

**Sandia National Laboratories**

**Primary Hazard Screening (PHS)**

**PHS Number: SNL07A00126-006**

**CINT- Rm: 1527/1528 - Etch Lab**

**I. Signatures (Electronic signature dates shown)****Risk Management Determination**

Hazard Classification: **Low** Required Documentation: **PHS with integral HA**

Facility/Project Designator: **Non-nuclear Facility** Date Created: **07/05/2011**

DOE Order References: **425.1D** Results as of: **08/02/2011**

Submitted for Review by: **Nogan,John** Org: 01132 Date: 07/15/2011

**Author / Technical Review**

I am knowledgeable of the activities and hazards covered by this PHS and, after doing due diligence, the description, notes, identified hazards, analyses, and other information contained in this PHS are complete and accurate.

Author: **Nogan,John** Org: **01132** CONCUR ON SUBMIT:  
**07/15/2011**

I have performed the above reviews and concur that those items are complete and accurate.

Industrial Facility Safety Basis SME: **Stirrup,Timothy Scott** Org: **04126** CONCUR: **07/27/2011**

**ES&H Coordinator Review**

The description and notes describe and scope the activities performed under this PHS. All hazards have been identified. Questions are answered correctly and, as necessary, rationale or clarification is provided. All hazards in the HA have been analyzed, including the identification of controls for each hazard. I have performed the above reviews and concur that those items are complete and accurate.

ES&H Coordinator: **Davis,M. Wayne** Org: **01100** CONCUR: **07/27/2011**

**Quality Review**

This PHS meets minimum Corporate standards for 1) description/notes and 2) required information. There are no gross inconsistencies. I have performed the above reviews and concur that those items are complete and accurate.

PHS Team: **Hall,Christopher Armando** Org: **04126** CONCUR: **07/27/2011**

## Approver

The description and notes describe and scope the activities performed under this PHS. All hazards have been identified. Questions are answered correctly and, as necessary, rationale or clarification is provided. All hazards in the HA have been analyzed, including the identification of controls for each hazard. I have reviewed this PHS and concur that its contents are accurate and complete. I will ensure that the requirements and commitments in this PHS are implemented prior to the start of work.

Approving Manager: **Hearne, Sean J.**

Org: **01132**

APPROVE: **08/02/2011**

## II. PHS Purpose, Limitations, and Use in Work Planning and Control

### Purpose of the PHS

For the scope of work identified, the PHS identifies:

- High-level (primary) hazards (e.g. chemicals, toxic gasses, explosives)
- Some, but not all controls (e.g. PPE, respirators, ventilation, lockout/tagout, and NEPA), please see the [limitations section](#), below for additional information.
- A Hazard Classification, which determines the requirements for additional Safety Basis documents [e.g., Hazard Analysis (HA), Safety Assessment (SA), Safety Assessment Document (SAD), Documented Safety Analysis (DSA) etc.]
- For the hazards and controls identified, the PHS enables the identification and communication of:
  - Requirements documents (such as Corporate Policy System sections) that must be reviewed to determine specific requirements applicable to the work.
  - Corporate Policy System-required training
  - Action and Warning messages that highlight key requirements.

The Hazard Analysis section of the PHS is used to perform a high-level hazards analysis and controls selection for hazards with a Hazard Classification of 'Low' and, optionally, for Standard Industrial Hazards (SIH).

### Limitations of the PHS for Use in Activity-level Work Planning and Control

Unless additional information is specifically added, a PHS **does not** contain all of the detail necessary to identify and control hazards at the activity/task level. The reasons for this include:

- PHSs are typically written at the project or work-area level and therefore, do not contain sufficient detail about individual tasks or the hazards/controls associated with them.
- While the PHS provides requirements for the hazards and controls identified, it **does not** provide a comprehensive list of all requirements in the Corporate Policy System and related documents. Furthermore, many of the requirements are identified by reference to sections of the Corporate Policy System, which must be evaluated for requirements applicable to the specific work being performed.
- It is impractical to ask enough questions to generate the level of detail necessary for activity/task-level hazard identification and control; human analysis must be employed. Consequently, details must be developed by a work planner, including:
  - [Specific details](#) about the hazard (e.g. what chemical, which laser, when, under what conditions, and where)
  - [Other controls](#) needed, since the only controls automatically identified are the ones with Corporate Policy System requirements that result from their use. Important controls, such as access control, interlocks, shielding, monitoring, and personnel qualifications are not identified.
  - [Specificity](#) about controls (e.g. type of PPE, ventilation specifications)
  - [Details](#) on how and when you implement each control
  - [Information](#) on who needs to take what training

## Recommended Use of the PHS to Support Activity-Level Work Planning & Control

The information developed in the PHS and any resultant Safety Basis documents should be utilized when performing the subsequent task of activity-level hazard identification, analysis, and control selection, where (1) the major work steps are identified; (2) the hazards associated with each major step are identified and analyzed; and (3) the controls for each hazard are identified and verified to be adequate to protect the involved workers. For the vast majority of work performed at Sandia, the Job Safety Analysis form (SF 2001-JSA) or equivalent is the recommended tool to use for this purpose. The JSA provides a systematic process for a team of involved workers and SMEs to ensure the activity-level work scope is rigorously analyzed to identify all potential hazards and specify appropriate controls for each hazard. Information from the PHS and Safety Basis documents is used as an input in developing the JSA, and the results of the JSA are used to develop TWDs, procedures, or other work instructions as appropriate.

In some cases, the PHS system may be used for activity level hazard identification, analysis, and controls identification, however, the PHS usually must be supplemented with additional information to provide the level of detail necessary to serve this purpose. In these cases, a PHS should be designated as an "Activity-Level PHS" on the PHS General Information page; however, these PHSs will be reviewed during the review and approval process to confirm that they contain the detail necessary to identify the hazards and controls at any stage of the work being performed. If determined to not be adequate, options include (1) revising the PHS to include adequate information; or (2) removing the "Activity-Level PHS" designation, and using a JSA/JSA-equivalent process to perform activity-level hazard identification, analysis, and control selection.

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### III. General Information

#### Document Status

Question Set Version: J

Status: **Approved**

Expiration Date: **08/02/2012**

Responsible Organization: **01132**

Operation Type: **Facility or Lab**

#### Radiological Protection Level

Radiological Protection Level for this facility of project: **None**

#### Description

Bay 1527 has two inductively coupled plasma (ICP) etch systems, a plasma enhanced chemical vapor deposition (PECVD) system, an electron beam/thermal evaporator, an atomic layer deposition (ALD) system, and a small bench top sputtering tool. The PECVD system allows the conformal deposition of multiple types of dielectric and other materials, such as poly-Si, silicon nitride, and silicon oxides. The ICP etch systems are used for etching for dry etching aluminum, carbon, oxides, nitrides, polysilicon, among other materials. Each of the etch tools have class 2 lasers for endpoint detection. The ALD system is used for conformal deposition of dielectric and metallic films with single atomic layer control on 3-dimensional nanostructures with aspect ratios of more than 2000. Standard ALD thin films include hafnium oxide, aluminum oxide, titanium nitride, zirconium oxide, and platinum. Ammonia and oxygen process gasses are also supplied to the ALD apparatus. Non-toxic gasses are stored in chase #1530 and are distributed into chase 1528, whereas the toxic gasses are self-contained within built-in toxic gas cabinets in each tool. A fully automatic silane gas cabinet for the CVD reactor is also located in chase 1528. There are toxic gas monitoring sensors located in each of the gas cabinets and in the vicinity of the tools to detect leaks. Additionally, a scanning laser 3a tool, called a Flexus, is located in 1527 and used to measure wafer curvature. The system is interlocked for safety purposes.

The Toxic Gas Monitoring System (TGMS) system is comprised of a decentralized Life Safety Network based on the LonWorks Technology with intelligent network nodes. The digitally networked input/output devices will notify personnel and shut down equipment based on a program customized for the requirements of the CINT Integration Labs.

Network devices include Honeywell (MST Technology) Satellite FTT gas monitors, Echelon digital interface modules, bus monitors, a Local Information Display and DVS (Data Visualization System). Output devices include beacons/horns, relay shut down of gases and signals to the Sandia Fire Protection panel for notification to the Sandia Emergency Operation Center.

#### Notes

##### General Document Notes

**Locations**

Site	Area	Building	Room	Description
<b>Primary Location</b>				
SSTP	No Tech Area	518	N/A	Lab 1527

**Responsible Organization History**

Organization Number	Effective (Starting) Date	This Org. Submitted Document for Review
01132	06/11/2004	Y

**Planned Changes**

## IV. Identified Hazards

Hazard Name	Hazard Description	Source
Traffic	Traffic related hazards for injury	general corporate business process
SIH - Roving Personnel and Visitors	Roving Personnel or Visitors entering work area	general corporate business process
Common electrical hazards	Common electrical hazards	general corporate business process
Chemicals	Potential personnel exposure to chemicals & fire protection regulatory requirements	QUESTION 5
Asphyxiant gas	Asphyxiant gas; Potential injury or death from unevaluated asphyxiant gas displacing oxygen in a workspace.	QUESTION 5d(1)a
Corrosive chemical	Corrosive chemical; Potential exposure to skin and eyes.	QUESTION 5e
Noncompliant storage, dispensing, or use of flammable/combustible liquids	Fire/Explosion Hazard	QUESTION 5g
Chemical physical hazards	Hazards from fires, reactions, and explosions	QUESTION 5h
Flammable gasses 500-1000 CF	Potential fire and explosion	QUESTION 5h(1)a
Toxic gasses	Potential exposure to toxic gasses in the event of a release	QUESTION 5j(1)
Exposed energized circuits	Potential electrical shock or arc	QUESTION 6a
Circuit breakers or disconnect switches	Potential electrical arc from operating circuit breakers or disconnect switches	QUESTION 6b
Electrical equipment (not approved by NRTL or Sandia)	Unknown hazard potential since items have not gone through the standards, testing rigor, and hazard analysis associated with an NRTL-evaluation	QUESTION 6d(1)
Mechanical hazards	Potential injury from mechanical forces	QUESTION 7
Unevaluated nonionizing radiation	Potential exposure to nonionizing radiation.	QUESTION 8a
Pressure source	Injury or damage	QUESTION 10
Potential environmental concerns	Potential for regulatory action	QUESTION 15
Air discharge	Potential to emit regulated contaminants	QUESTION 15b
Hazardous waste	Potential for regulatory action	QUESTION 15d
Less-Than-90-Day Accumulation Area	Potential for regulatory action	QUESTION 15d(1)
Offsite Work	Hazards associated with the site's other activities	QUESTION 21a
Low - Offsite Work Condition - MOW	Hazards encountered while conducting work offsite by members of the workforce	QUESTION 21b(1)a
Offsite Work - Domestic Travel	Hazards associated with domestic travel	QUESTION 21d
Exposure to hazardous energy	Potential injury to personnel from exposure to hazardous energy	QUESTION C3

## V. Required Actions

### Warning Messages

- 1.** All contractors performing servicing and maintenance on SNL-owned equipment shall perform LOTO when required in accordance with 29 CFR 1910.147 (OSHA Standards for General Industry) and comply with the following two additional requirements: (1) The contractor shall be briefed on SNL-specific LOTO devices and procedures applicable to the equipment under maintenance. (2) The contractor shall inform the SNL equipment owner and other authorized or affected workers of the contractor's energy control procedure/process, including any differences between that process and SNL-specific requirements. (QUESTION C3a(1)a)
- 2.** Equipment specific procedures are required for servicing and maintenance according to the requirements of Corporate Procedure: ESH100.2.IS.2, "Control Hazardous Energy (Lockout/Tagout)." (QUESTION C3a(1)b)
- 3.** All operators of the system must be qualified according to the requirements of the Pressure Safety Manual. The Pressure Operator Qualification Form (SF 2001-PQF) is available as an optional tool for documenting the applicable training and qualification requirements for pressure applications. See MN471000, Pressure Safety Manual, Chapter 2, "The Pressure Safety Program," for requirements and guidance on qualification of pressure operators. (QUESTION 10a)
- 4.** All installers of the system must be qualified according to the requirements of the Pressure Safety Manual. The Pressure Operator Qualification Form (SF 2001-PIQ) is available as an optional tool for documenting the applicable training and qualification requirements for pressure applications. See MN471000, Pressure Safety Manual, Chapter 2, "The Pressure Safety Program," for requirements and guidance on qualification of pressure installers. (QUESTION 10b)
- 5.** There may also be requirements for waste minimization and documentation of waste minimization efforts/results. Contact the Pollution Prevention Team for assistance with waste minimization. (QUESTION 15d)
- 6.** There may be hazards from other operations at the host site that could affect workers covered by this PHS; these hazards may change over time. Identify these hazards and any required safeguards to workers. This often involves establishing ongoing communications with the host facility about their hazards and required safeguards. You can also refer to Sandia's Roving Personnel Guidelines for additional information. (QUESTION 21a)
- 7.** There are a variety of requirements applicable to chemicals. Refer to the portions of Corporate Policy: ESH100, Environment, Safety and Health relevant to the activities being performed for requirements. (QUESTION 5)
- 8.** Flammable and combustible liquids must be bonded in accordance with the requirements in: The Sandia, "Record of Code Decision." (QUESTION 5g)
- 9.** Any activity inside the Limited Approach Boundary is considered working near energized parts and requires a senior-manager-approved technical work document (TWD). (QUESTION 6a)
- 10.** 10 Code of Federal Regulations Part 851, Worker Safety and Health Program (PG470246), as implemented through various Sandia requirement documents (e.g., Corporate Policy ESH100, Environment, Safety and Health), requires an exposure assessment of chemical, physical, and/or biological hazards to ensure hazards have been identified and prevented or abated. (QUESTION 8a)
- 11.** Hazards in your work area could impact Roving Personnel or Visitors. Evaluate these hazards and implement the appropriate precautions to protect these persons (e.g., access control, required PPE, training, escorts, pre-entry briefings, emergency procedures briefing). (general corporate business process)

## Action Messages

1. As required by ES&H, Corporate Procedure: ESH100.2.ENV.22, "Manage Hazardous Waste at SNL," Members of the Workforce who are owners or generators of hazardous waste shall plan how to control hazards and appropriately manage their hazardous waste. (QUESTION 15d)

**Response:** Members of the Workforce who are owners or generators of hazardous waste plan how to control hazards and appropriately manage their hazardous waste.

2. Do not exceed the less-than-90-day accumulation area limit. (QUESTION 15d(1))

**Response:** Personnel will not exceed the less-than-90-day accumulation area limit.

3. Where eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for emergency quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use. See Corporate Procedures ESH100.2.IH.13, Work with Injurious Corrosive Materials and Manage Safety Shower and Eyewash Use, for requirements. (QUESTION 5e)

**Response:** Suitable facilities for emergency quick drenching or flushing of the eyes and body are provided within the work area for immediate emergency use.

4. Refer to "Record of Code Decision," with a subject of, "Storage, Dispensing, Bonding, and Grounding of Flammable and Combustible Liquids." Contact Fire Protection Engineering for assistance. See the ES&H Direct Access Services List. (QUESTION 5g)

**Response:** As needed, personnel will contact Fire Protection Engineering for assistance.

5. Work on energized electrical circuits is restricted to certain individuals. Ensure only qualified personnel perform work on electrical equipment/systems at SNL. It is the responsibility of the department manager to determine an employee's electrical qualifications. To become qualified to perform electrical work a person shall do the following: Demonstrate a familiarity, through interview, demonstrated experience (i.e., resume/review) or direct observation, with the hazards of the workplace and the specific equipment to be worked on, as well as any associated ES&H Standard Operating Procedures (SOPs) and Operating Procedures (OPs). Demonstrate a familiarity, through interview, demonstrated experience (i.e., resume/reference) or direct observation, with electrical maintenance techniques, codes, and other general electrical knowledge. Have qualifications reviewed and approved by their department manager to ensure they are qualified for a particular job assignment. NOTE: A person qualified to work with certain equipment may be considered "unqualified" to work on similar equipment without first being advised of any differing hazards involved. (QUESTION 6a)

**Response:** The department manager will determine each employee's electrical qualifications.

6. Use a technical work document (TWD) to perform energized work as follows: If the energized work is diagnostic (such as troubleshooting, measuring voltage, etc.), an OP is required. You can find an example of a completed energized electrical OP on the Electrical Safety homepage. This could easily be used as a template for any R&D electrical activity. If the work involves manipulation or reconfiguration of an energized component, an Energized Work Permit (EWP) must be completed. A EWP is needed each time such tasks are to be completed. An EWP may be obtained from the SNL internal web under Corporate Forms EWP-SF2005-EWP (10-2005). (QUESTION 6a)

**Response:** A TWD is in place in the lab.

7. The energized work decision tool shall be used to determine PPE and hazard analysis requirements. Prior to PPE use, workers shall receive site-specific PPE training. See Corporate Procedure: ESH100.2.IS.8, "Assess Workplace Hazards and Provide and Maintain Personal Protective Equipment" for requirements regarding site-specific PPE training. See MN471004, Electrical Safety Manual, Section 2.10, "Electrical Personal Protective Equipment" for requirements. (QUESTION 6a)

**Response:** The energized work decision tool will be used to determine PPE and hazard analysis requirements. Prior to PPE use, workers will receive site-specific PPE training.

**8.** Identify PPE, shock approach, and arc flash boundary prior to operating disconnect switches. In addition, personnel shall be trained on safe switching techniques/hazards. See MN471004, Electrical Safety Manual, Sections: 2.1, "Electrical Work Requirements - General," 2.2 "Qualifications and Training," and 2.10, "Electrical Personal Protective Equipment" for requirements and guidance. (QUESTION 6b)

**Response:** Personnel will identify PPE, shock approach, and arc flash boundary prior to operating disconnect switches. In addition, personnel are trained on safe switching techniques/hazards.

**9.** All electrical equipment that is not NRTL-listed must be evaluated by an authorized equipment inspector. Contact your ES&H Coordinator for additional information on equipment inspections or to identify an authorized equipment inspector. (QUESTION 6d(1))

**Response:** As needed, personnel will contact the ES&H Coordinator for additional information on equipment inspections or to identify an authorized equipment inspector.

**10.** Contact the Industrial Hygienist on the appropriate Division ES&H Team prior to using nonionizing radiation sources, to evaluate exposure to nonionizing radiation and determine control measures. (QUESTION 8a)

**Response:** The Industrial Hygienist has evaluated exposure to nonionizing radiation and determined any needed control measures.

## Required Training

### PHS Identified Training

[Note: This training is a regulatory requirement for one or more people involved in operations associated with identified hazards. Each class may not be required by all people working in the area. Please note that some training classes are only provided occasionally. Please be sure to allow adequate lead-time for personnel to schedule and complete training.]

Course Code	Course Title	Exclusions	Training Interval (years)	One-time Training
CHM100	CHEMICAL SAFETY TRAINING Required by: QUESTION 5		3	No
CHM103	SITE-SPECIFIC CHEMICAL SAFETY TRAINING Required by: QUESTION C2a(1), QUESTION 5		3	No
ELC106	R&D ELECTRICAL SAFETY (> 50 VOLTS) Required by: QUESTION 6a(2)	ELC106, unless not required by the energized work decision tool	--	Yes

ELC106R	R&D ELECTRICAL SAFETY REFRESHER (> 50 VOLTS)	ELC106R, R&D Electrical Safety (> 50 volts) unless not required by the energized work decision tool.	3	No
	Required by: QUESTION 6a(2)			
ELC901	SAFE SWITCHING BRIEFING		--	Yes
	Required by: QUESTION 6b			
ENV112	HAZARDOUS WASTE & ENVIRONMENTAL MANAGEMENT TRAINING	(all locations other than SNL/CA will take ENV112)	1	No
	Required by: QUESTION 15d			
ENV216	RCRA<90 DAY ACCUMULATION AREA TRAINING FOR OWNERS & EMERGENCY COORDINATORS		1	No
	Required by: QUESTION 15d(1)			
ENV316	RCRA<90-DAYS ACCUMULATION AREA TRAINING FOR WASTE SITE WORKERS		1	No
	Required by: QUESTION 15d(1)			
ENV416	RCRA<90-DAYS ACCUMULATION AREA TRAINING FOR WASTE SITE WORKERS (SITE SPECIFIC)		1	No
	Required by: QUESTION 15d(1)			
ESH100	ES&H AWARENESS		1	No
	Required by: general corporate business process			
ESH200	SAFETY MANAGEMENT	ESH200 for new managers only	--	Yes
	Required by: general corporate business process			
LTO210	LOCKOUT/TAGOUT FOR AUTHORIZED WORKERS		3	No
	Required by: QUESTION C3a(1)b			
LTO220	ANNUAL LOCKOUT/TAGOUT (LOTO) ROLES & RESPONSIBILITIES FOR AUTHORIZED WORKERS		1	No
	Required by: QUESTION C3a(1)a, QUESTION C3a(1)b			
PPE106	PERSONAL PROTECTIVE EQUIPMENT TRAINING	PPE106 unless CHM103 trained. (CHM103 identifies PPE associated with Chemicals; PPE106 is all other PPE)	2	No
	Required by: QUESTION C2a(1)			
PRS150	PRESSURE SAFETY ORIENTATION	for all operators of the system	--	Yes
	Required by: QUESTION 10a, QUESTION 10b			
PRS150R	PRESSURE SAFETY ORIENTATION REFRESHER		3	No
	Required by: QUESTION 10a, QUESTION 10b			

PRS250	ADVANCED PRESSURE SAFETY	for all installers of the system	--	Yes
	Required by: QUESTION 10b			
PRS250R	ADVANCED PRESSURE SAFETY REFRESHER		3	No
	Required by: QUESTION 10b			

## Regulatory Requirements

Regulatory and Standards Drivers for this Facility or Lab. [Note: ES and H Manual sections listed below contain requirements and guidance that pertain to the hazards you have identified in this PHS. It is your responsibility to ensure these requirements have been fulfilled.]

- 1: Corporate Procedure: ESH100.1.EP.2, "Implement NEPA, Cultural Resources, and Historic Properties Requirements" (QUESTION C4)
- 2: Corporate Procedure: ESH100.2.ENV.12, "Obtain and Comply with Air Permits" (QUESTION 15b)
- 3: Corporate Procedure: ESH100.2.ENV.13, "Control Ozone Depleting Substances" (QUESTION 15b)
- 4: Corporate Procedure: ESH100.2.ENV.14, "Comply with Radionuclide National Emissions Standards for Hazardous Air Pollutants" (QUESTION 15b)
- 5: Corporate Procedure: ESH100.2.ENV.15, "Manage Hazardous Waste at SNL/CA" (QUESTION 15d)
- 6: Corporate Procedure: ESH100.2.ENV.16, "Manage Radioactive Waste at SNL/CA" (QUESTION 15d)
- 7: Corporate Procedure: ESH100.2.ENV.17, "Manage Mixed Waste at SNL/CA" (QUESTION 15d(1))
- 8: Corporate Procedure: ESH100.2.ENV.20, "Manage Other Waste at SNL/CA" (QUESTION 15d(1))
- 9: Corporate Procedure: ESH100.2.ENV.21, "Recycle or Reuse Waste at SNL/CA" (QUESTION 15d(1))
- 10: Corporate Procedure: ESH100.2.ENV.22, "Manage Hazardous Waste at SNL/NM" (QUESTION 15d(1))
- 11: Corporate Procedure: ESH100.2.ENV.23, "Manage Radioactive Waste at SNL" (QUESTION 15d)
- 12: Corporate Procedure: ESH100.2.ENV.24, "Manage Mixed Waste at SNL" (QUESTION 15d(1))
- 13: Corporate Procedure: ESH100.2.ENV.26, "Manage Other Waste at SNL/NM" (QUESTION 15d)
- 14: Corporate Procedure: ESH100.2.FP.1, "Manage Fire Protection Requirements" (QUESTION 5g)
- 15: Corporate Procedure: ESH100.2.IH.10, "Evaluate and Control Nonionizing Radiation" (QUESTION 8)
- 16: Corporate Procedure: ESH100.2.IH.13, "Work with Injurious Corrosive Materials and Manage Safety Shower and Eyewash Use" (QUESTION 5e)
- 17: Corporate Procedure: ESH100.2.IH.15, "Control Hazards Using Local Exhaust Ventilation and High Efficiency Particulate Air Filters" (QUESTION C1)
- 18: Corporate Procedure: ESH100.2.IH.20, "Maintain an Accurate Chemical and Biological Material Inventory" (QUESTION 5)
- 19: Corporate Procedure: ESH100.2.IH.4, "Evaluate and Control Chemical Hazards" (QUESTION 5)

- 20:** Corporate Procedure: ESH100.2.IS.2, "Control Hazardous Energy (Lockout/Tagout)" (QUESTION C3a(1)a)
- 21:** Corporate Procedure: ESH100.2.IS.8, "Assess Workplace Hazards and Provide and Maintain Personal Protective Equipment" (QUESTION C2a(1))
- 22:** Guidance on Hazardous Waste Management at SNL (Less than 90-Day Accumulation Area) (QUESTION 15d(1))
- 23:** MN471000, Pressure Safety Manual, Chapter 2, "The Pressure Safety Program" (QUESTION 10a)
- 24:** MN471000, Pressure Safety Manual, Chapter 6, "Testing and Evaluating Pressure Systems" (QUESTION 10f)
- 25:** MN471000, Pressure Safety Manual, Chapter 7, "Verifying the Safe Operation of Pressure Systems" (QUESTION 10f)
- 26:** MN471000, Pressure Safety Manual, Chapter 8, "Servicing Pressure Vessels and Components" (QUESTION 10f)
- 27:** MN471000, Pressure Safety Manual, Chapter 9, "Documenting the Operational Safety of Pressure Systems" (QUESTION 10e)
- 28:** MN471004, Electrical Safety Manual, Section 2.10, "Electrical Personal Protective Equipment" (QUESTION 6a)
- 29:** MN471004, Electrical Safety Manual, Section 2.2, "Qualifications and Training" (QUESTION 6a(2))
- 30:** MN471004, Electrical Safety Manual, Section 4.3, "Safe Work Practices" (QUESTION 6d(1))
- 31:** Corporate Procedure: ESH100.2.ELC.1, "Manage Electrical Hazards" (general corporate business process)
- 32:** Corporate Procedure: ESH100.2.IH.12, "Control Food and Beverage Consumption in Hazardous Areas" (general corporate business process)
- 33:** Corporate Procedure: ESH100.2.IH.17, "Address Indoor Air Quality Concerns" (general corporate business process)
- 34:** Corporate Procedure: ESH100.2.IH.21, "Control Ergonomics Hazards" (general corporate business process)
- 35:** Corporate Procedure: ESH100.2.IS.11, "Implement Housekeeping Safety" (general corporate business process)
- 36:** Corporate Procedure: ESH100.2.IS.7, "Implement Traffic Safety" (general corporate business process)
- 37:** Corporate Procedure: ESH100.3.1, "Prepare for and Manage Emergencies" (general corporate business process)
- 38:** Corporate Procedure: ESH100.4.RPT.2, "Report Injuries and Illnesses" (general corporate business process)
- 39:** Corporate Procedure: ESH100.5.RPT.5, "Report Vehicle Accidents and Property Damage" (general corporate business process)
- 40:** MN471001 - ES&H Manual, Section 4B, "Electrical Safety Practices" (general corporate business process)
- 41:** MN471001 - ES&H Manual, Section 4K, "Traffic Safety" (general corporate business process)
- 42:** MN471001, ES&H Manual, Section 21, "Technical Work Documents (TWDs)" (general corporate business process)

## VI. Related Documents

### Permits

Document Title	Number	Type	End Date
CINT's Authority-to-Construct Permit No. 1725 Actual Date of Initial Start-up	No. 1725	Air	
City of Albuquerque - Wastewater Discharge Permit for CINT	2238A	Water	

### NEPA Documents

Document Title	Number	Project End Date
CINT Integration Laboratories (1501, 1504, 1523, 1525, and 1527)	SNA07-0202	
CINT Bldg. 518/1527 Installation and Operation of Atomic Layer Deposition (ALD) Reactor	SNA10-0098	03/15/2015

### Other Documents

Document Title	Number	Type	Published Date
Operating Procedure for Toxic/Pyrophoric/Inert Gas Cylinders Change-Out	OP1100.189	OP	01/17/2008
Standard Operating Procedure for Working with Hazardous and Particularly Hazardous Chemicals in Center 1100 Laboratories	SOP1100.001 Issue D	SOP	11/01/2010
Electrical Troubleshooting in Center 1100, 50 to 25,000 Volts	SOP1100.005	SOP	05/06/2009

## VII. Primary Hazard Screening Worksheets

### Interview Worksheet

	Questions	Answers
1	<b>Radiation-Generating Devices (RGDs):</b> Is there a radiation-generating device (RGD)? (Answer this question "no" if the RGDs are registered in storage.)	No
2	<b>Radioactive Materials:</b> Is radioactive material present?	No
3	<b>Explosives and Ammunition:</b> Are any explosives or ammunition (including explosive waste) managed, handled, processed, used, or stored?	No
4	<b>Lasers:</b> Do the activities covered by this PHS involve Regulated Laser Activities? Please review the definition of Regulated Laser Activities before answering this question.	No
5	<b>Chemicals: (<i>Review the Help text before answering this question.</i>)</b> Do the activities involve chemicals?	Yes
5a	Has the Industrial Hygiene Program performed an exposure assessment of current activities conducted on Sandia-controlled premises involving chemicals that are covered by this PHS?	Yes
Notes: ALD Hazard Assessment Survey Report SNLNM02066, 5/2010.		
5a(1)	Did the results of the exposure assessment determine that workers are exposed to chemicals above an occupational exposure limit (regardless of respiratory protection)?	No
5b	Do any of the activities include? <ul style="list-style-type: none"> <li>- Hazardous waste cleanup operations (e.g., environmental restoration [ER] sites)</li> <li>- Treatment, storage, and disposal (TSD) facilities</li> <li>- Emergency response</li> </ul>	No
5c	Will activities have, use, synthesize, or liberate unbound engineered nanoscale particles (UNP)?	No
5d	<b>(<i>Review the help text before answering this question.</i>)</b> Do the activities involve storage or utilization of simple asphyxiants?	Yes
5d(1)	<b>(<i>Review the help text before answering this question.</i>)</b> Has an exposure assessment for potential oxygen deficient atmospheres involving the use of simple asphyxiants been performed?	Yes
5d(1)a	Did the exposure assessment indicate that there is a potential for an oxygen deficient atmosphere?	Yes
5e	Are the hazardous chemicals, hazardous substances, or hazardous waste involved in these activities considered injurious corrosive materials?	Yes
5e(1)	Do these activities involve the use of hydrofluoric acid?	No
5f	Do these activities involve working with new chemicals (a substance which has not been listed on the TSCA Inventory List)?	No
5g	Do the activities involve the storage, dispensing, or use of flammable or combustible liquids?	Yes

	Questions	Answers
5h	<p>Do activities involve any of the following?</p> <ul style="list-style-type: none"> <li>- Flammable chemicals in quantities greater than 5 liters of liquid, 1 kg of solid, or 500 cubic feet of gas (at STP) in any single container or manifolded series of containers</li> <li>- Equipment connected to a house system for flammable gases</li> <li>- Reactive chemicals in quantities greater than 1 liter of liquid, 100 g of solid, or 500 cubic feet of gas in any single container or manifolded series of containers</li> <li>- Oxidizers, other than nitric acid, in quantities greater than 5 liters of liquid, 1 kg of solid, or 500 cubic feet of gas in any single container or process</li> <li>- Pyrophoric chemicals in total quantities greater than 500g</li> <li>- Metal powders in quantities greater than 1 kg</li> </ul>	Yes
5h(1)	Is a flammable gas used for purposes OTHER THAN comfort heating or non-process hot water (e.g., restroom use)?	Yes
5h(1)a	Could more than 1000 cubic feet of flammable gas be released from a single container, manifolded series of containers, or house gas system?	No
5i	Do the activities include a process that involves highly hazardous chemicals at or above twenty-five percent of the Process Safety Management standard threshold quantities, or are there flammable liquids or gases involved in a process with a quantity of greater than 2,500 pounds?	No
5j	Do activities use or store toxic gases in quantities greater than the de minimus quantities listed in the Help file?	Yes
5j(1)	Do the activities use or store toxic gases in quantities equal to or greater than the threshold (total) quantities listed in the Help file?	No
5k	<b>(Refer to help file to determine if quantities have been exceeded.)</b> Do the activities use or store hazardous chemicals in quantities equal to or greater than the <b>Emergency Management screening threshold</b> quantities?	No
6	<p><b>Electrical:</b> Do workers conduct any of the following tasks?</p> <ul style="list-style-type: none"> <li>- Work on or near (within the limited approach boundary - 3.5 feet) exposed and energized (greater than or equal to 50 volts) electrical circuits or contact energized electrical circuit parts with tools or test probes?</li> <li>- Operate circuit breakers or disconnect switches operating at or above 50 Volts and 5 mA or more?</li> <li>- Perform non electrical work, but might contact exposed and energized electrical circuits - <i>operating at 50 volts or greater</i> - with equipment or materials, such as ladders, cranes, paint roller extensions, or forklifts?</li> <li>- Use Equipment that <b>operates at 50 Volts or more</b> and is <b>not listed</b> by an OSHA approved Nationally Recognized Testing Laboratory (e.g., UL) and operating at over 50 Volts, including extension cords and power strips?</li> </ul>	Yes

Electrical Hazards	
Source Name	Level
Electrical cords from equipment	varies Location: Site: SSTP, Area: No Tech Area, Building: 518, Room: 1527

	Questions	Answers
6a	Do workers work on or near <b>(within the limited approach boundary - 3.5 feet)</b> exposed and <b>(greater than or equal to 50 volts)</b> energized electrical circuits or contact energized electrical circuit parts with tools or test probes?	Yes
6a(1)	Are <b>circuit parts</b> storing 10 Joules or more, associated with <b>Marx generators or pulsed power circuits</b> ?	No
6a(2)	Are <b>circuit parts</b> associated with <b>facility</b> type <b>electrical distribution systems</b> ?	No
6b	Do workers operate <b>circuit breakers</b> or <b>disconnect switches</b> operating at <b>50 Volts or more</b> and <b>5 mA or more</b> ?	Yes
6c	Do workers <b>perform non electrical work</b> , but <b>might contact exposed and energized electrical circuits - operating at 50 volts or more</b> - with equipment or materials, such as ladders, cranes, paint-roller extensions, or forklifts?	No
6d	Do workers <b>use equipment</b> that operates at 50 Volts or more and is <b>not listed</b> by an OSHA-approved Nationally Recognized Testing Laboratory (e.g., UL), including extension cords and power strips?	Yes
6d(1)	Have all of the non-NRTL approved electrical equipment or appliances been approved and documented using the Sandia non-NRTL-evaluation process?	No
7	<b>Mechanical:</b> Does the facility or activity involve any of the following hazards or activities?  <ul style="list-style-type: none"> <li>- machine shop equipment</li> <li>- portable power tools</li> <li>- powder-actuated tools</li> <li>- centrifuge operations</li> <li>- forklifts</li> <li>- motorized hand trucks</li> <li>- cranes/hoists, miscellaneous lifting devices,</li> <li>- industrial robots or industrial robotic systems</li> <li>- operate light or heavy earth-moving equipment</li> <li>- excavations</li> <li>- trenches</li> <li>- floor or wall penetrations</li> <li>- stored or kinetic mechanical energy that could cause an injury during normal working conditions</li> </ul>	Yes

Mechanical Hazards			
Source Name	Potential Hazard	Com'I Available	Modified
ALD system	Pinch points	Yes	No
	Location: Site: SNLNM, Area: KAFB, Building: N/A, Room: N/A Comments: Reactor load lock and source cabinet		

	Questions	Answers
7a	Do workers operate machine shop equipment?	No
7b	Do workers operate portable power tools?	No
7c	Do workers operate powder-actuated tools (also known as explosive-actuated fastening tools )?	No
7d	Does this facility or project activity use centrifuges?	No
7e	Are forklifts used in any operations?	No
7f	Are motorized hand trucks used in any operations?	No

	Questions	Answers
7g	Are overhead cranes/hoists, mobile cranes, miscellaneous lifting devices (shop or gantry crane), or rigging used in any operations?	No
7h	Are industrial robots or industrial robotic systems used in this project or activity?	No
7i	Do workers operate light or heavy earth moving equipment?	No
7j	Do workers perform or come into close proximity to any of these activities:	No
	- Excavations	
	- Trenches	
	- Floor or Wall Penetrations	
7k	Do activities involve stored or kinetic mechanical energy that could cause an injury under normal working conditions?	No
8	<b>Nonionizing Radiation:</b> At any time, do activities produce nonionizing radiation (NIR) (excluding lasers)?	Yes
Notes: All plasma etch and deposition equipment in the area use RF 100 kHz - 13.56 MHz (up to 3000 watts) to ionize gas molecules within a reaction chamber. The reaction chambers and subsequent RF are well shielded to prevent uncontrolled emissions.		
8a	Has the Industrial Hygiene Program performed an exposure assessment of the source(s) of nonionizing radiation on Sandia-controlled premises that are covered by this PHS?	No
Notes: Need IH to perform an exposure assessment when the equipment is installed and operational. The equipment by design is inherently safe.		
8b	Are any of the nonionizing radiation sources intentional emitters, (e.g., transmitters)	No
9	<b>Thermal:</b> Do thermal hazards or thermal stressors exist in the work area? Please review the definition of thermal stressors before answering this question.	No
10	<b>Pressure:</b> Are workers involved in the design, installation, operation, or maintenance of a pressure system (including pressure, vacuum, cryogenic fluid applications)?	Yes
10a	Do personnel function as pressure system operators?	Yes
10b	Do personnel function as pressure installers?	Yes
10c	Do personnel handle cryogenic fluids, or design install or operate cryogenic fluid-handling systems?	No
10d	Do all systems meet the documentation requirements of the Pressure Safety Manual, Chapter 9? <b>Note:</b> Data packages on Pressure Safety Analysis Reports must reflect the current system configuration and personnel.	Yes
10e	Do supplier-established pressure ratings exist for all systems and system components?	Yes
10f	Are pressure system (or component) reevaluations being performed according to the requirements of the Pressure Safety Manual? (A common example would be the replacement or retesting of pressure relief valves.)	Yes
11	<b>Noise:</b> At any time, do sources of noise hazards exist during activities covered by this PHS?	No

Questions	Answers
<p>12 <b>Miscellaneous Hazards:</b> Does the facility or activity involve any of the following hazards or activities?</p> <ul style="list-style-type: none"> <li>- Ergonomic or musculoskeletal stressors</li> <li>- Construction-like activities</li> <li>- Work with and around asbestos</li> <li>- Elevated work</li> <li>- Underwater diving</li> <li>- Animals and Hazardous Plants</li> <li>- Aircraft</li> <li>- Airborne objects</li> <li>- Firearms</li> <li>- Use of human subjects</li> <li>- Use of Sealed Drum(s)</li> </ul>	No
<p>13 <b>Outside of Manufacturer's Recommendations:</b> Does this work involve the use of <b>equipment, tools, or materials</b> outside of their design specifications or outside of the manufacturer's recommendations? (See Help Text for examples). Please enter each item into the hazard table.</p>	No
<p>14 <b>Non-Commercial Hazards:</b> Does this work involve the use of noncommercial equipment or apparatus (excluding robots, robotics systems, and equipment where the only hazard is a pressure system that has a pressure safety data package)? Please <b>enter each</b> noncommercial piece of equipment into the hazard table.</p>	No
<p>15 <b>Environmental Concerns:</b> Are there any potential <b>environmental concerns</b> with this activity that align with the SNL Environmental Management System (EMS) aspects, such as chemical use, fuel or oil storage, waste generation (except sanitary trash), construction activities, disturbance to habitat or protected species, or discharges to the air, ground surface, ground water, or the sewer systems?</p>	Yes
<p>15a <b>Wastewater:</b> Are there any wastewater discharges from this activity?</p>	No
<p>15b <b>Air:</b> Are there any air discharges or emissions at this activity?</p>	Yes
<p>15b(1) <b>Ozone Depleting Substance (ODS):</b> Are there any <b>ODSs</b> at this activity?</p>	No
<p>15b(2) Will this activity include the installation and or use of <b>combustion equipment</b>? Combustion equipment includes boilers and internal combustion engines, such as generators.</p>	No
<p>15b(3) Will this activity involve open-burn activities?</p>	No
<p>15b(4) Will this activity involve <b>soil disturbance, building demolition, or construction</b> that <b>disturbs soil</b>, including access roads and staging areas?</p>	No
<p>15b(5) <b>Radionuclide NESHAP:</b> Are there any <b>radionuclide air discharges</b> or use of radionuclides in gaseous form or at elevated temperatures from this activity?</p>	No
<p>15c <b>Radioactive Waste:</b> Will this activity generate any radioactive waste, or will Members of the Workforce be required to handle radioactive waste?</p>	No
<p>15d <b>Hazardous Waste:</b> Will this activity generate any hazardous waste, or will Members of the Workforce be required to handle hazardous waste?</p>	Yes
<p>15d(1) <b>Less-Than-90-Day Accumulation Area:</b> Will this activity store any hazardous waste in a <b>less-than-90-day accumulation area</b>?</p>	Yes
<p>15d(2) <b>Acutely Hazardous Waste:</b> Will this activity generate any <b>acutely hazardous waste</b>?</p>	No

	Questions	Answers
15d(3)	<b>Waste Containing Mercury:</b> Will this activity generate any <b>waste containing mercury</b> (e.g., switches, thermometers, manometers, elemental mercury (Hg), or mercury compounds [e.g., mercuric oxide (HgO)], etc.)?	No
15e	<b>Mixed Waste:</b> Will this activity generate any <b>mixed waste</b> , or will Members of the Workforce be required to manage mixed waste?	No
15f	<b>Infectious / Biohazardous Waste:</b> Will this activity generate any infectious or biohazardous waste, or will Members of the Workforce be required to handle infectious or biohazardous waste?	No
15g	<b>Radioactive Contamination:</b> Will this activity be conducted in an area for which a reasonable potential exists for introducing <b>radioactive contamination</b> or causing activation of material that may become waste?	No
15h	<b>Material or Waste of Unknown Origin:</b> Will this activity require handling material or waste of unknown origin?	No
15i	<b>Fuels and Oil Storage:</b> Does this activity use a fuel or oil storage container capable of containing 55 gallons or more?	No
15j	<b>Discharges to Ground Surface:</b> Does this activity have a potential for any <b>discharges to the ground surface</b> ?	No
15k	<b>Improvements/modifications to structure/building exteriors and landscaping:</b> Will this project involve activities that require modifications to the exteriors of structures and buildings or modification to existing landscape, including removal of vegetation?	No
15l	<b>Disturbance to habitat or protected species:</b> Will this project involve activities that will disturb habitat or protected species, including wildlife management and outdoor projects or testing activities?	No
16	<b>Packaging and Transportation of Hazardous Materials:</b> Will any activities covered by this PHS involve the packaging and transportation of hazardous material (including explosives or radioactive material)?	No
17	<b>Fire Protection Concerns:</b> Will the activity include any of the following? <ul style="list-style-type: none"> <li>- Members of the Workforce modifying in any way any fire suppression or life safety system (fire rated walls, fire doors, fire sprinklers, fire alarm devices, fire extinguishers, or means of egress).</li> <li>- Members of the Workforce performing hot work in association with this facility or project activity.</li> </ul>	No
18	<b>Biological Agents: (see Help text before answering this question.)</b> Do activities involve the use of or potential exposure to biological agents?	No
19	<b>Confined Spaces:</b> Are confined spaces present in the work area?	No

Questions	Answers
<p>20 <b>Beryllium:</b> Do operations include any activities that? <i>(Review the Help text before answering this question)</i></p> <ul style="list-style-type: none"> <li>- Use or handle beryllium, beryllium-containing alloys or beryllium oxides?</li> <li>- Create or work with <b>beryllium ceramics</b>?</li> <li>- Handle waste potentially-contaminated with beryllium or waste containing beryllium?</li> <li>- Perform <b>decontamination</b> of beryllium contamination?</li> <li>- Entail work in a beryllium contaminated building or area?</li> <li>- Apply abrasive or destructive methods to metal objects, articles, weapon components or bar stock, potentially containing beryllium?</li> <li>- Use non sparking tools containing beryllium?</li> </ul>	No
<p>21 <b>Offsite Work:</b> Does this PHS involve any of the following?</p> <ul style="list-style-type: none"> <li>- Work at <b>non</b>-Sandia-controlled premises</li> <li>- Work locations <b>other than</b> KAFB, SNL/CA, or TTR</li> <li>- Sandia supplying non-commercial equipment or hazardous material for use by <b>non</b>-Members of the Workforce at <b>non</b>-Sandia-controlled premises <b>or</b> locations <b>other than</b> KAFB, SNL/CA, or TTR.</li> </ul>	Yes
<p>21a Are there any activities at the facility that are <b>not</b> conducted on Sandia-controlled premises? This includes work done by others, such as host-site personnel</p>	No
<p>21b Does work performed by Members of the Workforce on <b>non</b>-Sandia-controlled premises <b>or</b> locations <b>other than</b> KAFB, SNL/CA, or TTR involve any of the following (as defined in the listed PHS questions)? Please include in the question notes a brief description of all hazards driving a "yes" answer to this question, including information about the activities associated with each hazard.</p> <ul style="list-style-type: none"> <li>- radiation generating devices (question 1)</li> <li>- radioactive materials (question 2)</li> <li>- explosives (question 3)</li> <li>- lasers in navigable air space or affecting other operations (question 4b)</li> <li>- HAZWOPER operations (question 5b)</li> <li>- unbound engineered nanoparticles (question 5c)</li> <li>- newly developed chemical substance (question 5f)</li> <li>- chemical physical hazards (question 5h)</li> <li>- &gt;25% PSM quantities (question 5i)</li> <li>- toxic gases (question 5j)</li> <li>- &gt;Emergency Management screening quantities (question 5k)</li> <li>- personnel overexposure to nonionizing radiation (question 8a(1))</li> <li>- public overexposure to nonionizing radiation (question 8b(1))</li> <li>- non-routine aircraft (question 12g(1))</li> <li>- airborne objects other than aircraft (e.g., projectiles, fragments) (question 12h)</li> <li>- firearms (question 12i)</li> <li>- equipment used outside of manufacturer's recommendations with the potential to cause injury to co-located workers or public (question 13b) <ul style="list-style-type: none"> <li>- non-commercial equipment with the potential to cause injury to co-located workers or public (see question 14b)</li> <li>- biological agents BSL-2 or higher</li> </ul> </li> </ul>	Yes

Questions	Answers
Notes: Toxic gases and chemicals used in 1527 in support of dry etch, chemical vapor deposition and atomic layer deposition include BCl <sub>3</sub> (Boron Trichloride), Cl <sub>2</sub> (Chlorine), NH <sub>3</sub> (Ammonia), and various metal-organic or metal halide precursor that include but are not limited to TiCl <sub>4</sub> (titanium tetrachloride), TMA (Trimethylaluminum) and TDMAH (Tektrakis Dimethylamido Hafnium)and Trimethyl(methylcyclopentadienyl)Platinum.	
21b(1) Has the SNL Safety Basis Department determined a hazard classification for these activities?	Yes
21b(1)a What hazard classification was determined by the SNL Safety Basis Department?	Low
21c Does Sandia supply any of the following for use by <b>non</b> -Members of the Workforce on <b>non</b> -Sandia-controlled premises <b>or</b> locations <b>other than</b> KAFB, SNL/CA, and TTR? Please include in the question notes a brief description of all hazards driving a "yes" answer to this question, including information about the activities associated with each hazard.	No
<ul style="list-style-type: none"> <li>- radiation generating devices</li> <li>- radioactive material</li> <li>- explosives</li> <li>- Class 3b or Class 4 lasers where beam will be used outside</li> <li>- chemicals</li> <li>- aircraft</li> <li>- projectiles or objects that could become airborne as a result of the work</li> <li>- nonionizing radiation transmitters other than hand-held radios or Local Area Network (LAN) equipment.</li> <li>- equipment used outside of manufacturer recommendations, including modified equipment</li> <li>- non-commercial equipment, including custom-built equipment</li> <li>- biological agents BSL-2 or higher</li> </ul>	
21d Do these activities involve foreign travel?	No
22 <b>Roving Personnel:</b> Will any work covered by this PHS be conducted by Roving Personnel in a Sandia, non-office area (e.g. working in another organization's space)?	No
23 <b>Emergency Response:</b> Do activities include ES&H emergency response operations, (e.g., NEST, ARG, Hazmat, Medical)?	No
24 <b>Other Hazards:</b> Do the activities have important hazards not specifically identified elsewhere in this PHS?	No

## Controls Worksheet

Questions	Answers
C1 <b>Local Exhaust Ventilation:</b> Do the activities covered by this PHS use local exhaust ventilation (LEV) on Sandia-controlled premises (e.g., laboratory hoods, glove boxes, downdraft tables, "elephant trunks," canopy hoods, paint booths, slot ventilation, portable welding ventilation, etc.)?	Yes

Notes: LEV for the ALD system is connected to the reactor source cabinet where precursor bottles are stored. One 4 cabinet exhaust ~200 CFM (calculated) with a duct mounted NH<sub>3</sub>/smoke detector for leak detection will be installed. In the event of a NH<sub>3</sub> or a pyrophoric metal-organic leak within the tools enclosure, the tool will received a shut down command from the TGMS. The shut down command will place the tool into a failsafe condition aborting the process and triggering a TGMS global warning (Amber Light). If an NH<sub>3</sub> leak is detected, in addition to aborting the process, the TGMS will send a shut down signal to the NH<sub>3</sub> gas cabinet.

	Questions	Answers
C2	<b>Personal Protective Equipment:</b> Are hazards (e.g., chemicals radiological, electrical, mechanical, thermal, flying particles and/or falling or rolling objects) encountered that are capable of causing injury or impairment in the function of any part of the body through absorption, inhalation, or physical contact?	Yes
C2a	Has a workplace hazard assessment been performed for the activities on Sandia-controlled Premises?	Yes
C2a(1)	Did the workplace hazard assessment determine that personal protective equipment will be required?	Yes
C2a(1)a	Has the workplace hazard assessment determined respiratory protection is required?	No
C2a(2)	Does the workplace hazard assessment allow voluntary use of respiratory protection?	No
C3	<b>Control of Hazardous Energy (LOTO):</b> Do you have <b>any equipment</b> in your operations that requires any of the following activities? <ul style="list-style-type: none"> <li>- Construction</li> <li>- Installation</li> <li>- Setup</li> <li>- Adjustment</li> <li>- Inspection</li> <li>- Modification</li> <li>- Maintenance</li> <li>- Service</li> <li>- Lubrication</li> <li>- Cleaning</li> <li>- Unjamming</li> <li>- Making adjustments or tool changes</li> </ul>	Yes
C3a	While performing the servicing and maintenance activities identified above, is there potential for injury from the unexpected energization or start up of the machines, equipment, or process from a release of stored energy?	Yes
C3a(1)	Will service or maintenance be done on a machine, equipment, or a process by the Members of the Workforce <b>within your organization</b> ?	Yes
C3a(1)a	Will <b>ALL</b> service or maintenance be done on a machine, equipment, or a process by the Members of the Workforce <b>within your organization</b> ?	No
C3a(1)b	During the service or maintenance can all the equipment be <b>controlled by cord and plug</b> ?	No
C3b	Are there <b>any</b> activities where <b>control</b> of hazardous energy sources is <b>only necessary</b> for <b>protection of configuration, equipment, or property</b> (i.e., not for personnel protection)?	No
C4	<b>NEPA Compliance:</b> Has this project or activity been reviewed for National Environmental Policy Act (NEPA) compliance in the ISMS NEPA Module?	Yes
C4a	Are all relevant NEPA documents listed in the Documents section of this PHS?	Yes
C5	<b>Activity-Level PHS:</b> Will this PHS be used as an Activity-level PHS, in lieu of a Job Safety Analysis (JSA), for low rigor work?	No

## VIII. Hazard Analysis (HA) Section

### Hazard Analysis

Source Name or Question: **Question 5j(1)**

Source Reason: **Toxic gasses**

Hazardous Condition: **Inhalation / Potential for environmental release**

#### PHS Identified 'Low' Hazard.

**Author's Comment:** The gases of concern are Ammonia (1 lb), Chlorine (1 lb), Boron Trichloride (1 lb) and Silane (8 lbs). All are contained within gas cabinets which are designed to shut down upon detection of any leaks.

**Cause:** System/Component/Equipment Failure

The valve of the cylinder fails causing a leak.

**Consequence:** Major Illness/Injury

Personnel are exposed to gases.

**Mitigation:** Active Engineering Control-Other

The system is designed to shut off the gas if it were detected within the gas cabinet.

**Mitigation:** Procedural/TWD (SOP/OP/RWP)-Other

**Document Id:** OP1100.189, **Title:** Operating Procedure for Toxic/Pyrophoric/Inert Gas Cylinders Change-Out

Personnel have read and signed off on the operating procedure.

**Mitigation:** Warning Device-Audible Alarm (horn/bell/whistle)

A high level alarm will activate upon the detection of a leak at 3 times the Threshold Value Limit. A high level alarm also activates the fire alarm, notifying personnel to evacuate the building.

**Mitigation:** Training-Other

Personnel have completed site specific training for integration lab activities and are aware of the hazards and what to do in case of an emergency.

**Author Assessment of Adequacy:** Applied Mitigation and Prevention are sufficient.

**Adequacy Explanation:** The design of the cabinet to shut off the gas upon a leak detection, the procedure, alarm system and training are adequate controls for this hazard.

Source Name or Question: <b>Question 5h(1)a</b>
Source Reason: <b>Use or storage of flammable gasses</b>
Hazardous Condition: <b>Fire or explosion</b>

**PHS Identified 'Low' Hazard.****Author's Comment:**

**Cause:** System/Component/Equipment Failure

Regulator diaphragm failure or other component failure that results in a leak.

**Consequence:** Minor Property Damage

Fire inside of gas cabinet.

**Mitigation:** Active Engineering Control-Other

Restrictive flow orifice slows the release of gas.

**Mitigation:** Passive Engineering Control-Fire Barrier (fire wall/door/coating)

Gas enclosed in specialty designed cabinet to prevent the spread of fire.

**Mitigation:** Active Engineering Control-Fire Suppression System

Sprinkler integrated into the gas cabinet to maintain control of cylinder temperature.

**Mitigation:** Active Engineering Control-Other

Gas leak detection, shuts off gas supply at the cylinder in the event of a leak. A fusible link also breaks pneumatic air pressure to the cylinder's air operated valve when melted (~100C).

**Mitigation:** Warning Device-Audible Alarm (horn/bell/whistle)

Gas leak triggers both a local and global alarm.

**Author Assessment of Adequacy:** Applied Mitigation and Prevention are sufficient.

**Adequacy Explanation:** The gas cabinet used to store and deliver the pyrophoric gas is specifically designed for this particular hazard (Silane).

Source Name or Question: <b>Question 6d(1)</b>
Source Reason: <b>Electrical equipment operating at 50V or greater that is not NRTL-approved</b>
Hazardous Condition: <b>Electrocution/Arcs/Fires</b>

**PHS Identified 'Low' Hazard.**

**Author's Comment:**

**Cause:** System/Component/Equipment Failure

Short circuit to neutral or ground.

**Consequence:** Minor Mission Disruption/Delay

Loss of power to tool and subsequent shut down.

**Mitigation:** Active Engineering Control-Other

Properly sized circuit breaker or fuse to open circuit in the event of an overcurrent situation.

**Mitigation:** Passive Engineering Control-Other

Components and wiring appropriately sized to operate well above the trip point of the overcurrent protection devices.

**Author Assessment of Adequacy:** Applied Mitigation and Prevention are sufficient.

**Adequacy Explanation:** Preventions/mitigations follow typical NEC guidelines and industry standards.

**Consequence:** Death [Worker]

Electrocution if the worker should provide a low impedance path through the central nervous system or heart to ground.

**Mitigation:** Active Engineering Control-Other

Incorporation of UL approved ground fault interrupt circuit protection to outlets within 6' of water sources.

**Mitigation:** Passive Engineering Control-Access Prevention Barrier (locked door/gate)

Panels with exposed terminals are not easily accessible and require a tool for removal.

**Mitigation:** Procedural (Monitoring etc.)-Other

Ground fault interrupters are tested for proper operation on a routine basis.

**Mitigation:** Active Engineering Control-Other

Emergency power off circuitry, allows the removal of power from the entire system when pressed. Requires operator intervention to restart.

**Author Assessment of Adequacy:** Applied Mitigation and Prevention are sufficient.

**Adequacy Explanation:** Preventions and mitigations described above follow guidelines established by the NEC and are considered to be normal measures to protect against accidental electrocution.

**Consequence:** Minor Property Damage

Electrical fire in an enclosure.

**Mitigation:** Passive Engineering Control-Fire Barrier (fire wall/door/coating)

Electrical components and power distribution circuits are in metallic enclosures.

**Author Assessment of Adequacy:** Applied Mitigation and Prevention are sufficient.

**Adequacy Explanation:** Components and materials of construction follow industry standards that prevent the spread of fire.

Source Name or Question: <b>Question 5d(1)a</b>
Source Reason: <b>Asphyxiant gases</b>
Hazardous Condition: <b>Illness / Asphyxiation</b>

**PHS Identified 'Low' Hazard.**

**Author's Comment:**

**Cause:** System/Component/Equipment Failure

Leak in house nitrogen system.

**Consequence:** Death [Worker]

Asphyxiation

**Mitigation:** Warning Device-Audible Alarm (horn/bell/whistle)

O2 monitors.

**Author Assessment of Adequacy:** Applied Mitigation and Prevention are sufficient.

**Adequacy Explanation:** Oxygen monitors are installed in the Integration Laboratory where the equipment operates. Monitors are maintained and tested regularly.

Source Name or Question: <b>Question 8a</b>
Source Reason: <b>Unevaluated nonionizing radiation</b>
Hazardous Condition: <b>Potential exposure to nonionizing radiation.</b>

**PHS Identified 'Low' Hazard.**

**Author's Comment:**

**Cause:** System/Component/Equipment Failure

Leak of RF radiation to the environment through a reactor system failure

**Consequence:** Minor Illness/Injury

Exposure to RF radiation

**Mitigation:** Signage-Other

Signage on RF sources indicates potential radiation exposure. Key operators must inspect RF source housings for damage that may lead to RF exposure.

**Mitigation:** Passive Engineering Control-Other

By design, the sources are sealed and when used according to manufacturer's specifications, RF exposure is unlikely.

**Author Assessment of Adequacy:** Applied Mitigation and Prevention are sufficient.

**Adequacy Explanation:** RF sources are sealed. There is little chance of damage of the source housings in routine use or maintenance activities.

Source Name or Question: <b>Question 21b(1)a</b>
Source Reason: <b>Low-Level Offsite Hazardous Work Condition</b>
Hazardous Condition: <b>Potential for worker and co-located worker exposure</b>

**PHS Identified 'Low' Hazard.**

**Author's Comment:**

**Cause:** System/Component/Equipment Failure

Regulator diaphragm failure or other component failure that results in a leak.

**Consequence:** Minor Property Damage

Fire inside of gas cabinet.

**Mitigation:** Active Engineering Control-Other

Restrictive flow orifice slows the release of gas.

**Mitigation:** Passive Engineering Control-Fire Barrier (fire wall/door/coating)

Gas enclosed in specialty designed cabinet to prevent the spread of fire.

**Mitigation:** Active Engineering Control-Fire Suppression System

Sprinkler integrated into the gas cabinet to maintain control of cylinder temperature.

**Mitigation:** Active Engineering Control-Other

Gas leak detection, shuts off gas supply at the cylinder in the event of a leak. A fusible link also breaks pneumatic air pressure to the cylinder's air operated valve when melted (~100C).

**Mitigation:** Warning Device-Audible Alarm (horn/bell/whistle)

Gas leak triggers both a local and global alarm.

**Author Assessment of Adequacy:** Applied Mitigation and Prevention are sufficient.

**Adequacy Explanation:** The gas cabinet used to store and deliver the pyrophoric gas is specifically designed for this particular hazard (Silane).

**Cause:** System/Component/Equipment Failure

The valve of the cylinder fails causing a leak.

**Consequence:** Major Illness/Injury

Personnel are exposed to gases.

**Mitigation:** Active Engineering Control-Other

The system is designed to shut off the gas if it were detected within the gas cabinet.

**Mitigation:** Procedural/TWD (SOP/OP/RWP)-Other

**Document Id:** OP1100.189, **Title:** Operating Procedure for Toxic/Pyrophoric/Inert Gas Cylinders Change-Out

Personnel have read and signed off on the operating procedure.

**Mitigation:** Warning Device-Audible Alarm (horn/bell/whistle)

A high level alarm will activate upon the detection of a leak at 3 times the Threshold Value Limit. A high level alarm also activates the fire alarm, notifying personnel to evacuate the building.

**Mitigation:** Training-Other

Personnel have completed site specific training for integration lab activities and are aware of the hazards and what to do in case of an emergency.

**Author Assessment of Adequacy:** Applied Mitigation and Prevention are sufficient.

**Adequacy Explanation:** The design of the cabinet to shut off the gas upon a leak detection, the procedure, alarm system and training are adequate controls for this hazard.

**Note:** 18 hazard analysis(es) were not reported, because no (optional) hazard analysis was performed for them.

**IX. Supplemental Information**

**PHS Input**

**Notes from Interview Questions**

Q 5a - ALD Hazard Assessment Survey Report SNLNM02066, 5/2010.

Q 8 - All plasma etch and deposition equipment in the area use RF 100 kHz - 13.56 MHz (up to 3000 watts) to ionize gas molecules within a reaction chamber. The reaction chambers and subsequent RF are well shielded to prevent uncontrolled emissions.

Q 8a - Need IH to perform an exposure assessment when the equipment is installed and operational. The equipment by design is inherently safe.

Q 21b - Toxic gases and chemicals used in 1527 in support of dry etch, chemical vapor deposition and atomic layer deposition include BCl3 (Boron Trichloride), Cl2 (Chlorine), NH3 (Ammonia), and various metal-organic or metal halide precursor that include but are not limited to TiCl4 (titanium tetrachloride), TMA (Trimethylaluminum) and TDMAH (Tektrakis Dimethylamido Hafnium)and Trimethyl(methylcyclopentadienyl)Platinum.

**Notes from Controls Questions**

Q C1 - LEV for the ALD system is connected to the reactor source cabinet where precursor bottles are stored. One 4 cabinet exhaust ~200 CFM (calculated) with a duct mounted NH3/smoke detector for leak detection will be installed. In the event of a NH3 or a pyrophoric metal-organic leak within the tools enclosure, the tool will received a shut down command from the TGMS. The shut down command will place the tool into a failsafe condition aborting the process and triggering a TGMS global warning (Amber Light). If an NH3 leak is detected, in addition to aborting the process, the TGMS will send a shut down signal to the NH3 gas cabinet.

**User Entered Hazard Tables**

Electrical Hazards	
Source Name	Level
Electrical cords from equipment	varies
Location: Site: SSTP, Area: No Tech Area, Building: 518, Room: 1527	

Mechanical Hazards			
Source Name	Potential Hazard	Com'l Available	Modified
ALD system	Pinch points	Yes	No
Location: Site: SNLNM, Area: KAFB, Building: N/A, Room: N/A Comments: Reactor load lock and source cabinet			

## Assigned Reviewers

Review Type	Role	Person	Required/Requested
Technical SME	ISMS_IFSBReviewer	Stirrup,Timothy Scott	Required Review, due to: QUESTION 21b(1)
	Required Assignment: Review Question 21 and hazard-specific question sets that relate to the user-specified hazards identified in Question 21		
	Comment: [tss 07132011] IFSB review PHS Q#21b(1) for MOW performing activities at a non-Sandia controlled location -- location is CINT Bldg 518 Lab 1527. Design hazards analysis and HARP confirm no impact beyond 100 m and therefore low hazard facility. Listed hazard include flammable/reactive chemicals above threshold and toxic gases above de minimis but below ERPG3 threshold. CINT DHA and HARP support low hazard classification.		
ES&H Coordinator	ISMS_ESH_Coordinator	Davis,M. Wayne	Required Review by business rule.
Safety Basis Manager	ISMS_RiskManagerA	Hall,Christopher Armando	Required Review by business rule.
	ISMS_Manager	Hearne,Sean J.	Required Review by business rule.

## PHS Output

### Major Safety Concerns

**The hazard classification is:** Low

**The required documentation is:** PHS with integral HA

**Safety Concerns at this Low level include:**

(QUESTION 5d(1)a) Asphyxiant gas; Potential injury or death from unevaluated asphyxiant gas displacing oxygen in a workspace.

(QUESTION 5h(1)a) Potential fire and explosion

(QUESTION 5j(1)) Potential exposure to toxic gasses in the event of a release

(QUESTION 6d(1)) Unknown hazard potential since items have not gone through the standards, testing rigor, and hazard analysis associated with an NRTL-evaluation

(QUESTION 8a) Potential exposure to nonionizing radiation.

(QUESTION 21b(1)a) Hazards encountered while conducting work offsite by members of the workforce

### Other Safety Concerns

**Other Safety Concerns (potential hazard sources) for this: Facility or Lab**

(general corporate business process) Traffic related hazards for injury

(general corporate business process) Roving Personnel or Visitors entering work area

(general corporate business process) Common electrical hazards

(QUESTION 5) Potential personnel exposure to chemicals & fire protection regulatory requirements

(QUESTION 5e) Corrosive chemical; Potential exposure to skin and eyes.

(QUESTION 5g) Fire/Explosion Hazard

(QUESTION 5h) Hazards from fires, reactions, and explosions

(QUESTION 6a) Potential electrical shock or arc

(QUESTION 6b) Potential electrical arc from operating circuit breakers or disconnect switches

(QUESTION 7) Potential injury from mechanical forces

(QUESTION 10) Injury or damage

(QUESTION 15) Potential for regulatory action

(QUESTION 15b) Potential to emit regulated contaminants

(QUESTION 15d) Potential for regulatory action

(QUESTION 15d(1)) Potential for regulatory action

(QUESTION 21a) Hazards associated with the site's other activities

(QUESTION 21d) Hazards associated with domestic travel

(QUESTION C3) Potential injury to personnel from exposure to hazardous energy

## PHS Identified Training, by Source

**[Note: This training is a regulatory requirement for one or more people involved in operations associated with identified hazards. Each class may not be required by all people working in the area. Please note that some training classes are only provided occasionally. Please be sure to allow adequate lead-time for personnel to schedule and complete training.]**

CHM100: CHEMICAL SAFETY TRAINING (QUESTION 5)

CHM103: SITE-SPECIFIC CHEMICAL SAFETY TRAINING (QUESTION C2a(1))

CHM103: SITE-SPECIFIC CHEMICAL SAFETY TRAINING (QUESTION 5)

ELC106: R&D ELECTRICAL SAFETY (> 50 VOLTS) (QUESTION 6a(2))

ELC106R: R&D ELECTRICAL SAFETY REFRESHER (> 50 VOLTS) (QUESTION 6a(2))

ELC901: SAFE SWITCHING BRIEFING (QUESTION 6b)

ENV112: HAZARDOUS WASTE & ENVIRONMENTAL MANAGEMENT TRAINING (QUESTION 15d)

ENV216: RCRA< 90 DAY ACCUMULATION AREA TRAINING FOR OWNERS & EMERGENCY COORDINATORS (QUESTION 15d(1))

ENV316: RCRA< 90-DAYS ACCUMULATION AREA TRAINING FOR WASTE SITE WORKERS (QUESTION 15d(1))

ENV416: RCRA< 90-DAYS ACCUMULATION AREA TRAINING FOR WASTE SITE WORKERS (SITE SPECIFIC) (QUESTION 15d(1))

ESH100: ES&H AWARENESS (general corporate business process)

ESH200: SAFETY MANAGEMENT (general corporate business process)

LTO210: LOCKOUT/TAGOUT FOR AUTHORIZED WORKERS (QUESTION C3a(1)b)

LTO220: ANNUAL LOCKOUT/TAGOUT (LOTO) ROLES & RESPONSIBILITIES FOR AUTHORIZED WORKERS (QUESTION C3a(1)a)

LTO220: ANNUAL LOCKOUT/TAGOUT (LOTO) ROLES & RESPONSIBILITIES FOR AUTHORIZED WORKERS (QUESTION C3a(1)b)

PPE106: PERSONAL PROTECTIVE EQUIPMENT TRAINING (QUESTION C2a(1))

PRS150: PRESSURE SAFETY ORIENTATION (QUESTION 10a)

PRS150: PRESSURE SAFETY ORIENTATION (QUESTION 10b)

PRS150R: PRESSURE SAFETY ORIENTATION REFRESHER (QUESTION 10b)

PRS150R: PRESSURE SAFETY ORIENTATION REFRESHER (QUESTION 10a)

PRS250: ADVANCED PRESSURE SAFETY (QUESTION 10b)

PRS250R: ADVANCED PRESSURE SAFETY REFRESHER (QUESTION 10b)

## Results Based on Answers and User-Entered Hazards

**The results in this PHS were based on the following answers to interview questions and user-entered hazards:**

Q 0 answered: Y; Q 5 answered: Y; Q 5d(1)a answered: Y; Q 5e answered: Y; Q 5g answered: Y;  
Q 5h answered: Y; Q 5h(1)a answered: N; Q 5j(1) answered: N; Q 6a answered: Y; Q 6a(2) answered: N;  
Q 6b answered: Y; Q 6d(1) answered: N; Q 7 answered: Y; Q 8 answered: Y; Q 8a answered: N;  
Q 10 answered: Y; Q 10a answered: Y; Q 10b answered: Y; Q 10d answered: Y; Q 10e answered: Y;  
Q 10f answered: Y; Q 15 answered: Y; Q 15b answered: Y; Q 15d answered: Y; Q 15d(1) answered: Y;  
Q 21a answered: N; Q 21b(1) answered: Y; Q 21b(1)a answered: Low; Q 21d answered: N; Q C1 answered: Y;  
Q C2 answered: Y; Q C2a(1) answered: Y; Q C3 answered: Y; Q C3a(1)a answered: N; Q C3a(1)b answered: N;  
Q C4 answered: Y;

## **X. Emergency Operations Concerns**

Pressure

Environmental Concerns

Chemical

Energized Electrical

Energized Mechanical

Non-ionizing Radiation