. Additionally, PNNL has personnel deployed around the globe conducting a variety of scientific and engineering missions.

Recognition in DOE Voluntary Protection Program (VPP) requires a triennial onsite review by the Office of Health, Safety and Security (HSS) DOE-VPP team (Team) to determine whether the applicant is performing at a level deserving DOE-VPP Star recognition. The Team conducted the onsite review of PNNL at the Hanford Site from October 30-November 8, 2012. The Team evaluated PNNL safety programs against the provisions of DOE-VPP. During the site visit, the Team observed activities, evaluated relevant safety documents and procedures, and conducted interviews to assess the strength and effectiveness of PNNL's health and safety programs.

The Team had contact with over 250 employees, managers, and supervisors, either formally or during observation of field activities. Hazards associated with PNNL activities include potential radiological and chemical exposure associated with various activities, electrical hazards, elevated work, hoisting and rigging, and a multitude of other standard industrial hazards. Activities observed included: plan-of-the-day meetings, prejob briefings, dispatch work, planned work, construction activities, office work, research work, vendor operations, and maintenance work.

II. INJURY INCIDENCE/LOST WORKDAYS CASE RATE

Injury Incidence/Lost Workdays Case Rate (PNNL Employees)					
Calendar Year	Hours Worked	Total Recordable Cases (TRC)	TRC Incidence Rate	DART* Cases	DART* Case Rate
2009	7,801,812	34	0.87	13	0.33
2010	8,353,095	30	0.72	11	0.26
2011	8,378,425	25	0.60	10	0.24
3-Year Total	24,533,332	89	0.73	34	0.28
Bureau of Labor Statistics (BLS-2011) average for NAICS** Code #5417 Scientific research and development services			1.1		0.5
Injury Incidence/Lost Workdays Case Rate (PNNL Service Contractors)					
Calendar Year	Hours Worked	TRC	TRC Incidence Rate	DART* Cases	DART* Case Rate
2009	463,420	9	3.88	4	1.73
2010	186,417	2	2.15	0	0.00
2011	35,321	0	0.00	0	0.00
3-Year Total	685,158	11	3.21	4	1.17
Bureau of Labor Statistics (BLS-2011) average for NAICS** Code #5417 Scientific research and development services			1.1		0.5

* Days Away, Restricted or Transferred

** North American Industry Classification System

TRC Incidence Rate, including service contractors: 0.79

DART Case Rate, including service contractors: 0.30

Conclusion

Accident and injury rates at PNNL for the past 3 years have been declining, and that trend is continuing through calendar year 2012. The Team's review of the accident and injury logs demonstrated a willingness by personnel to report all injuries. PNNL does not offer any incentives tied to accident or injury rates, but does focus on actions that will raise worker awareness and help prevent accidents and injuries. A continued, positive emphasis on safety through a variety of methods is helping PNNL continue to prevent and avoid injuries.

The rates for service contractors were high in 2009 and 2010. In those years, the predominant work was construction of new buildings and laboratories. Comparing the contractor rates against the construction industry in those years, the PNNL rate was slightly above the construction

industry rate (3.7) in 2009 and below the rate (3.5) in 2010. The DOE-VPP criterion is that the aggregate average for all subcontractors for the previous year (2011 in this case) be at or below the comparison industry rate, which PNNL meets. As such, the rates meet the expectations for continued participation in DOE-VPP.

III. MANAGEMENT LEADERSHIP

Management leadership is a key element of obtaining and sustaining an effective safety culture. The contractor must demonstrate senior level management commitment to occupational safety and health, in general, and to meeting the requirements of DOE-VPP. Management systems for comprehensive planning must address health and safety requirements and initiatives. As with any other management system, authority and responsibility for employee health and safety must be integrated with the management system of the organization and must involve employees at all levels of the organization. Elements of that management system must include: (1) clearly communicated policies and goals; (2) clear definition and appropriate assignment of responsibility and authority; (3) adequate resources; (4) accountability for both managers and workers; and (5) managers must be visible, accessible, and credible to employees.

In 2007, HSS identified that management leadership in pursuit of safety excellence varied across PNNL Directorates; it was especially strong within the Facilities and Operations (F&O) Directorate, but additional emphasis was needed among Research and Development Directorates. Senior managers recognized the need to change the culture across PNNL and put measures in place that, if coordinated and followed through, would instill the requisite commitment at all levels of management. Two years later, management leadership was demonstrably more visible with increased resources for safety improvements and a broader awareness by personnel of PNNL's commitment to safety. As of this assessment, improvements initiated prior to 2009 are mature and creating the desired cultural changes.

Since 2009, PNNL broadened its efforts to improve safety into its Credo for Operational Excellence. This approach effectively integrates excellence across PNNL's critical business functions, including safety. The Credo focuses on four themes: leadership, risk management, continuous improvement, and engagement. In its most recent annual assessment, PNNL self-identified that senior managers understood the elements (I believe, I know, I do), but that understanding may not yet have effectively penetrated down through principle investigators and scientists. In particular, PNNL identified the elements that "I must act to reduce the likelihood and severity of human error to prevent incidents," and "anticipate and recognize change and reassess risks" as areas for continued emphasis.

Two years ago, PNNL reformatted its annual evaluation and Integrated Safety Management and Environmental assessments to provide a single, highly integrated assessment that recognizes health and safety as one of the critical performance areas for operational excellence. The evaluation includes an Operational Excellence Survey that selects 25 percent of Laboratory staff each quarter. PNNL tracks response rates on the survey by workgroup, with roughly 50 percent of respondents returning the survey. PNNL reviews all the survey responses, with special attention to any written comments on the survey. PNNL then forms focus groups that discuss and review those comments to gain additional understanding, context, and extent of condition. By performing the survey quarterly on a smaller selection of employees, PNNL avoids survey burnout, obtains more current information, and is able to evaluate effectiveness of actions more quickly. This approach also provides a more comprehensive survey as PNNL is more likely to get feedback from personnel working only a portion of the year, such as summer students. The integrated assessment approach also reduces laboratory staff burden performing assessments. While PNNL should find ways to improve the survey response rates to further improve its data collection, it should also share this integrated self-assessment approach with other DOE-VPP participants.

Opportunity for Improvement: PNNL should find ways to improve the Safety Conscious Work Environment Survey response rate and share its integrated self-assessment approach with other DOE-VPP participants.

Prior to 2009, PNNL implemented a Chief Operating Officer position in each Laboratory Directorate. The Laboratory Director intended this approach to allow Assistant Laboratory Directors to focus strategically on laboratory business lines, and allow Chief Operating Officers to focus on executing the business. This model has proven effective over the past 3 years. Managers interviewed by the Team expressed satisfaction that the Chief Operating Officer position has provided a single point of contact to address operational issues and concerns and permitted effective resolution of problems as they arise. The Chief Operating Officers for the research directorate meet periodically on the Research Operations Council (ROC). Personnel interviewed by the Team repeatedly referred to ROC as an effective tool to communicate across organizational lines and address common concerns and issues.

In addition to ROC, PNNL expanded the Laboratory and Directorate Zero Accident councils (formed prior to the 2009 evaluation) into the Laboratory Safety and Operations Council (LSOC), and Directorate Safety and Operations Councils (DSOC). These councils and committees foster communication across organizational boundaries and the chain of command. PNNL has professional communications staff distributed among the organizations to assist with communication efforts for internal and external communications that include a wide variety of media. PNNL effectively integrates these various councils and committees at the laboratory level. The Team attended meetings of some of these committees, and observed the members working together effectively to identify issues and implement effective solutions.

Prior to the 2009 evaluation, PNNL appointed a new manager for Environment, Health, Safety and Security (EHSS). Since assuming that position, the EHSS manager has established a positive reputation among the senior managers and EHSS staff, alike. His focus has been establishing the EHSS functions as key enabling functions for the laboratory business lines. He continually reminds the EHSS staff that their function is not simply to identify unsafe, unhealthy, or risky situations and stop work, but to work with Laboratory personnel to find safe and healthy methods to accomplish the laboratory goals. Managers interviewed by the Team were consistently complimentary of the distributed EHSS staff.

PNNL recently hired a new Worker Safety and Health Manager who brings a wealth of experience in chemistry and pharmaceutical research laboratories, and was a pioneer for VPP at his former employer (commercial pharmaceutical industry). Because of that background, the Worker Safety and Health Manager has significant credibility among the research staff that helps PNNL more effectively reach out to principle investigators and researchers about the importance of safety in laboratories.

Managers provide significant resources for operational excellence efforts, including safety and health. Resources are available for reward and recognition programs, additional training and conference attendance, expansion of the wellness program, annual surveys, and other celebrations. PNNL does not link reward and recognition to accident, injury, or illness statistics. Managers understand and reinforce the message that excellent safety and health is essential to performing excellent science. Managers expressed that EHSS supports projects. While managers recognized the business case for safety, they preferred to express that safety was a

value not to be compromised. Managers interviewed by the Team recognized these investments as contributing to, rather than a diversion of resources from, the laboratory mission.

As in 2009, PNNL continues to perform formal management assessments. Senior managers understand the value of their visibility in the laboratory spaces, and use the opportunity to develop relationships with laboratory personnel.

PNNL has improved subcontractor controls, particularly for laboratory suppliers. PNNL changed from managing the contracts with Technical Administrators to Technical Oversight Representatives (TOR). There are four TOR credential levels: TOR-1, TOR-2, TOR-3, and TOR-Offsite (TOR-O). Staff members with the TOR-1, 2, and 3 credentials are limited to oversight of procurements involving onsite work (i.e., PNNL worksites). While TOR-Os are limited to oversight of procurements involving offsite work (i.e., non-PNNL worksites, including DOE-owned or controlled sites). TORs are also limited to overseeing procurements within their approved Cognizant Areas (i.e., Project Management Offices and divisions within the laboratory).

Furthermore, TOR-1s are authorized to oversee procurement of goods and services that do not involve hands-on work (e.g., equipment, supplies, meetings, conferences, lectures). TOR-2s have TOR-1 authority and may also oversee procurements involving nonconstruction, hands-on work (e.g., repairs, calibrations, maintenance). TOR-3s have TOR-1 and TOR-2 authority and may also oversee procurements involving construction activities. Finally, TOR-Os are authorized to oversee any type of offsite work (e.g., repairs, calibrations, construction, equipment purchases).

TORs are now held accountable for providing appropriate oversight of subcontractor work (onsite and offsite) and also provide the technical expertise for determination and documentation of acquisitions requirements, risks, acceptable deliveries, payment and contract closeout. For onsite work, the TORs are responsible for completing an Acquisition Hazard Assessment and working with the appropriate Worker, Safety and Health representative.

In addition to increased involvement by the TOR, PNNL improved the training for contractors performing work on laboratory equipment. PNNL developed a training video for both contractors and laboratory personnel, requesting contractor support to reinforce the need to follow procedures and processes that ensure contractors follow PNNL expectations for performing work safely in PNNL workspaces. The video clearly demonstrates both the right and wrong way to obtain contractor support, the need to involve the Cognizant Space Manager (CSM), the building manager, the building engineer, and the TOR, and communicates the message in an engaging and interesting format. PNNL recently began developing and validating a predictive model for enterprise risk management. This model is attempting to use a collective assessment of risks (health, environment, cost, schedule, reputation), then comparing that assessment with workgroup history to identify those workgroups considered most likely to have an event. Workgroups were plotted on a "Temperature Map" that allowed more management attention on those groups considered to be higher risk. The model is in its demonstration phase, and PNNL will undoubtedly identify additional risk factors to include in the model. For example, during the past year, PNNL has begun training senior managers on elements of the Safety Conscious Work Environment. Some managers referred to this training during interviews, and actively sought feedback from their staff regarding management behaviors that contribute or detract from the safety conscious work environment. PNNL might consider means

of monitoring those behaviors and factoring that data into the predictive model for enterprise risk management. As the model matures, PNNL should broadly share its results with the scientific community.

Finally, managers have supported and sponsored “brown bags” where people have been brought to PNNL to discuss significant events that occurred at university and industry laboratories, identify lessons learned, and help laboratory personnel better understand the event and apply lessons to their work. For example, during the assessment, the Team observed a brown bag presentation by Dr. Alice Young, the Associate Vice President for Research at Texas Technical University. She presented a first person view of the actions taken in response to an explosion that occurred in 2010 that significantly injured a graduate student. Other presentations included a discussion of a researcher at Dartmouth University that died because of chemical exposure. PNNL also participated in an offsite Battelle Communities of Practice discussion of the BP Texas City Oil Refinery explosion in 2005.

Conclusion

PNNL managers clearly demonstrated an effective commitment to excellence in safety and health, and recognized safety and health as a core business process. They have increased their visibility, credibility, and accessibility to laboratory personnel, and are committing the necessary resources to foster continued improvement. They recognize the continued need to push that commitment down through the management structure to the principle investigators. They support broad involvement of laboratory personnel in safety and health improvements, and demonstrate the expectations for continued participation in DOE-VPP.

IV. EMPLOYEE INVOLVEMENT

Employees at all levels must continue to be involved in the structure and operation of the safety and health programs and in decisions that affect employee health and safety. Employee participation is in addition to the individual right to notify appropriate managers of hazardous conditions and practices. Field observations and interviews indicate that PNNL workers remain committed to their personal safety, as well as the safety of their coworkers, visitors, and their community.

Employees at all levels of PNNL have open communications with their managers that promotes a safe and healthy work environment. This open dialogue allows employees to bring safety and health concerns to their supervisors and managers freely, leading to a joint effort in resolving the concern. Bargaining and nonbargaining employees interviewed throughout PNNL regard this open communication as an effective means of resolving their concerns. Employees interviewed by the Team understood and exercised their right to stop work and question others about work practices without fear of reprisal.

Another avenue for PNNL employees to raise their concerns is through PNNL's Employee Concerns Program that includes the ability to report concerns anonymously. PNNL's Employee Concerns Web site informs employees about how to raise concerns at work. Employees can submit a written concern, call a hotline, or send an e-mail. The employee concerns coordinator indicated that she either calls or e-mails the concerned employee within 24 hours to recognize their concern and to initiate action to address their concern. Employees have two methods of reporting anonymous concerns; either by submitting their concern in writing through the Company's mail system, or leaving a message on the hotline. Employees that leave anonymous concerns cannot be contacted for followup or closure.

PNNL has a VPP Steering Committee that meets monthly and consists of both bargaining and exempt employees. There are two co-chairs: one union and one scientist. The Team observed a VPP Steering Committee meeting that included 3 bargaining unit employees and 13 exempt employees. The committee's agenda included a safety topic, subcommittee reports, DSOC reports, communications (Porcelain Press), and an open forum that allowed individuals to bring up concerns. The VPP Steering Committee continues to promote safety culture at PNNL through multiple facets. This includes evaluations of other DOE sites, outreach to other DOE sites to share safety and health information, and discussions about mentoring others considering or applying for VPP participation. The committee publishes a monthly newsletter that increases the awareness of safety and health issues, employee recognition, and VPP Steering Committee activities. The newsletter is visible throughout PNNL, and is available electronically. Personnel interviewed by the Team were consistently aware of items discussed in the newsletter.

Employees and their supervisors hold weekly or monthly safety meetings. Depending on the number of direct reports to the supervisor, the number of participants at the safety meetings varies. Employees interviewed believed the meetings were informative as a forum for sharing safety information and allowed them an opportunity to raise their safety and health concerns. None of the employees interviewed felt inhibited at the meetings when articulating concerns about safety and health. Employees expressed that PNNL expeditiously addressed any safety and health issues raised.

PNNL continues to send representatives to both the regional and national Voluntary Protection Programs Participants' Association conferences. Attendees include representatives from Environment, Safety and Health (ES&H), scientists, technicians, and craft.

PNNL has a strong culture of community involvement and captures those activities through Team Battelle. Team Battelle is a staff-driven, decentralized volunteer program that includes employees, retirees, and family members. Team Battelle supports a wide range of community outreach projects that focus on Arts and Culture; Civic and Community; Education; and Health and Human Services. An employee can either participate in one of the many existing projects or submit a request for a new project to the Team Battelle Advisory Committee, many of which promote safety and health. The Team Battelle coordinator tracks employees' participation hours, which have steadily increased over the last 3 years with approximately 35,000 hours over the last 12 months.

The Organizational Development Directorate at PNNL created a new employee recognition program called Tokenology that recognizes staff contributions and leads to improved morale. Tokenology is an easy-to-use program for peer-to-peer and manager-to-staff recognition. The theme of the program is a token of appreciation; employees and managers use tokens for immediate recognition of valued work efforts. Employees can present coworkers with tokens and managers can present tokens to employees. "Big Tokens" are given to 15 individuals chosen by the Organizational Development Leadership Team at all-hands meetings. The Tokenology program kits also contain note cards and buttons that include fun sayings (i.e., Integrity, Courage, and phrases like *you saved my bacon* or *you're tops*) and PNNL values which reinforce the company values to the staff. Recipients can save tokens and then exchange them for PNNL logo merchandise such as pens, hats, and water bottles.

Approximately 2 months prior to this assessment, PNNL launched a new Web-based employee recognition program. The Web page provided a way for an employee to recognize another employee. PNNL staff screen the recommendation and then notify the recipient via e-mail. The recipient selects one of several items offered as a reward, and is recognized on the Web page and through PNNL-wide newsletters. Many employees interviewed were not yet aware of the program, but some employees had already used it. PNNL is working to advertise the program and increase its use by employees, supervisors, and managers alike.

Even though PNNL has multiple employee recognition programs, the majority of employees interviewed could not recall either receiving an award or knowing someone that had received an award. PNNL is working to continue expanding awareness and use of available reward and recognition processes to continue expanding employee involvement.

PNNL holds an annual VPP picnic, attended by approximately 1,600 employees. PNNL and vendors have safety booths at the picnic that provide safety, security and sustainability information to attendees. The annual picnic is a *thank you* to the staff for being safe and healthy at work and home.

PNNL has supported the local Hanford Health and Safety Expo held in Pasco, Washington, for the last 18 years. The event draws an estimated 80,000 people from the Tri-Cities area during the 2-day event. Last year, PNNL's booth focused on driver distraction. The booth included two driving simulators for participants to operate while attempting to use a cell phone to either talk or text. The engaging activity increases the awareness of the dangers of distracted driving. Twelve volunteers from PNNL supported the PNNL booth over the 2-day period.

PNNL implemented a new program to encourage staff to telecommute, enhancing flexibility and sustainability at PNNL. This is part of PNNL's sustainability efforts to decrease environmental impact, reduce workers' carbon footprint, and creating a more attractive workplace for current and future employees. The program will allow employees to work at least one day per week at home. PNNL established program goals of 15 percent of staff teleworking by year 2015, and 40 percent by year 2020. Although primarily a human resource initiative, the program enhances worker participation and satisfaction in the workplace, and contributes to improved employee morale, health, and wellbeing.

PNNL has implemented several capital improvement projects in the past few years that included new facility construction. As the new facilities have become operational, the F&O Directorate and its employees recognized that PNNL could improve safety and reduce the lifecycle cost of maintenance significantly by involving maintenance craft personnel during the engineering and design phase of construction. The F&O Director recognized the potential safety improvements and cost savings this approach could achieve and actively solicited the recommendations of the F&O team leads and crafts for some existing projects. Specifically, PNNL included maintenance craft personnel and supervisors in the redesign and modification of the utility and chemical supply lines to the new gloveboxes at RPL. Team interviews revealed F&O crafts and team leads were enthusiastic for the opportunity to participate and provide input that would ultimately make their work safer, easier, and more efficient. PNNL should continue to foster this approach in current and future capital improvement projects and actively solicit the input of F&O crafts and team leads during the design phase to improve safety and reduce lifetime operational maintenance costs. Further, PNNL should track long-term cost savings from this approach and share the results with other DOE contractors and federal staff managing design and construction projects.

Opportunity for Improvement: PNNL should continue to seek craft personnel input on facility design and modifications, track long-term cost savings and safety improvements from that input, and share the results of this approach with other DOE contractors and Federal staff managing design and construction projects.

Conclusion

Employee involvement has led to a positive health and safety culture at PNNL. PNNL not only promotes employees' health and safety ideas at work, but also off-campus through many hours of community involvement. Managers should continue to empower their employees through their open communications at the VPP Steering Committee and safety meetings, and continue to recognize employees that contributed to the health and safety culture at PNNL. PNNL continues to meet the expectations for Employee Involvement in DOE-VPP.

V. WORKSITE ANALYSIS

Management of health and safety programs must begin with a thorough understanding of all hazards that might be encountered during the course of work and the ability to recognize and correct new hazards. There must be a systematic approach to identifying and analyzing all hazards encountered during the course of work, and the results of the analysis must be used in subsequent work planning efforts. Effective safety programs also integrate feedback from workers regarding additional hazards that are encountered and include a system to ensure that new or newly recognized hazards are properly addressed. Successful worksite analysis also involves implementing preventive and/or mitigating measures during work planning to anticipate and minimize the impact of such hazards.

In 2007, the Team found the suite of hazard analysis processes in place at PNNL included: Integrated Operations System (IOPS); Hazard Awareness Summary; Employee Job Task Analysis (EJTA); Job Performance Plans; Chemical Process Permits; Confined Space Evaluation; Energized Electrical Work Permits; Preliminary Hazard Assessment; Worker Safety and Health Assessments; Worker Exposure Assessments; Product Hazard Evaluations; and Qualitative Hazard Assessments. PNNL had access, either through assigned onsite professionals or through matrixed organizations, to the necessary subject matter expertise to evaluate the range of hazards encountered during work. Much of the work reviewed by the Team showed clear identification of hazards, documentation of controls, and a method of feedback after the work was completed. The Team identified a need for improvement to ensure that the analysis of identified hazards was adequate for all work, including research and development, to ensure that the hazard controls are appropriate and that the affected workers are knowledgeable of the hazards and controls. Two years later in a followup review, PNNL had begun to develop improvements to address weaknesses from the 2007 review. PNNL continuously searched for improvements through initiatives that augmented and enhanced an already robust hazard and work management system. PNNL also recognized that no matter what the system looks like, the key to its success was the people that implemented system requirements and always looked for improvements.

PNNL's previous work planning and control system was the Standards Based Management System (SBMS). This electronic system provided managers and researchers with a gateway into resources such as safety, procurement, training, qualifications, and environmental requirements. Although SBMS was a technically thorough collection of applicable standards and requirements, managers and researchers alike reported frustration with the SBMS framework to efficiently plan and execute work. In response, PNNL developed the 'How Do I' (HDI) process to enhance the user technology interface. This new system uses a flowchart system to point users directly to procedures, standards, and requirements based on what the user is trying to accomplish. The system embeds links to IOPS, the Electronic Preparation and Risk Procedure, and standard work controls (e.g., Sensitive Property and Materials, Noise in Work Environment, Thermal Stress in Work Environment, Personal Protective Equipment (PPE), Nuclear Material, and Chemical or other specific regulatory training requirements). Personnel interviewed by the Team expressed greater satisfaction with the HDI system over the SBMS system.

For F&O work, a work control process is in place that follows the Integrated Safety Management System guides for performing work. Formal analysis of ES&H hazards occur prior to performing work. Before work starts, workers, planners, and safety subject matter experts (SME) walk down the jobsite to identify any hazards or issues that require management. Supervisors and managers review all work and their written approval is required before work

activities begin. The F&O work control process is defined in the PNNL document titled, *Admin 16*. *Admin 16* lists four types of work:

1. Dispatch- Primarily skill of the craft with minimal planning required. The F&O IOPS Work Practices provide any requirements beyond those identified in HDI.
2. Planned work- Requires formal job planning package development and a formal prejob briefing.
3. Large projects- Consist primarily of capital projects and other projects too large for core teams to manage. Large projects are considered planned work.
4. Engineering and design support- Design engineer and drafting support.

All work is initiated through the Electronic Service Request system and is then triaged by the responsible Building Manager and/or Building Engineer. The Building manager or engineer is responsible to ensure the proposed work falls within the approved safety envelope for work within the facility. That safety envelope is based upon (but not limited to) multiple sources including Federal and State regulations, Documented Safety Analysis requirements, or Facility Use Agreements. The building manager or engineer also determines the category under which the work will be classified. From there, the work request is processed based on the requirements for each category listed in the *Admin 16* procedure. After work is planned and a job package has been developed, the building manager authorizes all work packages prior to it being released.

The F&O IOPS Handbook contains 21 chapters (practices) that provide guidelines to the F&O workers for safe operating practices related to each of the chapters. The chapters vary from the safe use of aerial lifts, chemical use, hand and power tools, to working with cryogenics. The information contained within each chapter is concise, similar to the HDI instructions used by a research worker. The F&O handbook is required reading for all F&O workers. Team observations and interviews demonstrated the crafts comfortable knowledge of the handbooks content.

PNNL's *Admin 16* defines dispatch work (low-level hazard work) by several criteria:

- The work does not require development of a facility modification permit;
- The work does not require services that must be provided by vendors or other non-PNNL personnel;
- The work will not require entrance into a 20-Gauss or greater magnetic field; or
- Performance of the work will impose no negative impacts on the operation of the facility or its occupants (outside operating boundary of the Facility Use Agreement or cause an unplanned system/equipment outage).

The *Admin 16* approach is widely used by F&O to perform low-hazard work that does not fall within the limits of regulatory requirements, the Facility Use Agreements, or Documented Safety Analysis requirements. The Team did not identify any specific problems with the *Admin 16* approach. F&O work supervisors understand the process and were clearly engaged with their workers and strongly supported by the safety professionals.

With the volume of low-hazard work performed at PNNL facilities, PNNL could see great operational benefits and efficiency by clearly documenting the basis for determining work that is low-hazard. Currently, supervisors and health and safety staff make the low-hazard determination each time they review the requested work, which may lead to redundant effort, or an incorrect assumption of hazard. They make the determination based on a simple description of the work, the workers' knowledge, and required training. If the work does not meet the threshold for the four elements defined above, then the work is determined to be low-hazard. However, if supervisors, workers, and health and safety staff documented their decision basis in a retrievable form (such as a work instruction), that determination would be available for review each time similar work is requested, and would provide a means to capture and revise assumptions or lessons learned. In addition, the work instructions would better define the hazards and controls associated with each dispatch work request, allowing team leads to determine quickly if new work exceeds the scope of the work instruction. In that event, supervisors and workers could properly analyze and control hazards associated with that new work. This approach would provide the PNNL work control process with a more effective documented hazard analysis process that proactively addresses the hazard analysis process for low-hazard work. PNNL could build and maintain a database of documented analyses for the work instructions for low-hazard work to ensure the availability of those work instructions for repetitive work, improving the efficiency and effectiveness of their work control process. PNNL should implement a process to document and retrieve the hazard analysis or other decision basis for low-hazard work determinations.

Opportunity for Improvement: PNNL should implement a process to document and retrieve the hazard analysis or other decision basis for low-hazard work determinations.

In response to a Battelle corporate initiative, the F&O Directorate initiated a process safety risk analysis that evaluated the greatest hazards presented by PNNL facilities. The analysis identified three critical facility risks that warranted additional review: boilers and steam distribution systems; cryogenic liquids; and flammable gasses. The review evaluated potential failures, the consequences of those failures, and the existing controls to prevent those failures. Managers, SMEs, building engineers, and operators participated in walkdowns to evaluate the as-built condition of systems that identified weaknesses, procedural deficiencies, potential valve lineup errors, current code exceptions, and labeling improvements. F&O is using this information to improve procedures and reevaluate responses to operational occurrences.

For research and development work, IOPS remains the vehicle to identify and safely manage hazards and controls in laboratory settings. IOPS causes the user, through interactive questioning, to request access to laboratory spaces; IOPS will then identify requirements and processes required prior to commencing any laboratory activities. The system is comprehensive and robust. In the prework phase, the process steps through a work acceptance procedure, initiated by the principle investigator/project manager. The project manager reviews and authorizes the proffered project. The project manager can consult with a health and safety SME prior to project acceptance for both onsite and offsite projects. An environmental professional is involved for both on and offsite work. IOPS triggers the creation and use of permits (Chemical Use, Chemical Process, Waste, etc.). The health and safety representative reviews the permit to ensure it discusses applicable risks and controls. The health and safety professional initiates a discipline-related assessment if additional procedures or assessments are required. For example, if the Chemical Use Permit identifies the use of a toxic material, the industrial hygienist

reviewing the permit may initiate a workplace exposure assessment to determine the need for monitoring. Work acceptance may also include the building manager to ensure the facility design and operating envelope support the proposed work.

With larger projects, the health and safety professional engages early in the process by participating in the subcontractor prequalification/review step and the development of technical specifications. A qualitative workplace exposure assessment is also performed at this stage. Later in the process, the subcontractor preparing the bid is required to produce a Job Safety Analysis that references required health and safety permits (e.g. Lift plans). Health and safety representatives perform oversight during frequent site assessments. They note serious issues, but do not document minor observations that personnel correct immediately.

A CSM (usually a senior scientist), is responsible and accountable to coordinate facility use, ensure compliance with safe work processes, mentor laboratory workers, and authorize access to only properly trained users. The user determines if the work falls within the laboratory's generic or routine operating envelope. If the experiment or work activity falls outside the generic or routine operating envelope, the user initiates an activity review, ensures permits or assessments are completed, and approvals are in place. The building managers and engineers are available to support the CSM throughout this process.

The Team reviewed many IOPS documents that support safe laboratory work including Workplace Exposure Assessments, Chemical Use Permits, Chemical Process Permits, Hazard Awareness Summaries, Basic Laboratory and Operations Procedures, Personnel Protective Clothing and Equipment Procedures, Laboratory Hood Measurements-Assessment Report, Chronic Beryllium Disease Prevention Program, and the Industrial Hygiene Beryllium Sampling Procedure.

The CSM is the critical link to ensure laboratory workers implement the IOPS process, and follow permits and requirements produced by the process. When a new activity begins or a new employee arrives in a laboratory, some CSMs conduct a face-to-face discussion with the new worker. This discussion is not required, but those CSMs believe it is necessary to ensure people working in a laboratory space are knowledgeable of the hazards, controls, and expectations. The introduction of a new hazard into the workspace, regardless of who introduced the hazard, requires the CSM to revise the appropriate IOPS documents for e-mail dissemination to staff. In one laboratory, the Team observed a refractory ceramic fiber material in use as insulation. A worker purchased the material from a local insulation contractor and added it to laboratory equipment without using the normal PNNL processes for purchasing laboratory equipment and materials, or consulting with the CSM or health and safety representative. Consequently, the CSM or health and safety representative did not evaluate the material for use in the PNNL workspace. The Team's review of this material identified it is a possible human carcinogen that would have required additional review, controls, or selection of another material. The failure of laboratory personnel to use the appropriate system for procurement of laboratory materials, and the failure of the CSM to recognize the changed equipment configuration resulted in the introduction of a hazard into a laboratory without analysis or subsequent controls.

PNNL captures general laboratory information and requirements in documents such as Basic Laboratory and Operations Practices. The Team observed a wide degree of variability associated with the documented hazard analysis for laboratory environment and benchtop laboratory work. Some analyses included very detailed assessment of hazards and consequences. Others provided only generic and cursory information. For example, one laboratory stored compressed gas

bottles with the gauges protruding slightly into a doorway. The Hazard Awareness Summary did not include a discussion that gas bottles should be stored to prevent interference (i.e. with doorways) and ensure the gauges would not be damaged nor have connections broken accidentally. Another laboratory using corrosives, documented in its Chemical Use Permit a good discussion of corrosive strengths and required precautions and PPE, but missed the hazards of lifting large volume, heavy corrosive containers to the benchtop or fume hood. PNNL should implement consistent expectations for detailed analysis of hazards within laboratories, particularly for laboratory benchwork.

A recent event clearly demonstrated how inconsistent implementation or understanding of the IOPS processes could lead to injury. In September 2012, the improper storage of chemicals exposed a CSM to chemical vapors, resulting in chemical pneumonitis, chemical exposure, and hemoptysis (blood in the sputum). The *Cause Analysis Report for: PSL Improper Chemical Storage and Inhalation Event*, SC-PNSO-PNNL-PNNLBOPER-2012-012, documents the event description, relevant information, and a summary of causes. The investigation estimated the CSM also exceeded the permissible exposure limits for nitrogen dioxide. Several opportunities were missed that may have prevented the event from occurring. Root Cause #1 states that: “Ineffective evaluation and management of safety risks presented by visiting scientists in PSL522A that result from differing languages and basic laboratory practices, created the conditions that led to this event.” Root Cause #2 states that “Failure to apply issue management requirements to investigate and improve from recent events on PSL 522A, allowed conditions to persist that caused this event.”

While this was an extreme case of misunderstanding resulting from language and cultural barriers (the visiting scientist spoke very little English and did not understand the training or direction from the CSM), other minor misunderstandings can collect and lead to similar results.

The documents and processes support safe laboratory work and help the CSM and laboratory staffs identify and understand the hazards in the workspaces. For most work, the CSMs and laboratory personnel work cohesively together to ensure work is performed safely. Despite these processes, PNNL continues to experience some errors and incidents, including some injuries, resulting from incomplete hazard analysis and misunderstanding or miscommunication of process requirements. PNNL should continue to emphasize the need for continued vigilance in implementing the processes and procedures through HDI and IOPS to CSMs and research personnel alike.

Opportunity for Improvement: PNNL should continue to emphasize the need for continued vigilance in implementing the processes and procedures through HDI and IOPS to CSMs and research personnel alike.

The Team reviewed the PNNL ergonomics program. An RPL walkthrough (IOPS generated checklist- ES&H and building management) included many ergonomic considerations, but overlooked glovebox ergonomic issues (anti-fatigue mats, frequency, and duration of use). One user stated that periodic use of gloveboxes might approach 6-8 hours per day. PNNL has developed and implemented a comprehensive office ergonomics program (advertised in the *Porcelain Press* issue #142) and periodically uses the services of a consulting ergonomist to support facility audits. The office ergonomics program relies on a method established in the 1980s and 1990s as a starting point for fitting the workstation to the user for administrative tasks (PNNL Ergonomic workstation setup pamphlet), but has limited applicability for other work

environments (i.e., material handling, gloveboxes, etc.). PNNL injury data from October 2011 through August 2012 shows ten "overexertion and strain" injuries that are nonoffice, ergonomics-related injuries. PNNL does not have a certified or professional ergonomist on staff and relies on the occupational medical provider and the local health and safety representative to evaluate ergonomics. PNNL should expand the scope of its ergonomic program to include nonoffice ergonomic hazards and ensure a consistent and effective implementation.

Opportunity for Improvement: PNNL should expand the scope of its ergonomic program to include nonoffice ergonomic hazards and ensure a consistent and effective implementation.

PNNL performs periodic safety walkdowns and inspections across the site. Senior managers, project managers, CSMs, or safety professionals may perform these inspections. The IOPS is the repository for these inspections. PNNL uses additional information from site and complex-wide lessons learned programs to augment assessments and communicate potentially pertinent information to laboratory users. The IOPS data is used to track and trend safety and performance information. The Team reviewed the second trimester worker safety and health performance indicators report. Programmatic areas that are tracked and trended are color-coded. Green indicates compliant and enabled programs, yellow indicates acceptable, but ongoing efforts to improve are in progress, and red indicates immediate improvement is needed. There were no red programs identified during the second trimester. Nanotechnology; Commercial Motor Vehicles, and Industrial Hygiene and Occupational Safety Records were the only three yellow programs identified. Examples of tracking and trending information contained in the report include a discussion of TRC and DART performance using 3-year averages and 1-year rolling averages. Hazardous energy programs such as pressure implementation showed 88 walkthroughs, 17 permits renewed or processed, no defective engineering controls identified, and training improvements underway. The Beryllium Worker Program shows 5 people overdue for training, negative sampling results, with the last Beryllium self-assessment completed in April 2012. PNNL documents similar tracking and trending information across all Occupational Safety Programs and Occupational Health Programs. These metrics provide PNNL managers with an effective evaluation of PNNL's safety and health programs.

Conclusion

PNNL continues to employ multiple processes under the IOPS to address hazards and develop controls. IOPS is a very robust system that provides user tools to CSMs. SMEs are available and engaged in helping CSMs and laboratory workers define hazards and identify controls. Workers demonstrated their awareness of hazards in their spaces, but some ambiguity existed in the documentation and implementation of controls. PNNL continues to implement new processes designed to improve management of hazardous substances and work activities. PNNL should continue to improve its planning and approval processes at the activity level, and ensure consistent expectations for work planning and control across the laboratory. PNNL continues to meet the expectations for Worksite Analysis in DOE-VPP.

VI. HAZARD PREVENTION AND CONTROL

Once hazards have been identified and analyzed, they must be eliminated (by substitution or changing work methods) or addressed by the implementation of effective controls (engineered controls, administrative controls, PPE). Equipment maintenance processes to ensure compliance with requirements and emergency preparedness must also be implemented where necessary. Safety rules and work procedures must be developed, communicated, and understood by supervisors and employees. These rules and procedures must also be followed by everyone in the workplace to prevent, control the frequency of, and reduce the severity of, mishaps.

In 2007, the Team found that hazards associated with operations and maintenance were well controlled. Systems were in place to implement controls, beginning with elimination or substitution and use of engineered controls, then administrative controls, and finally PPE. Workers were identifying process improvements to reduce worker risk and improve efficiency. Opportunities for improvement in 2007 and continuing into 2009, included workers using PPE incorrectly, particularly safety glasses, gloves, laboratory coats, and wearing inappropriate personal clothing (e.g., sandals and shorts in a laboratory).

PNNL continues to have processes in place to implement the proper hierarchy of controls. It has invested in, and implemented extensive engineering controls throughout its facilities. Laboratories are fitted with engineered controls such as ventilated fumehoods, a newly installed bulk solvent stabilizing dispenser, and installed improvements to recently redesigned laboratories at RPL that relocated connections for gas and other utilities to reduce interference with fumehood operations. The bulk solvent stabilizing dispenser uses an inert gas blanket and containment to control temperature and prevent exposure of bulk solvents to light and oxygen, thus limiting the formation of potentially unstable or shock-sensitive organic peroxides. The system reduces risk and saves money by extending the shelf life of organic solvents and reducing waste.

PNNL has also invested in engineered controls related to facility operations. One of the controls observed included a stair climbing material handler that allowed workers to move heavy loads up and down stairs with minimal physical effort. The Team observed routine use of adjustable hydraulic carts for moving and positioning heavy loads during installation of laboratory equipment. In addition, the F&O Directorate recently purchased a fall protection safety rail system specifically engineered for nonintrusive installation on existing ethylene propylene diene monomer (EPDM) rubber roofs. F&O workers believe that using such a system in lieu of installing costly anchor points and relying on independent fall protection was a more proactive solution. PNNL will install the system on the EMSL roof to facilitate safe, routine roof access on that facility by maintenance employees.

Chemical hazards are pervasive at PNNL. Through the IOPS process of permits and procedures, PNNL generally addresses those chemical hazards with the appropriate controls. One particular chemical hazard may warrant closer attention in the implementation of controls. Many laboratories at PNNL use hydrofluoric acid (HF). Other strong acids are also commonly used. Many IOPS documents reviewed by the Team related to acids were specific with respect to properties, hazards, required PPE, and mitigation strategies. In some cases however, the IOPS documents required the user to determine appropriate PPE based on concentration, engineered barriers, transfer tools, and or techniques. Consequently, in many cases users often selected the 6-mil or "laboratory grade" Kimberly Clarke™ purple nitrile exam gloves when the IOPS controls use the term "appropriate" gloves because the gloves were readily available. While

those gloves are adequate for many laboratory hazards, the Team observed some cases where the gloves were not protective, but were in use by laboratory personnel. The Kimberly Clarke Web site contains the manufacturer's recommendations for these gloves. The glove selector chart at the Kimberly Clark Web site indicates the gloves have not been tested or rated for HF permeability. The IOPS sheets in some cases recommended the gloves for splash protection, but this recommendation may not be adequate where penetration times are less than 1 minute HF, as the employee may not have sufficient time to recognize that a splash has occurred. The Occupational Safety and Health Administration guidelines for HF recommend avoiding nitrile gloves for HF protection.

The Kimberly Clarke Web site indicates that for other acids (e.g., concentrations of sulfuric acid greater than 47 percent), nitrile gloves may not provide adequate protection. The IOPS documents did not include additional direction on thickness, brand, or other pertinent data on nitrile glove selection. The glove selection chart accessed through HDI (chart alone) provides guidance that nitrile is sufficient in itself to protect against stronger caustics. Although material selection may be correct under certain conditions, the chart does not provide enough specificity (mil/thickness, requirement for dexterity, decontamination prior to removal, etc.). The glove selection chart does recommend consultation with an ES&H professional, but users do not always follow that recommendation.

Opportunity for Improvement: PNNL should evaluate the selection of gloves in laboratories to ensure glove selection criteria include the specific chemicals in use, and the manufacturer's specific recommendations.

In some cases, PNNL workers may not be critically evaluating work to implement engineered controls where appropriate. For example, in September 2012, two laboratory personnel were removing an electro-formed copper part from a steel mandrel. While trying to pull the part off the mandrel, the part became stuck on the mandrel. The two workers positioned themselves to exert more force on the copper part. When the part came loose suddenly, the part struck one worker in the mouth, chipping his tooth (a recordable injury). The corrective actions identified in the occurrence report included positioning the part differently, or including a vent plug in future mandrel designs to prevent a vacuum from forming between the part and the mandrel. There was no indication the workers considered an engineered solution or tool for removal of parts from the mandrel as a corrective action for the injury, or in the initial planning for the work. They have been performing this work in a similar manner for approximately 3 years.

PNNL's use of lasers is extensive with some laser laboratories having five independent laser systems operating within the same laboratory. The Team observed significant clutter in some laboratories, possibly due to the multiple laser operators and projects within a single laboratory. Laser PPE found within laboratories consisted of clear safety glasses, sunglasses, damaged and aging laser PPE, as well as appropriate laser PPE. Laser warning signs observed within laboratories were void of proper laser warning information required by American National Standards Institute (ANSI) Z136.1-2007, *American National Standard for Safe Use of Lasers*. PNNL analyzes the laser hazard and specifies the required PPE with a laser use permit. The laser use permit reviewed by the Team appropriately identified the correct PPE for eye exposure, but did not address the skin hazard presented by laser use. PPE typically used for ultraviolet exposure for lasers are face shields, gloves, and clothing (laboratory coats) to protect the skin. In addition, the PPE for ultraviolet protection should recommend clothing with appropriate fabric density, gloves, and face shield appropriate to the strength of the lasers ultraviolet power. PNNL

appears to rely heavily on the use of beam blocks and shields to control the Nominal Hazard Zone of the laser to the table, and allows individuals not to use PPE given this parameter. Beam blocks and shields are generally effective, but do not preclude the possibility of reflected or incident beam exposure.

The Laser Safety Officer agreed that the laser use permit needed clarification regarding PPE for skin protection. He believed the contractual requirement for PNNL was to comply with the previous version of the standard as specified in title 10, Code of Federal Regulations (CFR), part 851, *Worker Safety and Health Program*, subpart C 23, *Workplace Safety and Health Standards*, (11) ANSI Z136.1-2007, *Safe Use of Lasers* (10 CFR 851.23(11)). Changes to the standard in 2007, included identifying the optical density and rated wavelength of the required eyewear on all laser danger signs. PNNL's directive for laser safety invokes the 2007 version of the ANSI standard.

Opportunity for Improvement: PNNL should update its laser safety program to reflect ANSI Z136.1-2007, *American National Standard for Safe Use of Lasers*, and include appropriate PPE for ultraviolet skin protection for laser operations.

The PNNL Emergency Management Plan provides an overview of the emergency management program implemented by PNNL for PNNL-managed facilities at the PNNL site, the Hanford site, Sequim, and Richland North. PNNL established the program to meet DOE Contractor Requirements Document 151.1 C, *Comprehensive Emergency Management System*, as well as Federal and state regulations. PNNL performs approximately 70 drills per year ranging from tabletops, fire drills and evacuations, to full participation exercises. Interviews with emergency management personnel demonstrated that they have frequent interaction with upper management and believe senior managers strongly support the program. For example, the emergency management personnel believed an active shooter response should be an essential part of their program due to the campus-like layout of the PNNL facilities. Some laboratory personnel, including managers were initially hesitant of the idea. The emergency management personnel gave a presentation to ROC detailing the potential vulnerabilities an active shooter would present to the site, leading to strong support by members of ROC. PNNL has since successfully used the active shooter scenario in several drills.

The Team observed a PNNL drill during the review that consisted of a joint operation involving the Richland Fire Department, Washington Department of Health (providing Radiological support at Kadlec), and the Kadlec Medical Center. PNNL kept details of the drill scenario closely guarded in order to evaluate the personnel actions. Participants responded to the emergency as the information presented itself during the drill. The observed drill simulated a chemical reaction and over-pressurization in a fumehood that resulted in multiple injuries to three laboratory workers, and the spread of radiological contamination. The Richland Fire Department responded to the resulting fire alarm and worked with the Building Emergency Director to determine the basis of the event and to plan the appropriate response.

PNNL has worked with the Richland Fire Department for the past 2 years, training and familiarizing them with the unique challenges presented by PNNL facilities in the event of an emergency. In addition, since PNNL uses the Kadlec Medical Center, they must rely on the Washington Department of Health to provide radiological support for Kadlec in the event of a radiological incident. The drill was an excellent test of the participants' training and of the

differing organizations' ability to coordinate their responsibilities. The drill effectively identified several opportunities for improvement that PNNL is evaluating for implementation.

The Team interviewed the Radiation Protection Manager, observed technicians performing routine surveys, and toured the high-risk radiation facilities at PNNL. PNNL performs most of the radiochemistry work in RPL. Access control and radiation monitoring observed by the Team satisfied the intent of 10 CFR 835, *Occupational Radiation Protection*. The Team observed technicians using good radiation assessment techniques and processes. Spot checks of mobile survey instrumentation did not reveal any out-of-date calibration stickers, and all equipment was in good working order.

The Team toured the large detector laboratory where PNNL uses radiation-generating devices to x-ray truck compartments in conjunction with sensitive detectors for the Departments of Transportation and Homeland Security. Personnel interviewed by the Team understood the potential hazards and controls associated with the radiation-generating devices.

PNNL is switching to newer optical dosimeters that are more sensitive to low doses than the thermo-luminescent dosimeters used at Hanford. Most radiation work at PNNL does not involve high doses to workers. Because of this change, PNNL is establishing its own dosimetry program, including accreditation through the DOE Laboratory Accreditation Program.

PNNL discontinued its participation in the CSC Hanford Occupational Health Services (CSC) occupational medicine contract and subcontracted independently with AnovaWorks, PLLC on October 1, 2012. PNNL made this transition for several reasons. The CSC contract focused on the environmental cleanup and restoration aspects of the Hanford reservation rather than the needs of a research laboratory. In addition, the Hanford site occupational medical requirements did not allow PNNL to tailor the services to address the needs of the PNNL workforce effectively.

Subcontracting to AnovaWorks, PLLC and establishing space for AnovaWorks, PLLC in the Laboratory Support Building allows for a more customized occupational medical program that will more effectively provide for the PNNL workers' needs. For example, under the previous contract, a typical return to work examination required 3 hours to perform. Since the change, a return to work examination only requires 30 minutes to complete. The PNNL workers greatly appreciated this improvement. In addition, survey results with PNNL workers demonstrated that accessibility and communications between PNNL workers and the new occupational medical provider has greatly improved.

Based on employee feedback, AnovaWorks, PLLC modified the method by which it processed the foreign travel packets provided to PNNL employees. Previously, AnovaWorks, PLLC provided employees the prescriptions for any medicine required during foreign travel, which employees filled through their personal pharmacy. AnovaWorks, PLLC improved this process by providing the medications, rather than just the prescription.

In anticipation of leaving the CSC contract, PNNL withdrew from the CSC wellness program and used that funding to develop its own wellness program, called Wellness 4 Life. PNNL instituted the Wellness Trek Challenge under the new program that involved individuals or teams of individuals working on improving activity levels and health habits. Over 800 PNNL employees participated in the program, representing a significant increase in PNNL employee involvement over the CSC program.

With the transition from the Hanford site systems and conversion to the new occupational health provider on October 1, 2012, PNNL developed a new Web-based EJTA tool and began transitioning over to it a couple months prior to this assessment. PNNL and AnovaWorks, PLLC performed the conversion over the past few years in anticipation of the change. However, PNNL has not yet had sufficient time to reevaluate and improve the EJTAs to “customize” those EJTAs to the workers in more detail. For example, in 2012, a restricted case occurred when an employee experienced respiratory irritation because of exposure to paint chips, dust, and paint vapors. The worker was escorting subcontractors performing work in the basement of the National Security Building. The subcontractors were scraping and chipping paint, vacuuming the paint chips with a shop vacuum, and then repainting. The worker apparently had a history of respiratory problems. The incident report file contained a copy of the EJTA that identified only administrative duties. The EJTA specifically identified that paint fumes or particulates were not part of the worker’s exposure profile. If the EJTA had identified those potential exposures in connection with escorting duties, the reviewing physician might have reviewed the employee’s medical history and recommended the person not perform those duties, and avoided the exposure. With the new occupational medical provider now in place, PNNL should take the opportunity to ensure EJTAs correctly identify all hazards and duties, including the hazards associated with escorting subcontractors during construction and maintenance activities.

Opportunity for Improvement: PNNL should ensure EJTAs correctly identify all hazards and duties, including the hazards associated with escorting subcontractors during construction and maintenance activities.

Conclusion

PNNL continues to pursue improvements that strengthen its hazard controls hierarchy and invest in those controls. The IOPS process needs some improvement providing specific, detailed selection criteria for laser and chemical controls. The emergency management and the occupational medicine programs have been adapted and improved to better support PNNL employees. PNNL continues to satisfy the requirements as a Star site in Hazard Prevention and Control.

VII. SAFETY AND HEALTH TRAINING

Managers, supervisors, and employees must know and understand the policies, rules, and procedures established to prevent exposure to hazards. Training for health and safety must ensure that responsibilities are understood, personnel recognize hazards they may encounter, and they are capable of acting in accordance with managers' expectations and approved procedures.

PNNL administers training through the Training and Information Services (TIS) Department, which is responsible for over 400 classes, comprised of instructor led, Web-based training, external, and on-the-job training. PNNL employees are approximately 97 percent current for classes requiring refresher training. TIS employs 8 full-time trainers and approximately 120 part-time and/or SME trainers. PNNL also uses the Volpentest Hazardous Materials Management and Emergency Response (HAMMER) Training Center for courses such as hands-on fire extinguisher training and Hazardous Waste Operations and Emergency Response training. In addition, TIS brings in specialized training as necessary for PNNL's mission. One example is "Teaching to the Multi-Generational Learner", to address the learning differences and training needs of Baby Boomers, Generation X, Y, and Millennium workers, all of whom work at PNNL. TIS is planning to host this event again in the spring of 2013.

TIS has had several other successes since the last DOE-VPP onsite assessment. It updated and consolidated both the annual refresher training for all employees and the new hire orientation, saving an estimated \$2.6 million. Employees and managers alike complemented the classes and appreciated the reduced time and new material in the course, especially employees that have been at PNNL for many years.

Approximately 650 students participate in summer internships at PNNL. These interns have a varied background of experience that includes high school students, undergraduate and graduate students. PNNL identified this group of employees as a potentially higher risk for injury. Recognizing the potential risk, PNNL developed an Intern Road Show in 2011 to assimilate summer hires into the PNNL culture in a convenient and entertaining manner. The road show is a gathering of SMEs who set up displays and tables to convey information and answer questions from new and returning interns. Mentors are encouraged to attend along with their interns. PNNL conducts the Road Shows on several days at different locations to make attending convenient. To promote attendance, PNNL holds drawings and gives away prizes to attendees to entice them to stay and interact with SMEs. PNNL conducted four road shows at different locations around PNNL and attracted more than half the summer hires as well as a number of mentors. Planning is underway to repeat this approach for summer 2013.

The Team observed the Radworker Practical training and Beryllium Awareness class. TIS conducted the classes at the Laboratory Support Building in a professional manner with good student interaction. The Radworker class instructor was a full-time instructor and the Beryllium class instructor was an SME/part-time instructor. In both classes, the instructors were knowledgeable, enthusiastic, and engaged the students. Both instructors conducted their classes at an appropriate pace for the level of understanding of the students. They both asked questions, discussed answers given, and made sure students understood the correct answer. Both instructors referred frequently to lesson plans to ensure they covered all required topics.

All formal training classes include an examination. TIS analyzes test scores to determine if certain areas need greater emphasis or clarification, or if the questions are not well articulated and need to be rephrased. TIS customizes Web-based training for PNNL. Employees can elect

to test-out of most Web-based training classes with a score of 90 percent, or take the training and score 80 percent on the final exam. TIS has established standards for both the technical content and the quality of Web-based training. For instance, feedback from laboratory personnel demonstrated that researchers gave little credibility to poor animation or stick figures in the training materials. PNNL now sets a much higher standard for graphics and animation used in training materials.

Facilities, equipment, and training aids were all in excellent condition providing an atmosphere conducive to learning. The Beryllium class began with an interactive session between the SME and the students prior to the class. TIS determined students pay more attention and ask more questions when the class begins with a discussion led by the SME, rather than waiting until the end of the class. The SME instructing the observed class was Beryllium sensitized, and was very passionate about the subject, which improved the students' attentiveness to the class.

TIS also demonstrated good training management by bringing respirator training back in-house from HAMMER. The course currently taught at HAMMER covers all forms of respirators used at the Hanford site. PNNL only uses a limited number of respirators, and employees felt attending a class that addresses PPE they will likely never wear was not a good use of time.

TIS uses PeopleSoft® Electronic Learning Management System (ELMS) to track all training and administer Web-based training classes. ELMS provides PNNL with a very good system to inform workers when training is due and keeps their managers updated on employee training status. ELMS notifies workers on the first and fifteenth of each month of both upcoming and overdue training. Managers receive automatic notification when employees are overdue for training. Training records are available online to all employees and supervisors. TIS assigns a Training Coordinator to each of the six directorates. The training coordinators run reports for their assigned directorates as needed. Training coordinators ensure dedicated and constant communication between TIS and all divisions and channel feedback from management to TIS.

IOPS is PNNL's system that grants employee access to laboratories. IOPS identifies all required training and reading that employees must have to work in, or get unescorted access to, laboratories. IOPS tracks training and required reading and will not allow employee access if initial and recurrent training assignments have not been met. In some laboratories such as EMSL and RPL, IOPS is tied into the electronic building and laboratory access system and will lock-out employees from their laboratories if training has expired.

Cryogenics are widely used at PNNL, but there is no dedicated class for cryogenic safety. Cryogenic safety training only consists of required reading through IOPS. Researchers had different responses when asked what cryogenic PPE was required. One person observed by the Team using a small Dewar to pour a cryogenic liquid, felt they only needed eye protection for that operation, but stated use of pressurized cryogenic systems required gloves, apron, and a face shield. PNNL should consider developing a course to convey PNNL's requirements and expectations for cryogenic hazards to use in conjunction with specific activities throughout PNNL.

Opportunity for Improvement: PNNL should consider developing a course to convey PNNL's requirements and expectations for cryogenic hazards to use in conjunction with specific activities throughout PNNL.
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PNNL has a number of Class 3B and 4 lasers in numerous laboratories around its campus. Class 3B and 4 laser operators are aware of the requirement for a laser eye exam and approval from the CSM through IOPS prior to operating lasers or working in laboratories with high powered lasers. PNNL Course 683, *Laser Safety Training*, is designed to familiarize users of Class 3B or Class 4 lasers systems with the characteristics, capabilities, and hazards of lasers found at PNNL. This training covers laser fundamentals, classifications, biological effects, as well as required control measures and safe work practices. It is an overview of the laboratory's laser safety program. The course is Web based, self-paced, and lists time as "0" hours. Although the course appears to document workers meeting the minimum standards for laser safety training, it may not be fully effective ensuring workers fully understand PNNL's laser safety expectations and requirements. As discussed previously (Hazard Prevention and Control), the Team observed some inconsistent understanding and implementation among laser users regarding laser controls. Open beam-path laser operations pose a higher hazard than enclosed beams, especially in multi-use laboratories. CSMs and laser operators must ensure visitors or other laboratory users have access to clean and serviceable laser eyewear specific to the lasers in use and that appropriate warning labels are in place. PNNL should improve its laser safety training to ensure users gain a clear and consistent understanding of PNNL's requirements for Class 3B and 4 laser use, including PPE requirements for both laser operators and other laboratory personnel not associated with the laser in use.

Opportunity for Improvement: PNNL should improve its laser safety training to ensure users gain a clear and consistent understanding of PNNL's requirements for Class 3B and 4 laser use, including PPE requirements for both laser operators and other laboratory personnel not associated with the laser in use.

Conclusion

PNNL continues to make improvements to its safety and health training program. TIS has made a concerted effort to consolidate redundant training and be more customer driven in terms of seeking feedback on all classes. TIS is actively working with managers to streamline training and keep content relevant. TIS is working to support employees by updating classes to make refresher training more interesting, and consolidating classes to reduce demands on employees' time. PNNL should improve its training for cryogenic and laser hazards. The training meets or exceeds employees' expectations with no reported inadequacies in either training class content or method of delivery. PNNL meets DOE-VPP expectations for Safety and Health Training.

VIII. CONCLUSIONS

Since the last triennial recertification, PNNL has reenergized and expanded its safety and health initiatives into a sustainable focus on operational excellence. Increased employee involvement and manager commitment were evident throughout the organization. These efforts are proving effective as evidenced by a downward trend in accident and injury rates, which had been steady or increasing preceding the 2007 assessment. The HDI process is reaching maturity and gaining acceptance among researchers as a tool that helps them reach their research goals. Some opportunities remain for additional detail and clarity, primarily with laboratory bench work hazard analysis and hazard controls. PNNL is leveraging its influence with other institutions of higher learning through its intern and visiting scientist programs to effect changes to the safety culture at university laboratories. Improvements in training to reduce redundancy, deliver an effective message to the highly educated workforce, and continually refresh the message based on current experience not only conserves resources, but also improves employee participation. The Team recommends that PNNL continue in DOE-VPP at the Star level.

APPENDIX A

Onsite VPP Assessment Team Roster

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