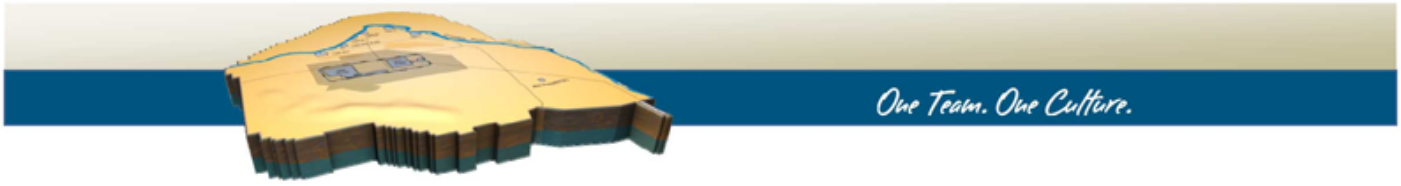

Administrative Procedure

PRC-PRO-SH-17916

Industrial Hygiene Exposure Assessments

Revision 4, Change 0

Published: 09/28/2017
Effective: 09/28/2017

Program: Occupational Safety and Industrial Hygiene
Topic: Occupational Safety and Industrial Health

Technical Authority: Hill, Elizabeth
Functional Manager: Robinson, Roby

Use Type: Administrative

- Central Plateau Surveillance and Maintenance :
  Categorical Exclusion: GCX-8 (Not in Safety Basis Compliance Matrices)
  Screener: Carson, David
- 100 K Facility :
  Screening Determination Performed: (Screening/Determination Performed (no issues))
  0340-2017
  Screener: Williams, James
- Canister Storage Building/Interim Storage Area :
  Categorical Exclusion: GCX-8 (Not in Safety Basis Compliance Matrices)
  Screener: Covey, Lori
- Plutonium Finishing Plant :
  Categorical Exclusion: GCX-7 (Minor Change)
  Screener: King, Jeffry
- Solid Waste Operations Complex :
  Screening Determination Performed: (Screening/Determination Performed (no issues))
  SWOC-17-053
  Screener: Jacobs, Orvil
- Transportation :
  Excluded from USQ
  Exclusion Reason:
  Procedure PRC-PRO-SH-17916, Rev. 4 chg. 0, Industrial Hygiene Exposure Assessments, provides a process for conducting and documenting Industrial Hygiene Exposure Assessments to support CHPRC-directed work activities. This procedure also provides guidance for the processes of hazard evaluation and identification of controls. The procedure states in Section 1.2 that it does not address radiological hazards covered under 10 CFR 830, Nuclear Safety Management. This procedure does not involve transportation activities or packaging systems with greater than 1 A2 quantities of radioactive material on the Hanford Site. Therefore, the release of this procedure is excluded from further review by the Transportation Safety Organization under the USQ Process per Section 1.3 of PRC-PRO-NS-062 Rev. 3. Please mark the change form as "N/A per Section 1.3 - < 1 A2"
- Waste Encapsulation Storage Facility :
  Categorical Exclusion: GCX-8 (Not in Safety Basis Compliance Matrices)
  Screener: Covey, Lori
- 324 Facility :
  Screening Determination Performed: (Screening/Determination Performed (no issues))
  324-17-150
  Screener: Waller, Mitchell
- 618-10 :
  Excluded from USQ
  Exclusion Reason:
  Excluded per PRC-PRO-NS-062, Section 3.1.1, less than hazard category 3 facility (see attached email Jay Lavender) llk

JHA: Administrative
Periodic Review Due Date:09/28/2022
Rev. 4, Chg. 0

Change Summary

Description of Change

CR 2016-0668 corrective actions

Industrial Hygiene Exposure Assessments

Published Date: 09/28/17 Effective Date: 09/28/17

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1.0 INTRODUCTION

1.1 Purpose

This procedure provides a process for conducting and documenting Industrial Hygiene Exposure Assessments (IHEA) to support CH2M HILL Plateau Remediation Company (CHPRC)-directed work activities. This procedure also provides guidance for the processes of hazard evaluation and identification of controls.

Industrial Hygiene Exposure Assessment (IHEA) documentation, with hazard evaluation and control considerations, provides the framework to support safe work, as described in PRC-PRO-WKM-12115, *Work Management*, and is a tool for the Industrial Hygienist (IH) to consistently characterize, document, and control exposure to occupational health hazards, including carcinogens.

1.2 Scope

The IHEA process identifies and evaluates anticipated biological, chemical, ergonomic, and physical agent hazards potentially present in products, materials, equipment and wastes associated with CHPRC-directed work activities. The IHEA provides the driver to develop and assess control measures to maintain occupational exposures as low as practicable.

This procedure does not address the following exposure hazards:

- Radiological hazards covered under 10 CFR 830, *Nuclear Safety Management;*
- Bloodborne pathogens covered under 29 CFR 1910.1030, *Bloodborne Pathogens;*
- Facility/process exposure hazards and controls addressed through design engineering.

1.3 Applicability

This procedure is applicable when conducting and documenting IHEAs to support CHPRC work activities.

1.4 Implementation

This procedure is effective on the date published. Existing IHEAs may continue to be used but must be revised to meet the requirements of this procedure during their next scheduled review.

2.0 RESPONSIBILITIES

Responsibilities associated with this procedure are identified in the process steps.

3.0 PROCESS

The IHEA process may involve development and use of multiple supporting documents, including:

- IH Screening Form
- IH Exposure Assessments and IHEA Summary Form
- IH Sample Plan
- IH Technical Evaluation
- IH Work Permit

3.1 IH Screening Processes

The IHEA process does not require a driver to be performed. If it serves the needs of the project, an IHEA may be generated at any time for any activity or chemical.

Two document processes identify when an IHEA is required:

1. Site Form A-6007-295, *Industrial Hygiene Hazard Screening Form*, identifies when an IHEA, or other hazard evaluation document, is required to support a work activity.

2. Where use of chemicals is involved, Site Form A-6005-592, *Chemical Product Screening Form,* (retained by the Facility Chemical Custodian) identifies when an IHEA is required.

3.1.1 IH Screening for Activities

Actionee	*Step*	*Action*
IH Professional	1.	DETERMINE if an IHEA is required for a given scope of work:
		a. COMPLETE the *Industrial Hygiene Hazard Screening Form* (Site Form A-6007-295) to determine if an IHEA is required.
	2.	COMMUNICATE hazard screening results and provide the applicable required documentation to the Responsible Manager (RM) and/or Work Planner.

3.1.2 IH Screening for Chemicals

Actionee	*Step*	*Action*
IH Professional	1.	DETERMINE if an IHEA is required for a given scope of work:
		a. IF chemicals are involved, THEN REVIEW the *Chemical Product Screening Form* (Site Form A-6005-592) to determine if an IHEA is required.

3.2 IH Exposure Assessment (IHEA)

IHEA documentation is required whenever exposures to biological, chemical, ergonomic, and physical agent hazards pose a potential hazard, such as exposure above an Administrative Control Level (ACL) set to 10% of the Occupational Exposure Limit (OEL). Controls are required when exposures are anticipated to reach or excel 50% of the OEL, or when there is a clearly recognized potential hazard such as exposure to mycotoxins in mold or to Hantavirus from animal excreta (biologic agents do not have established OELs, but do have established guidance).

IHEA requirements are considered "met" using the following agent-specific hazard evaluations, as conducted in accordance with their applicable procedure/regulations:

- Office Ergonomic Evaluation, per PRC-PRO-SH-40463, *Ergonomics*
- Hanford Confined Space Hazard Identification, per DOE-0360 *Hanford Site Confined Space Procedure (HSCSP)*
- Asbestos (Initial) Exposure Assessment, per 29 CFR 1926.1101 (f)(2)
- Asbestos (Negative) Exposure Assessment, per 29 CFR 1926.1101 (f)(2)(iii)
- Beryllium Hazard Assessment per DOE-0342-001, *Hanford Site Beryllium Work Permit (BWP) and Hazard Assessment Procedure*
- Heat Stress Evaluation, per PRC-PRO-SH-121, *Heat Stress Control*

Biological, chemical, ergonomic, and physical agent hazards that could pose an exposure above an ACL (or could pose an exposure hazard for agents lacking an OEL), that are not evaluated using the above-referenced hazard assessment documents, require an IHEA.

The IHEA may be prepared either by chemical/product or by activity. IHEAs developed by activity could identify multiple exposure hazards for an activity. It is expected that all agent exposures that are above an ACL will be evaluated through the IHEA process.

Use of the *Industrial Hygiene Exposure Assessment* (Site Form A-6007-357) standardizes IHEA evaluation and review. The summary form may be used as a cover sheet for a complex project/activity IHEA, or as a standalone IHEA document. IHEA documentation must contain the following required elements, summarized on *Industrial Hygiene Exposure Assessment*:

1. **Work Scope**
2. **Engineering Controls**
3. **Administrative Controls**
4. **Personal Protective Equipment**
5. **Supporting Documentation**

6. **Chemical Hazards**
   - **Chemicals of Potential Concern (COPC)**
   - **Similar Exposure Groups (SEGS)**
   - **Metals**
   - **Particulates**
   - **Emission Generation**
   - **Chemical Introduction**
7. **Physical Hazards**
   - **Thermal Stress**
   - **Noise**
   - **Ergonomics**
8. **Additional Hazards**

After IHEA analyses, exposure control requirements may be identified using Table 1, "Considerations for Exposure Controls."

Table 1. Considerations for Exposure Controls

Estimated Exposure (% OEL)	Exposure Control Actions
<10%	Sampling is not required. General hazard communication, procedures and training are required.
10 – 49%	Attach credible documentation to IHEA to validate exposures are < Action Level (AL) OR conduct several sampling surveys to verify exposures are < AL Chemical-specific hazard communication, procedures and training are required.
50 –100%	Sampling is required. Chemical-specific hazard communication, procedures and training are required. Medical surveillance and respiratory protection may be required. Interim engineering and/or administrative controls may be required.
>100%	Sampling is required. Chemical-specific hazard communication, procedures and training are required. Medical surveillance and/or respiratory protection are required. Implement the hierarchy of controls.

Actionee	*Step*	*Action*
IH Professional	1.	OBTAIN an IHEA number from the Site Wide Industrial Hygiene Database (SWIHD) Administrator AND NOTE the IHEA number on *Industrial Hygiene Exposure Assessment* (Site Form A-6007-357).
	2.	PREPARE an *Industrial Hygiene Exposure Assessment* AND PROVIDE comments, as needed, to characterize the exposure potential.
		a. IDENTIFY the absence of comments with “No Comments” or “None” so the field will not be left blank.
		b. IF chemical products/materials will be used in accordance with the manufacturer’s intended purpose, THEN REVIEW hazard information on the Safety Data Sheet (SDS) for the IHEA.
		• IF product/materials will NOT be used in accordance with the manufacturer’s intended purpose, THEN IDENTIFY how hazard information to be used in the IHEA is determined.
		c. DEFINE the exposure group(s) of potentially-exposed workers.
		d. NOTE biological, chemical, ergonomic, and physical agent parameters used to evaluate hazards in the comments, such as:
		• Chemical Agent Parameters – Chemical Abstract Society (CAS) Number, Vapor Pressure, per cent (%) of agent in product/material, flash point, boiling point, lower explosive limit (LEL), specific gravity, pH, state of matter, the most stringent OEL, route of entry, odor threshold, special notation(s) from the American Conference of Governmental Industrial Hygienists (ACGIH®), and/or notable Globally Harmonized System (GHS) statements; • Physical Agent Parameters – Sources, type of noise, noise and solvent exposure together, GHS statements or other notable properties. • Biological Agent Parameters – Size of affected area, type of biologic agent, and/or other notable properties. • Ergonomic Agent Parameters – Repetitive motion, force, affected body area, and other notable properties.
		e. IDENTIFY the control set to mitigate potential exposure hazards using the hierarchy of controls, and as needed, refer to Appendix C, “Recommended Controls for Carcinogens and Teratogens,” and/or Appendix D, “Recommended Control Sets for Biological Agents,” for guidance.

Actionee	*Step*	*Action*
IH Professional		f. IDENTIFY AND/OR ATTACH any additional or supporting documentation needed to support the IHEA, such as the IH Sample Plan or specialized work permits or compliance plans.
	3.	FORWARD the IHEA to a peer reviewer for evaluation and concurrence.
IH Peer	4.	REVIEW the IHEA, PROVIDE an approval signature after the review is complete, AND RETURN to the IH Professional.
IH Professional	5.	COMMUNICATE hazard controls to line management/planners using any of the following means: • *Job Hazard Analysis Checklist* (Site Form A-6006-681), or *Job Hazard Analysis/Activity Hazard Analysis for Subcontractors* (Site Form A-6004-784), in accordance with PRC-PRO-WKM-079, *Job Hazard Analysis*, OR • Language embedding the controls and requirements in the work package instruction. • IF multiple sets of controls are required, or if there are multiple exposure groups involved in a repetitive work activity, THEN CONSIDER use of the *IH Work Permit* (Site Form A-6007-313) to communicate complex requirements in the work package.
	6.	PROVIDE the completed, signed IHEA to the SWIHD Administrator for upload into SWIHD, in accordance with PRC-PRO-SH-409, *Industrial Hygiene Monitoring, Reporting and Records Management*.
OS&IH	7.	COLLECT AND RECORD exposure data, as applicable (e.g., for agents having either an established OEL or having established exposure guidance information), in accordance with PRC-PRO-SH-409.
IH Professional	8.	VALIDATE the exposure and controls after sufficient sample data is obtained, e.g., generally 6-12 samples (for additional information refer to Appendix B, “Statistical Evaluation of Exposure Data”). • DETERMINE the number of samples for each agent, the data range, the average and maximum values, AND COMPARE to the OEL to determine if controls are adequate. • As needed, PERFORM statistical analysis of exposure data to determine if the exposure group meets the definition of a SEG, in accordance with Appendix B. • REVISE IHEA information to show validation of a SEG and exposure controls, OR REVISE the definition of the exposure group and control set if sample statistics do not validate the SEG.

Actionee	*Step*	*Action*
IH Professional	9.	IDENTIFY conclusions, such as if exposures were judged acceptable or unacceptable, or if more data are needed to resolve the assessment, AND ATTACH to the IHEA. • A diagnostic exposure assessment report should provide observations and conclusion about the sources of exposure and the effectiveness of controls. • A compliance exposure assessment should include an evaluation of sample time to verify the sample may be directly compared to a Permissible Exposure Limit, and should identify if representative sampling is performed, if required. • Interpretive remarks should be provided. All assumptions and models should be identified or referenced.
	10.	After a SEG is validated and the exposure is judged, REVIEW the Employee Job Task Analysis (EJTA) of individuals in an exposure group AND DETERMINE if updates are needed, in accordance with PRC-PRO-SH-52755, *Employee Job Task Analysis*.
	11.	PROVIDE the validated IHEA to the SWIHD Administrator in accordance with PRC-PRO-SH-409.
SWIHD Administrator	12.	POST the IHEA to SWIHD and/or to the OS&IH website.

3.3 IH Sample Plan

The IH sample plan, required prior to collection of samples, identifies technical sampling and analytical information and helps identify decision outcomes based on sampling results.
A *CHPRC Soil and Groundwater Industrial Hygiene Sample Plan* (Site Form A-6005-784) or CHPRC *Industrial Hygiene Sample Plan* (Site Form A-6007-395) may be used to communicate sampling and analytical requirements, and is recommended for activities that involve complex or multiple agent sampling, agents with special/special requirements, and/or is performed by IH Technicians.

Actionee	*Step*	*Action*
IH Professional	1.	IDENTIFY required sampling, monitoring, and analytical information using: • *CHPRC Industrial Hygiene Sample Plan*, or • *CHPRC Soil and Groundwater Industrial Hygiene Sample Plan*. a. PROVIDE the IH Sample Plan, and updates, to the SWIHD Administrator, in accordance with PRC-PRO-SH-409.
	2.	ESTABLISH a priority/schedule for sampling and monitoring activities.

NOTE: *Most OSHA or National Institute of Occupational Safety and Health (NIOSH) sampling methods are written to sample chemical exposures that are above the agent Action Level or AL (e.g. 50% of the OEL). Sample volume may be adjusted by the IH when exposures are expected to be below the AL.*

3. As needed, ADJUST the minimum sample volume to obtain meaningful sample results using the following formula to adjust the minimum sample volume when chemical agent concentration is expected to be below the AL:

$$\textbf{Minimum Sample Volume} = \frac{\textbf{Agent Limit of Detection}}{\textbf{Agent OEL* x Anticipated Fraction of the OEL*}}$$

*in units of mg/m^3

SWIHD Administrator	4.	POST the IH Sample Plan to SWIHD and to the OS&IH website.

3.4 IH Technical Evaluations

An IH Technical Evaluation is a document that may be used to establish a decision basis or process not otherwise specified by regulation or industry standard (sometimes referred to as a white paper of interpretative guidance document). An IH Technical Evaluation is not a required document and cannot be used in lieu of an IHEA.

The following elements are typically documented in an IH Technical Evaluation:

- Summary of the technical issue
- Summary of the requirements (e.g., regulatory, procedural, contractual)
- Decision description
- Basis for the decision (including any assumptions)
- Bounding conditions of the decisions

Actionee	*Step*	*Action*
IH Professional	1.	OBTAIN an IH Technical Evaluation number from the IH Records Specialist.
	2.	PREPARE the IH Technical Evaluation using *Industrial Hygiene Technical Evaluation* (Site Form A-6006-552). • ATTACH calculations and supporting data. • IDENTIFY peer reviewer(s) AND FORWARD for peer review and approval signature.
IH Peer	3.	REVIEW the IH Technical Evaluation, PROVIDE an approval signature after the review is complete, AND RETURN to the IH Professional. a. IF the IHEA cannot be approved as is, THEN WORK with the IH Professional who prepared the IHEA to resolve the concern.
	4.	PROVIDE the completed, signed IH Technical Evaluation to the SWIHD Administrator in accordance with PRC-PRO-SH-409.
SWIHD Administrator	5.	POST the completed *Industrial Hygiene Technical Evaluation* to the OS&IH website.

3.5 IH Work Permit

The IH Work Permit (not a required document) may be used to communicate complex sampling and control set information for multiple exposure groups identified in the IHEA. The IH Work Permit may be used in an area/facility with multiple postings, where each posting identifies different requirements for personal protective equipment (PPE) and/or sampling. The IH Work Permit, with a map/legend that identifies areas with different postings, clarifies complex requirements for areas with multiple postings and/or changing conditions.

Actionee	*Step*	*Action*
IH Professional	1.	OBTAIN IH Work Permit number from the SWIHD Administrator.
	2.	PREPARE the IH Work Permit using the *Industrial Hygiene Work Permit* (Site Form A-6007-313).
	3.	PROVIDE a copy of the completed IH Work Permit to the: • SWIHD Administrator in accordance with PRC-PRO-SH-409 • Work Planner for inclusion in the work package with PRC-PRO-WKM-079
	4.	PROVIDE a briefing on the IH Work Permit requirements to management, IH Technicians, and project workers, as needed.
SWIHD Administrator	5.	POST the completed IH Work Permit) with its associated legend/map to the OS&IH website. a. FORWARD the completed IH Work Permit and attachments to the IRM Service Provider at Mail Stop A5-05, for storage in the Integrated Document Management System (IDMS).

4.0 FORMS

Chemical Product Screening Form (CPS), A-6005-592
Industrial Hygiene Hazard Screening Form, A-6007-295
Industrial Hygiene Exposure Assessment, A-6007-357
CHPRC Industrial Hygiene Sample Plan, A-6007-395
CHPRC Soil and Groundwater Industrial Hygiene Sample Plan, A-6005-784
Industrial Hygiene Technical Evaluation, A-6006-552
Industrial Hygiene Work Permit, Site Form A-6007-313
Job Hazard Analysis Checklist, A-6006-681
Job Hazard Analysis/Activity Hazard Analysis for Subcontractors, A-6004-784

5.0 RECORD IDENTIFICATION

All records are generated, processed, and maintained in accordance with PRC-PRO-IRM-10588, *Records Management Processes*.

Records Capture Table

Name of Document	Submittal Responsibility	Retention Responsibility
Industrial Hygiene Exposure Assessment, A-6007-357	IH Preparer (via SWIHD)	IRM Service Provider
CHPRC Industrial Hygiene Sample Plan, A-6007-395 or A-6005-784	IH Preparer (via SWIHD)	IRM Service Provider
Industrial Hygiene Technical Evaluation, A-6006-552	IH Preparer	IRM Service Provider
Industrial Hygiene Work Permit, A-6007-313	IH Preparer	IRM Service Provider

6.0 SOURCES

6.1 Requirements

10 CFR 851, *Worker Safety and Health Program*

29 CFR 1910, *Occupational Safety and Health Standards*

29 CFR 1926, *Safety and Health Regulations for Construction*

ACGIH, *Threshold Limit Values for Chemical Substances, Physical Agents and Biological Exposure Indices*, 2005

DOE-0342, *Hanford Site Chronic Beryllium Disease Prevention Program (CBDPP)*

PRC-MP-SH-32219, *10 CFR 851 CHPRC Worker Safety and Health Program Description*

6.2 References

10 CFR 830, *Nuclear Safety Management*

DOE-0342-001, *Hanford Site Beryllium Work Permit (BWP) and Hazard Assessment Procedure or the Hanford Site CBDPP*

DOE-0352, *Hanford Site Respiratory Protection Program (HSRPP)*

DOE-0360, *Hanford Site Confined Space Procedure*

PRC-PRO-IRM-10588, *Records Management Processes*

PRC-PRO-SH-121, *Heat Stress Control*

PRC-PRO-SH-409, *Industrial Hygiene Monitoring, Reporting and Records Management*

PRC-PRO-SH-40463, *Ergonomics*

PRC-STD-SH-40518, *Personal Protection*

PRC-PRO-SH-52755, *Employee Job Task Analysis*

PRC-PRO-WKM-079, *Job Hazard Analysis*

PRC-PRO-WKM-12115, *Work Management*

6.3 Other Basis Documents

PRC-PRO-SH-40469, *Occupational Carcinogen Control*

PRC-PRO-SH-40498, *Occupational Lead (Toxic Metals) Exposure Control*

PRC-PRO-SH-40516, *Chemical Management Program*

6.4 Developmental References

American Conference of Governmental Industrial Hygienists Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices, 2016, ACGIH Worldwide Signature Publications, Cincinnati, OH

Industrial Ventilation, A Manual of Recommended Practice, 26th edition, 2007, ACGIH Worldwide Signature Publications, Cincinnati, OH

Manual of Analytical Methods, 2015, Centers for Disease Control and Prevention-National Institute of Occupational Safety and Health, 5th edition

O*SHA Technical Manual, Section II, Personal Sampling for Air Contaminants*, 2014, U.S. Department of Labor, Occupational Safety & Health Administration, Washington DC

Armstrong, TW and BD Silverstein, editors, 2000, *User's Guide to "A Strategy for Assessing and Managing Occupational Exposures.* (Second Edition)." American Industrial Hygiene Association (AIHA) Press, Fairfax, VA.

Di Nardi, SR., editor, 2003. *The Occupational Environmental: Its Evaluation, Control, and Management*. 2nd Edition. AIHA Press, Fairfax, VA

Mulhausen, JR and J Damiano. 1998. *A Strategy for Assessing and Managing Occupational Exposures*, 2nd Edition. American Industrial Hygiene Association Press, Fairfax, VA

Jahn, S.D., WH Bullock and JS Ignacio, editors, 2015. *A Strategy for Assessing and Managing Occupational Exposures*, 4th Edition. American Industrial Hygiene Association Press, Fairfax, VA

Appendix A - Glossary

Term	*Definition*
Administrative Control Level (ACL)	The hazard level below which additional assessment may not be necessary. CHPRC uses 10% of the OEL for the ACL. The ACL is to be used as a decision point for determining the need for additional information to assess the exposure profile.
Action Level (AL)	A percentage, usually 50%, of the PEL assigned to some chemicals with vertical OSHA standards. The action level exposure level triggers actions to be taken to limit employee exposure, such as medical surveillance, exposure monitoring and training.
Exposure	Subjection of an individual to a biological, chemical, ergonomic or physical hazard; the amount of an agent that has reached the individual (external dose) or has been absorbed into the individual (internal dose).
Exposure Assessment	The process of estimating or measuring the magnitude, frequency and duration of exposure to an agent, along with the number and characteristics of the population exposed. Ideally, it describes the sources, pathways, routes, and the uncertainties in the assessment.
Occupational Exposure Limit (OEL)	A health-based upper limit on the acceptable concentration of a hazardous agent to protect workers from adverse health effects. At CHPRC, OELs are the lowest value obtained by comparing the OSHA PEL to the ACGIH TLV®.
OEL-TWA, **OEL-STEL,** **OEL-EL** **OEL-C**	OELs are typically expressed as: • OEL-TWAs as an 8-hour *Time-Weighted Average* exposure limit; • OEL-STEL as a15-minute *Short-Term Exposure Limit* • OEL-EL as a 30-minute *Excursion Limit* for asbestos; • OEL-C as an instantaneous *Ceiling* exposure limit.
Permissible Exposure Limit (PEL)	A legal limit for exposure of an employee to a chemical/physical agent, established by OSHA. A PEL is generally given as an 8-hour TWA (and/or 15-minute STEL for chemicals) that cannot be exceeded unless mitigations, such as respiratory or hearing protection, are used to reduce the exposure to a level below the PEL and/or STEL.
Professional Judgment	The process of forming an opinion or evaluation by the application and appropriate use of specialized knowledge gained from extensive academic preparation through formal education, observation, experimentation, inference and analogy, which is also characterized by conformance with technical and ethical standards within a discipline.
Recommended Exposure Limit (REL)	NIOSH publishes Recommended Exposure Limits (REL) in criteria documents and recommends to OSHA the adoption of RELs as PELs to reduce or eliminate adverse health effects.
Step Back Level	A Step Back Level (or Turnback Value) may be established for airborne contaminants that are detected with a Direct Reading Instrument. The Step Back Level, if applicable, is usually identified on the IH Sampling Plan, and is the point where workers are to back out of the work area.

Appendix A - (Cont.)

Term	*Definition*
SDS	Safety Data Sheet (and/or the predecessor *Material Safety Data Sheet*) contain standardized information from the manufacturer listing the chemical components, their amounts in the product, health hazards, required PPE spill protection requirements, and contact information.
Similar Exposure Group (SEG)	A group of workers having the same general exposure profile for the agent(s) being studied because of the similarity and frequency of the tasks they perform, the materials and processes with which they work, and the similarity of the way they perform the tasks. A SEG can be task-based, process-based or craft-based. A task-based SEG may include an unrelated group of workers who perform a similar defined task; a craft-based SEG may include a craft group performing a variety of tasks throughout the work day or week.
Threshold Limit Value (TLV®)	Threshold limit values (TLV) refer to concentrations of chemical substances or physical agents and represent conditions under which it is believed that *nearly all* workers may be repeatedly exposed, day after day, over a working lifetime, without adverse health effects. TLVs are developed to protect workers who are normal, healthy adults. TLVs for chemical agents are expressed as: TLV-TWA, TLV-STEL, or TLV-C. For ergonomic and physical agents, TLVs are generally identified for a range or set of conditions.
Time-Weighted Average (TWA)	The average measured exposure during a given work day or shift, generally expressed as an 8-hour TWA (within a 40-hour work week). The TWA may be adjusted to account for shorter or longer time periods within a 40-hour week.
Technical Evaluation (TE)	An evaluation used to establish a decision basis not otherwise specified by regulation or industry standard. An IH Technical Evaluation is documented by the process established in this procedure using Site Form A-6006-552, *Industrial Hygiene Technical Evaluation*.

Appendix B - Statistical Evaluation of Exposure Data

After a "sufficient" number of *representative* samples have been collected for compliance assessment, or for agents with an AL or OEL Exceedance, statistical evaluation may be performed to determine the:

- Type of distribution (normal versus lognormal),
- Measure of central tendency (geometric or arithmetic mean),
- Upper Confidence Limit (UCL) as a value, and as a percent (%) of the OEL,
- Homogeneity of the exposures.

NOTES:
1. Following the AIHA Exposure Assessment Strategy, a "sufficient" number of samples for a SEG having little variability is six (6). If results are more variable, up to twelve (12) samples may be collected.

2. If the SEG cannot be defined with twelve (12) samples, consider re-defining the SEG.

3. When calculating any statistical metric it is critical to include all data, including those values reported as less than limit of detection (LOD), which are reported in summary statistics as the numeric value of the LOD.

4. Metrics such as the 95th percentile or the exceedance fraction may also be useful in describing the potential to exceed the exposure limit for the exposure profile.

An exposure profile is a "snapshot" of the exposures experienced by a SEG. The use of statistical tools to characterize the exposure profile provides the IH with a technically sound basis for determining the acceptability or unacceptability of a SEG or exposure profile. While SEG exposures will show some variability, a SEG should reflect a fairly stationary exposure condition.

Critical SEGs are those having exposure profiles near (but below) the OEL. When critical SEGs are present, the IH should carefully review the number of samples required to demonstrate with 95% confidence that the true 95th percentile exposure result is less than the OEL.

Analysis of variance (ANOVA) is another statistical technique that can be used to determine if a SEG has been appropriately defined. For additional information, review the chapters on Sampling Strategy Design and Quantitative Exposure Data, and, Appendix V in the 4th edition of AIHA's *A Strategy for Assessing and Managing Occupational Exposures.*

E-Tools such as IHSTAT, a Microsoft® Excel e-tool from the AIHA, approved for use at CHPRC, may be used to assist the IH in determining the most appropriate data distribution (normal or log-normal), and in calculating summary statistics such as the mean, standard deviation, and the UCL.

<u>Calculate the mean, standard deviation and UCL.</u>

- Calculate the UCL for the dataset as a percent of the OEL (% OEL-UCL) and determine if all data points fall below the upper confidence limit.
  - If a data point falls beyond the 95% OEL-UCL, and/or if the geometric standard deviation >3, then re-evaluate the SEG and consider subdivision into 2 or more SEGs.

Appendix B – (Cont.)

Evaluate the homogeneity of the exposures.

- The arithmetic mean of exposures in a SEG should not differ by more than a factor of 2, for 95% of the workers evaluated. (NOTE: arithmetic mean exposures are the average of a set of numerical values, calculated by adding all sample results, and dividing by the number of samples in the dataset).

Verify the SEG:

- If all data points are all below the 95%OEL-UCL, AND, the data set meets a criterion for homogeneity, then the SEG may be considered as validated. Verify the 1-sided %OEL-UCL falls in the same Exposure Rating (ER) classification as predicted, or revise the SEG definition.

Appendix C - Recommended Controls for Carcinogens and Teratogens

Carcinogens and teratogens generally require special consideration when assessing exposure hazards, because:

- Compliance sampling is required;
- Some agents pose reproductive hazards;
- Some agents lack a recognized "safe" exposure level.

At CHPRC, the following chemical groups are defined as "carcinogens" and require an IHEA if present above threshold quantities:

- **International Agency for Research on Cancer (IARC):**
  - Group 1 (Carcinogenic to Humans)
  - Group 2A (Probably Carcinogenic to Humans)
    Group 2B (Possibly Carcinogenic to Humans)

- **American Conference of Governmental Industrial Hygienists (ACGIH®):**
  - A1 (Confirmed Human Carcinogen)
    A2 (Suspected Human Carcinogen)

- **National Toxicology Program (NTP):**
  - Group 1 (Known to be Human Carcinogens)
    Group 2 (Reasonably Anticipated to be Human Carcinogens)

- **OSHA-Specific Carcinogens that have a Vertical OSHA Standard (see Table D-1):**
  - OSHA-Regulated Carcinogen listed under 29 CFR 1910.1003 or 29 CFR 1926.1103 (see Table 2 "OSHA-Regulated Carcinogens")

General requirements for managing carcinogens include considerations such as threshold quantities, monitoring, reporting of monitoring results, exposure limits, medical surveillance, warning signs/labels, hygiene facilities/practices, use of PPE and training.

THRESHOLD QUANTITY EXEMPTIONS: Regulatory threshold quantities are the stipulated minimal prerequisite concentrations that must be present in a chemical product or waste mixture. Threshold quantities vary for OSHA-regulated carcinogens.

The following chemicals are exempt by OSHA for those mixtures of a solid or liquid with carcinogenic constituents less than or equal to **1.0 percent (%)**:

α-Naphthalene	3,3′-Dichlorobenzidine (and its salts)
Ethyleneimine	β -Propiolactone
2-Acetylaminofluorene	4-Dimethylaminoazobenzene
N-Nitrosodimethylamine	Asbestos

For chemical carcinogens not otherwise specified, the threshold quantity is **0.1%** or less by weight or volume. A limited number of chemical carcinogens regulated by OSHA standards have NO exempted threshold quantity.

Appendix C – (Cont.)

Table C-1. OSHA-Specific Carcinogens with Vertical Standards

Compound	CAS Number(s)	OSHA Reference
1, 2-Dibromo-3-chloropropane	96-12-8	29 CFR 1910.1044
1, 3-Butadiene	106-99-0	29 CFR 1910.1051
4,4'-Methylenedianaline	101-77-9	29 CFR 1910.1050
Acrylonitile	107-13-1	29 CFR 1910.1045
Asbestos	Varies by mineral	29 CFR 1910.1001
Benzene	71-43-2	29 CFR 1910.1028
Cadmium	Varies by compound	29 CFR 1910.1027
Chromium (VI) (Hexavalent)	Varies by compound	29 CFR 1910.1026
Ethylene oxide	75-21-8	29 CFR 1910.1047
Formaldehyde	50-00-1	29 CFR 1910.1048
Inorganic arsenic	Varies by compound	29 CFR 1910.1018
Methylene chloride	75-09-2	29 CFR 1910.1052
Vinyl chloride	75-01-4	29 CFR 1910.1017

Table C-2. OSHA-Regulated Carcinogens

Compound	CAS Number	OSHA Reference
4-Nitrobiphenyl	92-93-3	29 CFR 1910.1003
α-Naphthalene	134-32-7	29 CFR 1910.1004
Methyl chloromethyl ether	107-30-2	29 CFR 1910.1006
3,3'-Dichlorobenzidine, salts	91-94-1	29 CFR 1910.1007
Bis-Chloromethyl ether	542-88-1	29 CFR 1910.1008
β-Naphthalene	91-59-8	29 CFR 1910.1009
Benzidine	92-87-5	29 CFR 1910.1010
4-Aminodiphenyl	92-67-1	29 CFR 1910.1011
Ethyleneimine	151-56-4	29 CFR 1910.1012
β-Propiolactone	57-57-8	29 CFR 1910.1013
2-Acetylaminofluorene	53-96-3	29 CFR 1910.1014
4-Dimethyleaminobenzene	60-11-7	29 CFR 1910.1015
N-Nitrosodimethylamine	62-75-9	29 CFR 1910.1016

Appendix C – (Cont.)

IHEA Considerations for Carcinogens and Teratogens

1. Where feasible, IDENTIFY substitute products/materials to minimize exposure to carcinogens and/or teratogens.

2. DEVELOP exposure controls for CHPRC-defined “carcinogens” above threshold quantities that have the potential to:

   - Become airborne,
   - Cause skin/eye irritation,
   - Enter the body through the skin/eye.

3. CONDUCT baseline exposure assessment for all activities where the potential for carcinogen or teratogen exposure has been evaluated as greater than 10% of the OEL.

   - MANAGE all work activities involving carcinogens above threshold quantities as if they exceed the OSHA PEL until exposure assessment activities have been completed, i.e., until statistical analysis has validated the IHEA.

4. RECOMMEND the establishment of regulated areas where carcinogens identified in Tables D-1 and D-2 are processed, used, repackaged, released, or handled, where exposure is reasonably anticipated to exceed the OSHA PEL or STEL.

   - IDENTIFY prohibitions in the regulated area, such as prohibitions on storage and consumption of food, beverage, medicines, tobacco products, chewing gum, and the application of cosmetics or handling of contact lenses.

5. RECOMMEND use of personal protective equipment (PPE) where carcinogens and/or teratogens are processed, used, repackaged, released or handled.

   - IDENTIFY PPE and/or respiratory protection in accordance with PRC-STD-SH-40518, *Personal Protection,* and DOE-0352, *Hanford Site Respiratory Protection Program (HSRPP),* to include chemical protective clothing and respiratory protection.

6. IDENTIFY specialized training and medical surveillance on employee EJTA’s for those who may be exposed to a carcinogen at or above a regulatory action level.

Appendix D - Recommended Controls Sets for Biological Agents

Anticipated exposure to hazardous biological agents (HBA) in CHPRC operations is minimal. Human infection could result from inhalation of aerosolized dusts from infected animal excreta (urine, feces, saliva), fungal spores, or aerosolized mists from water systems containing legionella bacteria.

The key to prevention of illness from biological agents is to:

- Minimize contact with animal carcasses and wastes, molds, or water system components such as cooling towers; and/or
    - Limit time in locations where exposure could occur.

Hazards from biological agents in CHPRC Operations may include but are not limited to:

- Hantavirus Pulmonary or Cardiopulmonary Syndrome, from inhalation of aerosolized rodent (e.g., deer mice) urine and/or feces;
- Illness from inhalation of aerosolized fungal/histoplasma spores, or bacteria/protista (leptospira, coccidia, salmonella) potentially present in rodent, bird or bat urine or feces;
- Illness from or allergic response to inhalation of aerosolized mold and/or spores in facilities from water intrusion;
- Illness from inhalation of aerosolized legionella bacteria in water system cooling towers, evaporative coolers in facilities, and portable evaporative cooling equipment;
    - Illness from contact with blood or materials contaminated with a vector's blood (e.g., bloodborne pathogens) (refer to PRC-PRO-SH-40143, *Bloodborne Pathogens*).

IHEA Considerations for HBA

Use the guidance in Items 1-4, and Tables E-1 through E-4, to identify controls needed to safely handle HBA and/or minimize the potential for exposure.

1. TREAT all introduced biological material (e.g., rodent/bird/bat waste, mold, etc.) as potential HBA.
    - If potential HBA exposure hazards are present, the IH Professional should take care to limit exposure time and access to areas of concerns and plan work to mitigate hazards using Tables E-1 through E-4.
2. USE "Universal Precautions" to handle and dispose of HBA.
3. USE disinfectant solutions and identified wait times to deactivate HBA.
4. USE PPE while handling/cleaning/disposing of HBA.

Appendix D – (Cont.)

Table D-1. General Guidelines to Remediate Hazardous Biological Agents

1. If the affected area is an enclosed space, **ventilate** for **30 minutes** before entry.
2. If the affected area is in a posted radiological controlled area, complete dose rate and radiologic contamination surveys of the HBA before disturbing any material.
3. After wetting of HBA with disinfectants, **allow a wait time** for deactivation or soaking in accordance with the manufacturer or product recommendations (refer to Table 5, Disinfectant Selection).
4. Remove and containerize visible HBA, debris and cleaning rags/towels, using **wet methods**.
5. Do NOT dry sweep or dust.
6. HEPA-vacuuming is genera**lly not recommended** for HBA cleanup, but may be appropriate for certain areas, in accordance with direction of S&H and/or Rad Con.
7. After deactivation of fungi, **remove** mold on drywall, wood, or carpet, using tools to cut out the affected material with visible mold or water damage.
8. **Wrap waste** and dispose of waste in accordance with Environmental Compliance direction.
9. Disinfect substrate surfaces after HBAs have been removed.
10. Spray work gloves with disinfectant before doffing them, and dispose of as HBA waste.
11. If a respirator is used, wipe the respirator with disinfectant wet wipes before returning it to the respirator station.
12. Following HBA cleanup, **thoroughly wash hands** with disinfectant soap before eating, drinking, or smoking.

Table D-2. Disinfectant Class and Use Based on the Order of Organism Susceptibility

Type of Biohazard	Disinfectant Class	Disinfectant Base	Comments
1. **Fungi** (Candida, Cryptococcus, Aspergillus, Dermatophytes)	**Intermediate Level Disinfectant**	Peroxide	
2. **Bird Droppings** (may contain fungal spores, bacteria, and viruses)	**(Bio-Safety Level-1)**	Chlorine	Chlorine bleach has been deemed a dangerous waste
3. **Vegetative Bacteria** (Staphylococcus, Salmonella, Pseudomonas, coliforms)	**Low Level Disinfectant** **(Bio-Safety Level-1)**	Phenolics	
4. **Enveloped Viruses** (Herpes simplex, measles, mumps, rubella, influenza, respiratory syncytial, hepatitis B and C virus, **hantavirus,** HIV)		Quaternary ammoniums	Quat. Ammoniums may cause skin/respiratory irritation
5. **Blood and Bloodborne Pathogens** (hepatitis B and C viruses, HIV)		Chlorine	Chlorine bleach has been deemed a dangerous waste

Appendix D – (Cont.)

Table D-3. Disinfectant Selection

Disinfectant Class	Disinfectant Base	Approved Product	Product Use	Approximate Contact Times [a]	Can the Disinfected Waste be Disposed of as Non-Regulated Waste? [b] (Yes/No)
Intermediate	Chlorine	***Bleach*** MSDS# 012915A	Mix 1 part bleach/9 parts water, solution made daily	10 minutes	**No.** Disinfected waste is regulated. Request container(s) for disposal.
Intermediate	3 % Hydrogen Peroxide	***Oxivir TB*** MSDS# 073408	Ready to Use	10 minutes	**Yes. Small amounts of disinfected wastes may be placed into regular trash**; otherwise, request container(s) for disposal.
Low	Phenolic	***Lysol*** MSDS# 073292	Ready to Use	10 minutes	**Yes. Small amounts of disinfected wastes may be placed into regular trash**; otherwise, request container(s) for disposal.
Low	Quaternary Ammonium	***Lemon HG*** MSDS# 054060	Mix 2 oz/1 gal water, solution made daily	10 minutes	**Yes. Small amounts of disinfected wastes may be placed into regular trash**; otherwise, request container(s) for disposal.
Low	Quaternary Ammonium	***Nisus DSV*** MSDS# 073407	Mix 2 oz/1 gal water, solution made daily	10 minutes	**Yes. Small amounts of disinfected wastes may be placed into regular trash**; otherwise, request container(s) for disposal.

a. Consult the product label for approximate contact times.

b. Keep the following in mind: (1) **Animal carcasses**, **free liquids** and **large amounts** of biological waste are **prohibited** in the regular trash; and (2) **a waste determination path is necessary before disposing unused** disinfectant, *Ready to Use* products, and (or) **prepared disinfectant** solutions.

Table D-4. Personal Protective Equipment Selection Guidelines for Cleanup of Hazardous Biological Agents

Conditions of Use	Recommended Respiratory and PPE
Cleanup Indoors - Occupied Facilities: Minor rodent contamination; facility under active ventilation; JHA identifies hazards; Radiological Work Permit not required.	Nitrile, latex or surgeon's gloves
Entry/Remediation of Areas: Minor to moderate HBA contamination; facility or area can be ventilated and exposed to sunlight.	Nitrile, latex or surgeon's gloves Disposable coveralls
Entry/Remediation of Areas: Moderate to heavy HBA contamination; facility or area with limited ventilation and (or) other hazards.	Nitrile, latex or surgeon's gloves (2 pairs) Disposable coveralls; Air Purifying Respirator (or Powered Air Purifying Respirator) equipped with P-100 filters

Appendix E - Recommended Evaluation of Ventilation Controls

Ventilation systems used to control employee exposure require maintenance and evaluation. It is recommended that ventilation systems meet system requirements identified by a design authority, such as ACGIH®'s *Industrial Ventilation: A Manual of Recommended Practice*. Ventilation systems that are not adequately maintained, and/or have less than adequate flow rates, can lead to employee exposure and/or building occupant illness.

A review of ventilation types and common ventilation measures are presented in publications such as ACGIH's *Industrial Ventilation: A Manual of Recommended Practice,* and/or D. Jeff Burton's *Industrial Ventilation Workbook; Indoor Air Quality* (IAQ) *Workbook,* or *Laboratory Ventilation Workbook.* A summary of ventilation types is presented below.

Natural Ventilation:

- **Dilution,** and/or removal by passive exhaust.

Mechanical Ventilation:

- **Circulation System**, such as through use of a portable fan or blower.
- **Positive Pressure System**, such as when fresh or make-up air is brought into a space.
- **Negative Pressure (Vacuum) System**, such as when air is exhausted from a space.
- **Balanced System,** such as a **Heating, Ventilation and Air Conditioning (HVAC) System.**

  Common Air Plenum, a duct or air space that facilitates HVAC system recirculation.

  - **Local Exhaust** or **Capture System**, such as a hood, HEPA-filtered vacuum cleaner; or negature pressure containment.

Evaluating Ventilation Systems

Ventilation system evaluation is required when chemicals or particulates are introduced into a space. Agents used are evaluated under the IHEA process and measurements of the ventilation system and/or space are taken to determine its performance. In general, the higher the toxicity or agent concentration, the greater the *Volume Flow Rate* of air required to exhaust or remove the agent.

NOTE: *The IH Technical Evaluation process, used to document calculations, requires that calculations and measurements are reviewed and verified by another qualified individual. Reference the IH Technical Evaluation number in the IHEA.*

Calculations to identify the rate a contaminant will be cleared from a space, or brought below an applicable action level, can be made with a few measured parameters. Measurements and calculations are compared with design requirements to determine if the ventilation system meets control requirements.

Appendix E – (Cont.)

Common Ventilation Measures

- Air *Velocity*, V, through a space.
- *Volume Flow Rate* of air, Q, typically measured or calculated according to the formula: *Q=AV*, where A is the *Cross-Sectional Area* of the duct/space and V is the *Velocity* of air moving through it.
- Agent chemical and physical properties, including the *Vapor Pressure*, *Density*, *Specific Gravity*, etc., to understand agent mixing and dispersal in the air space.
- Physical characteristics of the air (*Temperature, Pressure, Humidity*, etc.) in the space.
- The building HVAC system to determine the percentage of outdoor air introduced, the amount recirculated, and the amount exhausted (may vary seasonally).