Hard copy of this document, if not marked "CONTROLLED" in red,
is by definition uncontrolled and may be out of date.

Specification
for

Arsenic Protection Program

REVISION

Rev.	DCN No.	Change Summary	Release Date	DCN Initiator	Document Owner
3	DCN0992	Update Logo	10-16-13	B. Borden	R. Segura

Prior revision history, if applicable, is available from the Document Control Office.

1. PURPOSE AND SCOPE

1.1 The purpose of this Program is to define the key elements of an Arsenic Protection Program to minimize and/or eliminate worker exposures to inorganic arsenic during work activities.

1.2 The primary goal of this Program is to implement arsenic control measures to below the action level (AL) without regard to the use of respirators, and minimize surface contamination.

1.3 This Program is designed to accomplish the following:

1.3.1 Ensure CNSE meets or exceeds governmental regulatory requirements relating to occupational employee exposures to inorganic arsenic.

1.3.2 Meet CNSE internal policies and procedures to protect employees from exposures to inorganic arsenic.

1.4 This Program applies to all CNSE employees, tenant employees, students, professors and contractors. Any deviations from the requirements set forth in this Program must be approved by the EHS department.

1.5 This Program does not apply to the following:

1.5.1 Electronic parts, components or wafers containing inorganic arsenic that is encapsulated or bound within the product in a way that does not allow arsenic to be released during tasks performed on or with the parts, components or wafers.

1.5.2 Operations or tasks that involve working with, using or handling materials that have arsenic content less than 0.02% by weight. This should be determined by means of a laboratory analysis of representative bulk samples of the materials suspected of containing inorganic arsenic.

1.5.3 Tasks or operations that involve arsine, but no other forms of inorganic arsenic – either as process chemicals or as process by-products. However, operations which use arsine as a process gas, and generate inorganic arsenic as a by-product do fall under the scope of this Program.

1.6 Tasks / Operations that fall under the scope of this program include the following:

1.6.1 Preventative maintenance and service tasks on tools or equipment that are contaminated with arsenic and present the potential for employee exposures.

1.6.2 Cleaning, refurbishing or recycling of parts from Ion Implanters or other tools or equipment that have used arsenic as a dopant (e.g., arsine gas or solid arsenic sources) and may be contaminated with inorganic arsenic as a by-product from the tool process.

1.6.3 Collection of arsenic contaminated hazardous waste (e.g., collecting, emptying arsenic hazardous waste containers).

1.6.4 Housekeeping of areas potentially contaminated with inorganic arsenic. This could include floors, fume hoods, work benches and other surfaces that are potentially contaminated with inorganic arsenic. This also includes decontaminating areas where fume hoods, bead blasters, or other arsenic-cleaning equipment are used (e.g., floors, other areas outside of equipment).

1.6.5 Facility maintenance tasks that involve working with equipment that is contaminated with inorganic arsenic; such as:

- Maintenance on point of use abatement systems for arsenic exhaust streams,
- Maintenance of facility exhaust systems handling inorganic arsenic particulate and emissions,
- Replacing filters in portable HEPA vacuums or exhaust ventilation systems that handle inorganic arsenic particulate and emissions.

2. REFERENCES

2.1 **EHS-00010** – CNSE Personal Protective Equipment Requirements

2.2 **EHS-00015** – CNSE Respiratory Protection Program

2.3 **EHS-00030** - Policy for Equipment Decommissioning

2.4 **EHS-00037** - Procedure for Equipment Decontamination

2.5 ACGIH, Industrial Ventilation, A Manual of Recommended Practice, 24th edition, 2001.

2.6 ACGIH, Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices, – most current edition.

3. ACRONYMS & DEFINITIONS

3.1 **ACGIH -** American Conference of Governmental Industrial Hygienists.

3.2 **Action Level (AL) -** The AL for inorganic arsenic is 0.005 mg/m^3 averaged over any 8 hour period.

3.3 **Administrative Controls -** The use of work practices, training, signs and labels, written procedures and other management-dictated work practices to prevent or reduce employee exposures to potential health hazards.

3.4 **Area Air Sample -** A sample that represents the level of chemical (i.e., concentration) in the air in a specific area for a specific duration of time. Area air samples can be integrated samples or direct reading measurements. Area air samples are not collected in the breathing zone of the employee and are not considered to be representative of the exposure(s) received by workers.

3.5 **Arsenic (As) -** The 33rd element on the periodic table. Atomic weight is 74.9.

3.6 **Baseline Monitoring** - The initial exposure monitoring performed for a specific potential health hazard (chemical, radiation, noise, etc.) and for a specific operation or task to establish the levels of exposure for future comparisons.

3.7 **Breathing Zone -** The area surrounding a worker's nose and mouth from which he or she draws breathing air over the course of a work period. This zone can be pictured by inscribing a sphere with a radius of about 10 inches centered at the worker's nose.

3.8 **Control Strategies** - Tools, techniques, methods and designs to reduce and control employee exposures to potential health hazards in the workplace. Examples include substitution of a less toxic agent; engineering controls such as local exhaust ventilation; administrative controls such as changes in work practices and training; and use of personal protective equipment.

3.9 **Engineering Controls –** Controls that reduce exposures to employees by removing the hazard from the process or placing a barrier between the hazard and the employee (e.g., protective guards, shielding, fume hood, etc.).

3.10 **Exposure -** The exposure of a worker to inorganic arsenic through skin contact, ingestion, and / or inhalation during work tasks.

3.11 **High Efficiency Particulate Air (HEPA) vacuum –** Vacuums that contain high efficiency air filters that have particulate removal efficiency (99.97%) of 0.3 micron sized particles.

3.12 **Industrial Hygiene (IH)** - The recognition, evaluation and control of occupational health hazards in the work place.

3.13 **Exposure Monitoring –** Sampling of target contaminants to evaluate concentrations (exposures) associated with specific tasks, operations or work areas. Exposure monitoring for airborne contaminants can be performed in an employee's personal breathing zone. Area air sampling can be performed to evaluate the concentrations of airborne contaminants in a specific location. Surface wipe sampling can be performed to observe the amount of contamination deposited on surfaces.

3.14 **Inorganic arsenic -** For the purpose of this Program, inorganic arsenic includes elemental arsenic and all of its inorganic compounds, **with the exception of arsine**. For the purposes and requirements of this definition, any substance with a total inorganic arsenic content of 0.02 percent or less, by weight, is excluded.

3.15 **Occupational Safety and Health Administration (OSHA) -** OSHA is a federal agency created by the Occupation Safety and Health Act of December 29, 1970 and is mandated to prevent on-the-job accidents and injuries in US factories and other industries. OSHA establishes and issues safety and health regulations, and enforces compliance.

3.16 **Occupational Exposure Limit (OEL) -** The OEL is defined to be the lower of either the local regulatory limit or the most current ACGIH TLV. For inorganic arsenic, the TLV and the PEL (permissible exposure limit - the OSHA regulatory limit) are both 0.010 mg/m^3 as an 8-hour TWA exposure.

3.17 **Potential Health Hazard -** The capability of an environmental agent to cause deleterious effects in an exposed worker. Whether a specific health effect actually results from an exposure is related to a variety of factors including concentration, duration of exposure, specific agent involved, physical state of the agent, route of entry and frequency of exposure.

3.18 **Fit Testing -** A procedure which tests for leakage of an airborne test agent into a respirator while being worn by the employee.

3.19 **Quantitative Exposure Assessment -** The assessment of employee exposures to chemicals, noise or physical agents in a workplace based upon quantitative measurement of the chemical or physical agent using direct reading instruments and / or collection of integrated samples that are analyzed by a laboratory to provide the results.

3.20 **Industrial Hygienist** - A person who has a college or university degree in engineering, chemistry, physics or medicine or related biological sciences and who by virtue of special studies and training has acquired competence in industrial hygiene.

3.21 **Restricted Access Area -** An area where employee exposure to airborne inorganic arsenic, without regard to the use of respirators, can exceed the AL.

3.22 **Threshold Limit Value (TLV) -** TLVs refer to airborne levels of exposure and represents 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 established by the ACGIH are the primary basis for establishing applied OELs, except where a local regulatory limit is lower.

3.23 **Time Weighted Average (TWA)**: The average concentration over a period of time. Employee exposures to arsenic are expressed as TWA results based upon samples collected over an exposure period (e.g., 8-hour work-shift).

3.24 **Ultra Low Penetration Air (ULPA) vacuum:** Vacuums that contain filters that provide very high efficiency removal of particulates (99.999% of 0.12 micron sized particles).

3.25 **Wipe Sample -** A sample collected on a surface to characterize the amount of accumulation over the course of time. Wipe samples can be used to indicate the adequacy of housekeeping and relate to the potential for employee exposures, but do **not** represent employee exposure levels.

4. RESPONSIBILITIES

4.1 The **Supervisors, Managers and/or Professors are** accountable for compliance with this Program and are responsible for:

4.1.1 Implementing this Program

4.1.2 Providing information needed to assess the potential for inorganic arsenic exposures.

4.1.3 Establishing timelines and providing resources & funding that allow for the timely implementation of this Program

4.1.4 Ensure that affected workers are trained, as required.

4.1.5 Ensure medical surveillance participation by affected workers.

4.2 The **EHS Department** is responsible for:

4.2.1 Communicating responsibilities of this Program to the Managers/Supervisors/Professors and addressing any questions.

4.2.2 Developing, maintaining and (if necessary) interpreting this document.

4.2.3 Maintaining this Program including re-evaluating the overall effectiveness and applicability of this Program on an annual basis.

4.2.4 Providing assistance to supervisors/managers, employees, tenant employees, students and/or contractors on mitigation of hazards through engineering, administrative and PPE controls.

4.2.5 Working with Managers/Supervisors/Professors to identify employees, students or contractors that should be included in the medical surveillance program based upon the criteria in the Arsenic Program and tracking their participation.

4.2.6 Defining the content / scope of medical surveillance for affected workers.

4.2.7 Identifying the clinics, medical analytical labs, appropriate lab analysis and other resources in support of medical surveillance for affected workers.

4.2.8 Reviewing the results for each employee to identify any results that require follow-up.

4.2.9 Providing follow-up notification to employees, tenant employees and/or students and management on the steps to be taken in response to the medical surveillance results.

4.2.10 Summarizing the medical surveillance results on a yearly basis in order to identify any trends or issues that need to be addressed.

4.2.11 Providing training as described in this program to all employees included in this Arsenic Protection Program.

4.2.12 Performing hazard assessments and employee exposure monitoring to document exposure levels and the effectiveness of the controls, and notifying workers and management of these results.

4.2.13 Performing wipe sampling to verify the effectiveness of housekeeping procedures in accordance with the tiered approach identified in this Program

4.2.14 Facilitating employee exposure assessments of contractors included in this Program at the CNSE facility.

4.3 **Facilities** is responsible for:

4.3.1 Providing assistance in implementing engineering controls that require Facilities support (e.g., local exhaust ventilation),

4.3.2 Ensuring that facilities workers that are involved in tasks or operations that fall under the scope of this Program are included in the Arsenic Protection Program.

4.4 **CNSE employees, tenant employees, students and contractors** are responsible for the following:

4.4.1 Being familiar with the procedures and other requirements as described in this Program.

4.4.2 Successfully completing the Arsenic Protection Training and quiz, and any other required facility/task specific training.

4.4.3 Being familiar with the SDS for all materials that contain arsenic.

4.4.4 Getting a physical, fit test and training, if required, to wear a respirator.

4.4.5 Participating in medical surveillance as directed by the EHS Department.

4.4.6 Cleaning up the immediate work area at the end of the task or at the end of the work shift.

4.4.7 Following the procedures and proper use of protective measures when performing maintenance, service or repair tasks that fall under the scope of this Program.

4.4.8 Maintain respirators clean and in good working order.

4.4.9 Properly dispose of arsenic contaminated waste.

5. WORK PRACTICES

The protective control measures and Program elements are the minimum requirements at the CNSE facility. These must be implemented for all those involved in tasks with the potential for arsenic exposures.

Detailed work procedures or SOPs (details steps for cleaning parts) should include the following good work practices. These work practices apply to cleaning tasks performed at the tool, in a fume hood, or in a dedicated remote parts cleaning room or area.

5.1 Wet techniques should be used during manual parts cleaning. Manual parts cleaning should be based upon the CNSE Arsenic Contaminated Parts Cleaning Work Instruction.

5.2 Never dry sweep or dry clean contaminated surfaces, equipment or materials containing arsenic.

5.3 Dispose of arsenic contaminated materials in dedicated arsenic disposal containers – never in general waste.

5.4 Do not touch clean surfaces with contaminated gloves – remove the outer gloves first.

5.5 Do not walk around cleanroom in contaminated PPE.

6. ENGINEERING CONTROLS

6.1 **Fume Hood**: Laboratory fume hoods should be used for tasks performed away from the tool or equipment (e.g., dedicated cleaning operation). The fume hood should include a sash to allow the size of the opening to be adjusted based upon the task being performed. The exhaust ventilation for the fume hood should provide 80-125 fpm face velocity with the sash positioned at the designated working height. The optimal approach is to have two dedicated fume hoods; a “Contaminated Parts” hood for cleaning contaminated parts from the tools and a “Clean Parts” hood for handling / assembling cleaned parts prior to replacement on the tool.

6.2 **Exhausted Abrasive Blast Cabinet** (if used): If an abrasive blasting cabinet is used, the abrasive blasting cabinet / enclosure should be provided with exhaust ventilation and should not allow the escape of dust from the enclosure during operation. A design guideline for this type of equipment is provided in the ACGIH *Industrial Ventilation Manual*. The exhaust ventilation provided for this control should meet the following criteria:

- 20 air changes per minute
- 500 fpm inward velocity at any opening in the enclosure
- Minimum duct velocity of 4000 fpm

6.3 **Dedicated Arsenic Cleaning Room/Area**: Whenever possible, a remote, dedicated parts cleaning room or area should be used for parts cleaning and other tasks that involve the potential for generation of arsenic dust and particulate. This effectively limits the spread of arsenic contamination in the cleanroom. The most effective approach is to install the various

engineering controls in this dedicated room or area and perform activities that could release arsenic only in this area.

6.3.1 Use of Dedicated Parts Clean Room - If parts-cleaning is performed in a dedicated remote area / room, a procedure should be developed to address key aspects of the use of the room / area including the following:

- Parts transport procedures: The procedure should describe the steps to follow when transporting arsenic contaminated parts from the tool or another area of the facility to the remote area where parts cleaning or other tasks are performed.
- Storage of contaminated parts and cleaned parts.
- Use of controls to prevent exposures; e.g., location of controls, any instructions on proper use, means of ensuring the controls are operating correctly, maintenance schedule for controls (e.g., frequency for checking exhaust on fume hood, frequency for changing out vacuum filters, etc.).
- Gowning procedures for putting on / taking off PPE: This procedure should describe the steps to follow when putting on protective clothing; and when and where to remove contaminated protective clothing after PM tasks, and proper disposal of contaminated PPE.

6.4 **Snorkel at the tool for in-situ cleaning**: Where possible, local portable exhaust ventilation should be used at the tool (e.g., snorkel exhaust) for tasks such as parts cleaning that cannot be performed remotely in a dedicated clean area. Whenever possible, tasks should be performed in a fume hood away from the tool / equipment rather than at the tool using local portable exhaust. Using a fume hood limits the locations where arsenic can be released into the facility.

6.5 Engineering controls must be validated to ensure that they are working properly and providing effective protection against arsenic exposures each time they are used based upon the following approach:

- Controls should be tested on a periodic basis to ensure that the controls meet the criteria in this Program (e.g., face velocity measurements on fume hood). The frequency for these validation tests will depend on the type of control and manufacturer's instructions.
- Controls should be provided with a means of verifying that the control is operating at the minimum acceptable level of performance. Examples of these types of verification methods are:

magnehelic gauge with minimum static pressure; alarms that are connected to a monitoring device (gauge, anemometer, etc.); velocity gauge at the duct with a readout or visual indicator to show velocity is within acceptable ranges.

If the control is found to be operating at an unacceptable level, respiratory protection must be used until control operations are at acceptable performance levels.

7. HYGIENE

The following good hygiene and work practices should be used by all personnel that perform tasks that involve working with arsenic contaminated parts, tools, equipment, or work surfaces. These practices should be part of the arsenic training provided to workers involved in tasks with the potential for arsenic exposures.

7.1 Always wash hands and face after changing out of arsenic contaminated PPE following the completion of tasks involving the potential for arsenic exposures.

7.2 Always remove PPE and wash hands and face before eating, drinking or smoking.

7.3 No storage or consumption of food or beverages in the work area.

7.4 No smoking or chewing of tobacco products in the work area.

7.5 No gum chewing in the work area.

7.6 No storage or application of cosmetics in the work area.

7.7 Hygiene Facilities

7.7.1 Workers potentially exposed to arsenic should be provided with hygiene facilities as follows:

- A location with sink with running water, soap and towels where workers can wash their hands and face after tasks. This facility does not have to be dedicated to arsenic tasks or operations.
- A location for eating, drinking, and smoking that is clean and separated from the restricted work areas.

7.7.2 If workers are exposed to airborne arsenic levels that exceed the Arsenic OEL of 0.010 mg/m^3, the following facilities must be provided for workers involved in these tasks.

- Change rooms for PPE
- Shower facilities
- Lunch facilities

8. HOUSEKEEPING

8.1 Housekeeping of areas where arsenic contaminated materials are handled or worked with should be performed on a regular basis to prevent the accumulation of arsenic containing dust or particulates. A housekeeping plan should be developed in terms of location, method and frequency of cleaning.

8.2 Each worker at CNSE is responsible for their immediate work area and equipment, such as personal work tools, and dedicated work cart.

8.3 NEVER dry sweep and / or dry clean the work area being cleaned.

8.4 Never use compressed air for cleaning arsenic contaminated surfaces.

8.5 Only use a dedicated arsenic HEPA or ULPA vacuum (labeled with the appropriate arsenic warning labels) or wet methods for housekeeping performed under this Program. **CAUTION**: The HEPA or ULPA vacuum cleaners should be dedicated for cleaning arsenic contamination only. Do not use dedicated arsenic vacuums for general cleanup applications because all of the waste must be treated as arsenic contaminated. Conversely, do not use general vacuum cleaners for arsenic contaminated areas because of the potential for arsenic contamination of the general vacuum cleaner.

8.5.1 Filter Changes for arsenic-dedicated vacuums is the responsibility of the employees working in the arsenic-restricted area. This should be based upon the manufacturer's recommended bag changing procedure. This procedure should be performed inside of a fume hood. The vacuum filter and any contaminated cleaning materials (e.g., wet wipes) should be handled and disposed of as hazardous waste.

8.5.2 Clean the vacuum hose, transport cart and tools using wet wipes after PM tasks are completed.

8.6 All arsenic contaminated waste is toxic and must be discarded in yellow bags or container. These bags and containers must have the red hazardous waste label on them and be labeled, 'Toxic Arsenic Contaminated Hazardous Solid Waste'.

8.6.1 If wafer shards or arsenic-contaminated parts with sharp edges are to be discarded, use a hard walled container so that the edges do not pierce the plastic waste bag.

9. PERSONAL PROTECTIVE EQUIPMENT (PPE)

PPE should be worn for all tasks performed by personnel that present the potential for arsenic exposure through inhalation or skin contact and to prevent exposure of street clothing or cleanroom suits to arsenic contamination.

9.1 **Disposable suits/coveralls with head cover** (e.g., tyvek suits) should be worn to cover and prevent arsenic contamination of cleanroom suits. Street clothing cannot be used as protection for any tasks that present the potential for arsenic exposure through inhalation or skin contact.

9.2 **Shoe covers** (two layers) that completely cover the shoes. In the cleanroom, the additional pair of shoe covers should be worn before entering the restricted area and discarded immediately before leaving the restricted area to prevent arsenic contamination from spreading to other areas of the fab.

9.3 **Gloves**. (two layers) so that the outer contaminated layer can be removed before touching / handling non-contaminated surfaces (e.g., door knobs, handles, etc.). Depending on the nature of the task, the outer layer may be cleanroom gloves; however, a different type of glove may be required for some tasks (e.g., chemical resistant or abrasion-resistant gloves). Replace torn or damaged gloves with new gloves. Do not touch clean surfaces with contaminated gloves – remove the outer layer of gloves first, then re-double glove, if necessary.

9.4 **Respiratory Protection** is required for all tasks performed in-situ (at tool) with arsenic contamination or for tasks that involve work on arsenic contaminated parts that cannot be performed inside of a properly ventilated fume hood. However, respiratory protection may not be required if exposure assessments have been performed to validate the effectiveness of engineering controls**.** The following criteria must be met in order to determine that respiratory protection is not required (refer to section 12 for more detail):

- Two successive personal exposure assessments (at least 7 days apart) must be performed and demonstrate that the exposures are below the AL for arsenic of 0.005 mg/m^3 as an 8-hour TWA. These assessments must be based upon personal samples collected in worker's breathing zone while performing tasks that are expected to

result in the realistic worst case exposure levels. This testing must be performed in accordance with OSHA regulatory requirements.

- If the controls, the tasks, or the operation change, personal monitoring must be repeated (as described above) to validate that the exposure levels have not increased. Respiratory protection must be used in the interim period while the repeat monitoring results are being collected.

9.4.1 Respiratory protection must be selected in accordance with the CNSE Respiratory Protection Program, EHS-00015. The type of respiratory protection required will depend on the tasks performed and the level of exposure determined by employees' personal monitoring results. Respirators should be selected based on the following criteria:

- Full face-piece air purifying respirator (APR) with HEPA cartridges should be used for tasks that can result in exposures to arsenic that do not exceed 0.125 mg/m^3. The North elastomeric full face-piece respirator is an example of this type of respirator.

- Air-supplied respirator in pressure demand mode should be used for tasks that present the potential for employee exposures to arsenic at concentrations above 0.125 mg/m^3 or for arsine at concentrations above 0.005 ppm (5 ppb) as an 8-hour TWA exposure. Arsine can sometimes be generated as a by-product such as when arsenic contaminated surfaces are wetted with water. The Scott full face-piece Supplied Air Respirator is an example of this type of respirator.

10. PROCEDURE FOR REMOVING CONTAMINATED PPE

Contaminated PPE should not be cleaned by shaking or by the use of compressed air or other compressed gases. All contaminated clothing should be handled carefully to avoid the generation of airborne arsenic dust. All disposable PPE should be disposed of as toxic waste.

10.1 Remove your contaminated PPE just inside the restricted area. Have disposal bags / containers and cleaning wipes prepared.

10.2 If the PPE is dusty, remove the coveralls and head covering and dispose into the waste container before removing the respirator.

10.3 Remove the respirator and place in a plastic bag. Then remove outer shoe coverings, and outer layer of gloves and move to an area just outside the restricted area.

10.4 Using respirator cleaning wet wipes, wipe down the outside of the respirator. Use a fresh wipe to clean the inner seal of the respirator. Discard wipes as arsenic hazardous toxic waste and store respirator in a clean, plastic bag.

10.5 Remove remaining PPE, leave cleanroom and proceed to the hygiene facility to wash hands and face.

11. EMPLOYEE EXPOSURE ASSESSMENTS

11.1 Employees performing the tasks / operations that involve potential exposure to inorganic arsenic should be assessed to document the levels of exposure to arsenic and to verify that the existing controls are adequate.

11.2 Sampling should be performed to represent the realistic worst case exposures.

11.3 Personal breathing zone air samples should be collected over the employee's work shift (i.e., at least 7 continuous hours) to evaluate exposures.

- If various tasks involving arsenic exposures are performed on different shifts, data should be collected to cover the various tasks.
- Monitor at least one sample for each shift for each job classification in each work area.

11.4 Employee exposure monitoring should be based upon the procedures set forth by OSHA and NIOSH. Ensure flow rate used will allow a detection limit to below the AL of 5 $\mu g/m^3$.

11.5 **Baseline Monitoring**: Baseline monitoring should be performed initially for each job category / task at each location where the potential for employee exposures to arsenic exist.

11.6 **Follow-up Monitoring**: Follow-up monitoring should be performed based on results of baseline monitoring.

11.6.1 Less than AL: Two rounds at least 7 days apart. Can discontinue monitoring if both sets of results are less than the AL. Follow the criteria below if either round exceeds the AL or PEL.

- Greater than or equal to AL but less than PEL. Every 6 months. Continue monitoring until two sets of results at least 7 days apart are less than the AL.

- Greater than the PEL. Every 3 months. Continue monitoring until two sets of results at least 7 days apart are less than the AL.

11.7 **Additional Monitoring** Whenever there has been a personnel, production, process, control, or other change which may result in new or increased exposure to inorganic arsenic, additional monitoring which complies with this Program should be conducted for all potentially affected workers within 30 days of any such change.

11.8 Area measurements at each location (e.g., lab, cleanroom, etc.) where these tasks are performed can supplement personal monitoring data. However, area sampling data are not acceptable as the basis for evaluating employee exposures.

12. WIPE SAMPLES

12.1 Wipe samples should be collected on a periodic basis from horizontal and other work surfaces in areas where tasks with the potential for arsenic contamination are performed to validate the effectiveness of housekeeping and clean-up activities.

12.2 Areas sampled should be at least 100 cm^2 in size and should be analyzed for arsenic. The laboratory analytical method must be capable of providing a limit of detection that is less than 1 µg per sample.

12.3 The CNSE Surface Contamination Assessment Criterion for arsenic is 50 µg arsenic /100 cm^2 of surface area. Results that exceed the 50 µg/100 cm^2 criterion indicate that the housekeeping / clean-up procedures are not adequate and these areas require more frequent and / or more careful cleaning of residual accumulations of arsenic.

13. RESTRICTED ACCESS AREAS

13.1 EHS is responsible for identifying the need for Restricted Access Area based upon monitoring results and discuss with supervisors/managers/professors regarding what tasks or operations are affected.

13.2 Areas in which operations are performed that present the potential for exposures to inorganic arsenic above the AL, without regard to the use of respirators, should be identified as Restricted Access Areas.

13.3 Access to Restricted Access Areas should be limited to personnel that have received the appropriate training and PPE, and are included in the medical surveillance program for arsenic as described in this document.

13.4 Personnel not directly involved in tasks performed in these areas should not enter these areas.

13.5 Restricted Access Areas should be identified to warn personnel of the potential hazard and the need for controls as follows:

13.5.1 If tasks are performed at tools that can result in levels above the AL, a temporary Restricted Access Area should be created; e.g., orange cones around the area with a posted sign. The boundary indicators should be placed at the periphery of the operation well removed from the potential source of release of airborne arsenic from the tool.

13.5.2 Note that the use of a Restricted Access Area should only be necessary if controls to reduce the exposures to below the AL (outside of the respirator face-piece) are not effective or cannot be implemented for an extended time period (e.g., > 1 month).

13.5.3 Signage should clearly indicate arsenic hazard. The sign format shown in Appendix A can be used.

14. SIGNS AND LABELS

Labels and signs are an effective means of notifying personnel present in the work area containing arsenic hazards. The format and content of signs and labels should comply with local regulations and requirements. Appendix A provides a standardized format and content for signs and labels which shall be used.

The following items must have hazardous warning labels and/or signs:

- Arsenic restricted access areas
- Arsenic dedicated vacuums
- Fume hoods used for cleaning arsenic contaminated parts, III-V wafer cleaving, and other activities that may produce airborne arsenic particulates.
- FOUPs, FOSBs, or other carriers containing arsenic materials on wafers
- Bags and containers containing arsenic contaminated waste
- Snorkels used to control airborne arsenic particulates.

- Storage cabinets and other locations used for storing contaminated arsenic parts or materials.

EXCEPTION: Labels are not required when the inorganic arsenic is encapsulated or bound within the product in such a manner as to make unlikely the possibility of exposure to airborne inorganic arsenic. Examples include semiconductors, wafers, light emitting diodes, and glass.

15. EMPLOYEE TRAINING

15.1 All workers performing tasks where they are potentially exposed to inorganic arsenic must take CNSE Inorganic Arsenic Training. The training will consist of two parts:

1) Generic training on arsenic toxicology, key work practices, controls, etc. that can be used in all locations, operations. This could be a web-based training approach.

2) Task-specific training for specific locations with arsenic exposure potential, protocols for work practices, housekeeping, hygiene, PPE, disposal, etc. This will normally be an instructor led training class; however, the instructor could be a supervisor or other non-EHS personnel.

15.2 **Frequency of Arsenic Training**:

15.2.1 The generic section and the facility-specific training should be presented initially for all workers that fall under the Program.

15.2.2 Refresher training for both the generic and facility-specific training should be once every 2 years.

16. MEDICAL SURVEILLANCE

16.1 Employees who perform tasks where they are exposed to inorganic arsenic above the AL, without regard to the use of respirators, should be included in the CNSE Arsenic Medical Surveillance Program. Employees who perform these tasks are included in the program without regard to the number of times they are exposed to arsenic or whether they are wearing a respirator for these tasks.

16.2 The Medical Surveillance Program is administered by the Occupational Health Center and includes:

- Work and medical history

- Urine analysis for arsenic
- Standard posterior-anterior chest X-ray
- Nasal and skin examination
- Maintaining medical clearance to wear respirators

17. RECORDS

17.1 Exposure monitoring records for operations involving arsenic ;records shall be retained for a minimum of 40 years.

17.2 Workers must be provided copies of their records as follows:

- Workers must be notified of the results from the monitoring within 15 working days of receipt of the results, either individually in writing or by posting the results in an appropriate location that is accessible to employees.
- Employee medical records: Workers must be provided with a copy of their own personal medical results. Workers may not receive copies of other workers' medical records. Consult the EHS department for assistance in responding to employee requests for medical records.

18. APPENDICES

18.1 **Appendix A** – Signs and Labels

18.2 **Appendix B** – CNSE/SEMATECH Environmental, Health and Safety, Requirements for Handling III-V Broken Wafers

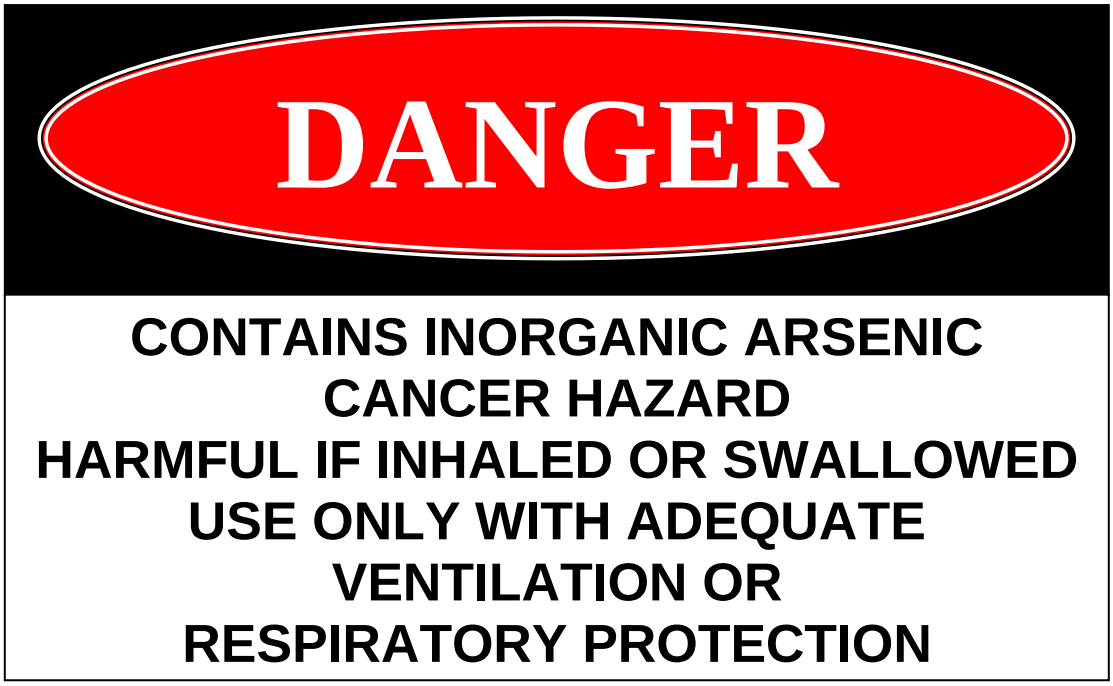
18.3 **Appendix C** – CNSE Arsenic-Handling Housekeeping Document for CNI01 and CNI02

18.4 **Appendix D** – CNSE III-V Wafer Cleaving Procedure

APPENDIX A
Signs and Labels

The sign format shown below can be used to identify Restricted Access Areas.

During maintenance activities, labels should read as follows:



APPENDIX B
CNSE/SEMATECH Environmental, Health and Safety Requirements for Handling III-V Broken Wafers

1. PURPOSE AND SCOPE

The purpose of this document is to provide procedures for handling wafers with III-V films that contain As (arsenic) as a component. Also included are precautions to be considered prior to preventive maintenance activities. The FOUP containing these wafers will have white handles and a saddle bag with a warning label – **"DANGER. WAFERS IN THIS FOUP CONTAIN III-V FILMS WITH ARSENIC AS A COMPONENT. IN THE CASE OF ANY BROKEN WAFER EVENT, PLEASE CONTACT LOT & TOOL OWNER, ERT, and EHS. PLEASE DO NOT REMOVE THIS WARNING LABEL FROM THE FOUP".** The warning label includes the Lot and FOUP ID.

Specific operations comprehended by this document include; metrology, wets tools, plasma tools, lithography, and chemical mechanical planarization (CMP).

1.1 Associated Documents and Forms

1.1.1 **EHS-00010** – CNSE Personal Protective Equipment Requirements

1.1.2 **EHS-00052** – Arsenic Protection Program

1.1.3 **OPS-04030** – Broken Wafer / FOUP Recovery Procedure

1.1.4 **EHS-00015** – CNSE Respiratory Protection Program

1.1.5 **EHS-00062-F1** – Non-Routine Hazardous Work Permit

1.1.6 **CFM-00004-F1** – Work Authorization Permit

1.1.7 **OPS-00005-F1** – Cleanroom Tool Maintenance Form

1.1.8 **EHS-00032-F1** – Floor Tile Removal Approval From

2. BROKEN WAFER RECOVERY PROCEDURE FOR III-V WAFERS

2.1 Broken III-V Wafer Event in FOUP

a. Contact Lot Owner (LO) listed in SiView. Apply a label to the FOUP indicating "broken wafer containing arsenic inside" (or a proper tag that is already being used at CNSE that may say "arsenic contaminated"). **LEAVE THE FOUP CLOSED and place entire FOUP in a plastic bag.**
b. Place FOUP in parts outgassing glovebox.
c. Only personnel trained in Arsenic handling should open the FOUP and recover broken pieces. Wafer pieces should be double bagged and

disposed of in an Arsenic-contaminated hazardous waste container with required hazardous waste labeling. **DO NOT USE THE STANDARD WAFER DISPOSAL DRUM**.

2.2 General Requirements – Broken III-V Wafer Event in Tool

a. Processing of III-V wafers **must** be conducted under the supervision of the requestor/engineer who knows that III-V wafers are being processed. If the tool is operated by someone other than the requestor, it is the responsibility of the requestor to inform the tool operator what procedures to follow in the event of a III-V wafer break. It is extremely important that a third party does not try to recover the III-V wafer as if it was a silicon wafer because they were unaware of the hazards. The procedures set in this document must be followed for III-V wafer breaks.
b. Processing of III-V wafers will be conducted during the day shift, Monday through Friday.
c. Completion of the CNSE Arsenic Protocol Training is required for all personnel who will respond to handling and managing the broken wafers that contain arsenic.

2.3 Procedure for Recovering Broken III-V Wafer in Tool

a. Determine if a III-V wafer has been processed in the tool.
b. Contact LO, Tool Owner (TO), and Security (518-437-8600). Security will inform ERT.
c. Place Lot on STOP hold. Operator cancels any Lots waiting to be processed on the same module/chamber. Unload any Lots waiting to be processed. Code tool as down in SiView.
d. Put up soft barriers around the tool and post signage indicating “BROKEN III-V WAFER, CONTAINS INORGANIC ARSENIC CANCER HAZARD. AUTHORIZED WORKERS ONLY. RESPIRATORY PROTECTION REQUIRED.”
e. Tool Owner and lot owner will contact vendor support or tool vendor to coordinate recovery and clean-up.
f. Tool Owner will complete a Cleanroom Maintenance Form (OPS-00005-F1), and Floor Tile Removal Permit EHS-00032-F1 (if applicable) and will submit it to the equipment support technicians for sign off. A Work Authorization Permit (CFM-00004-F1), and Non-Routine Hazardous Work Permit (EHS-00062-F1) are submitted together to the daily permit meetings.
    - Equipment support technicians will confirm the safety requirements (barriers, PPE, etc.) and provide gas detector monitoring and supplied air cylinders.

g. **Work Area**

- Tacky mats – Use tacky mats in the work area where possible.
- Barricades – The work area must be barricaded at least 10 feet (or distance specified by tool manufacturer) from the work area with red DANGER tape to prevent unauthorized people from entering until work is completed. This includes the SubFab area when applicable.
- Postings – Sign(s) must be clearly posted in the work area and should include "Danger – Inorganic Arsenic, Cancer Hazard, Authorized Personnel Only, Respirator Required"

    i. If the work area is left unattended at any time, a notice with date, contact name and number must be hung on a visible location along the danger tape.

h. **Monitoring**

- Air sampling – Personal air monitoring for arsenic will be performed during broken wafer cleanup activities to determine that exposures are less than the OSHA action required level (AL) of 0.005 mg/m^3. Air sampling media will be placed in the breathing zone of the employee(s) with the greatest potential exposure and for the entire time the worker may be exposed to arsenic during the shift.

    i. If air concentrations are above the AL, engineering controls and work practices should be re-evaluated to minimize aersolization of airborne arsenic to below the AL. Additional personal monitoring will be performed to confirm these results.

    ii. If the employee's exposure to airborne arsenic is measured between the AL and 0.125 mg/m^3, the employee must wear an air-purifying respirator that protects the user from particulates. If air concentrations exceed 0.125 mg/m^3, respiratory protection must consist of a supplied air respirator.

    iii. If a minimum of 2 sampling results (with two measurements at least 7 days apart) of the same activity results in concentrations that are below the CNSE AL, then respiratory protection can be discontinued for these activities. If any change in the process, personnel, controls, or other reason where we would expect an increase in exposures occurs, then respiratory protection will be required until the exposures have been re-evaluated.

NOTE: If other hazards (e.g., toxic gases) are potentially present during the activity, respiratory protection is still required.

- Wipe sampling – Wipe sampling of various work surfaces outside the tool will be performed after all decontamination activities have been completed to ensure that surface contamination levels are below 50 µg/100cm^2. If levels exceed 50 µg/100cm^2, additional decontamination must be performed.

NOTE: The tool can run as normal while waiting for wipe sampling results. Surface sampling results above 50 µg/100cm^2 will dictate the need for additional housekeeping measures as soon as results are known.

i. **During Decontamination**

- Use local exhaust ventilation (e.g., maintenance exhaust, fume hood)
    i. Maintenance exhaust must be checked before each use to ensure adequate flow (minimum requirement: 100 cfm).
    ii. The opening of the maintenance exhaust must be placed as close to the contaminant source as possible to maximize its effectiveness.
- Use dedicated arsenic vacuum cleaner with a HEPA filter for all vacuuming during recovery. No arsenic vacuum filter changes should be done at CNSE without notifying EHS and using appropriate controls in an approved location.
- All non-porous surfaces adjacent to and below wafer break area should be thoroughly wiped down with 10% IPA solution in DI water in a manner that does not spread contamination.
- Porous surfaces should be decontaminated otherwise parts/items may need to be replaced.
- If parts exposed to the broken wafer must be shipped offsite, they should be double bagged and tagged “Arsenic contaminated”.
- Any non-disposable PPE and equipment should be thoroughly cleaned prior to leaving the work area. Dust removal by blowing or shaking is not allowed.
- Post- clean the work area surfaces using tacky rollers.

j. **Personal Protective Equipment**

- Gloves – Use at least two layers of gloves so that the outer contaminated layer can be removed before touching non-contaminated surfaces. Depending on the nature of the task, chemical resistant gloves or abrasion-resistant gloves may be needed.
- Tyvek suit with booties
- Over-booties – extra set of booties to be discarded before leaving the contaminated area to reduce spread of arsenic particles.
- Safety glasses (if full face respirator is not worn)
- At a minimum, NIOSH-approved full face-piece air purifying respirator with a HEPA filter should be worn at all times during the cleanup activity.

NOTE: If other hazards (e.g., toxic gases) are potentially present during the activity, additional protective clothing and a higher level of respiratory protection will be required.

k. **Waste Materials** should either be double bagged OR single bagged in a disposable hard-walled container (e.g., 5-gallon bucket) to prevent sharp edges of the shards from puncturing an opening in the bag. This should be disposed of as arsenic contaminated hazardous waste per federal and state regulations.
   - The bags and/or associated containers must be appropriately and clearly labeled “Arsenic contaminated hazardous waste”.
     i. Solid contaminated waste
     ii. Wafer pieces
     iii. Contaminated disposable PPE
   - Labeled waste containers should be placed in the satellite accumulation area for Air Liquide pickup.

l. **Hygiene**
   - Always wash hands and face after changing out of arsenic contaminated PPE.
   - Do not eat, drink, smoke, chew tobacco, or apply cosmetics.

m. **Training Requirements**
   - Individuals accessing arsenic regulated area must have successfully completed the CNSE Arsenic Safety training and completed and submitted the quiz (EHS-00052A) to CNSE EHS.
   - Individuals required to wear respirators must meet the requirements in OSHA standard1910.134 including fit testing, training, and medical clearance. Refer to EHS-00015-R5.

2.4 Tool Specific Procedures During Wafer Break

In addition to the procedures listed in section 2.3, the following items specific to the following tools will also be performed:

Mappers and Metrology Tools

a. If tools are located in a positively pressurized mini-environment, the fans to the mini-environment must be turned off prior to opening the tool for clean-up. This will help minimize the spread of potentially contaminated dust.
b. Please refer to matrix of responsibilities tables (below).

Wets Tools

a. During Lot processing for each wafer, CNSE will collect liquid sample from collection port installed on the acid drain line.
b. The chamber will be wipe-sampled by an industrial hygienist or under the direct supervision of an industrial hygienist.
c. In the event that a wafer break occurs in the robot handling area, the contractor will be called in to decontaminate the areas surrounding the tool

including waffle and SubFab (if applicable). Refer to matrix of responsibilities tables for more information.

d. The dedicated Arsenic-HEPA vacuum cleaner from the MOCVD room in NFC will be used for these clean-up activities.

Etch Tools:

a. Follow manufacturer's recommended chamber open/close procedures and tool operation documents for process requalification and restart.
b. EHS documents for TEL etch tools have been submitted to CNSE EHS.

CMP Tools

a. EHS evaluation prior to run should be performed to review chemistries on the tool to assess potential arsine generation in case of wafer break (or overpolish).
b. The tool enclosure may need modifications to seal the upper enclosure.

Matrix of Responsibilities Tables

Table 1. III-V Wafer Break Matrix of Responsibilities for Applied Materials (AMAT) Tools

Location	Clean-up Responsibility	Sampling	PPE	Cleaning Equipment	Permits	Notification Path
Process module	Arsenic trained AMAT personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	AMAT control	Arsenic HEPA vacuum -> AMAT DI/IPA/wipes -> supplier As waste drum -> CNSE/Air Liquide	Cleanroom Tool Maintenance Form (OPS-00005-F1); Non Routine Hazardous Work Permit (EHS-00062-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT
Transfer module	Arsenic trained AMAT personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	AMAT control	Arsenic HEPA vacuum -> SMT (MOCVD room NFC) DI/IPA/wipes -> supplier As waste drum -> CNSE/Air Liquide	Cleanroom Tool Maintenance Form (OPS-00005-F1); Non Routine Hazardous Work Permit (EHS-00062-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT
Affected work areas beyond the tool skin (e.g., SubFab/Adjacent tool)	Arsenic trained Techtron personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	Techtron control	Arsenic HEPA vacuum -> Techtron DI/IPA/wipes -> Techtron As waste drum -> CNSE/Air Liquide	Floor Tile Removal Permit (EHS-00032-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT & Techtron

EST- Equipment Support Technicians
ADK – Adirondack
FSE – Field Service Engineers
SMT - SEMATECH

Table 2. III-V Wafer Break Matrix of Responsibilities for ASML Tools

Location	Clean-Up Responsibility	Sampling	PPE	Cleaning Equipment	Permits	Notification Path
Process module	Arsenic trained ASML personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	ASML control	Arsenic HEPA vacuum -> SMT (MOCVD room NFC) DI/IPA/wipes -> supplier As waste drum -> CNSE/Air Liquide	Cleanroom Tool Maintenance Form (OPS-00005-F1); Non Routine Hazardous Work Permit (EHS-00062-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT
Transfer module	Arsenic trained ASML personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	ASML control	Arsenic HEPA vacuum -> SMT (MOCVD room NFC) DI/IPA/wipes -> supplier As waste drum -> CNSE/Air Liquide	Cleanroom Tool Maintenance Form (OPS-00005-F1); Non Routine Hazardous Work Permit (EHS-00062-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT
Affected work areas beyond the tool skin (e.g., SubFab/Adjacent tool)	Arsenic trained Techtron personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	Techtron control	Arsenic HEPA vacuum -> Techtron DI/IPA/wipes -> Techtron As waste drum -> CNSE/Air Liquide	Floor Tile Removal Permit (EHS-00032-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT & Techtron

EST- Equipment Support Technicians
ADK – Adirondack
FSE – Field Service Engineers
SMT - SEMATECH

Table 3. III-V Wafer Break Matrix of Responsibilities for DNS Electronics Tools

Location	Clean-Up Responsibility	Sampling	PPE	Cleaning Equipment	Permits	Notification Path
Process module	Arsenic trained DNS personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	DNS control	Arsenic HEPA vacuum -> SMT (MOCVD room NFC) DI/IPA/wipes -> supplier As waste drum -> CNSE/Air Liquide	Cleanroom Tool Maintenance Form (OPS-00005-F1); Non Routine Hazardous Work Permit (EHS-00062-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT
Transfer module	Arsenic trained DNS personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	DNS control	Arsenic HEPA vacuum -> SMT (MOCVD room NFC) DI/IPA/wipes -> supplier As waste drum -> CNSE/Air Liquide	Cleanroom Tool Maintenance Form (OPS-00005-F1); Non Routine Hazardous Work Permit (EHS-00062-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT
Affected work areas beyond the tool skin (e.g., SubFab/Adjacent tool)	Arsenic trained Techtron personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	Techtron control	Arsenic HEPA vacuum -> Techtron DI/IPA/wipes -> Techtron As waste drum -> CNSE/Air Liquide	Floor Tile Removal Permit (EHS-00032-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT & Techtron

EST- Equipment Support Technicians
ADK – Adirondack
FSE – Field Service Engineers
SMT - SEMATECH

Table 4. III-V Wafer Break Matrix of Responsibilities for KLA-Tencor Tools

Location	Clean-Up Responsibility	Sampling	PPE	Cleaning Equipment	Permits	Notification Path
Process module	Arsenic trained Techtron personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	Techtron control	Arsenic HEPA vacuum -> Techtron DI/IPA/wipes -> Techtron As waste drum -> CNSE/Air Liquide	Cleanroom Tool Maintenance Form (OPS-00005-F1); Non Routine Hazardous Work Permit (EHS-00062-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT & Techtron
Transfer module	Arsenic trained Techtron personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	Techtron control	Arsenic HEPA vacuum -> Techtron DI/IPA/wipes -> Techtron As waste drum -> CNSE/Air Liquide	Cleanroom Tool Maintenance Form (OPS-00005-F1); Non Routine Hazardous Work Permit (EHS-00062-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT & Techtron
Affected work areas beyond the tool skin (e.g., SubFab/Adjacent tool)	Arsenic trained Techtron personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	Techtron control	Arsenic HEPA vacuum -> Techtron DI/IPA/wipes -> Techtron As waste drum -> CNSE/Air Liquide	Floor Tile Removal Permit (EHS-00032-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT & Techtron

EST- Equipment Support Technicians
ADK – Adirondack
FSE – Field Service Engineers
SMT - SEMATECH

Table 5. III-V Wafer Break Matrix of Responsibilities for Tokyo Electron (TEL) Tools

Location	Clean-Up Responsibility	Sampling	PPE	Cleaning Equipment	Permits	Notification Path
Process module	Arsenic trained TEL personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	TEL control	Arsenic HEPA vacuum -> SMT (MOCVD room NFC) DI/IPA/wipes -> supplier As waste drum -> CNSE/Air Liquide	Cleanroom Tool Maintenance Form (OPS-00005-F1); Non Routine Hazardous Work Permit (EHS-00062-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT
Transfer module	Arsenic trained TEL personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	TEL control	Arsenic HEPA vacuum -> SMT (MOCVD room NFC) DI/IPA/wipes -> supplier As waste drum -> CNSE/Air Liquide	Cleanroom Tool Maintenance Form (OPS-00005-F1); Non Routine Hazardous Work Permit (EHS-00062-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT
Affected work areas beyond the tool skin (e.g., SubFab/Adjacent tool)	Arsenic trained Techtron personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	Techtron control	Arsenic HEPA vacuum -> Techtron DI/IPA/wipes -> Techtron As waste drum -> CNSE/Air Liquide	Floor Tile Removal Permit (EHS-00032-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT & Techtron

EST- Equipment support technicians
ADK – Adirondack
FSE – Field Service Engineers
SMT – SEMATECH

Table 6. III-V Wafer Break Matrix of Responsibilities for All Other Tools

Location	Clean-Up Responsibility	Sampling	PPE	Cleaning Equipment	Permits	Notification Path
Process module	Arsenic trained Techtron personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	Techtron control	Arsenic HEPA vacuum -> Techtron DI/IPA/wipes -> Techtron As waste drum -> CNSE/Air Liquide	Cleanroom Tool Maintenance Form (OPS-00005-F1); Non Routine Hazardous Work Permit (EHS-00062-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT & Techtron
Transfer module	Arsenic trained Techtron personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	Techtron control	Arsenic HEPA vacuum -> Techtron DI/IPA/wipes -> Techtron As waste drum -> CNSE/Air Liquide	Cleanroom Tool Maintenance Form (OPS-00005-F1); Non Routine Hazardous Work Permit (EHS-00062-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT & Techtron
Affected work areas beyond the tool skin (e.g., SubFab/Adjacent tool)	Arsenic trained Techtron personnel	CM4 (arsine) - CNSE EST As wipe sampling/analysis - ADK/FSE Arsenic air sampling - ISMI/ADK Data collation/distribution - SMT/ISMI	Techtron control	Arsenic HEPA vacuum -> Techtron DI/IPA/wipes -> Techtron As waste drum -> CNSE/Air Liquide	Floor Tile Removal Permit (EHS-00032-F1)	1. Tool Owner -> supplier & CNSE EST 2. Lot Owner -> SMT & Techtron

EST- Equipment support technicians
ADK – Adirondack
FSE – Field Service Engineers
SMT - SEMATECH

APPENDIX C
CNSE Housekeeping Document for Ion Implanters, MBE, and MOCVD Tools Contaminated with Arsenic

1. **Scope**: This document describes housekeeping procedures aimed at minimizing arsenic contamination in the tool core, ballroom, waffle, and sub-fab areas below the tool. In addition to the guidelines outlined below, those working in this area must also comply with the requirements set forth in the CNSE Arsenic Protection document EHS-00052.

2. **Working at or in the Implanters (PM, source change, repairs, etc.):**

2.1 Prior to commencing work on a major PM, signs must be posted on the doors to the restricted area indicating the PM is in progress. Label should read:

STOP
PM IN PROGRESS
DO NOT ENTER
Authorized Workers Only

2.2 Lay down tacky mats along/in front of areas where the work will be performed.

2.3 If parts must be moved outside the tool, bag the part before transporting.

2.4 If contaminated items need to be taken to the exhaust hood or other area, line the walkway with a covering to prevent dust, flakes, or other contaminated material from falling into the waffle and/or SubFab (preferably tacky mats).

2.5 Tyvek disposable jumpsuits and disposable over-booties, double layered gloves and a P100 full faced cartridge respirator (or higher level of respiratory protection if other hazards are present) are to be worn while performing any major PM on the implanters. At no time shall anyone with a contaminated suit, over-booties, or dirty gloves leave the restricted area to walk in the core ballroom areas.

2.6 After PM is complete, clean all exposed surfaces with dampened wipes.

2.7 If a vacuum is used, it must be a dedicated HEPA vacuum for arsenic only and should be labeled as such.

2.8 All tools and HEPA vacuums including hoses must be thoroughly cleaned with dampened wipes in the restricted area before being transported back to their storage areas.

2.9 When appropriate, double-bag all contaminated parts upon removal from the vacuum system.

2.10 Transport parts using a cart dedicated for moving arsenic-contaminated material only to hood, as soon as possible. If utility carts are used, they must be cleaned with dampened wipes after every use.

2.11 When ready to remove tacky mats, start from the edges and fold in to contain any loose debris in the mats.

2.12 Place used tacky mats, used damp wipes, and disposable PPE (contaminated suits, gloves, and over-booties) in a yellow hazardous materials bag that is labeled with a red hazardous waste sticker or in the solid arsenic dedicated hazardous waste storage bin before leaving the restricted area.

2.13 After tacky mats, cleanup materials and contaminated PPE has been disposed of, roll tacky rollers on the floor and accessible horizontal surfaces.

3. **Working in the Exhaust Hoods**:

3.1 Keep the vent slots at the back of the hood clear. Any obstructions will reduce or alter the air flow at the sash opening which could compromise the airborne particle capture.

3.2 A disposable lab coat, jumpsuit, or Tyvek suit must be worn while working in the hoods to prevent contamination of the CNSE-supplied cleanroom garments.

3.3 Clean gloves and wipes must not be stored in the exhaust hoods. Stow these items in storage compartment under the work surface.

3.4 Once work is completed, wipe down internal and external surfaces of the hood with 10% IPA and pull off the top layer of the tacky mats in front of the hoods.

3.5 Triple bag all dirty parts if shipping offsite.

3.6 Properly discard used wipes, tacky mats, and disposable garments after each use either in a yellow hazardous materials bag that is labeled with a red hazardous waste sticker or in the solid arsenic dedicated hazardous waste storage bin.

3.7 Empty the hood trash when full into the solid arsenic dedicated hazardous waste storage bin supplied by CNSE. If none are available, contact Air Liquide for replacement.

APPENDIX D
III-V Wafer Cleaving Procedures

1. Requestor must **label** III-V wafer's transfer container (silver bag, FOUP, or FOSB) with

   "**III-V Wafer**
   Inorganic Arsenic, Cancer Hazard"

2. **Work Area**
   - Room posting – Sign(s) must be clearly posted in the entrance(s) to the room and should indicate **"Danger – Inorganic Arsenic; May Cause Cancer; No Eating, Drinking, or Smoking. Authorized Personnel Only"**

3. **Cleaving Process**
   a. III-V wafers should be cleaved in Arsenic dedicated hood(s) ONLY.
   b. Hood should be labeled with sign **"Danger – Inorganic Arsenic; May Cause Cancer. Authorized Personnel Only"**
   c. Work surface in the hood should be covered with aluminum foil.
   d. Once work is complete, fold up foil, and discard in appropriate Arsenic labeled container.
   e. Wet wipe methods should be used to remove dust or clean surfaces. Compressed gas, blowing, or shaking should **NEVER** be used to clean dust off wafers or any other material.
   f. Tools – all tools should be dedicated for cleaving III-V wafers only and should not be removed from the fume hood.

4. **SIM/SEM Imaging Process**
   a. If the instrument is left unattended during imaging of III-V wafers, postings should be hung on the instrument to indicate that III-V wafers are being run – and specify:

   "III-V Wafer containing ARSENIC being run
   Danger - May Cause Cancer, Authorized Personnel Only
   DO NOT TOUCH"

5. **Training**
   a. Only employees who have successfully completed the CNSE EHS Arsenic training course may handle III-V wafers.
   b. Employees required to wear respirators must comply with CNSE Respiratory Protection Program and meet all requirements including fit test, medical testing, and training.

6. **Personal Protective Equipment**
   a. Nitrile gloves
   b. Safety glasses (if full face respirator is not worn)

7. **Waste Materials** should be double bagged and disposed of as arsenic contaminated hazardous waste per federal and state regulations. Wafers pieces with sharp edges that have the possibility of puncturing the bag must be placed in a container with rigid walls or another layer of bagging must be used. The bags and/or associated containers must be appropriately and clearly labeled Arsenic contaminated waste. **III-V wafer pieces should NEVER be thrown in regular trash.**
    - Solid contaminated waste
    - Wafer pieces
    - Arsenic-contaminated disposable PPE

    Containers of contaminated PPE which are to be removed from the workplace should be labeled:
    "DANGER: CONTAMINATED WITH INORGANIC ARSENIC; MAY CAUSE CANCER. DO NOT REMOVE DUST BY BLOWING OR SHAKING."

8. **Housekeeping**
    a. All non-porous surfaces should be thoroughly wiped down with 10% IPA solution in DI water in a manner that does not spread contamination.
    b. Porous surfaces should be decontaminated otherwise parts/items may need to be replaced.
    c. Any non-disposable PPE and equipment should be thoroughly cleaned prior to leaving the work area. Do NOT remove dust by blowing, shaking, or using compressed gas.

9. **Hygiene**
    a. After handling III-V wafers and discarding gloves, always wash hands.
    b. Do not touch items outside the hood with contaminated gloves (e.g., safety glasses)
    c. Do not eat, drink, smoke, chew tobacco, or apply cosmetics.

10. **Monitoring**
    a. Wipe sampling – Wipe sampling of various work surfaces outside the hood will be performed annually after decontamination activities have been completed to ensure that surface contamination levels are below 50 $\mu g/100cm^2$. If levels exceed 50 $\mu g/100cm^2$, additional decontamination must be performed.
    b. Air sampling - Personal air monitoring for arsenic will be performed during cleaving activities to determine that exposures are less than the OSHA action required level (AL) of 0.005 mg/m^3. Air sampling media will be placed in the breathing zone of the employee(s) with the greatest potential exposure and for the entire time the worker may be exposed to arsenic during the shift.
        i. If air concentrations are above the AL, engineering controls and work practices should be re-evaluated to minimize aersolization of

airborne arsenic to below the AL. Additional personal monitoring will be performed to confirm these results.

ii. If the employee's exposure to airborne arsenic is measured between the AL and 0.125 mg/m^3, the employee must wear an air-purifying respirator that protects the user from particulates. If air concentrations exceed 0.125 mg/m^3, respiratory protection must consist of a full face-piece supplied air respirator.

iii. If a minimum of 2 sampling results (with two measurements at least 7 days apart) of the same activity results in concentrations that are below the CNSE AL, then respiratory protection can be discontinued for these activities. If any change in the process, personnel, controls, or other reason where we would expect an increase in exposures occurs, then respiratory protection will be required until the exposures have been re-evaluated.