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Environmental Molecular Sciences Laboratory Operations System

Version 4.0
System Requirements Specification

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Foreword

This systems requirements specification is in accordance with the IEEE "Recommended Practice for Software Requirements Specifications" and contains three sections. Each section contains ever-increasing levels of detail regarding system requirements. The introductory section, Section 1.0, familiarizes the reader with the purpose, scope, and organization of the document. Section 2.0 provides a general description of the requirements of the EMSL OPS and some background material explaining the basis for the requirements. The final section, Section 3.0, contains detailed descriptions of the EMSL OPS system requirements sufficient to allow for the design, phased development, and testing of a system that satisfies those requirements. The EMSL OPS specification is matrixed to the guidelines of DOE 5480.19, "Conduct of Operations Requirements for DOE Facilities," in Appendix VIII.

Acknowledgments

Dale Knutson, Steve Colson, Monty Rosbach and John Daschbach provided major features of the EMSL OPS design concept. In addition, John Daschbach developed an early Web-based prototype of the system which was an invaluable guide to the developers. Mike Blackford's insight into system requirements was a great help. In addition, the following individuals provided valuable input: Diane Bolger, Glen Dunham, Tina Foley, Jerry Massey, Genevieve Millsap, Marc Moise, Douglas Ray, Ronald S. Smith, Tobe Taylor, Hans Vogel, and Bonnie Williams.

Thanks to all for the great ideas, excellent comments, and timely critical reviews.

Glossary

accountability	a high standard of individual responsibility
ALARA	as low as reasonably achievable (DOE 5480.19)
annotation	text entered by the cognizant space manager to provide supplementary information
ASCII	American Standard Code for Information Interchange
browser	software on a user's terminal or PC which enables access to and browsing searches of the World-Wide Web
checklist segment	the text which makes up the hazard class checklist
CSM	Cognizant Space Manager
cognizant space manager	the person who has responsibility for the safety, and management of a particular laboratory and/or job function linked to space type in emsl
CSF	critical success factor
DOE	US Department of Energy
EMSL	Environmental Molecular Sciences Laboratory
excerpt (DOE 5480.19)	interpretation of nuclear standard requirement as it applies in part to non-nuclear operations
Guideline	recommended conduct of operations or safety requirement from DOE 5480.19
HAS	hazard awareness summary
hazard	source of energy or process that can through misuse, system, or equipment failure or other improper operation generate a concern for safety or actual unsafe condition
hazard category	any of 21 predefined categories of hazards (e.g., General, Fire Safety, Electrical, etc.). See "Identification of Hazard Classes in Research Laboratories," EMSL Checklist template October 1995.
hazard identification	the process by which a cognizant space manager identifies the specific hazards that exist within a particular laboratory
laboratory	a room under the jurisdiction of the EMSL where research is performed

MA	"A-level" manual
monitoring of operating performance	DOE 5480.19 monitoring guidelines applied to research operations, facility operations, and personnel and programs operations
OJT	on-the-job-training
one over	the immediate supervisor of the CSM
operations policy	procedures or other definitive electronic documentation that specifically apply to operations (DOE 5480.19)
PNNL	Pacific Northwest National Laboratory
POC	point of contact
SAC	Self-Assessment Checklist
SBMS	Standards-Based Management System or Standards-Based Management Information System (SBMIS)
Self-Assessment Checklist	checklists which guide a cognizant space manager in the assessment of all hazards in a research laboratory or facility space
users	anyone using or desiring use of one or more specific EMSL research spaces
Web	World-Wide Web (or WWW); a group of computers on the Internet which operates with a standard protocol for access and data interchange
Web browser	a client software application that accepts the Web protocol and implements it for the Web user
Web page	the screen data that the browser displays
WWW	World-Wide Web

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1.0 Introduction

1.1 Purpose

This document is intended to provide an operations standard for the Environmental Molecular Sciences Laboratory OPerations System (EMSL OPS). It is directed toward three primary audiences: (1) Environmental Molecular Sciences Laboratory (EMSL) facility and operations personnel; (2) laboratory line managers and staff; and (3) researchers, equipment operators, and laboratory users. It is also a statement of system requirements for software developers of EMSL OPS.

The need for a finely tuned, superior research environment as provided by the US Department of Energy's (DOE) Environmental Molecular Sciences Laboratory has never been greater. The abrupt end of the Cold War and the realignment of national priorities caused major US and competing overseas laboratories to reposition themselves in a highly competitive research marketplace. For a new laboratory such as the EMSL, this means coming into existence in a rapidly changing external environment. For any major laboratory, these changes create funding uncertainties and increasing global competition along with concomitant demands for higher standards of research product quality and innovation. While more laboratories are chasing fewer funding dollars (Stark 1994), research ideas and proposals, especially for molecular-level research in the materials and biological sciences, are burgeoning. In such an economically constrained atmosphere, reduced costs, improved productivity, and strategic research project portfolio building become essential to establish and maintain any distinct competitive advantage. For EMSL, this environment and these demands require clear operational objectives, specific goals, and a well-crafted strategy. Specific goals will evolve and change with the evolution of the nature and definition of DOE's environmental research needs. Hence, EMSL OPS is designed to facilitate migration of these changes with ease into every pertinent job function, creating a facile "learning organization."

The "learning organization" is one that is able to adjust and adapt continuously to changes in external business and competitive environments, and to internal needs for improvements in behavior which bring greater organizational responsiveness and flexibility. Ram Charan, quoted in *The Learning Imperative* (Harvard College 1993), says that such a capability means "superior execution in a volatile environment." Understandably, superior execution means adaptation. Peter Senge describes this aspect of a learning organization as "a paradigm centered on continual adaptation to an ever-changing environment" (Senge 1990). Also, superior execution means that the organization is "a quick study." As Bill Hitt asserts, this aspect of a learning organization means that, "in the end, the only real competitive advantage will be which organization can learn the fastest" (Hitt 1995).

An EMSL implementation goal is to provide the means whereby all elements of the EMSL organization remain focused on and are measured against the evolving goals and performance parameters of EMSL. EMSL OPS supports that goal by providing the underlying, unifying network for rapid and facile changes and implementation of laboratory, facilities, and personnel

or program requirements. With its emphasis on provision for assessment of each phase of its operations, at all levels, EMSL is a classic learning organization.

The EMSL will become a leading US center for fundamental research in the environmental molecular sciences. A critical component in the success of EMSL is the implementation of a coherent operational approach that supports the efficiency in an integrated, multidisciplinary laboratory. Information tools fitted to the task of innovation and flexibility, delivered in a uniformly structured operations system, can do much to contribute to this success.

Use of information in EMSL operations must support the unique EMSL operational implementation objectives:

> *to develop, refine, and use state-of-the-art research methods for investigating the molecular processes that control complex environmental processes,*

and provide the basis for the operational objective:

> *to operate a National collaborative research facility.*

The EMSL vision statement mandates scientific activity with a national purpose:

> *EMSL staff will capitalize on the current revolution in experimental, theoretical, and computational molecular science to acquire knowledge that is critical to the environmental missions of the US Department of Energy.*

1.2 Scope

EMSL OPS is an electronic system with operational capabilities for (1) the Conduct of Research Laboratory Operations, (2) Conduct of Facilities Operations and (3) Conduct of Personnel and Program Operations for EMSL. The operations system will provide a uniform means for self assessment in each of these three operational areas. EMSL OPS provides automated resources for conduct of operations at the lowest operational level for evaluation of an activity or laboratory space. This automated tool will provide the capability, together with the necessary standards, for cognizant space managers (CSMs) to evaluate or assess a particular lab or facility space for hazards, evaluate the conduct of operations, and secondarily evaluate the conduct of personnel and program operations (see DOE 5480.19, Chapter IA). In this context, programs are all organizational functions, such as research, finance, procurement, visitor handling, etc.

Facility-wide and laboratory-specific efficiencies—the information-process principles intrinsic to EMSL OPS final design—include the following:

- *common information structure* which promotes unification of laboratory resources;
- *adaptive information-focusing functions* which keep operational goals and tasks in alignment;
- *integration of electronic reference access, information screening, and information-tailoring mechanisms* for efficient document control and delivery;
- *information-brokering service* which encourages proactive management; and
- *operational knowledge base* which creates research efficiencies in training, time and opportunity.

Understanding the EMSL operational objectives and vision will help focus development of the EMSL OPS on direct support of the quality and efficiency of EMSL operations. Through its development from draft to final version, this document will serve as a vehicle for review, evolving with clarification and refinement of the capabilities required for the final EMSL OPS, and its associated software/hardware implementation.

1.3 Organization

The order of EMSL OPS development has been assigned as:

First, the conduct of research laboratory operations,	Provided in release through 9/96 by EMSL line item.
Second, conduct of facilities operations, and	Provided through evolution and introduction of EMSL OPS by EMSL operating budget.
Third, conduct of personnel and programs operations.	Provided through evolution and introduction of EMSL OPS by EMSL operating budget.

A system design concept for the three operational areas above-listed involves:

- Reduction of operational standards and procedural manuals, except equipment manuals, to a condensed electronic form;
- A working concept for linked electronic file folders to promote a uniform information structure;
- A common use of the self-assessment checklist format for all internal EMSL performance and compliance evaluations; and
- The EMSL OPS operating model as a broker for EMSL OPS services.

The interrelationships among users of EMSL OPS, the information types supplied, and the goals or uses of the information are shown in Table 1.1.

EMSL OPS begins at the working research level with integration for facility management and safety concerns across the entire laboratory. Personnel and programs provide additional evaluation tools and management actions in direct support of safety and hazard awareness. Because it reaches automatically to all levels in the laboratory and to all major functions, EMSL OPS establishes a new level of performance as an operational standard. Safety guidance must be accessed and reviewed by each laboratory researcher, using EMSL OPS, before unrestricted entry is allowed into any laboratory. EMSL OPS, by its structure and user-controlled screens, involves each user in a proactive dialogue which forces increased levels of hazard recognition and awareness. Requirements for each laboratory are known throughout the laboratory and are available on a 24-hour basis for access and use.

EMSL OPS is also designed to propagate integrated laboratory and safety practices and permits to every EMSL operating level and laboratory. Policy integration comes from the unique Standards-Based Management System that supports EMSL and from the integration within EMSL OPS of research and facilities and hazard management. The relationship between EMSL OPS and the general requirements of DOE 5480.19, "Conduct of Operations Requirements for DOE Facilities," is shown in Appendix IX.

Table 1.1. Interrelationships Among Users of EMSL OPS, Information Types Supplied, and Goals or Uses of the Information

	Researcher	**Cognizant Space Manager**	**Facility Manager**	**Personnel and Programs (to be developed)**
Information Type	Hazards; Laboratory Bench Practices; Laboratory Safety; Training	Hazards; Safety; Self-Assessment Checklists; Researcher Qualification; Visitor/Researcher Training	Hazards; Facility Safety; Facility/Equip-ment Management	Personnel Qualification; Programs; Product Quality; Business Support and Cost Containment; Communications; Visitor Handling
Information Use	Safety; Health; Laboratory Operations Practice	Safety; Health; Laboratory Operations Efficiency and Management; Research Project Planning, Schedule and Performance	Safety; Health; Efficiency; Economy; Environment	Efficiency; Economy; Competitiveness; Research Project Cost, Schedule and Product Performance

2.0 Overall Description

2.1 Product Perspective

Writing for the *Annals of New York Academy of Sciences* (Stark 1994), Stanley Stark points out that for laboratories, both our ability to detect hazards and our sensitivity to them has increased. Safety has become a major criterion for quality in laboratory competitive evaluation. It has become important for laboratories to offer or broker services in support of safety which can remove the associated, non-safety-related administrative burden with which these services are often associated. Not only have safety and hazards mitigation become economically important, they have become so at a time when the volume of required reading for safety and hazards requirements has never been greater. The amount of material that must be read to work in the typical laboratory constitutes no small assignment, and grows with the introduction of each new technology, laboratory instrument, or regulatory requirement. These reading assignments and the administration of hazards mitigation, instead of being an integral part of operations, take time from the business of research, time more valuable than ever before.

2.1.1 Critical Success Factors

EMSL's strong vision requires that it be designed with certain clearly stated criteria for performance and success. These criteria have been captured as critical success factors.

A combination of talents and experience at EMSL will be brought to bear on fundamental research supporting US Department of Energy (DOE) technical needs. How to focus this talent and experience to achieve the performance and desired success means implementing a research portfolio with the right criteria. The resulting focused research portfolio will be implemented with criteria embodied in eight critical success factors (CSF). These eight CSFs apply key elements of the overall EMSL strategy to every operational area of the laboratory. Efficient application of the critical success factors ties EMSL operations to outcomes designed to enhance EMSL performance. A detailed review of the CSFs is useful to improve understanding of EMSL operations.

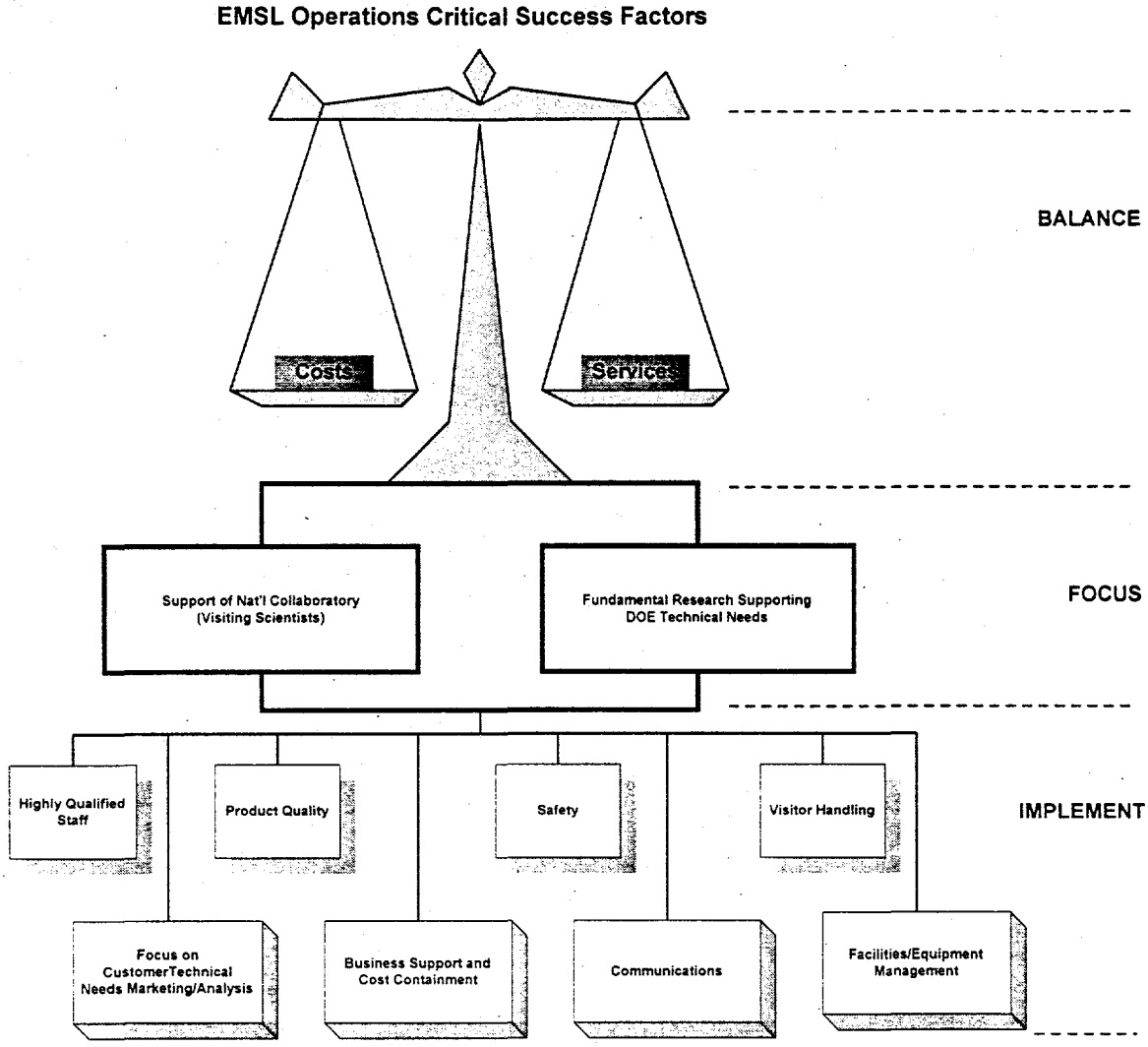
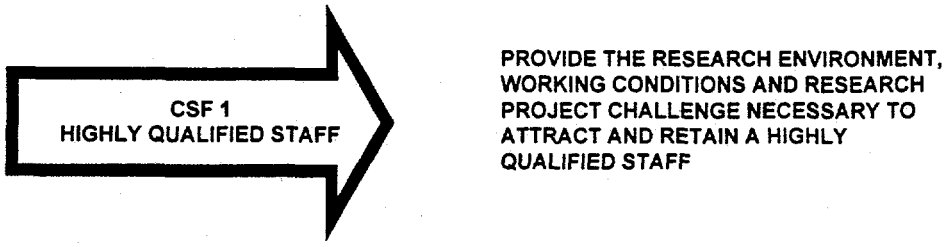
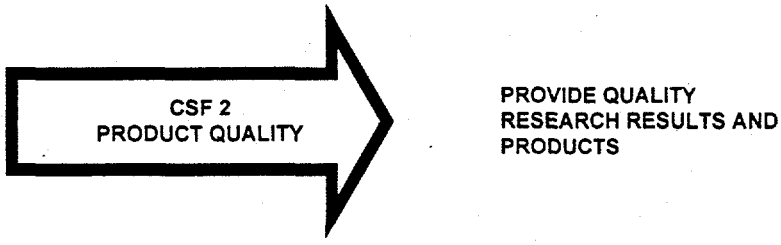


Figure 2.1. EMSL Operations Critical Success Factors



A Highly Qualified Staff

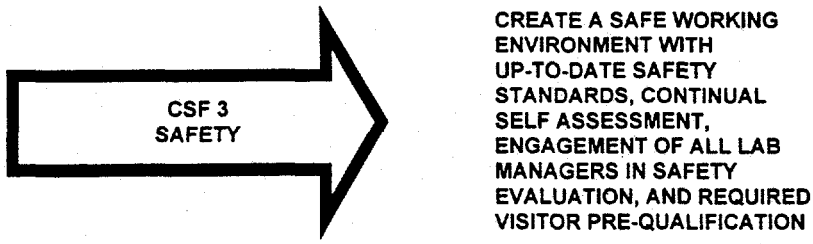
The ultimate basis for a first-class laboratory is a highly qualified staff. EMSL OPS is designed to promote efficiency, dedicated use of research time, and a system ease-of-access that can contribute positively to this critical success factor.



Product Quality

Assessment of Personnel and Programs activities of the laboratory as well as an efficient Conduct of Operations will improve and maintain high quality research products and services. This quality objective is ensured not only by quality-assurance goals and programs, but also by providing a consistent set of requirements.

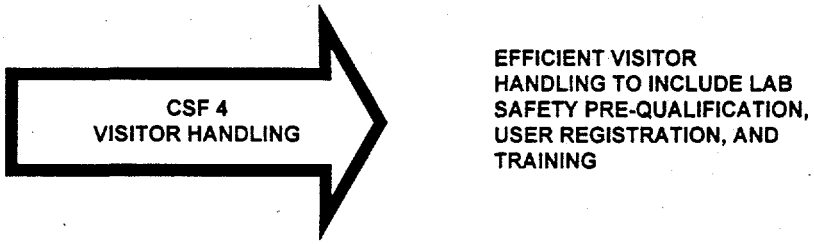
This activities assessment looks at the use of peer review, advisory committees, and other quality-assurance tools, strategies, techniques, and feedback mechanisms.



Safety

A wide variety of hazards can exist in a multidisciplinary laboratory and for every hazard, the safety regulations are typically voluminous. For the most part, the actual safe practices

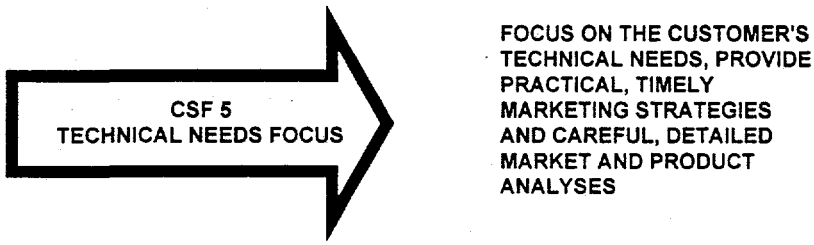
defined by regulation can be condensed to a readable, understandable form. EMSL OPS applies benchmark "best laboratory practices," i.e., effective operations protocols, including those for safety, that have been condensed from governing regulations. EMSL OPS provides those essential safety functions of the laboratory to assist the individual researcher or staff member in achieving a safe working environment.



Visitor Handling

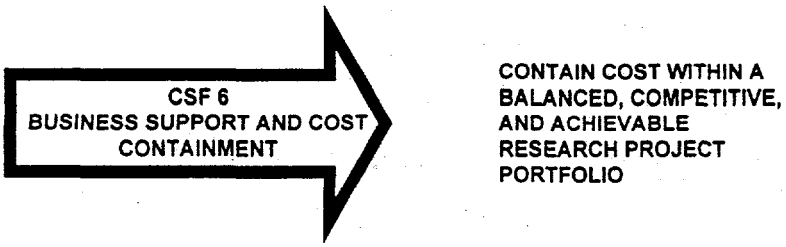
EMSL OPS provides an automated mechanism for visitors to access and become cleared for a visit to EMSL before their actual visit. The intent is to pre-qualify visitors in necessary hazard training, allowing the visitor to spend more time in the laboratory, and facilitate greater use of the laboratories and resources for actual research.

A "best practice" applicable here is that job-specific training based on the hazards and unique aspects of equipment usage in the visited laboratory is more efficient than mandatory qualification standards that may have no bearing upon the research task. The visitor can access job-specific training through EMSL OPS, which also keeps track of the visitor's training profile and other clearance requirements for subsequent visits.



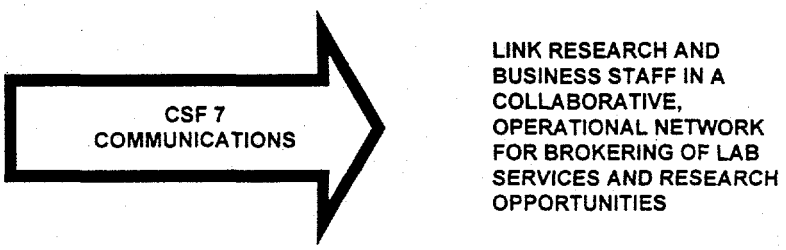
Technical Needs Focus

Using EMSL OPS, managers establish an integrated research project selection process, keeping research focused on the technical needs of DOE and other customers for whom EMSL will become the vendor of choice. Product and program managers will be provided with self-assessment checklists to determine, for example, how well the research product/project development process is operating. Most importantly, EMSL OPS will supply expected outcome and management system measures that will help to determine how well the process focuses on customer technical needs.



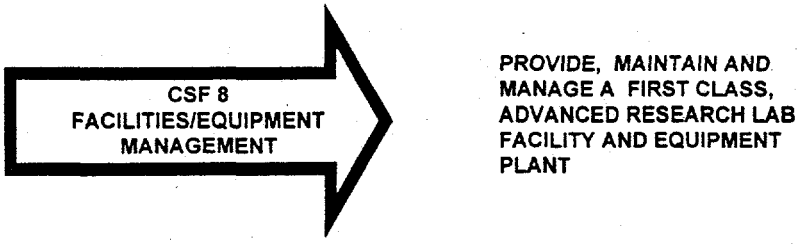
Business Support and Cost Containment

EMSL's interlocking operations system, linked effectively through the World-Wide Web (WWW or Web) and the EMSL integrated file folder information metaphor, provides opportunity for economies of scale. Examples of costs which will be eliminated include database management, duplicating and printing of regulations, and lost hands-on laboratory time due to inability of a visitor to conduct training and be cleared before arrival at the laboratory.



Communications

EMSL OPS as a communications tool directly supports the "collaboratory" purpose of EMSL OPS. The ease of access, use, functionality, and flexibility of EMSL OPS are not only desirable but mandatory features.



Facilities and Equipment Management

An open and available facility with a full complement of research and computer equipment is a mandatory prerequisite for achieving EMSL's operational objectives. As a result, assessment and evaluation of facility operations and management issues is another major laboratory operational area of EMSL OPS. In general, EMSL operations consist of all operations that will take place in any space defined by EMSL OPS. Categories of operations are broken

into multiple-space types generally associated with research laboratories (up to the building interface) and facility space everywhere else.

While there are common areas in EMSL OPS between the research laboratories and facilities, the facilities operations area of EMSL OPS will include other, more detailed self-assessment checklists and other technical crafts-management system concerns. In all cases, the regulatory requirements and linkages to requirements remain consistent. It is in the application and introduction of work that unique differentiation is made, entirely within EMSL OPS, with strictly controlled applications based on hazard type and necessary mitigation.

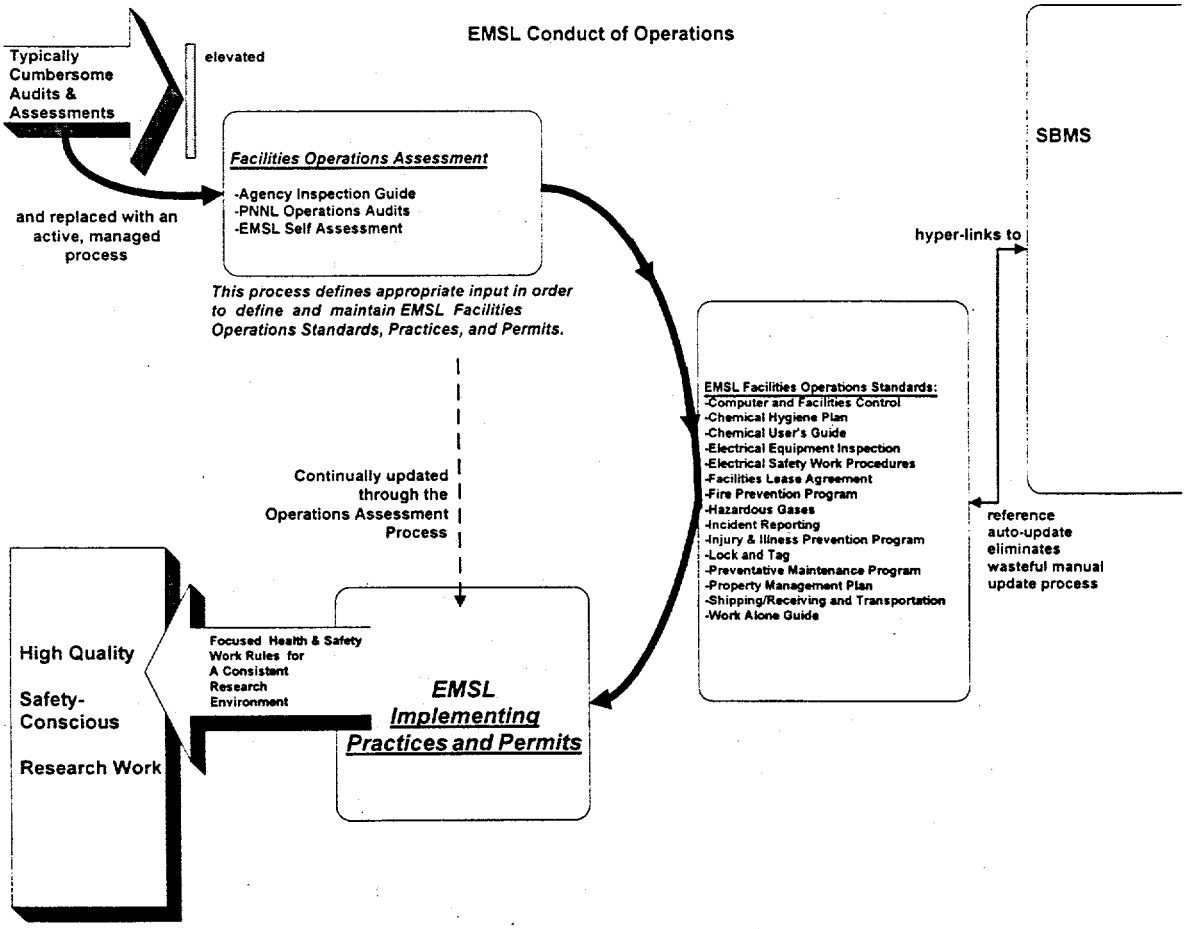


Figure 2.2. EMSL Conduct of Operations

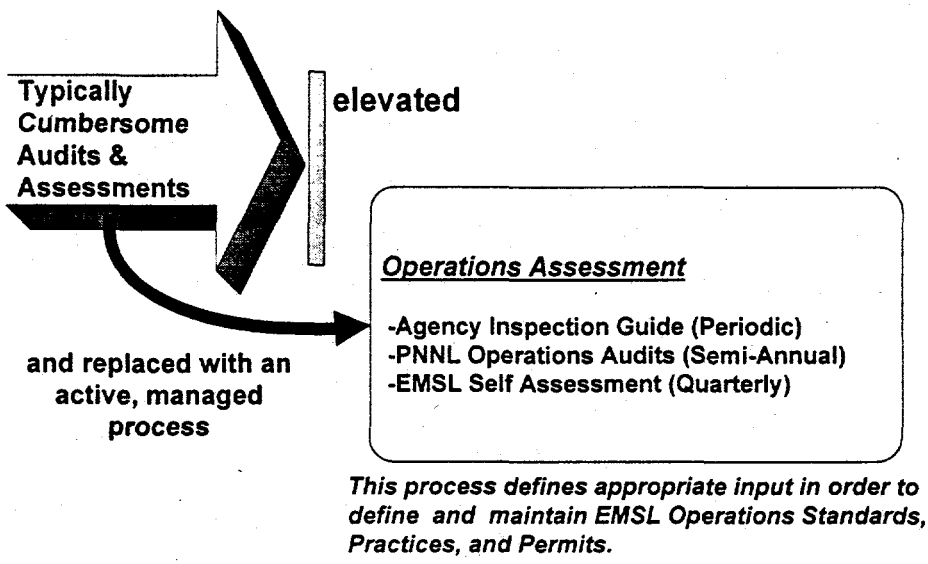


Figure 2.3. Typical Audit Process

2.1.2 Design Concepts

While EMSL OPS will be managed using the efficiency-promoting CSFs, EMSL OPS also has inherent design concepts to enhance those efficiencies further: a proactive, focused safety program and brokering of open-access services.

Proactive, Focused Safety Program

This design concept, illustrated in Figure 2.2, enables EMSL to generate greater research and laboratory operational efficiency. The typical environment, safety, and health (ES&H) audit process often prove very costly and ineffective in terms of manager and research laboratory manager or researcher time. EMSL OPS improves ES&H audit processes and assessments required of a laboratory of EMSL's size and research equipment format.

The actively managed process comes about through a unique condensation of a basic set of EMSL operating practices distilled from the full set of regulatory requirements. This condensed set focuses upon the exact laboratory room, space, or function where it must be applied. To create this focus, the Pacific Northwest National Laboratory's (PNNL) Standards-Based Management System (SBMS) subject matter experts first review requirements documents for safety-essential material. This material is then mapped into an essential set of EMSL Operations Standards. EMSL OPS maintains linkages to the appropriate SBMS document for each safety issue. As an SBMS document is updated, the appropriate EMSL manager is notified of changes in related EMSL Operations Standards. As shown in the next figure, these Operations Standards are then condensed to those essential operational procedures and requirements that define the

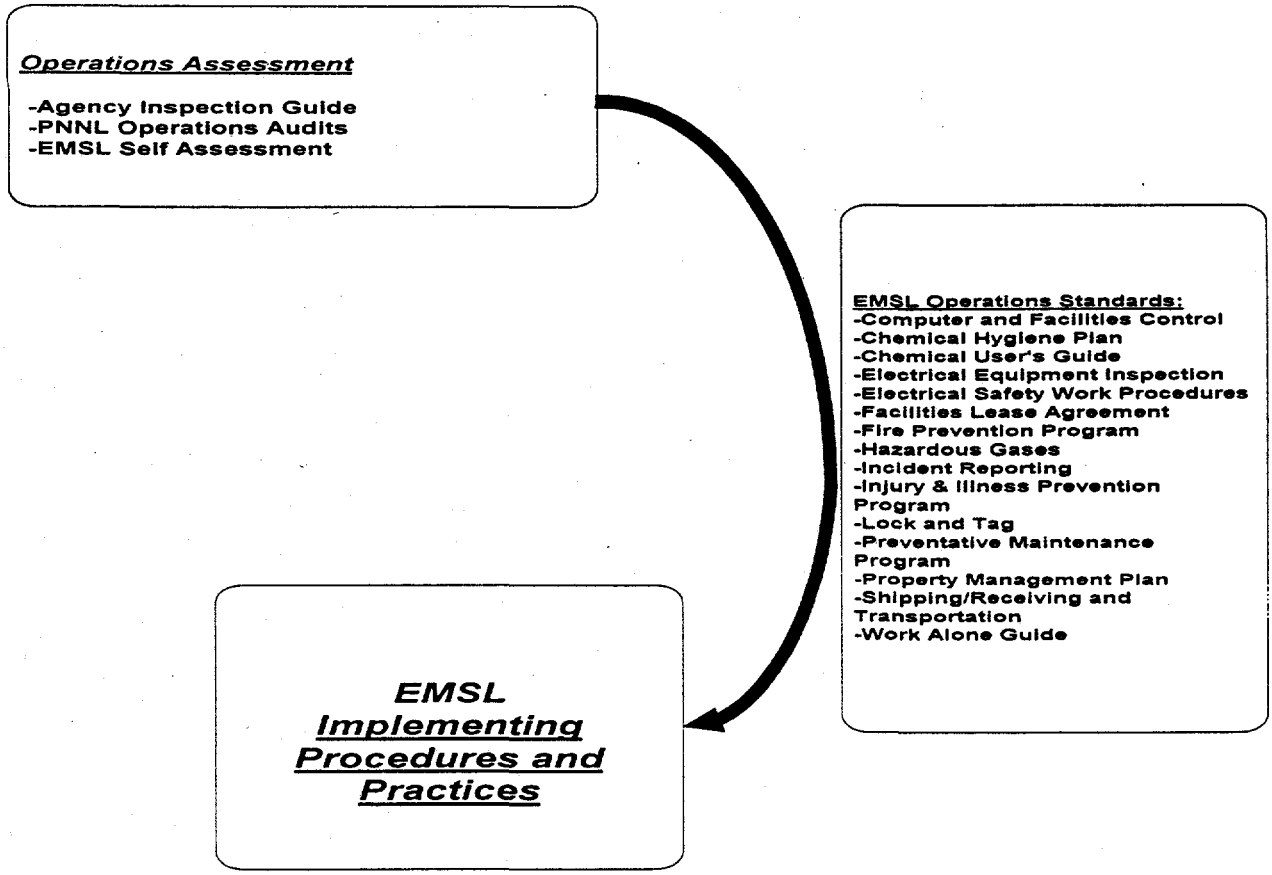


Figure 2.4. EMSL Operations Assessment Process

EMSL Practices used in the individual laboratory or facility space. "Conduct of Operations for DOE Facilities," DOE 5480.19, Chapter XVIC1 states, "procedure (Practices and Permits) preparation, verification, and validation should receive the highest level of attention." EMSL OPS promotes that high level of attention.

The cognizant space manager integrates laboratory safety and other efficiency-promoting actions into a seamless management activity, giving safety a proactive stance heretofore difficult to achieve with audits and other after-the-fact management efforts.

Simplifying and focusing regulations affects the work environment directly, as shown in the remaining portion of the figure below.

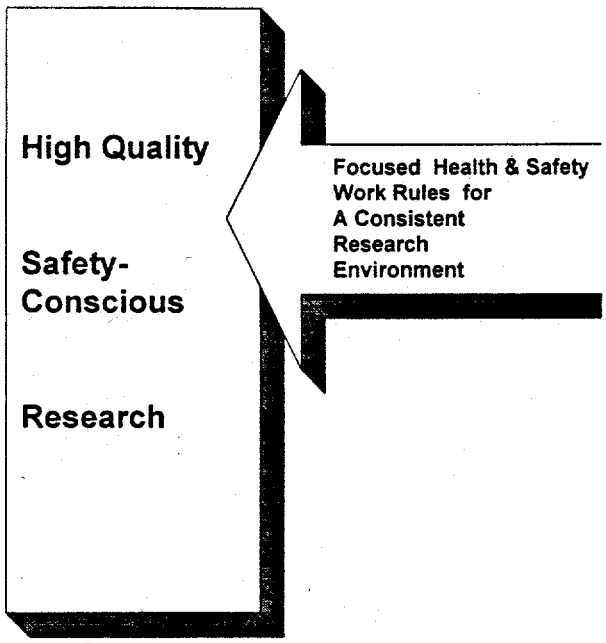


Figure 2.5. Research Environment Essentials

The impact of the audit is shifted from the assumption of laboratory negligence, with disruptive workplace follow-up inspections, to one of correcting and updating EMSL Operations Standards and creating changes to EMSL Practices and Permits. Furthermore, the manager is enabled to make immediate corrections (annotations) on the Self-Assessment Checklists specific to a laboratory. EMSL OPS is focused on those results and guidelines in "Conduct of Operations Requirements for DOE Facilities," DOE 5480.19, namely: (1) a different approach; (2) a flexible set of operating practices; and (3) a high level of performance (DOE 5480.19, "Introduction").

Broker of Open-Access Services

EMSL is available through the free information service utility of the Web, which include user pre-qualification for entry into an EMSL space, as well as full access to all EMSL lab-specific Practices and Permits and all DOE operations orders (all DOE orders are published on HanInfo and are available to users on the Web from the same terminal or PC used for EMSL OPS). For modest costs of access and commercial carrier fees, any user world-wide can access the Internet and the EMSL URL for what appears to be essentially free services. Web access enables EMSL OPS to broker its services in a free and open user environment and avoid the traditional approach of establishing an administrative oversight function. EMSL OPS as a service broker can speed up laboratory access, authorized entry, and training qualification of collaboratory researchers, and the conduct of the research operations themselves. Only the user's room-specific access function will be available outside the firewall. The importance of

making operations practices and permits freely available is emphasized in "Conduct of Operations Requirements for DOE Facilities," DOE 5480.19, Chapter XVIC6.

2.2 Product Design Description

EMSL OPS provides rapid ease of access to all standards, consolidates major operational control functions (hazard identification and self assessment; user registration and training; and safety and training requirements information) and provides exact, hazard-specific safety and standards reference for each room or separately identified facility space.

Operational control functions are available electronically at the lowest responsible operational level and for every type of laboratory operation, including research, general facility, and personnel and program operations. The operational control functions consolidate conduct of operations standards for all ES&H assessment, visitor and user access, and standards reference, review, update and application; they control every space in the facility. In fact, through these functions, each facility space has associated with it the exact hazards present, registered users who can access that space, and the training requirements necessary to conduct operations in that space. EMSL OPS keeps up with changes to standards and with the rapidly varying user population vying for access to EMSL. EMSL OPS provides the linkage of the dynamic operations in each space with the relevant standards of conduct for operations and the best practices to use while operating in each space.

This operations-oriented design feature provides a uniform yet highly flexible information system structure for EMSL OPS. The system-information structure requires a uniform use of condensed electronically available standards or performance documents which have been condensed into "best practices" and "operating permits." These documents capture the essential requirements of each operational standard to be applied: in accessing each potential user for necessary training requirements prior to entry; in any given self assessment of the facility space; and in the maintenance of the highest standards for conduct of operations (see DOE 5480.19, "Introduction").

Because it brings together the space, the hazards present, and the user's qualifications, the EMSL OPS design adds significant "understanding value" to the letter of the conduct of operations standard. By focusing on the exact space, the actual hazard present, and the specific practice or permit requirements for that hazard, EMSL OPS promotes a fully responsible hazard-based understanding for any user.

Electronic linkage provides access from the hazard identification and self-assessment functions to practices and permits. SBMS original full-text standard-reference electronic documents can also be referenced and are available from the user's screen by button access to the SBMS system. These documents can be used to provide additional reference for the practices and permits.

The EMSL OPS design is specifically structured to promote a proactive safety-management environment through use of the checklist to be used by the cognizant space manager (CSM) for assessment. The Self-Assessment Checklist, designed to promote proactive, responsible

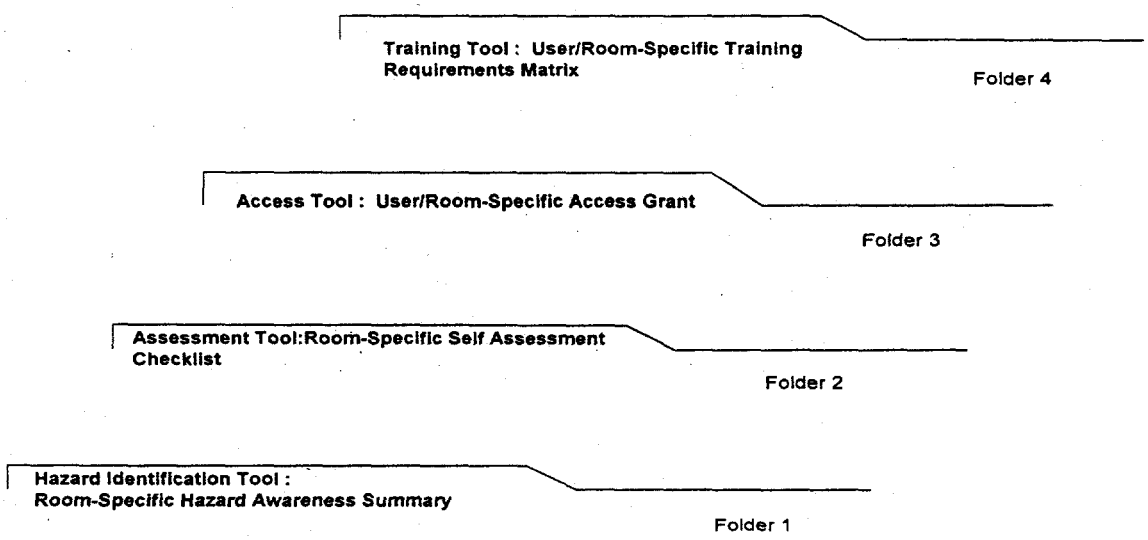


Figure 2.6. Essential Operational Information

management, not only encourages safety-oriented operations, but makes it easy to do and maintain current.

To give the CSM greater control over hazards within each managed space, EMSL OPS provides the manager with the capability to annotate the hazards summaries, increasing their value to promote hazard awareness. Changes due to variability of actual operating conditions, new laboratory equipment requirements, or new operational policies and goals can be provided by rapid hazard summary and self-assessment checklist modification.

The basic EMSL OPS information system structure concept is a normalized database-table structure which maintains the flexible motif of the EMSL OPS design. The tables have been structured so that new data elements supporting new functionality can be added without database redesign. This is important because the EMSL OPS learning-organization culture can well demand changes and additions to EMSL OPS functionality. This may come about not only to keep EMSL competitive as a laboratory, but to bring all elements of the operation, including personnel and programs as the final system evolves, more fully into the integrated EMSL OPS design.

In the original EMSL OPS design concept, integration capability was embodied in a folder metaphor representing six key reference and operational files. Each folder/file had an operational purpose for achieving an integration across all aspects of operations, including research, facility, and personnel and program operations. Integration of personnel qualification and performance in the conduct of operations could be linked easily to the day-to-day control of conduct of operations. If one considers a folder to contain only essential operational information, then this file metaphor remains valid but it is simplified to four folders, as illustrated in Figure 2.6.

The folders are actually represented by a more flexible database-table structure. Again, note that the file-folder metaphor is used above primarily to convey that EMSL OPS is based on essential operational groupings of information that are easily integrated across all management

and operational activities of EMSL. The information in the folders is stored in tables in the EMSL OPS database and assembled on user demand. The folder numbers are used here only for reference. Each set or "folder" of operational information is a tool used to answer basic questions which could be asked of any on-going, dynamic operation.

Folder 1 information grouping answers a basic operational question, "what is the requirement?" It contains the Hazard Awareness Summary (HAS) which ties a specific facility space to the presence of specific hazards and requirements for the management of those hazards. This folder tool can be annotated for each hazard with additional, specific instructions to improve the safety or increase the awareness of each potential user of the dangers presented by the hazard.

Folder 2 information grouping answers a basic operational question, "what is the assessment or what is the status?" It contains results from each assessment, the Self-Assessment Checklist. The checklist is made by the cognizant space manager, using EMSL OPS to create a room-specific hazards- and safety-requirements checklist; the checklist can have the perspective of a research space cognizant manager or a facility space cognizant manager (see Appendix I for examples). Checklists can be printed out; it must be reviewed by the next higher line manager upon initial creation and modification, and a permanent record is kept on file (see "Conduct of Operations Requirements for DOE Facilities," DOE 5480.19, Chapter X, "Independent Verification Program").

Folder 3 information grouping answers a basic operational question, "who has been granted access to which spaces in EMSL?" It contains the registered list of users granted access to a particular space for a specified period of time, their responsible EMSL host, and their status as a user with respect to access for research, escorted visit, or other purposes. This information is essential in maintaining the security and operationally safe status of EMSL.

Folder 4 information grouping answers a basic operational question, "what training does a particular user have, require for entry into specific rooms, or need to have updated?" It is actually represented in the EMSL database as a training matrix; all information can be updated easily for each potential or actual user of each space in the facility.

Once again, note that the four operational questions illustrate the fact that the database-table structure of these folders provide basic information from a purely operational viewpoint. EMSL OPS establishes and maintains an operational orientation across all operational areas and is capable of extending this dynamic table structure to new operational and management functions as the organization's learning process extends EMSL's capabilities and efficiencies.

2.2.1 Hazard Identification and Self Assessment

Understanding how the three operational control functions work will show how EMSL OPS achieves increased efficiencies for conduct of operations and how it provides increased opportunities for responsible ES&H management. The key to all three functions is hazard identification and self assessment, which produces two primary products, (1) a Hazard Awareness Summary (HAS) for each or any space in the facility; and (2) a Self-Assessment Checklist for each or any space in the facility.

Hazard identification and self assessment is performed by the CSM. It is the CSM's responsibility to ensure that each space for which responsibility is assigned has a Hazard Awareness Summary that has been completed and fully annotated for any special additional instructions and any unique properties or features of the facility space. Note the importance placed upon the Hazard Awareness Summary, which must be read by all users, by the DOE 5480.19, "Conduct of Operations Requirements for DOE Facilities," Chapter XIV, "Required Reading." Once filled out, filed, and available electronically on EMSL OPS, the HAS is the integrating document, linking space, hazard and CSM responsible oversight. Any potential user's training requirements must meet the training requirements associated with each piece of equipment or operating hazard present in the space as recorded on the HAS. Note again that DOE 5480.19 emphasizes that each user must receive the information important to their "position."

It is also the CSM's responsibility to prepare a facility space for user entry or research activity by executing a Self-Assessment Checklist for the space and for all of the hazards present. It is based on the hazards identified in the HAS. The self assessment becomes the log of operating conditions and is filed in the EMSL Laboratory Handbook for the laboratory space which was evaluated. A review is conducted by the line manager prior to the filing. See "Conduct of Operations Requirements for DOE Facilities," DOE 5480.19, Chapter XI "Logkeeping," and also Chapter XC3f, "Operations Self-Appraisal and Verification."

Self assessments can be made from the viewpoint of either a cognizant space manager of a research laboratory or by a cognizant space manager of any other type of facility space. Self assessments can also be made from the perspective of a facility cognizant space manager who is assessing a research space. Examples of all three self-assessments are shown in Appendix I.

To support these responsibilities, EMSL OPS provides for the function to be performed as follows.

Step	Action	Note
1	CSM is notified when self assessment is required	Start dates for assessment and intervals between assessments accessible to Safety Officer in database.
2	CSM performs hazard identification, annotates Hazard Awareness Summary and creates or modifies permits as appropriate.	EMSL Practices and Permits available for review electronically in WP format
3	CSM prints annotated Hazard Awareness Summary and files it in appropriate EMSL Laboratory Handbook.	A screen-provided dialogue box accepts a separate direct annotation entry for each hazard present. Annotation is quickly and easily made and becomes a permanent part of the HAS, until changed by CSM.
4	CSM accesses and reviews Self-Assessment Checklist.	CSM prints out checklist. EMSL Practices and Permits are available for review electronically in PDF format.

Step	Action	Note
5	CSM or designate performs self assessment by answering on-screen questions.	CSM answers questions on printout.
6	Line manager verifies completion of Self-Assessment Checklist.	Line manager verifies printout.
7	Clerk enters completion date into database. Completed Self-Assessment Checklist is accessible electronically.	Manual copy goes to CSM and filed hard copy becomes official record.
8	CSM files completed Self-Assessment Checklist in appropriate EMSL Laboratory Handbook.	Manually posted.

2.2.2 User Access and Qualification Requirements

Once the HAS has been prepared, determination of user access and qualification requirements can begin. The user access and qualification function has two purposes: (1) control access to a space; and (2) define training requirements for the user in that space (see "Conduct of Operations Requirements for DOE Facilities," DOE 5480.19, Chapter XIVA2, "Reading Assignments").

The registration and training function produces two outputs, a list of registered users and a training matrix for each user (see Table 2.1). Registration is for a specified period, identifies the user's EMSL host, and the spaces to be authorized for entry by the user. The user's training matrix includes all facility spaces for which the user has authorization and shows training requirements for each hazard present in each of the authorized spaces with which the user will be associated.

2.2.3 Safety and Training Requirements Information

This is the third EMSL OPS function; safety and training requirements information is presented in Table 2.2. This function provides ready reference for EMSL OPS foundation information to all users, including the off-site user (off-site access is not available at initial release of this version). This function completes a critical flow of information back to the user and provides an electronic format for the reading requirements of "Conduct of Operations Requirements for DOE Facilities," DOE 5480.19 Chapter XIV, "Required Reading." Excerpts of this order which are satisfied using EMSL OPS are:

1. ". . . proper use of a required reading file." The Hazard Awareness Summary and other versions of this information are required reading. Specifically, personnel desiring use of a laboratory space, however briefly, must read and acknowledge the Hazard Awareness Summary for that space (DOE 5480.19, Chapter XIVA).

2. ". . . a method to ensure that each individual receives the information important to his/her position." Users are not allowed into a space without completion of proper reading assignments. Access cannot be granted for use of laboratory without this completion (DOE 5480.19, Chapter XIVB).

Table 2.1. User Training Matrix

Step	Action	Note
1	Host requests access to space for user.	EMSL OPS provides on-screen display of hazard matrix for that space.
2	Host identifies as active or passive each hazard present in each space for which access is required.	
3	EMSL OPS notifies CSM of access request.	
4a	CSM authorizes/denies access and modifies type of access (active/passive) for each hazard/equipment present in the space as appropriate.	
4b	CSM enters data into a training vector for each space. All spaces together or all training vectors together form the training matrix for the user.	
5	EMSL OPS provides training matrix to the user. The matrix consists of a label at the top or an orientation box. The matrix has four rows: First row--Review of Hazard Awareness Summary; Second row--Training Requirement: Hazard-Specific Training required; Third row--Training Requirement: Job-Specific Training required; and Fourth row--User's training deficiencies for all the Spaces in the matrix, created by summing the second and third rows for the user's training requirement for all Spaces and subtracting the sum from current training possessed by the user. Host prints out Training Matrix for user. Blank boxes in fourth row indicate training deficiencies.	Codes used to show user training status is complete are C, F, W, and R. C: User has completed PNNL training course; F: User has reviewed the appropriate Fact Sheet; W: CSM waives the requirement; and R: User has reciprocal training or experience and reciprocity is granted.
6	Training deficiency removal must be performed next. This is done in one of two ways in combination: CSM can 1) award reciprocity (R) or 2) waive the requirement (W) User can 1) complete the appropriate PNNL training course (C) or 2) review the appropriate fact sheet (F)	Removal of deficiency is denoted by entry of the appropriate letter in the empty box and initialing the entry.
7	User signs and sends completed Training Matrix to access clerk. DOE 5480.19 requires completion of reading by user be documented (Chapter XIVC4, "Documentation").	User physically carries to access clerk. Partially completed Training Matrix may be submitted for those spaces for which training has been completed or accepted.
8	Access clerk closes the user registration cycle. 1) Copies and files completed Training Matrix; 2) Returns original Training Matrix to user 3) Enables access to the space(s) for user, as appropriate 4) Enters data (what, when, how) into training database.	Once access to a space has been granted, either the host, the CSM, or the user can have it revoked at any time by sending a message to the access clerk. The access clerk performs duties manually.

Table 2.2. Safety and Training Requirements Information

Step	Action	Note
1	User selects training information, hazard awareness information, or EMSL *Users' Guide.*	
2	User selects training information path; the user's personal training matrix appears.	
3	User selects hazard awareness information path: User enters spaces for which entry is desired, EMSL OPS returns Hazard Awareness Summaries.	On-screen links are provided to practices and permits. User may also select and view EMSL practices or SBMS full-text documents.
4	User selects EMSL *Users' Guide*; user views of EMSL *Users' Guide* Table of Contents	

3. "File index" of only the important information. All changes to practices, equipment, best industry practice and related information are part of the Hazard Awareness Summary or the annotation by the CSM (DOE 5480.19, Chapter XIVC1).

4. ". . . a method should be in place to designate which documents need to be read." This is a design feature of EMSL OPS. Only the pertinent documents required for entry into a space are also required to be read (DOE 5480.19, Chapter XIVC2).

5. ". . . a required reading date should be designated for reading each document." Entry is not allowed without completion of the reading assignment, endorsement and dating of the record copy (DOE 5480.19, Chapter XIVC3).

Note that this function also provides for the DOE 5480.19 requirement for management to provide short-term information (DOE 5480.19, Chapter XVA, "Timely Orders to Operators").

EMSL OPS achieves a simplicity of operational control based on a registration process which maps each host-sponsored user into a specific laboratory space. Identification of all hazards present in the space and comparison of the training required for those hazards with deficiencies in user's current training are described in the training matrix.

All training requirements are built into a single training matrix for each user. Each row or vector in the matrix contains the training requirements for all hazards present in a given space for which access is desired. These requirements are compared, space by space, with the user's current requirements, additional training is determined by the CSM, and authorization is granted as the additional training is completed, waived, or reciprocity is granted to the user.

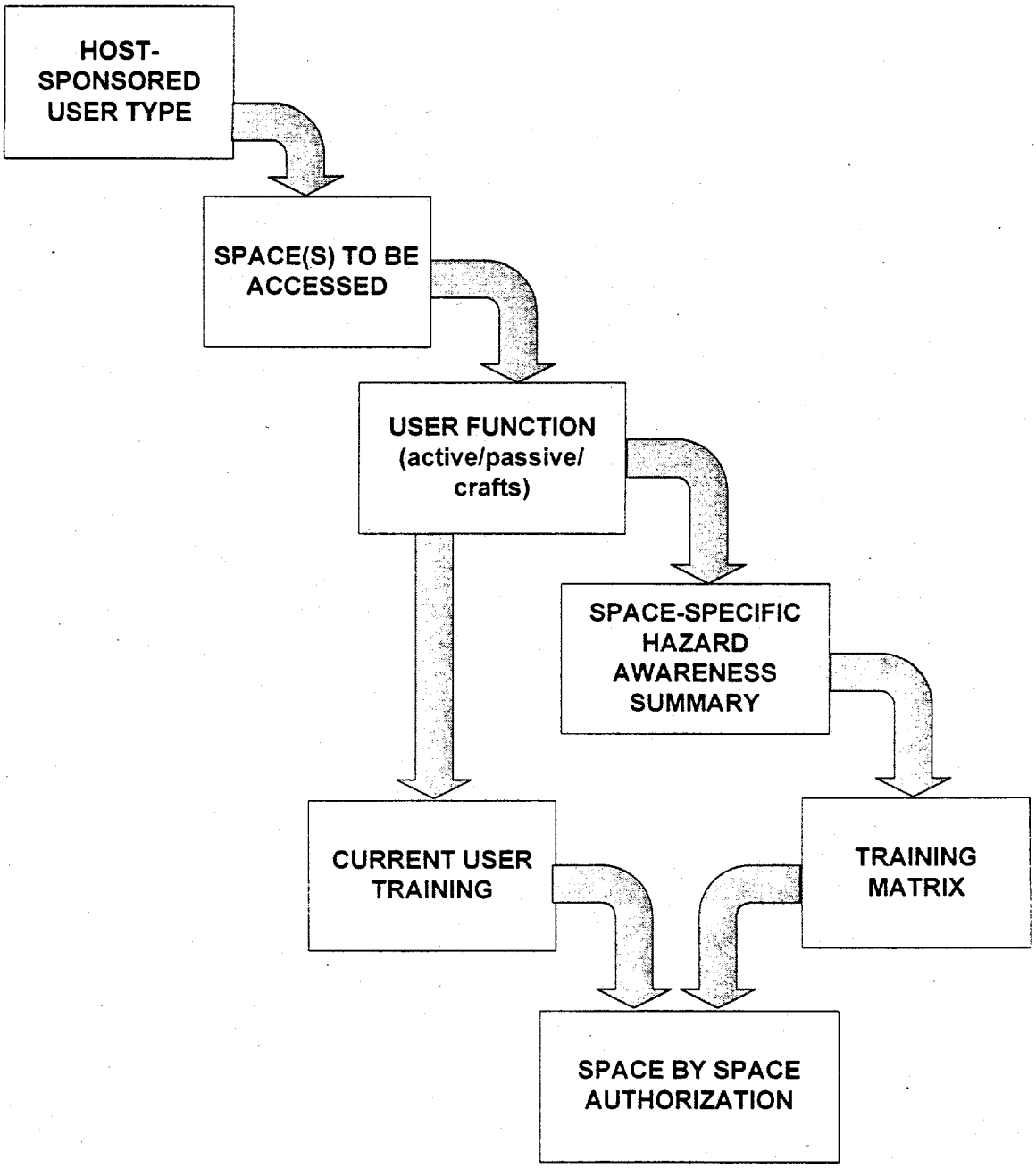


Figure 2.7. User Authorization Review

2.2.4 Stepping Through the Information Flow: EMSL OPS Controls

Once EMSL OPS recognizes the user as a cognizant space manager, the three CSM control functions discussed above are displayed for selection. The CSM's answers to the hazard identification questions/selections gives EMSL OPS a space-specific Hazard Awareness Summary to provide for the research laboratory space, the associated dock/storeroom space, the chemical storeroom, the adjacent utility service corridor, or whatever facility space is under hazard identification review. The flow of control maintained by EMSL OPS is shown in Table 2.3.

Creation of the space-specific Self-Assessment Checklist can only be done by a registered cognizant space manager. EMSL OPS allows only persons fully responsible for a space to determine its hazards and to append an annotation for additional guidance or information for each hazard type. This includes further definition of each user's responsibilities with respect to process control for operations involving facility chemistry and unique processes (DOE 5480.19, Chapter XIII, "Operations Aspects of Facility Chemistry and Unique Processes").

The CSM also has full authority to approve requests for registration as a user qualified to enter the space under purview of the CSM. In addition to spaces controlled as part of Conduct of Research Operations, there are also more general facility spaces under a Conduct of Facility Operations and an essential linking of these space operations with a Personnel and Program Conduct of Operations. Clearly the CSMs for facility operations include the Building Manager and designated personnel.

At the same time, Personnel and Program Managers and their staff must be able to tie selection of qualified staff, development of competitive laboratory programs, and staff and program performance measurement criteria into the use of all laboratory spaces. Direct tie-in of Personnel and Programs Conduct of Operations will not occur in the early version of EMSL OPS, but will be incorporated as later versions integrate a wider scope of EMSL operations than can be satisfied by the EMSL construction line item at initial release.

2.2.5 Stepping Through the Information Flow: Distribution of Functionality and Training

Another view of both functionality and system flows is seen in Figure 2.8. Note that the Building Manager has as much responsibility, and possibly more, as a cognizant space manager has for a research laboratory. Note also that of the fifteen types of facility spaces, only one of them is a research space type.

While the improper operation, maintenance, or application of equipment in the research laboratory is a major source of potential laboratory hazards, supporting areas in the laboratory

Table 2.3. Cognizant Space Manager Access to EMSL OPS: Control Flow

EMSL OPS recognizes individual user type as a registered CSM.	CSM functions are displayed for selection.
EMSL accepts Hazard Awareness Summary with annotation from CSM as official summary for the designated space.	Database populated with HAS information.
EMSL OPS accepts CSM approval/denial of user registration request.	CSM modification to user active/passive status for each hazard present in the space is recorded along with user registration acceptance/denial.
EMSL OPS accepts CSM modifications to existing HAS.	
EMSL OPS makes Self-Assessment Checklist available to CSM.	
EMSL OPS accepts completed SAC as current safety status for selected space.	Database populated with SAC information.
EMSL OPS notifies appropriate CSM of changes to EMSL Practice, Permit, or SBMS Reference.	
EMSL OPS accepts CSM changes to EMSL Practice or Permit.	Database for EMSL Practice/Permit is updated.
EMSL OPS accepts CSM as host for recommendation of users for registration.	
EMSL OPS accepts user self-checkout from a space.	
EMSL OPS accepts host (EMSL staff) checkout of a user from a space.	

including utility rooms, service corridors, and power, gas, and other service nodes are also spaces or points within the facility that require special attention to hazard mitigation measures. The levels of power, pressure, and temperature in these service areas can be at the same hazard levels as those within the laboratory itself. The responsible staff assigned to each of these non-research areas are usually not the individual cognizant space manager or the laboratory monitor. While a cognizant space manager may be responsible for certain equipment in a corridor, there will be a manager with overall responsibility for safety within the utility corridor. For example, a research laboratory space will have associated with it a utility service corridor and several other types of spaces. In some utility service corridors, cognizant space managers may have equipment under their purview for research purposes, while a single line manager will be responsible for common resources and for maintenance personnel assigned to service the equipment in the corridor. Some equipment that is principally in place for laboratory safety may not be under the cognizant space manager's purview. Pumps that maintain positive-pressure zones and cooling systems that dissipate large heat fluxes may constitute fail-safe systems for one or more individual laboratory or for a region of the entire facility. Even though directly related to laboratory safety, these also may be the sole responsibility of a line manager and

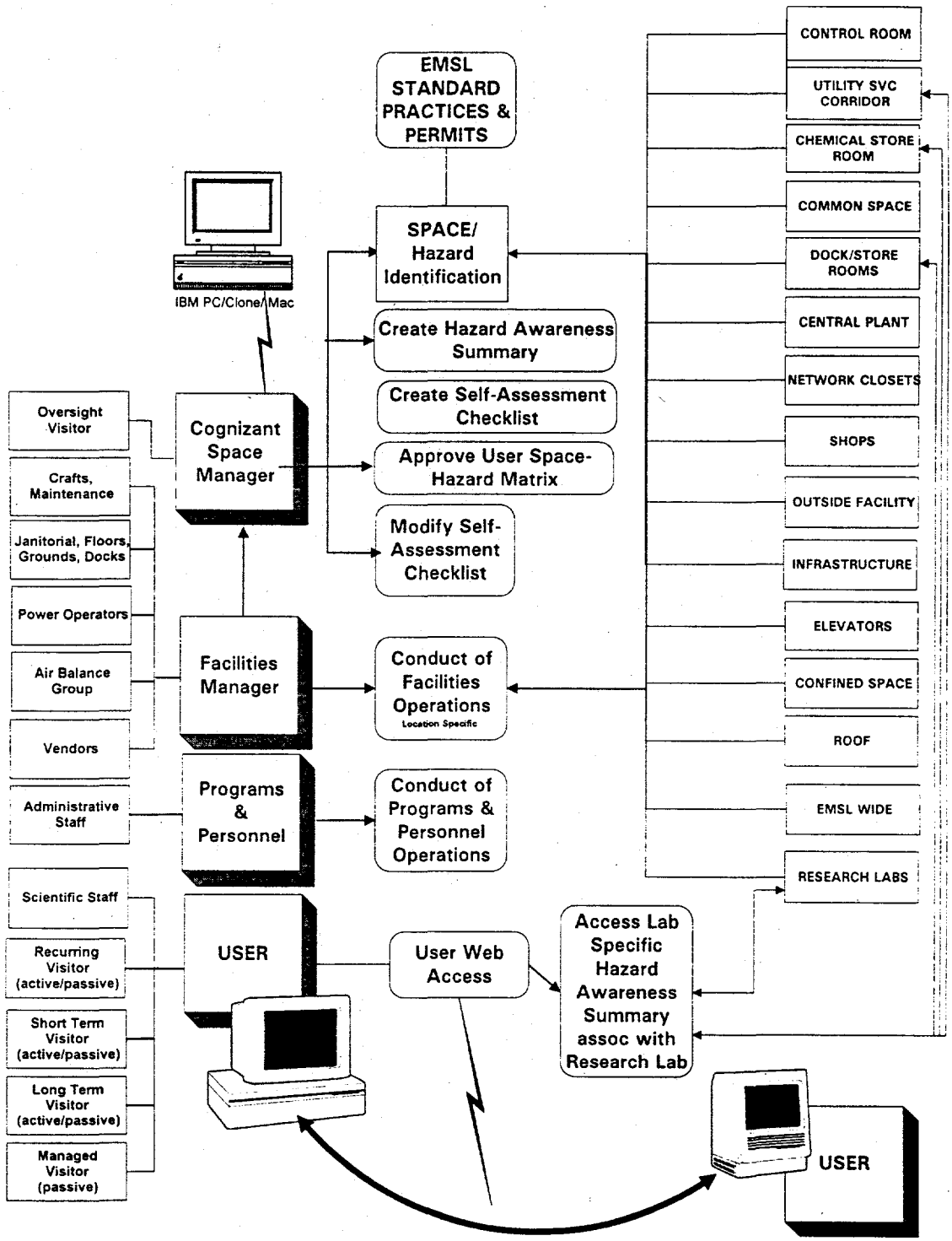


Figure 2.8. Distribution of Functionality and Training

associated cognizant space manager for maintenance staff personnel, and not that of a cognizant space manager for the research space.

No functionality is shown for Personnel and Programs Conduct of Operations; however, this functionality is being developed on the WWW as a separate activity. Integration into EMSL OPS will occur at a later date. The two user boxes are to depict the many possible users who will access EMSL OPS from the Internet as the full capability of the system is opened up for world-wide research access. Also note the user types shown (on the right in the figure) are merely representative and are not meant to limit EMSL OPS to those types.

There will be differences in required training for different user types and different levels of access required for each user as defined by specific levels of training acquired by each user.

Generally, the amount of training is proportionally increased based on whether the worker is passive, supervised, or active with respect to interaction with a hazard. All persons entering a common or shared space must comply with those hazard checklists which provide safety and health information for protection for their type of laboratory activity (research, crafts, etc.). Power control operators and crafts personnel *entering the same shared area* will obviously have a different, usually more detailed, procedural checklist than has the researcher. Crafts personnel may also have on-the-job or other required training before entry is allowed. This is discussed in greater detail under Conduct of Facilities Operations. In general, user training requirements specific to the purpose will be detailed in the training matrix for that space.

2.2.6 Host/User Interaction with EMSL OPS System

In the current EMSL OPS version, the user is set up for access to a space by a host, usually an EMSL staff member (see Figure 2.9). The host will complete a space-hazard matrix for the user. This matrix becomes the basis for the user's training matrix. The CSM, in the approval process, can modify the active/passive classification, requested by the host for each of the hazards present. Upon approval by the CSM, the host prints the training matrix and gives it to the user so that the training requirement will be completed before entry into the requested space(s).

No matter to which of the EMSL OPS laboratories or other facility spaces a user is requesting access, an authorized host must request the access and a CSM must approve the user's training matrix.

2.2.7 Cognizant Space Manager View of System

From the cognizant space manager's viewpoint, as shown in Figure 2.10, the CSM can choose from several EMSL OPS functions to produce a range of products from the Hazard Awareness Summary to the user training matrix. In summary, the cognizant space manager accesses the EMSL OPS as a manager coming to EMSL to perform a specified management function: hazard identification and self assessment, user registration and training, or safety and training requirements.

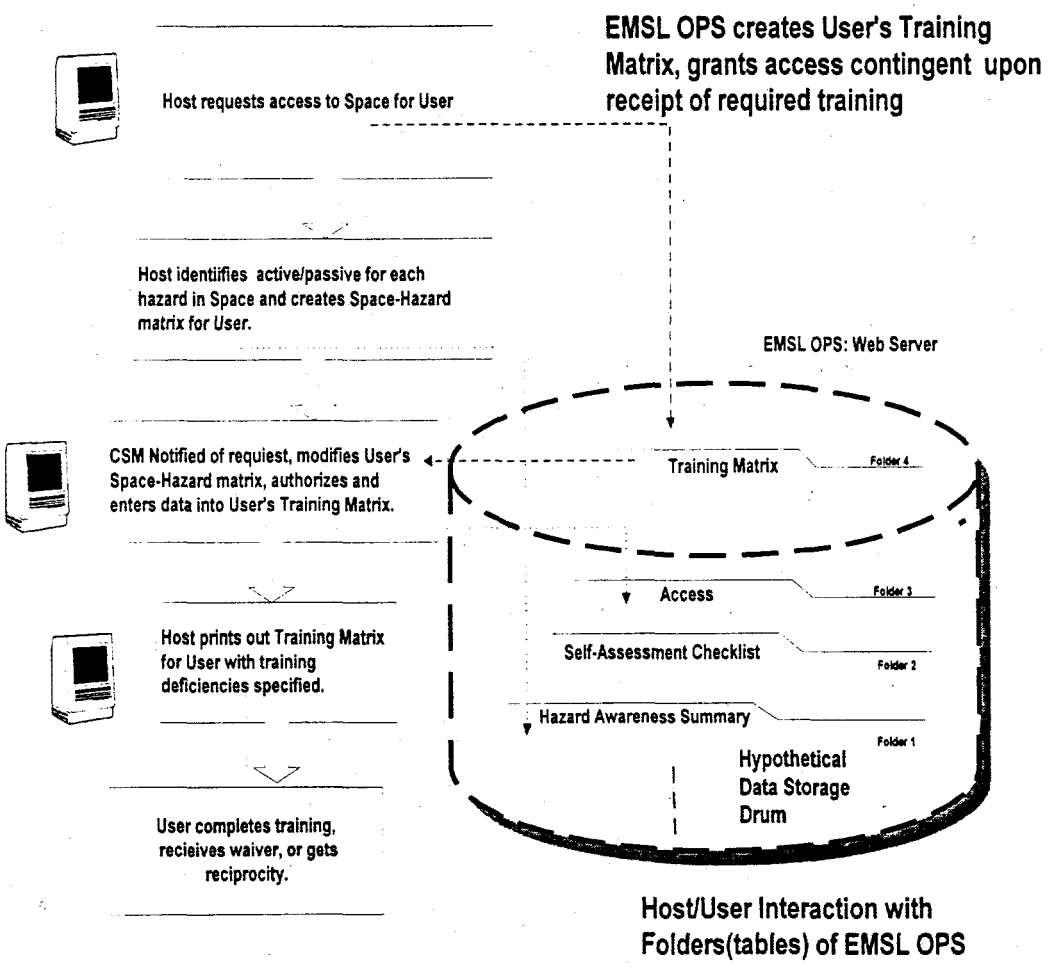


Figure 2.9. EMSL OPS User Training-Matrix Mechanisms

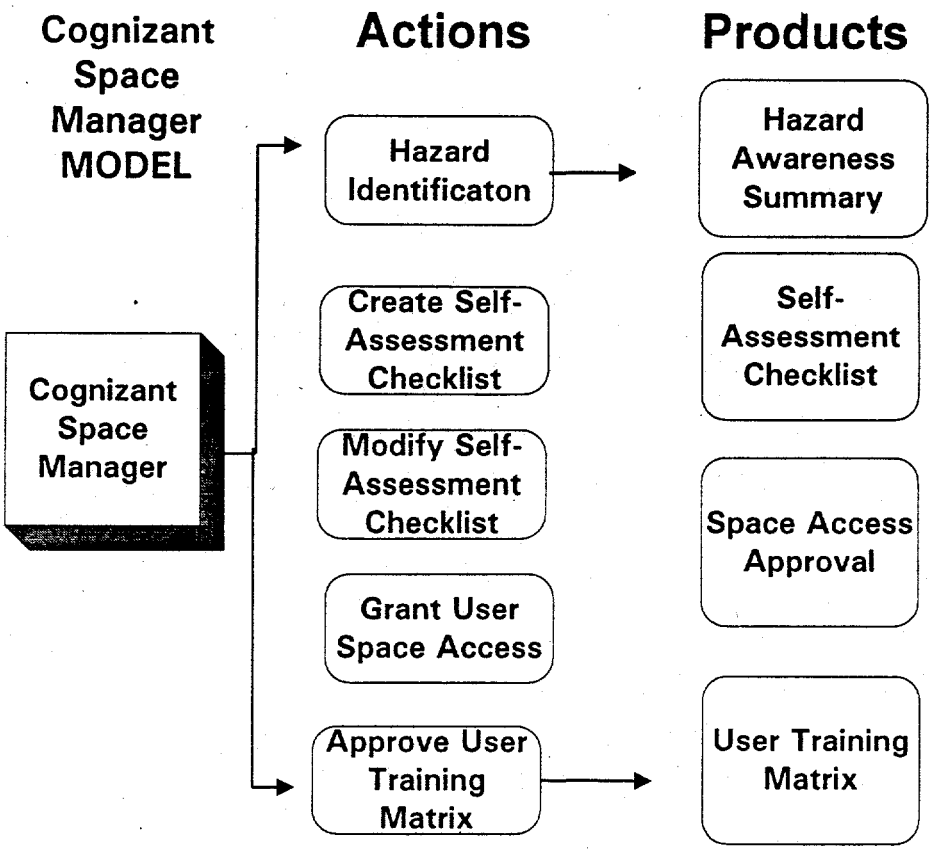


Figure 2.10. Cognizant Space Manager Model

2.2.8 Conduct of Research Laboratory Operations

Hazard identification and mitigation is an essential function supporting the daily, efficient operation of any laboratory. With an active Hazard Awareness Summary using a hazard identification and mitigation program or process, a laboratory is not unduly exposed to risk or loss of laboratory capital assets, loss of injury-free person-days, and perhaps even physical harm to the research staff. Hazards originate in each of the many research laboratories that make up the facility and each of the research projects within these laboratories. Common service areas, under the management of laboratory staff other than the research staff, that are poorly maintained or inadequately supervised may also contribute to hazard exposure and loss of hazard containment. Because of this dual local and area/regional potential hazard impact, hazard identification and mitigation is both an individual and a corporate laboratory responsibility.

In the past, safety has been enforced from the top with the individual subject to numerous compliance directives. The primary goal of EMSL OPS is to make all resources appear as a free-networked utility so that the individual CSM is empowered to take greater initiative for all local operations, including hazard identification and mitigation. The Hazard Awareness Summary, which results from the hazard identification action, is used by the host to qualify a potential user for access to a particular space. EMSL OPS brings the host recommendations, based upon user need and the HAS, back to the CSM for approval, giving full-access authority to the individual most fully aware of all hazards for the research space under their control. Finally, the CSM also must approve the user's individualized training required to enter that space.

2.2.9 Conduct of Facilities Operations

Facilities (non-laboratory space) operations require a more detailed checklist than the Self-Assessment Checklist provides. In general, non-laboratory space checklists will include more information than the laboratory checklist because all pertinent information about safety, fire, and alarm systems is part of these documents. Additionally, any safety programs will be explained in these Crafts-oriented Self-Assessment Checklists. The Self-Assessment Checklists used by the cognizant space managers are considerably shorter, each an appropriate subset of one of the research CSM Self-Assessment Checklists.

Especially important are control area or control-room operations, which are under the direct supervision of the Building Manager. Entry into the EMSL Control Room is strictly controlled using the full suite of EMSL OPS access controls. Only visitors or users cleared through EMSL OPS can obtain entry. Control Room access will be limited as proscribed by "Conduct of Operations Requirements for DOE Facilities," DOE 5480.19, Chapter IIIB, "Control Area Activities for DOE Facilities."

Control-area access within the Control Room will be further restricted, with special attention paid to the "at-the-controls" area of the Control Room to restrict access further to that area (DOE 5480.19, Chapter IIIC1).

Professional behavior of control operators, their activities while in the Control Room, ancillary duties, and operation of the equipment are all specified by EMSL Practices.

The responsible Environment, Safety and Health staff currently assigned to each space are listed in Table 2.4.

Table 2.4. Environment, Safety and Health Staff Assignments

Space	Responsible Staff	Ancillary Safety Staff
Control Room	Building Manager	Utility Operations Supervisor and Staff Safety Officer assist and advise
Utility Service Corridor	Building Manager	Maintenance and Utility Operations Supervisors and Staff Safety Officer assist and advise
Chemical Store Room Compressed Gas Storage	HMECR (Hazardous Material Environmental Compliance Representative)	Hazard Material Custodian (HMC) Chemical Hygiene Officer
Common Space	Building Manager	Janitorial and Floor Service Supervisors and Staff Safety Officer assist and advise
Docks/Store Rooms	Building Manager/ HMECR	Transportation/Grounds Supervisor and Staff Safety Officer assist and advise
Central Plant	Building Manager	Utility Operations and Maintenance Supervisors and Staff Safety Officer assist and advise
Network Closets	Building Manager	Maintenance Supervisor and Staff Safety Officer assist and advise
Shops	Maintenance Supervisor	Safety Officer assist and advise
Outside Facility	Building Manager	Transportation/Grounds Supervisor and Staff Safety Officer assist and advise
Infrastructure	Building Manager	Maintenance and Utility Operations Supervisors and Staff, Facility Engineering Staff Safety Officer assist and advise
Elevators	Building Manager	Maintenance Supervisor and Staff Safety Officer assist and advise
Mechanical Rooms	Building Manager	Maintenance and Utility Operations Supervisors and Staff Safety Officer assist and advise
Roof	Building Manager	Maintenance and Utility Operations Supervisors and Staff Safety Officer assist and advise
Research Laboratories	Cognizant Space Manager	Chemical Hygiene Officer Safety Officer assist and advise

Table 2.5. Safety Functions and Responsible Office

No.	Safety Function	Responsible Office
1	Facility Safety Programs	Operations Manager, Building Manager
2	Agency and Others Inspection (periodic)	Operations Manager, Building Manager Cognizant Space Manager
3	Prep and Risk on project initiation or change of scope	Cognizant Space Manager , Principal Investigator
4	Office/dry laboratory safety semi-annual	Building Manager, Cognizant Space Manager
5	Hazardous laboratory safety quarterly	Building Manager, Cognizant Space Manager
6	Safety status report, event-driven	Cognizant Space Manager

The 14 facility-space types are subject to six types of safety functions, inspections, or assessments and reporting requirements, as shown in Table 2.5. Maintaining an active safety program is the direct responsibility of line management and includes the Operations Manager and the Building Manager, as assisted and advised by the Laboratory Safety Officer.

The Operations Manager, with advice from the Safety Officer, is ultimately responsible for the proper performance of all of the above safety functions. This is true even though the cognizant space manager may initiate safety functions 2, 3, 4, or 5. The cognizant space manager is responsible to be present during the conduct of safety functions 3 and 4, the annual and quarterly inspections, and must provide any required corrective action. A principal investigator may initiate safety function 2 for any given project. Any researcher may initiate function 6 to report a safety incident. Generally, any staff member may initiate a safety report in keeping with the organization's central goal for taking responsibility and improvement down to the lowest operational line.

2.2.10 Conduct of Personnel and Program Operations

Personnel and Program managers, while being developed separately, will be integrated into EMSL OPS with WWW access in the future. Current PNNL Practices will continue to be used in the interim. Personnel and Program functions will be provided for the following operations.

Storage and retrieval of checklists and performance outcome and system efficiency measures in support of the following functional areas:

- General
- Research
- Business/Finance
- Visitors
- Procurement

- Security
- Facilities
- Communication
- Computer Support
- Administration Support
  - Training
  - Medical.

EMSL OPS Practices for Personnel and Programs will contain, among other documents, "Outcome Measures" and "Measures of Management Systems," which define the non-hazard system operation and which ensure implementation of the critical success factors discussed in section 2.1.1. Ultimately, a set of Outcome Measures and Measures of Management Systems will be provided for each of the CSFs.

A condensed set of documents for each CSF, such as one for Highly Qualified Staff, will be integrated into the EMSL Practices. In conjunction with this larger set of Practices, a set of Self-Assessment Checklists also will be created, similar to those provided for hazards but oriented toward Personnel and Programs.

Finally, the EMSL Practices, Permits, and the Self-Assessment Checklists will be used by Personnel and Programs Managers (Responsible Manager), as shown in Figure 2.11 In the case

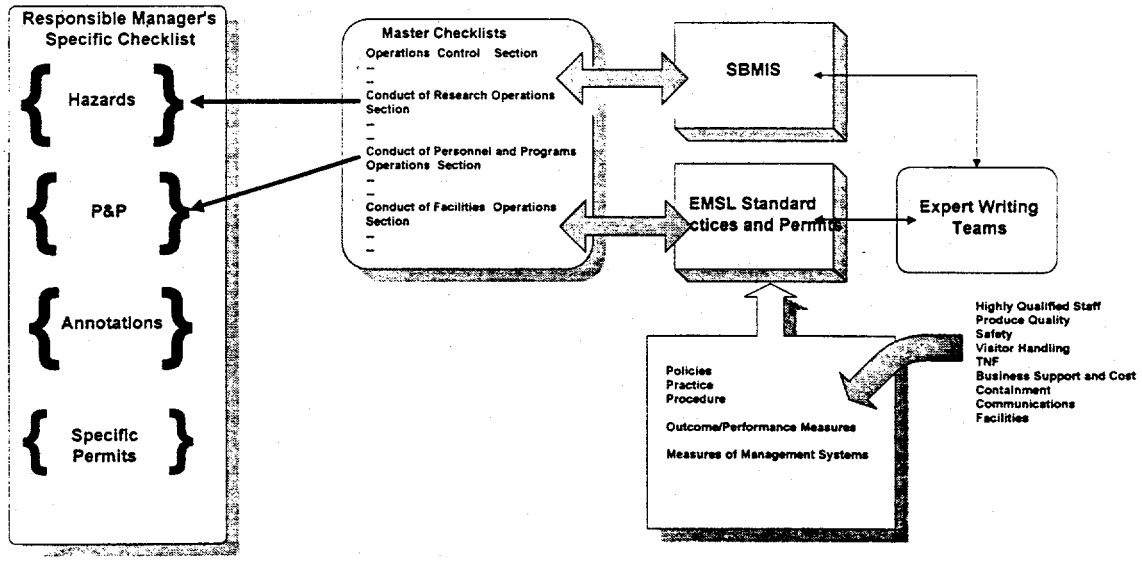


Figure 2.11. EMSL Practices, Permits, and Self-Assessment Checklists Used by Personnel and Programs Managers

Table 2.6. Working Level Functions

Working Level Function	Programs	People
General	√	√
Research	√	
Business/Finance	√	
Visitors	√	√
Procurement	√	
Security	√	
Facilities	√	
Communications	√	√
Computer Support	√	√
Administrative Support	√	√
Staff Development		√
Managing Concerns		√
Working Structures		√
Out-Placement		√
Recruiting		√
Training	√	
Medical Surveillance		√

of the researcher or cognizant space manager, the responsible manager's specific checklist is the Self-Assessment Checklist for hazards in a space. The Personnel and Programs responsible manager will be able to create their Self-Assessment Checklist and annotate it, just as can the CSM create the Self-Assessment Checklist. Upon integration of Personnel and Programs, a single, unified design concept, with outcome measures for performance will be established for EMSL OPS.

The working level functions managed under this rubric can include almost any function that might be necessary to perform in the management of programs or people. This is covered under the "General" category (see Table 2.6). The EMSL OPS system is being structured for Conduct of Personnel and Programs as a manager self-assessment tool, evaluating how well programs, policies, activities are performing in each of the 17 working level functions shown in Table 2.6. Because of its flexibility, EMSL OPS will be adapted as new program opportunities or personnel issues and problems not shown in the current table arise.

2.2.11 EMSL OPS System Integration Summary

Because the EMSL OPS system integrates several classes of users, operates three major functional controls, and maintains an integrated set of database tables (conceptual folders) for space/hazard, space/hazard/user, user/training, space/training, and space/user/hazard/training combinations, a summary of system integration is in order. EMSL OPS is a highly integrated instrument for conduct of operations. The EMSL OPS software, the server hardware, and any associated programs constitute the actual server with added essential support features.

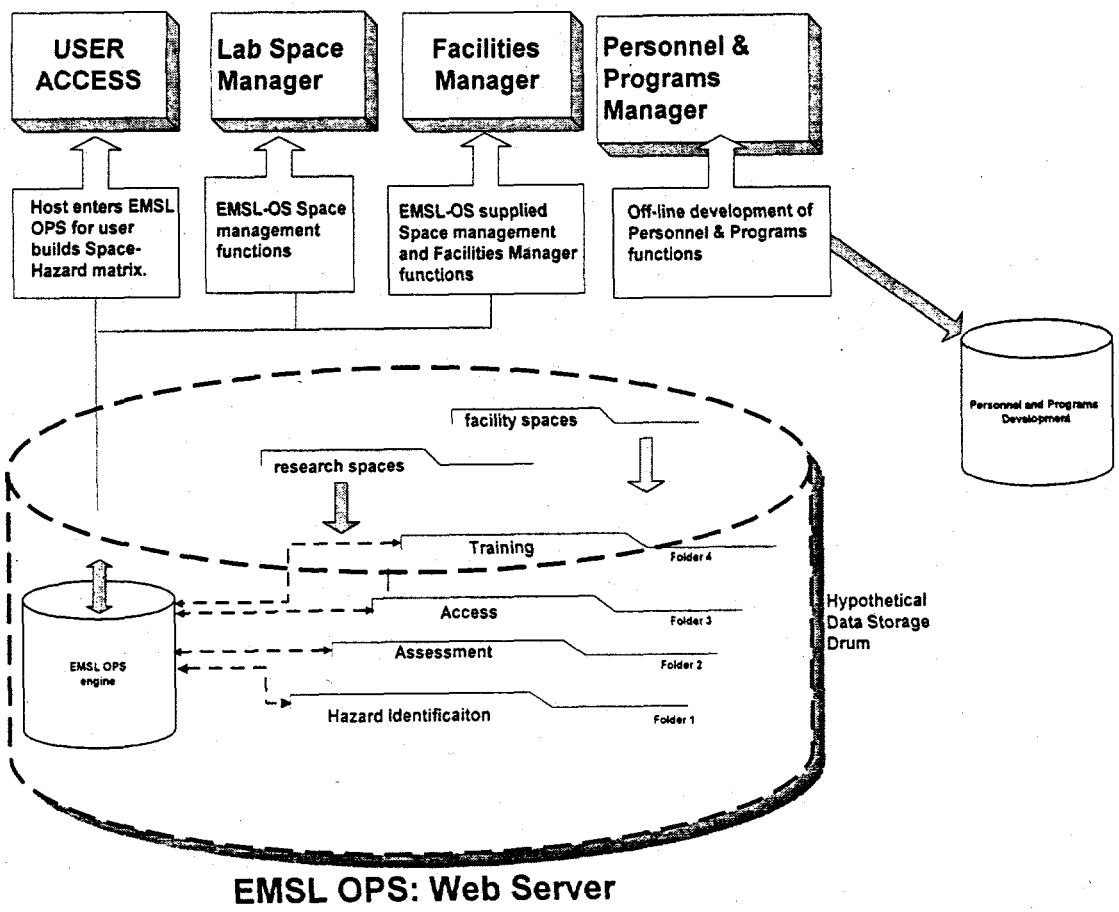


Figure 2.12. EMSL OPS Web Server

EMSL OPS is a combination of

(1) a Web server;

(2) executable scripts (written in Perl) that create HTML documents dynamically;

(3) user-controlled screen functionality for hazard identification, hazard assessment, user training requirements, and electronic access to full-text documents through SBMS and HanInfo;

(4) a database for maintenance of the integrated table structure that will store all EMSL OPS data;

(5) documents for reference and checklist update; and

(6) interfaces to any ancillary or support system, such as for visitors, training, etc.

Principal access is provided as shown in Figure 2.12.

2.3 Product Support Systems

A key business problem solved by EMSL OPS is the lack of an efficient, electronic support system necessary for Conduct of Operations Standards accessibility and operational usefulness. To provide this solution, EMSL OPS requires support from a system that can supply all standard references in electronic format. All hazards mitigation activities in the laboratory have reference standards, some of which are required by State or Federal law and some of which are not well specified but nonetheless are management policy. With an imposing number of these interfaces to those systems supplying full-text, hypertext markup language documents, all in hard copy manual form, they often fail to serve their intended purpose in support of hazards assessment and mitigation and other features of laboratory management.

The dangers of relying on a printed set of hazard assessment and mitigation standards manuals or documents are multiple. Significant time is expended trying to maintain this volume of material, especially in making changes to those subsections that don't apply to EMSL. Staff members and visitors will be forced to look at less relevant material and, because of the volume of the reading assignment, will not focus on the material they absolutely need to know for hazard assessment and mitigation. Finally, the immense volume of material in manuals becomes quickly outdated.

Generally, EMSL or ES&H-required hazard references consist of those from facility equipment and operations, laboratory equipment, special properties of laboratory materials (toxicity, radioactivity), security system requirements, and some of the chemical storage and inventory, use, and disposal.

The following key subject areas and classification sources represent some of the major standards classifications for EMSL. There are many more.

EMSL "Laboratory Handbook" Practices
Cranes, Hoisting, and Rigging
Emergency Response Guidelines
Lock and Tag
Medical Monitoring Guidelines
Ordering Chemicals
Spill Response
Safe Handling Practices for
  Liquid Nitrogen and Liquid Helium
"Stop Work" Responsibility
Use of Compressed Gases
Use of Toxic Gases
Use of Personal Protective Devices
Using Pressure Systems
Use of Laboratory Hoods
Waste Disposal Practices
Working Alone
Working with Carcinogens

EMSL "Laboratory Handbook" Permits
Biological Hazards Use Permit
Chemical Use Permit
Electrical Use Permit
Laser Use Permit
NIR Use Permit
Radiation Work Permit

EMSL "Laboratory Handbook" Appendices
PPE References, Appendix A
Chemical Compatibility, Appendix B
Chemical Inventory, Appendix C
MSDS, Appendix D
EMSLpedia, Appendix E
Update Procedure, Appendix F
NIR Fact Sheets

Computer and Facilities Access Control	Facilities-Level Controls
Chemical Hygiene Plan	MA-43, IH 2.0
Electrical Equipment Safety	MA-43
Toxic Chemicals, Carcinogens, and Biological Materials	MA-43, IH 3.0
Hazard Communication	MA-43, IH 1.0
Hazard Monitoring	MA-43, IH 4.0
Medical Monitoring	MA-43, IH 4.0
Respiratory Protection	MA-43, IH 5.0

Hazardous Gases	MA-43, IH 7.0
Asbestos Program	MA-43, IH 8.0
Safety in Research Laboratories	MA-43, OS 1.0
Chemical Storage and Handling	MA-43, OS 20
Compressed Gases	MA-43, OS 8.0
Protective Clothing and Equipment	MA-43, OS 9.0
Flammable and Combustible Liquids	MA-43, FP 5.0
Chemical Recycling	MA-8, 3.6
Hazardous Waste	MA-8, 8.0
Airborne Emissions	MA-8, 11.0
Liquid Effluent	MA-8, 12.0
Operational Procedures	MA-50, 4.4
Emergency Preparedness	MA-50, 6.0
Project Management Plan	MA-95
Chemical Management System User's Guide	MA-845
NEPA	MA-9
Hazardous Gases	MA-43
Incident Reporting	MA-43
Ionizing Radiation	MA-26
Laser Safety	MA-43, IH14
Non-Ionizing Radiation	MA-43, IH15
Lock and Tag	MA-43
Others (to be specified)	

One manual, MA-43, contains many safety requirements that pertain to EMSL; some requirements come from more than one source. A chemical-hygiene plan, required by MA-43, states the Washington Industrial Safety and Hygiene Act (WISHA) and OSHA regulations for each laboratory where hazardous chemicals are used. The OSHA regulation supersedes the Washington State regulation; it will be replaced in the EMSL OPS with an electronic version. Specific laboratory requirements for this information will be met through the Permit process.

At present, the electronic "A-level" documents are being replaced by a larger topical set of SBMS subject areas. The "A-level" documents are a subset, topically, of the SBMS documents. The cognizant space manager identifies from 30 hazard categories which are drawn from the SBMS subject areas. The CSM is supplied with hazards information, safety support systems information, and ES&H program information. From this information, cognizant space managers, using the Hazards function of EMSL OPS, will select standards for 23 Hazard Identification forms that will be used to prepare the job- or laboratory-specific checklists.

If this symbolism is used: $\mathbf{A} \subseteq \mathbf{B}$ to mean A is contained in B, and the symbolism $\mathbf{A} \rightarrow \mathbf{B}$ to mean that B is a derivative of A, then the relationship between these documents is as follows:

A-Level Manuals $\subseteq$ **SBMS Subject Areas (190)** $\rightarrow$ **Hazard Assessment Checklists (36)** $\supseteq$ **Hazard Class Checklists (23)**

Hazard Assessment Checklists (36) $\rightarrow$ **Checklists for All Other Facility Spaces (includes hazards, systems, and programs)**

Hazard Class Checklists (23) $\rightarrow$ **Laboratory-Specific Checklists (87) (hazards only)**

As shown above, there is a clear path from the current PNNL "A-Level" manuals to the larger set of SBMS subject-area documents through the Hazard Identification forms to the Hazard Class Checklists and to the Laboratory-Specific Checklists. The implication is that nothing is lost from the documentation of the current system safety standards and value is added in the EMSL process.

The "A-Level" manuals and the SBMS subject areas are drawn from a wide range of regulatory document sources, including orders, acts, and codes. The SBMS subject areas are being expanded to include all Laboratory requirements. SBMS and any other electronic document source used provide support for EMSL in the digitization and uniform access of all pertinent regulatory document types. The major classifications of requirements documents and interfaces included as sources initially for the "A-Level" manuals and subsequently for the SBMS subject areas are shown in Appendix VI.

2.4 Product Functions

As discussed above, EMSL OPS provides three sets of primary functions that apply to operations in any operational space, i.e., for Conduct of Research Laboratory Operations, Conduct of Facilities Operations, and Conduct of Personnel and Programs Operations (currently being developed off-line).

2.5 User Characteristics

EMSL OPS must be usable by people who are knowledgeable in simple access and use of the Web and who require information about entry and use of a specific EMSL laboratory, or who manage some aspect of EMSL operations. "Users" can be categorized into two general sets: Users who will be visiting EMSL to conduct research and users who are staff working at EMSL on a routine basis. This simple categorization is far from adequate when determining who needs training and what certification is required before working in a particular laboratory.

The following breakout of user types illustrates the complexity of keeping track of and managing the potential visitor/user population:

- Visitors who will merely tour, be guided, or attend seminars;
- Visitors who will use a laboratory or one or more laboratories for short periods;
- Visitors who will come to use one or more laboratories for extended periods;
- Users from Pacific Northwest National Laboratory/Battelle who will use one or more laboratories periodically;
- Users from neighboring universities who will use one or more laboratories periodically;
- Laboratory maintenance/crafts personnel, not dedicated EMSL staff, who must visit a laboratory or service corridor for emergency repair after hours;
- Laboratory maintenance/crafts personnel, who are dedicated EMSL staff, who visit for any reason under any conditions;
- Air Balance Group personnel, who are not dedicated EMSL staff, who visit at any time or as required;
- Visitors to a utility corridor that belongs to one or more laboratories but is also an extension of the Central Plant;
- Janitorial/floor service/grounds personnel who require access to facility space areas;
- Visitors to Docks where pre-established training is required;
- Facility Manager visits to laboratory spaces for quarterly inspection as required by job description;
- City of Richland Fire Department staff who inspect all facility spaces;
- Laboratory internal Fire Safety/Industrial Hygiene/Electrical Safety staff who perform quarterly and annual inspections of all facility spaces;
- City of Richland Effluent Monitoring staff who inspect facility spaces;
- EMSL research staff who require routine access to more than one laboratory and as many as 10 or more laboratories;
- EMSL administrative staff who must enter a laboratory for any reason;
- EMSL emeritus staff with laboratory privileges;
- DOE Facility representatives and DOE auditors/assessors;

- External regulatory inspectors;
- DOE program/product line managers;
- Remote or virtual user; and
- Foreign users.

A closer look at user access authorization is designed to solve most of the laboratory user/visitor classification problems, as shown in Figure 2.13.

For those accepted into the system as users, the definition of user classifies everyone in two groups, those who need no supervision versus those who need supervision (active/passive). The graded definition in the figure above of users, in terms of access and degree of escort required, further distinguishes user type. The gradation in the figure goes from "active supervision" to "active interaction with hazard manipulated" and shows the type and duration of training indicated for each level of user. EMSL OPS will notify laboratory or space users of major or significant procedural changes. Note that the figure pertains to researchers and that, in general, crafts and maintenance personnel require considerably more than two hours of training.

2.6 General Constraints

EMSL OPS operates within the boundaries and conditions of the PNNL network support environment in which it exists and the systems with which it interfaces. External and internal influences which might constrain the system design include the following.

- *Regulatory policy* - DOE and PNNL guidance for automated system development will be followed.
- *Hardware limitations* - Design options will be limited to those that are compatible with the computer-equipment capacities and protocols on which EMSL OPS will run.
- *Interfaces to other applications* - EMSL OPS is accessible to the browser software used on the Web. The design must also consider other applications with which it interfaces, such as SBMS, the Hanford Technical Library (via the PNNL Network Installer), People Soft, and other systems and databases.
- *Audit functions* - The system design considers the protection of personal information (e.g., passport, security clearance, training requirements, certifications, etc.). EMSL OPS may be subjected to audits of the handling of this type of information. Audit functions include security which is consistent with the EMSL Security Plan and the wider PNNL Computer Security Plan, and audit access of all security and personal information areas.
- *Signal handshake protocols* - Compatibility with Internet protocols is paramount for EMSL OPS. System designers must incorporate all required communications protocols into the final design.

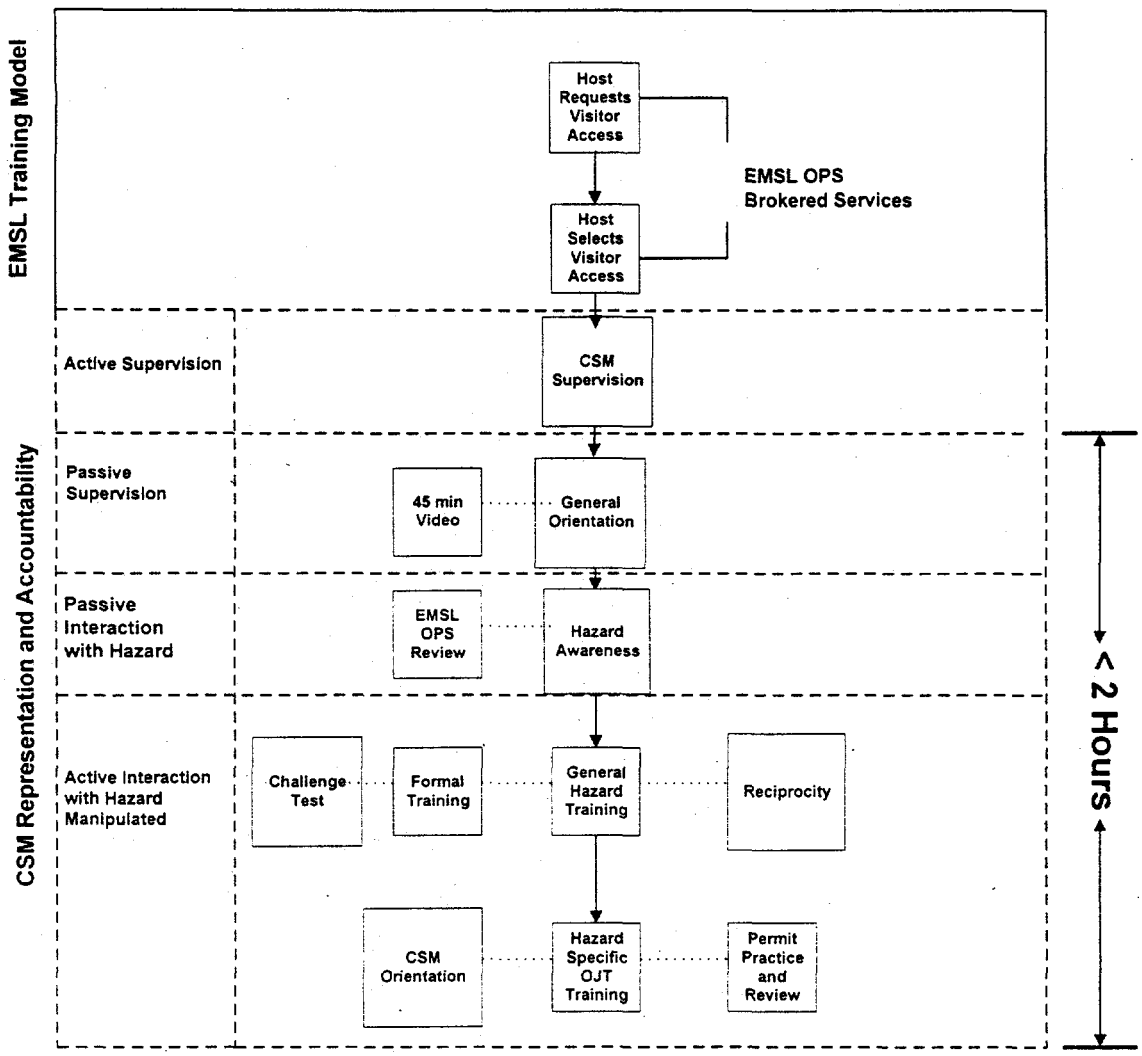


Figure 2.13. User Access Authorization

- *Reliability requirements* - The EMSL OPS design incorporates customer requirements for service by meeting a principal goal of the reliability measure, system availability. Use of an accepted industrial standard will guide final reliability evaluation.

- *Safety and security considerations* - These functions apply to the system design. Data security is important and is accommodated in the final design.

EMSL depends on the electronic supply and auto-update of its digital regulatory input and future reference accessibility. All current requirements documentation is available electronically

on the PNNL network (at HanInfo) with plans to extend this documentation further and the system that maintains it to provide necessary up-to-date references.

2.7 Assumptions

2.7.1 System Access

When EMSL OPS reaches system maturity, any user will be able to access EMSL OPS for all required user functions through the Web.

2.7.2 Regulatory Guidance

Regulatory guidance for EMSL can be either external or internal (PNNL policies or procedures). External regulatory guidance (OSHA, EPA, WISHA, and selected industrial best practices) will be supplied by PNNL through SBMS with full-text external reference source material available through hypertext linkage.

2.7.3 Reference Access

All reference material supplied by PNNL will be accessible beyond the firewall by any user without restriction of copyright, property right, or security in the mature EMSL OPS system.

2.7.4 Self-Assessment Checklist Validity

A checklist will be considered valid or in a valid operational state when it contains all of the information or procedures required for a given operation and can be applied to fulfill and complete certain management or user tasks, such as those required by ES&H regulations.

Managers will be able to create and use checklists for self assessment and other user tasks. These checklists can be maintained in a fully valid operational state. This is an area where EMSL OPS will support the development and management of performance measures.

Subject matter experts will convert this and other DOE, Battelle, and PNNL requirements documents into SBMS documentation.

All external and internal guidance will be reviewed by the EMSL Safety Officer.

3.0 System Requirements

To provide a uniform and robust operating system in direct support of Conduct of Operations, EMSL OPS achieves effective implementation and control of operations by ensuring periodic monitoring and assessment of performance; providing ready access to written standards for operations; and tracking personal accountability for performance. The system is easy to use and employs a succinct style to maximize the transfer of critical information. The system structure is adaptable to additional functionality and data manipulation and is capable of accommodating all phases of Conduct of Operations, including research, personnel and programs, and facilities.

3.1 Functional Requirements

3.1.1 Conduct of Research Laboratory Operations

Conduct of research laboratory operations requires functionality for hazard identification, hazard self-assessment, hazard awareness summarization, user access control, user-specific qualification requirements, and a system for integration and management of conduct of operations. The following specifications and cross links to aspects of functional criteria apply.

- Individual Practices are readily apparent and those with single unit or laboratory space applicability are identified to avoid confusion (DOE 5480.19, Chapter XVIC2a).
- Practices incorporate on-screen button reference to appropriate source document full text (DOE 5480.19, Chapter XVIC2b).
- Prerequisites and initial conditions are detailed in EMSL Permits (DOE 5480.19, Chapter XVIC2c).
- Definitions for unique terms are provided in the EMSL Practices and Permits (DOE 5480.19, Chapter XVIC2d).
- Practices are easily understood, all required actions are clearly stated, and all actions are described in individual steps clarity and simplicity of operations (DOE 5480.19, Chapter XVIC2e & f).
- Practices and Permits avoid use of excessive detail but provide focus and sufficient information (DOE 5480.19, Chapter XVIC2g).
- Warnings, notes, and cautions are easily identifiable and precede the step to which they pertain (DOE 5480.19, Chapter XVIC2h & i).
- Practices and Permits are administratively correct (DOE 5480.19, Chapter XVIC2j).

- Individual sign-offs are provided for succinct, critical steps (DOE 5480.19, Chapter XVIC2k).

- Limits, tolerances, and acceptance criteria for surveillance or test are specified and easily discerned (DOE 5480.19, Chapter XVIC2l & m).

- Practice sequences correspond to normally accepted operational-sequence flow and other human-factor considerations (DOE 5480.19, Chapter XVIC2o & n).

- Steps from one Practice(s) within another Practice are specifically detailed in either Practice (DOE 5480.19, Chapter XVIC2q).

Space-Specific Hazard Identification

All equipment configurations and facility design with associated hazards present in each space are documented and identified with the space for all access, use, training, and maintenance activities (DOE 5480.19, Chapter VIIIA). The cognizant space manager (CSM) and all personnel with access to the space are fully aware of all hazards present (DOE 5480.19, Chapter VIIIA). The CSM's self assessment of the space reflects the current status of equipment and systems in the space. Changes in equipment and system configuration are reevaluated by completing a new Self-Assessment Checklist (SAC) and providing the revised SAC to all users prior to entry of the next shift into the space (DOE 5480.19, Chapter VIIIB).

All operators and users in the space have reviewed a Hazard Awareness Summary (HAS) and are cognizant of the status of all equipment and systems in the space (DOE 5480.19, Chapter VIIIB).

User Access Control and Qualification Requirements

Only trained and qualified personnel are authorized unsupervised space and equipment access. Users authorized access must be aware of all activities affecting equipment. The CSM is responsible for all user access to their space(s) (DOE 5480.19, Chapter IIC9). All users are trained and qualified before they enter an EMSL space; users must be aware of all hazards present in the space. Equally important, users are trained to industrial safety, hazard protection, and quality assurance best practices (DOE 5480.19, Chapter IIB).

Highly reliable communications provide accurate transmission and facile electronic access to information (DOE 5480.19, Chapter IVA).

Space-Specific Hazard Awareness Summaries

A Hazard Awareness Summary is a principal step in establishing written operations standards for effective implementation and control of operating activities (DOE 5480.19, Chapter IA). The HAS documents all of the hazards present in the space; with proper annotation it also is a guide for quick reference, and as such provides a vehicle for increased awareness of all hazards (DOE 5480.19, Chapter IIC3, 4).

Space-Specific Permits

Permits are fundamental tools for ensuring the safety levels in operating practices. Permits focus on requirements and regulations for safety practices (DOE 5480.19, Chapter IIC2), requirements for round/tour inspections (DOE 5480.19, Chapter IIC4), and the authority to operate equipment (DOE 5480.19, Chapter IIC9).

Space-Specific Equipment Practices

Space-specific Practices reflect the specific equipment configuration of the space and ensure that configuration is in conformance with facility-design specifications (DOE 5480.19, Chapter VIIIA). Practices provide for alignment of equipment and systems. Before placing the equipment or system into operation, individual facility equipment and systems components are aligned properly or checked for proper alignment.

EMSL Practices

EMSL Practices, based on well-developed industrial practices, are at the core of EMSL OPS. The Practices are written to be flexible, to support a high level of performance, and to contribute to safe and reliable laboratory operation (DOE 5480.19, "Introduction"). The use of learning-organization techniques and formalities of personal responsibility and accountability are emphasized in the EMSL OPS structure.

PNNL Standards-Based Management System

EMSL OPS captures the full set of requirements—over 190 safety subject areas—offered by the Standards-Based Management System (SBMS).

User-Specific Qualification Requirements

A completed hazard- and space-dependent matrix is required before any user can be evaluated for access to a given space. The difference between the user's training and experience and the requirements of the training matrix constitute the user's specific qualification requirements. Complete documentation of user qualification with respect to hazards and safety requirements is formally documented in this way (DOE 5480.19, Chapter VC5). Users will be able to recognize out-of-specification conditions or adverse trends and will be familiar with corrective actions for minimization or avoidance of chemistry or process problems (DOE 5480.19, Chapter XIIIC1).

Space-Specific Access Lists

EMSL OPS records the list of users for each of the work spaces in EMSL. Both the individual and the period of use are recorded.

3.1.2 Conduct of Facility Operations

Conduct of Facility Operations provides the Building and Operations Managers and their staff with all of the functionality for control of facility spaces and hazards as listed above for research laboratories or spaces. In general, the focus of Conduct of Facility Operations is on a broader set of room types, including the following:

- Control Room;
- Utility Service Corridor;
- Chemical Store Room;
- Compressed Gas Storage;
- Common Space;
- Docks/Store Rooms;
- Central Plant;
- Network Closets;
- Shops;
- Outside Facility;
- Infrastructure;
- Elevators;
- Mechanical Rooms;
- Roof; and
- Research Laboratories where required.

For each of these space types, standard EMSL OPS hazard- and self-assessment documents are available, as follows:

- Room-Specific Hazard Identification;
- Room-Specific Hazard Self-Assessment Checklist; and
- Room-Specific Hazard Awareness Summary.

Each room has access controls and specific documentation, as follows:

- User Access Control;
- User-Specific Qualification Requirements for hazard interaction;
- Room-Specific Hazard Awareness Summaries;
- Room-Specific Permits; and
- Room-Specific Practices.

The Permits and Practices are based on the best industrial practices and appropriate DOE, Federal, and State standards. Requirements documents are available through the PNNL Standards-Based Management System Web home page.

Equally important to Conduct of Facility Operations is control of all access to each facility space. For all spaces, user qualification, access, and access period are tracked and controlled via user-specific qualification requirements and room-specific access lists.

3.1.3 Conduct of Personnel and Program Operations

Conduct of Personnel and Program Operations is being developed separately for later integration with EMSL OPS. The following minimal set of Conduct of Personnel and Program Operations functions is available for this version of EMSL OPS.

- Manage visitor information, needs, and qualification requirements;
- Facilitate access control to all spaces within EMSL; and
- Provide electronic access to

  EMSL Users' Guide,

  User-Specific Access Lists, and

  User-Specific Qualification Requirements.

The full set of fully developed Conduct of Personnel and Programs functions are shown in Table 3.1.

Table 3.1. EMSL OPS Functional Requirements for Conduct of Personnel and Program Operations

1.0	General. Track and evaluate performance of general function for personnel or programs. Evaluate system and administrative performance/efficiency in direct support of function.
1.1	Highly Qualified Staff
1.2	Product Quality. Track personnel or programs function performance that supports and sustains quality research projects and products.
1.3	Safety
1.4	Visitors. Manage visitors' access, training, security clearances, and/or future visits. Evaluate productive research time achieved for each visitor.
1.5	Technical Needs Focus
1.6	Business/Finance. Evaluate business/finance performance in relation to research project valuation (market, research community, investment community, present value of projected worth, potential for advanced research project development) and cost containment. Manage procurement. Evaluate procurement performance.
1.7	Communications. Measure efficiency, transaction rates, supported traffic, availability, degree of connectivity, and media offered.
1.8	Facilities. Evaluate use of facilities, facility up-time, equipment availability, maintenance delay, repair prioritization, etc.
2.0	Staff Development. Evaluate development levels, goal formulation and achievement, opportunities provided, publication measures, collaboration measures, number of research challenges, etc.
3.0	Managing Concerns
4.0	Working Structures
5.0	Out-Placement
6.0	Training
7.0	Medical Surveillance
8.0	Recruitment

3.1.4 Electronic Data Requirements

EMSL OPS data requirements must deal with a wide range of data and document types, from fully formatted reference documents to statements of practice, safety plans, and simple checklists. The number of documents or their references will vary by space. EMSL OPS provides, by space, for appropriate access to full text of key documents and clear reference to ES&H requirements documents.

Document categories of all governing documents and references are listed below; the list is not meant to be exhaustive and is subject to change as safety issues change. The document categories fall into three broad categories: EMSL governing-level documents, space-level documents, and hazard-specific level documents.

"Governing documents" include the following:

- EMSL Practices;
- *EMSL Users' Guide;*

- Specific SBMS-supplied references; and
- Other governing documents, plans, Directives and Orders.

"Space-level documents" include space/room-specific Practices and Permits. "Hazard-level/hazard-specific documents" are:

- Hazard Identification Checklists;
- Hazard Awareness Summary Statements; and
- Self-Assessment Checklists.

3.2 Interface Requirements

Requirements to interface with necessary external systems are discussed in this section.

3.2.1 User Interfaces

This section provides the set of user interface design guidelines that were used to make EMSL OPS easier for users to learn and use.

The "user interface" includes any part of the computer system's software with which the user interacts; it is sometimes described as the "look and feel" of a system. Today's user expects software to be easy to learn and operate and yet powerful in application. Understandably, users are unwilling to spend large amounts of time learning how to use a system. Because EMSL OPS integrates services for a broad range of users and user experience, the user interface is one of the keys to efficient system operations.

Guidelines for user interface design chosen by EMSL OPS developers had to be of self-evident, intrinsic value to the average user. The following guidelines were used in the development of the user interface. See Appendix V, "Entity Relationship Diagram for EMSL OPS Database," for more details.

Valid Displays. Display valid links, screen metaphors, and functions. Avoid "dummy" or undeveloped function calls.

Easy to Understand. Divide EMSL OPS into meaningful subsystems. The screens should be easy to understand and navigate.

Avoid the Unnecessary. Keep screens and pages to a minimum and keep it simple and direct.

Pertinence of Data. Display only data that is pertinent to the current user. Avoid superfluous information or data.

Helpful Prompts. Prompt the user for required actions on the main menu. Any required actions should be prompted from the user by the system.

Availability of Toolbar. Give the user a toolbar for ease in choosing actions and editing.

"Help" pages. Provide a "help page" service for every function or user-directed action.

3.2.2 Software Interfaces

User Browser

The principal software interface required for the EMSL OPS is the browser located on the user's terminal/computer. Any browser that can access EMSL OPS as defined below will be sufficient. The browser is the user's responsibility.

Human Resources System

The Human Resources system provides names, locations, and other data on the personnel involved with EMSL.

Visitor System

The visitor system is divided into two separate systems: one for US citizens and one for foreign nationals. EMSL OPS supplies the visitor system with information on EMSL visitors who are US citizens, using either a direct link to the visitor system or to the common database interface.

Training System

The People Core Training (PCT) system provides training course information and course completion dates. The PCT will populate the training database. The common database provides access to required course completion and training data as recorded in the training database. EMSL OPS accesses the data on the common database and checks training data to ensure that users have the training required for access to particular rooms.

Common Database

The common database provides common business information to software applications running on various PNNL database servers. Software applications publish data to the common database and receive data from other databases through the common database Interface. This common interface minimizes data redundancy and feeds data back and forth between the individual applications. EMSL OPS will use the common database to share information with other PNNL databases.

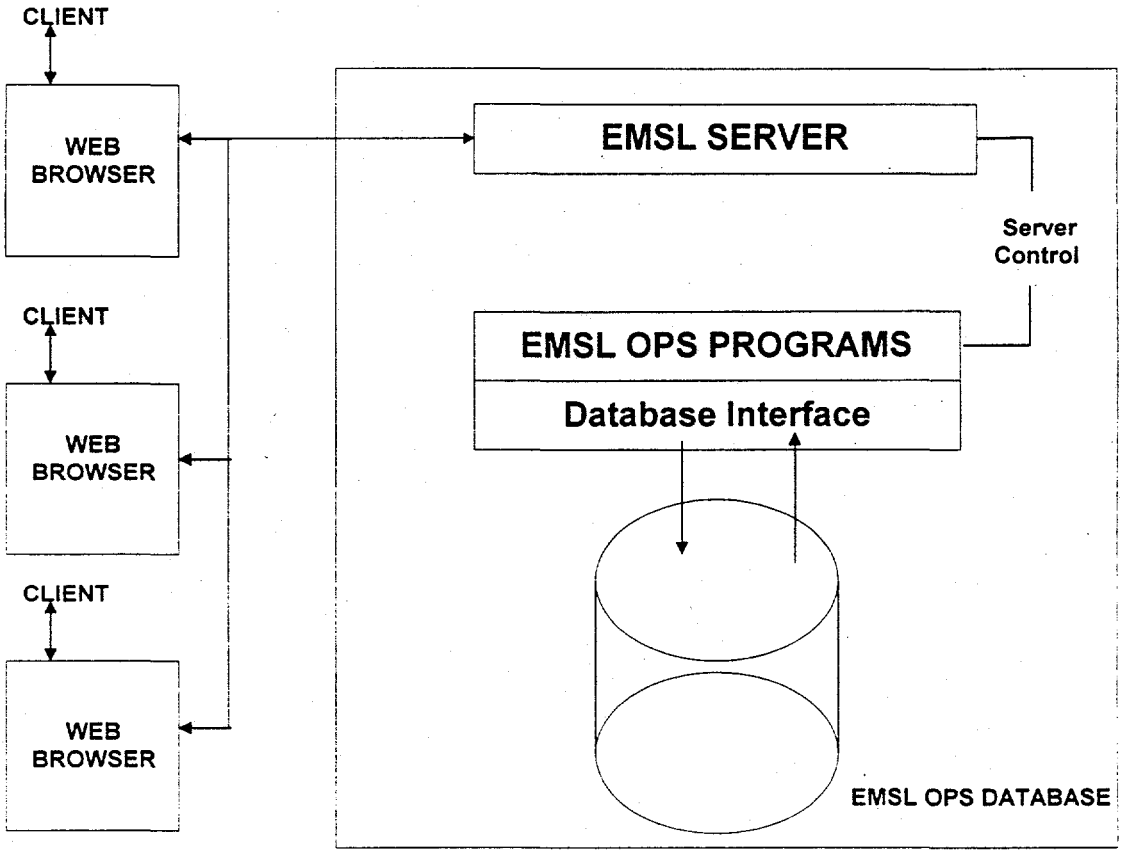


Figure 3.1. General EMSL OPS Structure

3.3 System Requirements

3.3.1 General EMSL OPS Structure

A general structure for EMSL OPS as a client-server system serving clients with browsers is depicted in Figure 3.1.

Web Browser and EMSL Server

The Web browser is the program that runs on the user's or computer. This computer and its browser is also referred to as "the client."

The EMSL server addresses requests from the EMSL browsers and sends documents to the browser. It can either copy a pre-existing document to the browser or request an EMSL OPS program to create a document based on parameters given by the client through the browser. The server must have gateway-interface capability and authenticate the user's identity. The server must be approved through PNNL Computer Security.

EMSL OPS Programs

These programs write EMSL documents in response to client requests. In addition, they may update the database with information supplied by the client (only authorized clients, working from within PNNL's firewall will be able to update the database). Programs operate on a Sun computer running the Solaris operating system. The gateway interface will be written using an appropriate programming language, preferably Oraperl 5.0 (a version of Perl).

Database and Database Interface

The EMSL OPS database is Oracle; interface to Oracle is provided by the Oraperl 5.0 programming language. The database was implemented using the latest version of the Oracle relational database-management system. Oracle was selected to allow easy access to other databases that will be used to supply information to EMSL OPS, and also because it is a proven client/server system with the capability to meet all of the EMSL OPS requirements. Each of the required data sets is implemented using a table. See Appendix V, "Entity Relationship Diagram for EMSL OPS Database," for the entity relationship diagram.

The database can be extended quickly to provide support for new functions by the addition of tables to the flexible table schemes. This structure links EMSL visitors and users to rooms or spaces, hazard type, training requirements, training courses, and required Practices and Permits through a viewpoint (EMSL OPS Viewpoint) and a hazard type (EMSL OPS Room Hazard Type). From its basic database structure on up, EMSL OPS links together those critical and key features required to ensure user and laboratory safety as well as features in support of efficient operations.

An interface is required for communicating with the Oracle database system. Requests for information are passed to the database system from the gateway; the resulting information is received by the gateway and presented in a user-friendly format.

3.4 Performance Requirements

3.4.1 EMSL OPS Response Time

EMSL OPS response time is the time it takes for the user to click on an icon and the system to respond to that request. Every attempt has been made to minimize this response time. The database must be capable of responding to requests in under one second ninety percent of the time.

Client/User Hardware Platforms

There is no limitation on user hardware for user access of EMSL OPS. Any terminal which can operate a Web browser can access EMSL OPS. The EMSL OPS Web server is accessible to the Internet; the EMSL OPS database is accessible to the EMSL OPS Web server (it may or may not be the same platform).

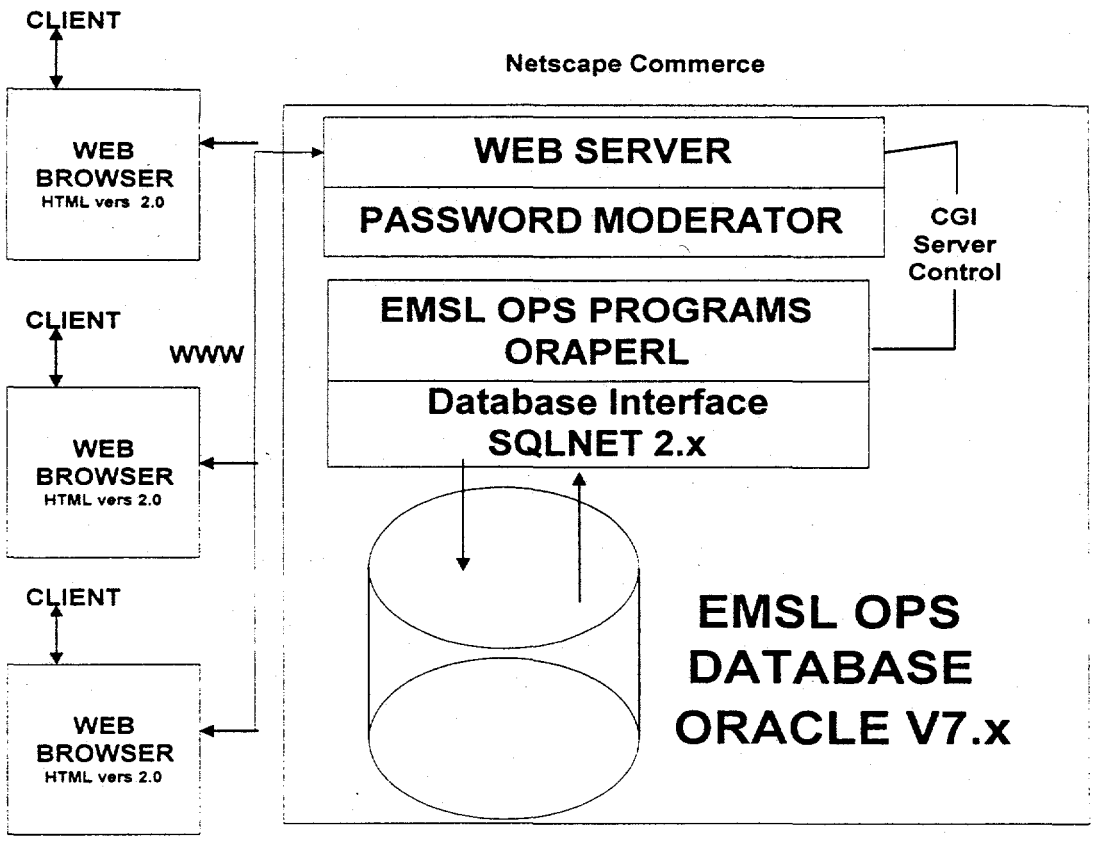


Figure 3.2. EMSL OPS Implementation Features

3.5 Design and Implementation

3.5.1 Specific EMSL OPS Structure

EMSL OPS is structured as a client-server system serving clients with Web browsers. Implementation features of the system are depicted in Figure 3.2.

The Web *browser* is a program that runs on the user's computer and interfaces with the Web server, and displays the HTML output from the server. *Users are responsible* for operation, maintenance, or performance of the browser apart from performance determined by the EMSL OPS. Supply of the Web browser is the user's responsibility. Use of EMSL OPS requires a browser which can access the Web and that supports HTML Version 2.0 or higher. Fully operational manual backup systems exist for laboratory users outside the PNNL computer network, or who are not part of the EMSL OPS research staff.

The Web *server* is the program that runs continuously and services requests from the Web browser. When a request from the browser is made, the server validates that the user is

Table 3.2. Server Features and Descriptions

Server Feature	Description / List
Installation and Maintenance	Graphical installation process Hierarchical display of directory tree Actions associated with file type Actions associated with header Graphical maintenance tools User directories
Documentation	Suitable Help format Help in HTML format Printed manuals
Tools Included	Browser FTP/Gopher or Jughead/WAIS Search engines CERN or NCSL log format Mail (SMTP)/Systems log
Security	Groups File access control IP-based access control Host name-based access control Redirection SSL/S-HTTP/User passwords
Other	Maximum number of threads Compliance with common gateway interface version (tbd) Compliance with HTML Version 2.0 ISMAP support MME mapping Can function as a proxy server

authorized to access the system, and passes the request on to the appropriate common gateway interfaces. EMSL OPS uses the Unix version of the Netscape Commerce server. The Netscape Commerce server was selected because it allows authentication of the user through an application programming interface (API), and optionally provides secure communications between the browser and the server. It should be noted that the Netscape Commerce server is not currently approved by PNNL Computer Security to operate outside of the firewall. Server features are shown in Table 3.2.

The password moderator is a PNNL-written program which is executed from the application programming interface of the Netscape Web server. When a user attempts to access EMSL OPS, the Netscape Web server validates their authorization through the password moderator (only authorized clients working from within PNNL's firewall will be allowed to update the database).

EMSL OPS Programs

Often referred to as common gateway interfaces (cgi), these programs write HTML documents in response to client requests. In addition, they may update or query the database with information supplied by the client (only authorized clients working from within PNNL's firewall will be able to update the database). Programs are written in Oraperl 5.0 (a version of Perl with an API to Oracle).

EMSL OPS programs provide all of the functionality required for

- complete assessment of all hazards present in the EMSL facility;
- visitor and user training requirements determinations;
- control of changes in hazards in any space; and
- creation of hazard identification and awareness summaries for any new space in the facility.

Self-paced, user-friendly screens guide the CSM through complete space self-assessments using one of the Self-Assessment Checklists (see Appendix I). These checklists are tailored to the specific facility space and depend on hazards identified and annotated for the space, and the perspective of the cognizant space manager.

Three perspectives are possible:

(1) a researcher assessing a research-controlled space;

(2) a facility space manager assessing hazards in a facility-controlled space; or

(3) a facility space manager assessing facility-related hazards in a research-controlled space.

Hazards are identified and annotated for each space using the function represented by the Self-Assessment: Hazard Identification Screen (Appendix II).

After completion of hazard identification, a Hazard Awareness Summary can be prepared for the space (Appendix III). This last step prepares a space for one of the Self-Assessment Checklists, as shown in Appendix I, or the training functions for evaluation of a new user's training requirements for the space (Appendix IV).

3.6 Future Requirements

The next developmental generation of EMSL OPS will be made accessible to selected potential users and visitors with access through the Web (visible outside the firewall). Additionally, EMSL OPS will be fully integrated into Conduct of Personnel and Program Operations through the evolution of these systems and availability of the EMSL Operations budget.

4.0 References

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APPENDIX I

SELF-ASSESSMENT CHECKLISTS

RESEARCHER ASSESSING A RESEARCH-CONTROLLED SPACE

Appendix I

☑☐ Self-Assessment Checklist for EMSL 2700

Cognizant Manager:
Date Created: 25-JUN-96
EMSL 2700 Phone Number:

Print this Self-Assessment Checklist, answer the questions, sign your name at the bottom and send the completed Self-Assessment Checklist to your line manager; then you're done!

General Annotations:
This space is used to make general annotations concerning the room

---

General Hazards

1. Do all telephones have a sticker with emergency number(s) listed?
2. Is there an EMSL Laboratory Handbook in the laboratory and is it up to date?
3. Are offices and work areas clean and orderly? Examples of things to avoid are:
   - ☐ broken furniture (chairs, stools, cabinets, etc.)
   - ☐ trip hazards (power cords or electric cables runs across passageway, etc.)
   - ☐ storage of materials in unstable configurations
   - ☐ unsecured cabinets or shelves > 1.5 m tall
   - ☐ top heavy file cabinets
4. Are normal electrical hazards minimized? Examples of things to avoid are:
   - ☐ ungrounded, non-ULI listed electrical equipment (non ULI listed equipment should have three prong grounded plugs)
   - ☐ permanent use of extension cords
   - ☐ multiple outlet strips plugged into multiple outlet strips
   - ☐ obstructed circuit breaker panels
   - ☐ excessively worn or frayed power cords or other electrical cables

Practices:
Stop Work Responsibility

Fire Hazards

1. Are emergency exits clear of obstructions and operational?
2. Are self-closing devices on doors operational and enabled?
3. Are non-exits which could be mistaken as exits clearly labeled "**Not an Exit**"?
4. Are fire code clearances maintained at all times? Such clearances include:
   - ☐ 45 cm clearance between sprinkler heads and stored materials
   - ☐ 70 cm clearance in routes to exits from labs and offices
5. Are fire extinguishers easily accessed?
6. Are flammable and combustible materials used and stored appropriately? Things to avoid include:
   - ☐ excessive accumulation of flammable and/or combustible material,
   - ☐ storage or use of flammable or combustible materials in areas that could block exit routes,
   - ☐ storage of flammable liquids in locations other than specified,flammable liquids storage cabinets,
   - ☐ use of open flames without a permit.

Chemical Hazards:

1. Have Chemical Process Permits been developed and approved for work involving chemical hazards?
2. Do the Chemical Process Permits adequately address the chemical hazards of current operations and activities?
3. Are the personnel protective equipment and the administrative and engineering controls identified in the Chemical Process Permits in place and being utilized?
4. Have the users fulfilled the training and medical qualification requirements specified in the Chemical Process Permits?
5. Are Material Safety Data Sheets (MSDSs) readily available?
6. Is there a current laboratory inventory of chemicals utilizing the Chemical Management System (CMS)?

Annotations:
Note any special chemicals here

Practices:
Use of Toxic Gases - Not Available
Chemical Spills Response - Not Available
Ordering Chemicals - Not Available
Waste Disposal Practices - Not Available
Use of Laboratory Hoods

Cryogens:

1. Is work with cryogens in this laboratory adequately described by an approved work practice?
2. Are cryogens handled in accordance with the work practice?
3. Are the personnel protective equipment and the administrative and engineering controls that are identified in the approved work practice in place and being utilized?

Practices:
Use of Cryogens - Not Available

Compressed Gases:

1. Is work with compressed gases in this laboratory adequately described by an approved work practice?
2. Are compressed gases handled in accordance with the work practice? This includes:
   - ☐ fastening of cylinders adequately by belts or chains
   - ☐ installation of protective caps on head valves of cylinders in storage,
   - ☐ installation of regulators on head valves of cylinders in use,
   - ☐ clear indication of the contents of each cylinder,
   - ☐ valves and lines in compressed gas systems clearly labeled, clamped, and secured
   - ☐ separation of cylinders from flammable and/or combustible materials.
3. Are the personnel protective equipment and the administrative and engineering controls that are identified in the approved work practice in place and being utilized?

Practices:
Use of Compressed Gases - Not Available

Non-Ionizing Radiation Generating Devices:

1. Have Non-Ionizing Radiation Use Permits been approved for work with sources of non-ionizing radiation?
2. Do the Non-Ionizing Radiation Use Permits adequately address the radiation hazards of current operations and activities?
3. Are the personnel protective equipment and the administrative and engineering controls that are identified in the Non-Ionizing Radiation Use Permits in place and being utilized?
4. Have the users fulfilled the training and medical qualification requirements specified in the Non-Ionizing Radiation Use Permits?

Vacuum Chambers and Systems:

1. Are all vacuum chambers electrically grounded?
2. Are pressure relief devices in use on each vacuum system which utilizes compressed gas backfilling?

Cognizant Manager:
Date:

One-Over-One (Optional):
Date:

FACILITY SPACE MANAGER ASSESSING HAZARDS IN A FACILITY-CONTROLLED SPACE

Appendix I

☑☐Self-Assessment Checklist for EMSL 2700

Cognizant Manager:
Date Created: 25-JUN-96
EMSL 2700 Phone Number:

Print this Self-Assessment Checklist, answer the questions, sign your name at the bottom and send the completed Self-Assessment Checklist to your line manager; then you're done!

Researcher's General Annotations:
This space is used to make general annotations concerning the room

---

General Hazards

1. Are stairs, corridors, aisles, doorways and exits clear of obstructions at all times?
2. Are building surfaces (i.e. floors, walls, doors, windows, bathroom fixtures) kept clean in appearance and sanitized where appropriate?
3. Are cabinets, bookcases, and shelves, over 5 feet, secured to building surfaces and the weight is distributed in file cabinets so that upper drawers' contents do not create a top heavy condition?
4. Are tripping hazards from loose floor tiles, projections or worn carpet repaired or prevented by arrangement of furniture or other means?
5. Is the emergency telephone number stickers attached to the telephones within the building?

Practices:
Stop Work Responsibility

Fire Protection

Fire Detection & Alarm Equipment

1. Is each manual fire alarm station accessible, unobstructed, visible, and of the same general type?
2. Is fire protection and life safety equipment maintained and tested?

Automatic Sprinkler Systems

1. Are automatic sprinklers connected, unobstructed, undamaged, not painted or corroded, and free of foreign material?

Portable Fire Extinguishers

1. Are the fire extinguishers of the proper types, sizes, and located appropriately?
2. Are the fire extinguishers charged, accessible, readily visible and identified?

Life Safety Code

1. Do all areas having high hazards have two clear means of egress? Are doors with self-closing devices not secured or blocked in an open position?
2. Is any exit enclosure such as enclosed stairwell used for purpose of storage?
3. Are flammable liquids or gases stored or handled where they could jeopardize egress?
4. Is illumination of means of egress continuous when building is occupied and of not less than 1 foot candle? (2 lumens)
5. Is emergency lighting provided in the event of loss of normal lighting and is the performance of the emergency lighting verified?
6. Are illuminated means of egress, exit signs, and directional exit signs provided?
7. Is periodic testing of emergency lighting equipment conducted?
8. Is periodic testing of toxic gas systems conducted?

Laboratory Operations and Apparatus

1. Is unattended heating equipment, if susceptible to fire or explosion, equipped with a manual reset over-temperature shutoff switch?
2. Is laboratory heating equipment such as ovens, furnaces, environmental chambers, and other heated enclosures not used to heat, store, or test flammable or combustible liquids or aerosols containing flammable gases unless designed or modified to prevent internal explosions?
3. Are operating controls accessible under normal and emergency conditions?

Compressed Gases

Are compressed gases handled in accordance with required use practices? This includes:

1. fastening of cylinders adequately by belt or chain
2. installation of protective caps on head valves of cylinders in storage
3. installation of regulators on head valves of cylinders in use
4. valves and lines in compressed gas systems clearly labeled and secured
5. separation of cylinders from flammable and/or combustible materials
6. cylinders located outside are out of direct sunlight, weather extremes, and temperatures in excess of 125F
7. separation of flammable and oxidizing gases
8. empty cylinders are stored separately from full cylinders and are tagged as empty
9. cylinders have been hydro-tested within the last five years
10. cylinders contents are identified by labeling or by some other means
11. persons handling and moving cylinders have received the proper training

---

Effluent Monitoring (FacRes)

Part B: Airborne Effluents

1. Does Environmental Compliance and Effluent Monitoring have records of proposed activities?
2. Are potential airborne emissions from research and development or analytical activities identified and reviewed with EC prior to emission occurring?

Effluent Monitoring

1. Check practices utilized for the wash down of laboratory surfaces (frequency, water usage, detergents). What is the frequency of a wash down? How is wash water disposed?
2. If floor drains are sealed, do employees have access?
3. Is cooling water used? If so, how is it disposed of, and has approval for that disposal been obtained?

Lock and Tag

1. Are locks and caution/danger tags installed, where appropriate, by authorized workers?
2. Is tagged equipment being operated within the limits specified on the tag?
3. Do applied tags contain the following minimum information:
   - the building and room number location of the lock and tag logbook;
   - the signature of the individual verifying the lock-out/tag-out;
   - identification of information pertaining to specific conditions, qualifications, or actions that should be considered during the lock-out/tag-out process
   - "Controlling Organization" associated with the work to be performed identified on the tag?
4. Are all tags applied within a lab or to research equipment in a service corridor co-signed by the laboratory or equipment owner?
5. Are lock-out devices identified with and keyed to a specific individual or group?
6. Has a lock & tag logbook been maintained for each lock-out/tag-out device?
7. Does the lock and tag logbook contain the following information at a minimum:
   - lock/tag number;
   - type of tag;
   - work document (if applicable);
   - equipment/component identification;
   - reason installed;
   - date installed;
   - installation authorized by;
   - date removed;
   - removal authorized by?

Independent Verification

1. Has a requirement for independent verification of a lock-out/tag-out been established and documented on the tag?

Surveillance & Inspections

1. Has a documented annual periodic inspection been conducted by each organization responsible for authorized workers to determine the effectiveness of the lock-out/tag-outs and status procedure compliance? Note: The periodic documented inspection is required to be completed by October 1st of each year.
2. Are lock-outs/tag-outs being surveyed at least quarterly?

Protective Clothing & Equipment

1. Are safety shower and eyewash facilities available, in good condition, unobstructed, and periodically tested for functionality?
2. Are safety glasses, shoes, clothing, and respiratory protection available where needed?

Ventilation

1. Are open-face hoods, such as a chemical fume hood or an auxiliary air hood, evaluated at least quarterly by air balance personnel to determine if the average linear face velocity is between 100-125 ft/min?
2. Is there an audible or visual device that warns if the air flow stops?
3. Are local exhaust systems provided with emergency power if they are used to control exposure to toxic or hazardous materials?
4. Are perchloric acid hoods identified, washed down after each use, and periodically tested for perchlorate buildup?

Cognizant Manager:
Date:

One-Over-One (Optional):
Date:

FACILITY SPACE MANAGER ASSESSING FACILITY-RELATED HAZARDS IN A RESEARCH-CONTROLLED SPACE

Appendix I

☑☐ Self-Assessment Checklist for EMSL_TEST 4TEST

Cognizant Manager:
Date Created: 25-JUN-96
EMSL_TEST 4TEST Phone Number:

Print this Self-Assessment Checklist, answer the questions, sign your name at the bottom and send the completed Self-Assessment Checklist to your line manager; then you're done!

Researcher's General Annotations:
Test General Annotation

General Hazards

1. Are stairs, corridors, aisles, doorways and exits clear of obstructions at all times?
2. Are building surfaces (i.e. floors, walls, doors, windows, bathroom fixtures) kept clean in appearance and sanitized where appropriate?
3. Are cabinets, bookcases, and shelves, over 5 feet, secured to building surfaces and the weight is distributed in file cabinets so that upper drawers' contents do not create a top heavy condition?
4. Are tripping hazards from loose floor tiles, projections or worn carpet repaired or prevented by arrangement of furniture or other means?
5. Is the emergency telephone number stickers attached to the telephones within the building?

Practices:
Stop Work Responsibility

Fire Protection

Fire Detection & Alarm Equipment

1. Is each manual fire alarm station accessible, unobstructed, visible, and of the same general type?
2. Is fire protection and life safety equipment maintained and tested?

Automatic Sprinkler Systems

1. Are automatic sprinklers connected, unobstructed, undamaged, not painted or corroded, and free of foreign material?

Portable Fire Extinguishers

1. Are the fire extinguishers of the proper types, sizes, and located appropriately?
2. Are the fire extinguishers charged, accessible, readily visible and identified?

Life Safety Code

1. Do all areas having high hazards have two clear means of egress? Are doors with self-closing devices not secured or blocked in an open position?
2. Is any exit enclosure such as enclosed stairwell used for purpose of storage?
3. Are flammable liquids or gases stored or handled where they could jeopardize egress?
4. Is illumination of means of egress continuous when building is occupied and of not less than 1 foot candle? (2 lumens)
5. Is emergency lighting provided in the event of loss of normal lighting and is the performance of the emergency lighting verified?
6. Are illuminated means of egress, exit signs, and directional exit signs provided?
7. Is periodic testing of emergency lighting equipment conducted?
8. Is periodic testing of toxic gas systems conducted?

Laboratory Operations and Apparatus

1. Is unattended heating equipment, if susceptible to fire or explosion, equipped with a manual reset over-temperature shutoff switch?
2. Is laboratory heating equipment such as ovens, furnaces, environmental chambers, and other heated enclosures not used to heat, store, or test flammable or combustible liquids or aerosols containing flammable gases unless designed or modified to prevent internal explosions?
3. Are operating controls accessible under normal and emergency conditions?

Compressed Gases

Are compressed gases handled in accordance with required use practices? This includes:

1. fastening of cylinders adequately by belt or chain
2. installation of protective caps on head valves of cylinders in storage
3. installation of regulators on head valves of cylinders in use
4. valves and lines in compressed gas systems clearly labeled and secured
5. separation of cylinders from flammable and/or combustible materials
6. cylinders located outside are out of direct sunlight, weather extremes, and temperatures in excess of 125F
7. separation of flammable and oxidizing gases
8. empty cylinders are stored separately from full cylinders and are tagged as empty
9. cylinders have been hydro-tested within the last five years
10. cylinders contents are identified by labeling or by some other means
11. persons handling and moving cylinders have received the proper training

---

Extraordinary Electrical Hazards

1. Are normal electrical hazards mitigated? Examples of things to avoid include:
   - ungrounded, non-ULI listed electrical equipment (non-ULI listed equipment should have three-pronged grounded plugs)
   - permanent use of extension cords
   - multiple outlet strips plugged into multiple outlet strips

- obstructed circuit breaker panels
- excessively worn or frayed power cords or other electrical cables.

2. Are electrical receptacles, switches, and controls located so as not to be subject to liquid spills?
3. Are electrical panels and disconnects labeled?
4. Are guards or cover panels in place for wall outlets, circuit panel, and junction boxes?(no exposed wiring)
5. Are Ground Fault Interrupters (GFI's) located within 5 feet of wet locations such as labs, restrooms, kitchens, and other actually or potentially wet locations such as outdoor outlets?
6. Are all exposed conductors at voltages >50 V above ground labeled and situated to avoid inadvertent contact by occupants?
7. Is all instrumentation and equipment containing voltages >600 V above ground labeled "**DANGER HIGH VOLTAGE**"?
8. Does all permanently installed electrical equipment satisfy the requirements of the National Electrical Code?
9. Are all disconnects on permanently installed electrical equipment accessible and labeled with both the power source (circuit breaker and distribution panel) and the electrical equipment controlled?
10. Are all guards or cover panels in place (i.e., no exposed wiring)?

Researcher's Annotations:
Test electrical annotation

Mechanical Lifting Devices

1. Is the equipment being maintained/inspected in accordance with DOE-RL-92-36, 'Hanford Hoisting and Rigging Manual?'
2. Are below the hook lifting devices properly designed and inspected as per the Hanford Hoisting and Rigging Manual?
3. Has inspections/maintenance been conducted in accordance with DOE-RL-92-36, 'Hanford Hoisting and Rigging Manual?'

Pressurized Systems

Pressure Vessels

1. Have all pressure vessels > 100kPa(15 psi) been reviewed by a representative of facilities engineering (PNL-MA-21, Pressure Systems Manual)?

Pressure Hoses

1. Are all system components (e.g. tubing, connections, vessels) rated for use at pressures 50% greater than the maximum anticipated operating pressure?
2. Are all hose or tubing connections positively secured? For example, tubing containing non-recirculating water should be securely clamped not just pushed on a hose barb or stuck in a drain.

Pressure relief valves

1. Are pressure relief valves provided where appropriate?
2. Are relief devices on systems vented in a safe and environmentally acceptable manner when toxic, corrosive, or flammable materials are discharged?

3. Are pressure relief valves periodically inspected and maintained?

Hot Surfaces

1. Are all exposed high temperatures surfaces > 50 C separated from combustible materials?

Researcher's Annotations:
Test

Effluent Monitoring (FacRes)

Part B: Airborne Effluents

1. Does Environmental Compliance and Effluent Monitoring have records of proposed activities?
2. Are potential airborne emissions from research and development or analytical activities identified and reviewed with EC prior to emission occurring?

Effluent Monitoring

1. Check practices utilized for the wash down of laboratory surfaces (frequency, water usage, detergents). What is the frequency of a wash down? How is wash water disposed?
2. If floor drains are sealed, do employees have access?
3. Is cooling water used? If so, how is it disposed of, and has approval for that disposal been obtained?

Lock and Tag

1. Are locks and caution/danger tags installed, where appropriate, by authorized workers?
2. Is tagged equipment being operated within the limits specified on the tag?
3. Do applied tags contain the following minimum information:
   - ☐ the building and room number location of the lock and tag logbook;
   - ☐ the signature of the individual verifying the lock-out/tag-out;
   - ☐ identification of information pertaining to specific conditions, qualifications, or actions that should be considered during the lock-out/tag-out process
   - ☐ "Controlling Organization" associated with the work to be performed identified on the tag?
4. Are all tags applied within a lab or to research equipment in a service corridor co-signed by the laboratory or equipment owner?
5. Are lock-out devices identified with and keyed to a specific individual or group?
6. Has a lock & tag logbook been maintained for each lock-out/tag-out device?
7. Does the lock and tag logbook contain the following information at a minimum:
   - ☐ lock/tag number;
   - ☐ type of tag;
   - ☐ work document (if applicable);
   - ☐ equipment/component identification;
   - ☐ reason installed;
   - ☐ date installed;

- installation authorized by;
- date removed;
- removal authorized by?

Independent Verification

1. Has a requirement for independent verification of a lock-out/tag-out been established and documented on the tag?

Surveillance & Inspections

1. Has a documented annual periodic inspection been conducted by each organization responsible for authorized workers to determine the effectiveness of the lock-out/tag-outs and status procedure compliance? Note: The periodic documented inspection is required to be completed by October 1st of each year.
2. Are lock-outs/tag-outs being surveyed at least quarterly?

Protective Clothing & Equipment

1. Are safety shower and eyewash facilities available, in good condition, unobstructed, and periodically tested for functionality?
2. Are safety glasses, shoes, clothing, and respiratory protection available where needed?

Ventilation

1. Are open-face hoods, such as a chemical fume hood or an auxiliary air hood, evaluated at least quarterly by air balance personnel to determine if the average linear face velocity is between 100-125 ft/min?
2. Is there an audible or visual device that warns if the air flow stops?
3. Are local exhaust systems provided with emergency power if they are used to control exposure to toxic or hazardous materials?
4. Are perchloric acid hoods identified, washed down after each use, and periodically tested for perchlorate buildup?

Cognizant Manager:
Date:

One-Over-One (Optional):
Date:

APPENDIX II

HAZARDS IDENTIFICATION SCREEN

☑☐ Self-Assessment: Hazard Identification

Room Name:	Test Room
Room Phone Number:	(509) 375-3717

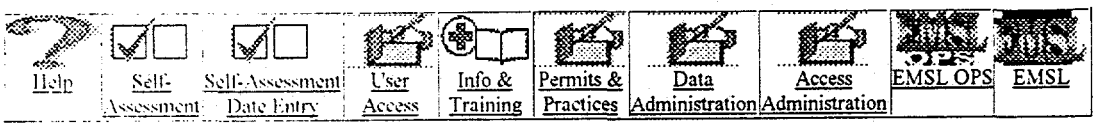
Identify the hazards in EMSL 2700 by selecting the appropriate buttons. Contact the EMSL Safety and Health representative (Monty L. Rosbach) with questions.

Yes No

- (●) ( ) Chemical hazards that pose significant risk to humans or the environment, such as flammable liquids and solids, peroxide formers, pyrophorics, explosives, compressed gases or hazardous materials:
  - specifically listed in 29 CFR Part 1910, Subpart Z, Toxic and Hazardous Substances (aka the Z list);
  - assigned a threshold limit value by the American Conference of Governmental Industrial Hygienists, Inc.; or
  - determined to be cancer causing, corrosive, toxic, an irritant, a sensitizer, or has damaging effects on specific body organs.
- ( ) (●) Biological hazards that pose significant risk to humans or the environment such as substances classified by the EPA, the OSHA, or the DOT as Biological Hazards: human blood, body fluids, tissues, viruses, bacteria, protozoa, parasitic organisms, fungal agents, rickettsial, or recombinant DNA.
- ( ) (●) Radiological materials
- (●) ( ) Cryogens (e.g., liquid nitrogen).
- (●) ( ) Compressed gases (e.g., lecture bottles, cylinders, or gas lines).
- ( ) (●) Ionizing radiation generating devices such as:
  - x-ray sources
  - sealed radioactive sources
- ( ) (●) Class II, IIIa, or IIIb (visible < 15 mW) lasers.
- ( ) (●) Class IIIb (other than visible < 15 mW) or IV lasers.
- ( ) (●) Significant sources of non-ionizing radiation are used, such as:
  - static magnetic fields > 5 G at locations accessible to personnel
  - static magnetic fields > 600 G at any location
  - dynamic magnetic fields > 1 G at 60 Hz
  - dynamic electric fields > 1kV/m at 60 Hz
  - RF or microwave sources exceeding 10 mW radiated output
  - infrared sources > 10 W
  - ultraviolet sources > 1 W.
- ( ) (●) Extraordinary electrical hazards exist, such as:
  - exposed conductors at electrical potentials > 50V
  - sources of high voltage (> 600V)
  - permanently installed (i.e., hard-wired) electrical equipment
- ( ) (●) Mechanical lifting devices
- ( ) (●) Noise levels > 85 dBA.
- ( ) (●) Pressurized vessels or systems operating at > 100 kPa (15 psi) above atmospheric pressure.
- (●) ( ) Vacuum chambers or systems with > 10 J stored energy (i.e., $\Delta pV > 0.1$ l-atm, e.g., an evacuated 100 ml container).
- ( ) (●) Mechanical power transmission apparatus, such as belts, chains, gears, rollers, or rotating shafts.
- ( ) (●) Exposed sources of temperatures > 50°C or < 0°C

Exposed sources of temperatures > 50°C or < 0°C

Continue Clear



APPENDIX III

HAZARD AWARENESS SUMMARY

☑☐ Hazard Awareness Summary for EMSL 2700

Room Type:	Laboratory
Room Name:	Test Room
Date Created:	25-JUN-96
EMSL 2700 Phone Number:	(509) 375-3717
Cognizant Manager:	
Phone Number:	

Print this Hazard Awareness Summary and put it in the EMSL Laboratory Handbook in EMSL 2700.

Click continue to generate the Self-Assessment Checklist for EMSL 2700.

General Annotations:
This space is used to make general annotations concerning the room

---

Hazardous chemicals are present in this room. Controls for mitigating the hazards to an acceptable level of risk are described in the Chemical Process Permit(s) in the EMSL Laboratory Handbook located in this room. Directions for accessing Material Safety Data Sheets that describe the hazards of each chemical can also be found in the EMSL Laboratory Handbook.

Annotations:
Note any special chemicals here

Practices:
Use of Toxic Gases - Not Available
Chemical Spills Response - Not Available
Ordering Chemicals - Not Available
Waste Disposal Practices - Not Available
Use of Laboratory Hoods

Cryogenic materials, such as liquid nitrogen or liquid helium, are stored or used within this area. Controls for mitigating the associated hazards to an acceptable level of risk are described in the Use of Cryogens section of the EMSL Laboratory Handbook located in each EMSL laboratory.

Practices:
Use of Cryogens - Not Available

Compressed gases are present in this laboratory. Controls for mitigating the associated hazards to an acceptable level of risk are described in the Use of

Compressed Gases section of the EMSL Laboratory Handbook located in each EMSL Laboratory.

Practices:
Use of Compressed Gases - Not Available

At least one significant source of non-ionizing radiation is present in this room. Examples of significant sources of non-ionizing radiation are high field magnets, UV lamps, and RF or microwave radiation. Controls for mitigating the associated hazards to an acceptable level of risk are described in the Non-Ionizing Radiation (NIR) Use Permit(s) in the EMSL Laboratory Handbook located in this laboratory.

At least one vacuum chamber or system is located in this room.

Help | Self-Assessment | User Access | Info & Training | Permits & Practices | EMSL OPS | EMSL

APPENDIX IV

INDIVIDUALIZED TRAINING REQUIREMENTS

Individualized Training Requirements

Print this page, and after reading, sign it, date it, and return it to your host. See [Help] below in the toolbar for additional instructions.

Name Genevieve A. Millsap
Id Number 3G675
Manager's Name Marc C. Moise

While you are at the Battelle complex, you may not bring weapons, alcohol, or cameras onto the premises

In addition, your host has requested for you to have unescorted access to one or more laboratories. This system is designed to allow you to preview the equipment and conditions that exist within the laboratories to which you will have access. Review each of the Hazard Awareness Summaries provided.

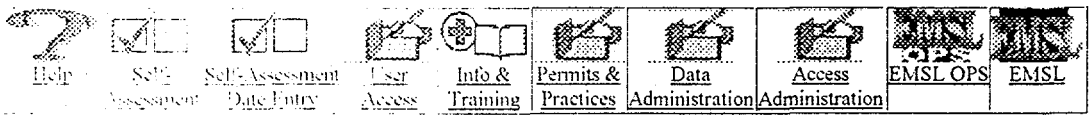
Hazard Awareness Summaries
EMSL, TEST 2TEST Montys room
EMSL, TEST 4TEST Gen's Room

My signature indicates that I have read and understood the Hazard Awareness information provided above

Signature	Date

In addition, you must complete the following courses at PNNL

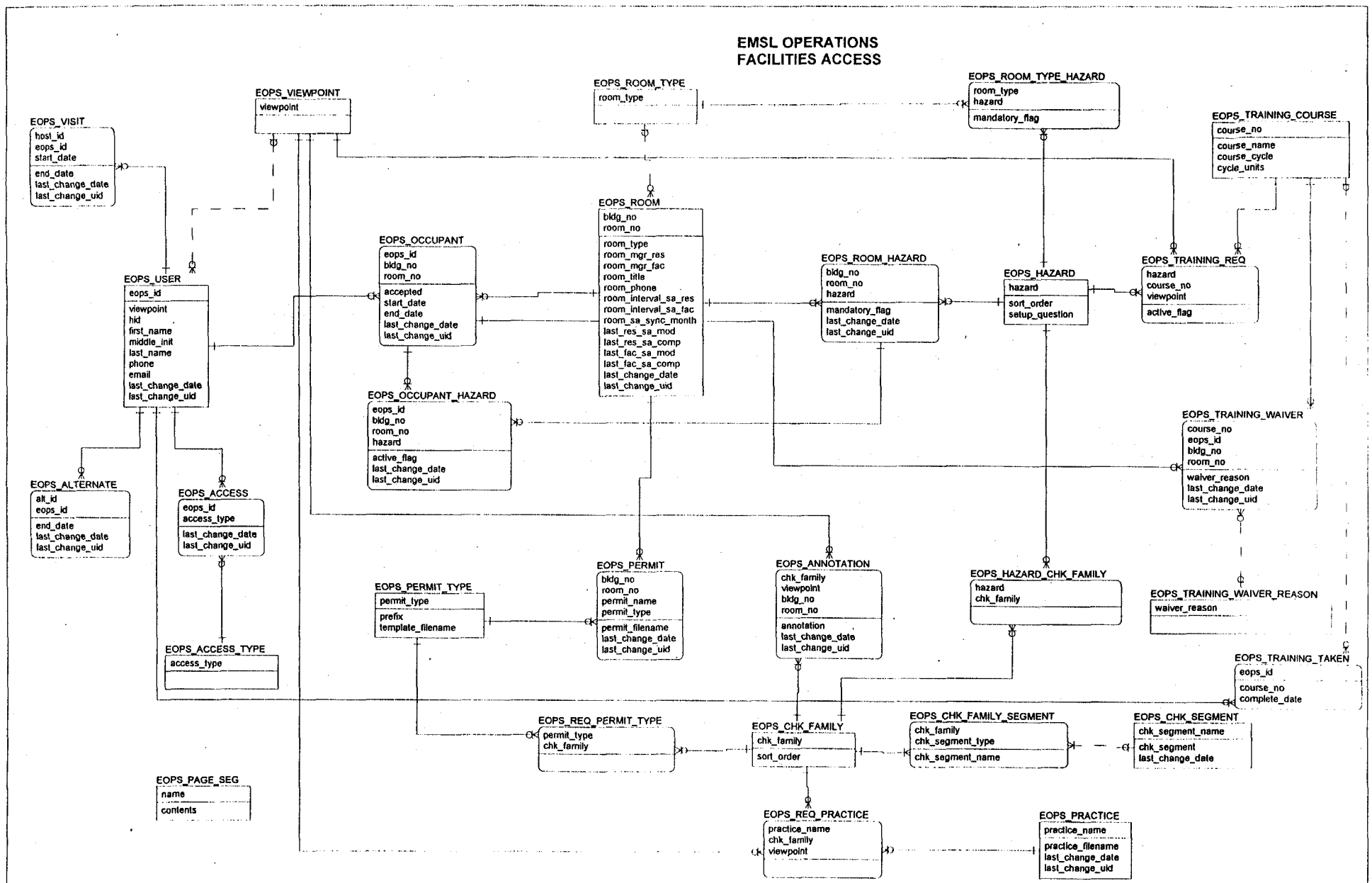
	EMSL_TEST 2TEST Montys room	EMSL_TEST 4TEST Gen's Room
SAF-IS-021 General Compressed Gases Safety		Will not perform this task
SAF-IS-003 Laser Safety	**REQUIRED**	**REQUIRED**
SAF-HH-001 Hearing Conservation-Noise Control	**REQUIRED**	**REQUIRED**
SAF-RP-001 Respiratory Protection Training	**REQUIRED**	Trained at other location
SAF-WM-001 Hazardous Waste Management	**REQUIRED**	**REQUIRED**
SAF-HM-020 Lab Safety - Hazard Communication	**REQUIRED**	Expert in the field
SAF-RS-020 GERT (General Employee Radiological Training		**REQUIRED**
SAF-RS-021 Radworker 1		**REQUIRED**
SAF-RS-022 Radworker 2		**REQUIRED**



APPENDIX V

ENTITY RELATIONSHIP DIAGRAM FOR EMSL OPS DATABASE

EMSL OPERATIONS
FACILITIES ACCESS



APPENDIX VI

CONTROLLING LASER HAZARDS IN THE WORKPLACE

| SBMS Home Page | All Subject Areas | Search | Instructions | About |
| Subject Area Introduction | Subject Area Definitions |

Contents: Controlling Laser Hazards in the Workplace

Effective Date: **June 19, 1995**	Point of Contact: Laser Safety Officer; or Safety and Health Representative

Procedures	Exhibits	Related Information
Introduction	Engineered and Administrative Controls Matrix	*American National Standard for the Safe Use of Lasers,* ANSI Z136.1-1993
Definitions	Hazards Associated with Using Lasers	PNL-MA-50, *PNL Operations Manual*
1. Selecting the Workplace	Laser Use Permit	.
2. Conducting the Preliminary Safety Hazard Analysis	.	.
3. Purchasing or Acquiring Lasers	.	.
4. Installing Laser Equipment	.	.
5. Conducting the Safety Hazard Analysis	.	.
6. Developing the Laser Safety Work Permit	.	.
7. Using Lasers for Experiments ⊏ Laser Alignment ⊏ Laser Service and Repair ⊏ General Laser Operation	.	.
8. Placing a Laser in Idle Mode	.	.
9. Ensuring Worker Qualification	.	.
10. Using Engineered and Administrative Controls	.	.
11. Wearing Personal Protective Equipment	.	.

| Subject Area Introduction | Subject Area Definitions |

Send a question or comment to the SBMS Help Desk

00.00-TBD-/standard/0d/0d00t010.htm

APPENDIX VII

PACIFIC NORTHWEST NATIONAL LABORATORY
LASER USE PERMIT

PACIFIC NORTHWEST NATIONAL LABORATORY LASER USE PERMIT	ORG. CODE: WORK PERMIT NO.: EMSL-LUP- REV. NO.: 0 EFFECTIVE DATE:
TITLE:	
AUTHOR:	PAGE 1 OF

PURPOSE:

LOCATION:

APPROVALS/SIGNATURES

Author _____ (Signature) _____ (Date)

Activity Supervisor _____ (Signature) _____ (Date)

All installations, new or modified, involving Class 3b and 4 lasers require the review of the PNNL Laser Safety Officer, in addition to the Supervisor (PNL-MA-43, IH 14.0). This approval is typically acquired after the permit is approved and an inspection of the final installation has been accomplished by the PNNL Laser Safety Officer.

CONCURRENCE:

PNNL Laser Safety Officer _____ (Signature) _____ (Date)

ADDITIONAL CONCURRENCES, AS APPROPRIATE:

Technical Reviewer _____ (Signature) _____ (Date)

_____ (Signature) _____ (Date)

_____ (Signature) _____ (Date)

_____ (Signature) _____ (Date)

PACIFIC NORTHWEST NATIONAL LABORATORY LASER USE PERMIT	ORG. CODE: WORK PERMIT NO.: EMSL-LUP- REV. NO.: 0 EFFECTIVE DATE:
TITLE:	
AUTHOR:	PAGE 2 OF

ASSOCIATED PROCEDURES AND SAFETY REQUIREMENTS	
Lasers: ANSI-Z136.1 (1993) PNL-MA-43, Section IH 14.0 Laser Operation Manual	Lock and Tag: PNL-MA-50, Section 3.9 PNL-MA-43, Section OS 5.0
Electrical Safety: PNL-MA-43, Section OS 6.0	Off-Normal Events: PNL-MA-50, Section 7.0 PNL-MA-7, All
Other Requirements: PNL-MA-69, Section 3.2, "Property Management"	

APPLICABLE LASER OPERATIONS

☒ General Operation ☐ Alignment ☐ Service/Repair ☐ Specific Operation ☐ Fiber Optics

LASER CHARACTERISTICS

Laser Type	Wavelengths	Class	Maximum Power of Energy/Pulse	Pulse Length	Repetition Rate

Description of Laser Use:

PACIFIC NORTHWEST NATIONAL LABORATORY LASER USE PERMIT	ORG. CODE: WORK PERMIT NO.: EMSL-LUP- REV. NO.: 0 EFFECTIVE DATE:
TITLE:	
AUTHOR:	PAGE 3 OF

HAZARDS ANALYSIS			
☒ Laser Light	☒ Electrical	☐ Cryogens	☐ Toxic Chemicals
☐ Fire	☐ Noise	☐ Compressed Gases	☐ Flashtubes
Description:			

ENGINEERING CONTROLS		
☒ Protective Housing	☐ Protective Housing Interlocks	☐ Beam Stop or Attenuator
☒ Enclosed Beam Path	☐ Activation Warning System	☒ Key Controls
☐ Control Area	☐ Emission Delay	☐ Safety Interlocks
Description:		

PACIFIC NORTHWEST NATIONAL LABORATORY LASER USE PERMIT	ORG. CODE: WORK PERMIT NO.: EMSL-LUP- REV. NO.: 0 EFFECTIVE DATE:
TITLE:	
AUTHOR:	PAGE 4 OF

ADMINISTRATIVE CONTROLS

☒ Labels	☒ Signs	☐ Output Emission Limits
☐ Barrier and Curtains	☐ Operating Limits	☐ Critical Beam Path

Description:
1. All lasers within the scope of this permit are labeled as to the type, class, and power.
2. An ANSI laser DANGER sign is clearly posted at the laboratory entrance.
3. During normal operations, the access interlock system will operate in the "hazard" mode. During operations where laser radiation may leave the controlled area of the optical table, the interlock operates in the "high hazard" mode.
4. Repair and maintenance operations of this system may pose electrical hazards. Refer to PNL-MA-43, OS 6.0 for guidance.

STANDARD REQUIREMENTS

1. Verify that all appropriate engineering controls are functioning.
2. Verify that all applicable administrative controls are understood and being used.
3. Ensure that all optical paths from the laser or laser system are controlled to within the nominal hazard control zone.
4. Operate the laser using the guidance of this permit and supplement with the laser operating manual, when appropriate.

PERSONAL PROTECTIVE EQUIPMENT

☒ Eye Protection	☐ Skin Protection

Laser eyewear specifications are:

Wavelength	Intrabeam OD	Diffuse OD

General Operations: Laser safety eyewear is recommended for the normal operation of this laser system by all personnel within the nominal hazard zone.

Alignment: Laser safety eyewear is used during alignment and repair of this laser system when a potential exists for exposure to the laser radiation above the maximum permissible exposure limit.

The optical density of the laser safety eyewear is dependent on the power capacity and wavelength of the laser(s).

PACIFIC NORTHWEST NATIONAL LABORATORY LASER USE PERMIT	ORG. CODE: WORK PERMIT NO.: EMSL-LUP- REV. NO.: 0 EFFECTIVE DATE:
TITLE:	
AUTHOR:	PAGE 5 OF

DESCRIPTION OF EMERGENCY RESPONSE

Should an emergency of any kind occur during and in conjunction with operation, maintenance, or alignment of the laser, the system should be deactivated immediately. Deactivation of the laser system is relatively simple:

1. Press RED crash button integrated with the interlock system; OR,
2. Depress the OFF button on the power supply; OR
3. Turn the MAIN POWER KEY SWITCH (labeled LOCK) on the power supply console counterclockwise, then remove the key.

In case of electric shock, calmly and quickly complete one of the above steps to disable the laser's power supply; remove the victim from contact with any laser components, using a NON-CONDUCTIVE object such as a wooden stick or plastic rod; and immediately administer any first aid measures that may be necessary (CPR, treat for shock, etc.).

In the event of an emergency or off-normal event, call (9) 375-2400. State the problem to the 375-2400 operator, request any needed emergency assistance, and request notice of the appropriate personnel. If you need further instructions, be sure the 375-2400 operator has the telephone number where you can be reached. This applies 24 hours a day, 365 days of the year. All injured individuals must report to first aid and notify their supervisor of the injury.

PACIFIC NORTHWEST NATIONAL LABORATORY LASER USE PERMIT	ORG. CODE: WORK PERMIT NO.: EMSL-LUP- REV. NO.: 0 EFFECTIVE DATE:
TITLE:	
AUTHOR:	PAGE 6 OF

LASER USER QUALIFICATION

Both basic laser safety training and on-the-job laser safety training are required and provided for resident laser users and temporary visitors/guest laser users, as defined in PNL-MA-43, IH 14.10, who work in a Class 3b and Class 4 laser control area. Basic laser safety training must be retaken every two years. Basic laser safety training is not required of escorted laser observers.

Medical examinations are required and provided for resident laser users working with or in an area of Class 3b or Class 4 lasers (see PNL-MA-43, IH 5.0). Medical examination is not required for temporary guests, escorted laser observers, and maintenance/repair personnel.

Please check the boxes below that are applicable to your qualification and provide a signature, which designates current qualifications are met.

Basic Laser Training	On-the-Job Training	Medical Surveillance	Printed Name	Signature

APPENDIX VIII

PACIFIC NORTHWEST NATIONAL LABORATORY
MA SERIES SOURCES

MA SERIES SOURCES

Document	Contact	Frequency	Source	Access	Internet Address
DOE Orders	VC Thompson	As issued	Director and Direct	SARIS, HanInfo, DOE WWW; hard copy files in VC Thompson's office	http://vm1.hqadmin.doe.gov /refshelf.html Directives http://apollo.osti.gov/html/ techstds/techstds.html DOE TECHNICAL STANDARDS PAGE
BNA Environmental Regulations	M Dagle	As issued	Direct	Hard copy at Legal Library; CD-ROM at LL and HTL; current versions are kept	
NTIS FedWorld Information Network				Telnet access only for some databases.	http://www.fedworld.gov/
Code of Federal Regulations	Legal Library and Hanford Technical Library	As issued		SARIS (5, 10, 18, 29, 30, 4041, 43, 48, 40, 50); 29 CFR on HLAN from HTL; BNA on CD-ROM; House of Representatives Home Page (experimental)	NTIS Fedworld http://www.pls.com:8001/his /cfr.html

Document	Contact	Frequency	Source	Access	Internet Address
Federal Register (new CFRs and other information)	M Dagle T Lazarski	Weekly	Direct	SARIS (table of contents for review); paper copies at legal library (microfiche to 1985), HTL (microfilm to 1980), and T. Lazarski's office (recent); LEXIS/NEXIS; WWW	Text Optimum Retrieval Engine/Federal Register (TORE/FR) Free access updated daily (due online in early Oct.); see also NTIS Fedworld
Washington State Register (new WACS/RCW)	M Dagle T Lazarski	Twice monthly	Direct	Legal Library (back issues to 1991); some are available electronically; selected issues on CD-Law CD-ROM T. Lazarski's office	
WAC/RCW (existing)	M Dagle	As issued	Direct	SARIS (Text-Trieve); print (1989, 1990, 1992) at Legal Library	http://leginfo.leg.wa.govl WA legislature home page

Document	Contact	Frequency	Source	Access	Internet Address
Environmental Reporter (Updates to CFRs and other legal environmental documents)	M Dagle B Day	Weekly	Direct	Legal Library	
OSHA Reporter	M Dagle	Updated periodically	Direct online	Legal Library; OSHA WWW home page	http://www.osha-slc.gov/OSHA
Environmental Weekly Report	T Lazarski		Direct	Distributed by WHC	On "soft reporting" system, available to WHC and Kaiser, by special link from PNL
NRC Documents 1.Reg Guidelines 2.Information Notices 3.Admin Letters 4.Bulletins	RL Gruel	As issued	Direct from NRC	SARIS; NRC home page on WWW; Gruel keeps hard copy files	Fedworld
NEPA Documents	RC Phillips	As issued	Direct from EPA	NEPA home page on WWW ; Philips keeps hard copy files	http://www.eh.doe.gov/nepa/ (2K); http://charis.pnl.gov:8001/esh/nepa/tools/regulate/nepa_reg/nepa_reg.htm#nepa_reg http://charis.pnl.gov:8001/esh/nepa/tools/regulate/ceq/1506.htm(PART 1506--OTHER REQUIREMENTS

Document	Contact	Frequency	Source	Access	Internet Address
Environmental Protection Act (EPA) Rules, Regulation and Legislation.	M Dagle	As issued	Direct	Legal Library; WWW	http://www.epa.gov/ Rules.html
WHC-EP-0063 updates	WJ Bjorklund	As issued	Direct	Files	
Yakama Indian Nation; Nez Perce tribe; CTUIR (Umatilla Indians)	TY Hosaka	As issued	Direct	Files	
Construction Codes and Standards (ASME, AWS, AISC, ASTM, ANSI, etc.)	RM Jones, RE Hawks for Jan Bright	As issued	Direct from societies	ICF Kaiser Library is official Site Repository (ASTM and UL on CD; all others in hard copy; PNL has access for reference) Jones and Hawks have some hard copies	http://www.ansi.org/ catalog of standards for online ordering
Fire Protection regulations (NFPA codes and standards; UBC, UFC in city of Richland	AG Minister	As issued	Direct	Files; hard copy only	

Document	Contact	Frequency	Source	Access	Internet Address
CASB Cost Accounting Standards (from Commerce Clearing House); 48 CFR Federal Acquisitions Regulation	FW Wentz	As issued	Direct	Files; hard copy only	

APPENDIX IX

CONDUCT OF OPERATIONS REQUIREMENTS FOR DOE FACILITIES (DOE 5480.19) CROSS REFERENCED TO EMSL OPS

"CONDUCT OF OPERATIONS REQUIREMENTS FOR DOE FACILITIES" (DOE 5480.19) CROSS REFERENCED TO EMSL OPS

EMSL OPS SECTION REFERENCES, 1.0 THROUGH 3.0

Chapter and Paragraph Reference, DOE 5480.19, w/C1	Section 1.0	Section 1.0 (repeat reference)	Section 2.0	Section 2.0 (repeat reference)	Section 3.0	Section 3.0 (repeat reference)
IA "Introduction"	1.1 Purpose		2.1.2 Design Concepts	2.2 Product Design Description		
All	4.0 References	Foreword				
XVIC1 "Procedure Development"			2.1.2 Design Concepts			
XVIC6 "Procedure Availability"			2.1.2 Design Concepts			
X "Independent Verification"			2.2 Product Design Description			
XIV "Required Reading"			2.2.1 Hazard Identification and Self-Assessment	2.2.3 Safety and Training Requirements Information		
XI "Logkeeping"			2.2.1 Hazard Identification and Self-Assessment			
XC3f "Operations Self-Appraisal and Verification"			2.2.1 Hazard Identification and Self-Assessment			

Chapter and Paragraph Reference, DOE 5480.19, w/C1	Section 1.0	Section 1.0 (repeat reference)	Section 2.0	Section 2.0 (repeat reference)	Section 3.0	Section 3.0 (repeat reference)
XIVA2 "Reading Assignments"			2.2.2 User Registration and Training			
XIVC4 "Documentation"			2.2.2 User Registration and Training			
XIVA "Required Reading Introduction"			2.2.3 Safety and Training Requirements Information			
XIVB "Required Reading Discussion"			2.2.3 Safety and Training Requirements Information			
XIVC1 "File Index"			2.2.3 Safety and Training Requirements Information			
XIVC2 "Reading Assignments"			2.2.3 Safety and Training Requirements Information			
XIVC3 "Required Dates for Completion of Reading"			2.2.3 Safety and Training Requirements Information			

Chapter and Paragraph Reference, DOE 5480.19, w/C1	Section 1.0	Section 1.0 (repeat reference)	Section 2.0	Section 2.0 (repeat reference)	Section 3.0	Section 3.0 (repeat reference)
XVA "Timely Orders to Operators"			2.2.3 Safety and Training Requirements Information			
XIII "Operations Aspects of Facility Chemistry and Unique Processes"			2.2.4 Stepping Through the Information--EMSL OPS System Controls			
IIIB "Control Area Activities for DOE Facilities"			2.2.9 Conduct of Facilities Operations			
IIIC1 "Control Area Access"			2.2.9 Conduct of Facilities Operations, p33			
IIIC "Guidelines 2,3,4,5"			2.2.9 Conduct of Facilities Operations			
II "Shift Routines and Operating Practices"			2.2.9 Conduct of Facilities Operations			
XVIC2 a through q "Procedure Content"					3.1.1 Conduct of Research Laboratory Operations	

Chapter and Paragraph Reference, DOE 5480.19, w/C1	Section 1.0	Section 1.0 (repeat reference)	Section 2.0	Section 2.0 (repeat reference)	Section 3.0	Section 3.0 (repeat reference)
VIIIA, "Control of Equipment and System Status Introduction"					3.1.1 Space-Specific Hazards Identification	3.1.1 Space-Specific Hazards Identification
VIIIB, "Control of Equipment and System Status, Discussion"					3.1.1 Space-Specific Hazards Identification	3.1.1 Space-Specific Hazards Identification
IIC9 Excerpt: "Shift Routines and Operating Practices, Authority to Operate Equipment"					3.1.1 User Access Control and Qualification Requirements	
IIB Excerpt: "Shift Routines and Operating Practices, Discussion"					3.1.1 User Access Control and Qualification Requirements	
IVA "Communications"					3.1.1 User Access Control and Qualification Requirements	
IA, "Introduction					3.1.1 Space-Specific Hazard Awareness Summary	

Chapter and Paragraph Reference, DOE 5480.19, w/C1	Section 1.0	Section 1.0 (repeat reference)	Section 2.0	Section 2.0 (repeat reference)	Section 3.0	Section 3.0 (repeat reference)
IIC3 & 4 "Shift Routines and Operating Practices, Guidelines--Operator Inspection Tours and Round/Tour Inspection Sheets"					3.1.1 Specific Hazard Awareness Summaries	
IIC4, Excerpt: "Round/Tour Inspection Sheets"					3.1.1 Space-Specific Permit	
IIC2, "Safety Practices					3.1.1 Space-Specific Permit	
VIIIA, Excerpt: "Control of Equipment and System Status Introduction"					3.1.1 Space-Specific Permit	
XIIIC1, Excerpt: "Operations Aspects of Facility Chemistry and Unique Processes—Operator Responsibilities"					3.1.1 Space-Specific Permit	
IIC9 Excerpt: "Shift Routines and Operating Practices, Guidelines--Authority to Operate Equipment"					3.1.1 Space-Specific Permit	

Chapter and Paragraph Reference, DOE 5480.19, w/C1	Section 1.0	Section 1.0 (repeat reference)	Section 2.0	Section 2.0 (repeat reference)	Section 3.0	Section 3.0 (repeat reference)
VIIIC2 Excerpt: "Control of Equipment and System Status--Equipment and System Alignments"					3.1.1 Space-Specific Permit	
"Operations Organizations and Administration *Introduction*"					3.1.1 EMSL Practices	
VC5 Excerpt: "Control of On-shift Training-Training Documentation"					3.1.1 User-Specific Qualification Requirements	
XIIIC2 Excerpt: "Operations Aspect of Facility Chemistry and Unique Processes--Operator Knowledge"					3.1.1 User-Specific Qualification Requirements	