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Procedure
for

Equipment Commissioning

REVISION HISTORY

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1. INTRODUCTION

This procedure is for use at the CNSE Facilities to assist in the tool/equipment commissioning process. The content of the Equipment Commissioning Checklist (EHS-00017-F1) is in no way intended to address all safety and regulatory issues related to all equipment installation projects. It is intended to stimulate aggressive code, safety, health and environmental review for each installation project and address the majority of such issues as seen fit by CNSE Facility Operations Management, and Environmental Health, and Safety personnel and as required by the University at Albany Facilities Management Office.

2. PURPOSE

2.1 To ensure that all equipment commissioning projects within the scope of this procedure are designed and installed in a manner consistent with applicable codes, regulations, and sound engineering practices.

2.2 To proactively address safety, health and environmental concerns related to the design, installation, startup, operation and maintenance of equipment within the scope of this procedure.

2.3 The Equipment Commissioning Checklist provides a record of each equipment installation and the associated review process for the CNSE Facility Operations Management and the University at Albany Facilities Management Office.

3. SCOPE

This checklist is for use in approving the completed installation of tools for commissioning to be used in the CNSE Facilities. The checklist is divided into two (2) parts. Part 1 covers the electrical, mechanical, non-HPM chemicals and facilities release. Part 2 covers the release of all Hazardous Production Materials and Physical Hazards for tool/equipment operation. This checklist must be completed prior to releasing the tool/equipment to the tool owner for process transition and operational use.

4. ASSOCIATED DOCUMENTS

EHS-00017-F1 – Equipment Commissioning Checklist

EHS-00017-F2 – Tool Owner Matrix Form, is to be filled out and submitted as part of the submission; and it can be placed on the tool to satisfy Tool Owner labeling requirements.

EHS-00017-F3 – EHS Equipment Safety Compliance Checklist, an optional form created to assist those involved in factory source inspections or final install locations. While comprehensive, it is not intended to be all inclusive and should be used to stimulate observation of the equipment to ensure proper safety compliance.

5. DEFINITIONS

The following definitions apply to this procedure and the corresponding Equipment Commissioning Checklist (EHS-00017-F1).

5.1 **Bulk Chemical Delivery System** - A system that consists of chemical storage vessels located outside of the fabrication area from which chemicals are delivered, via distribution piping, to equipment located in the fabrication area.

5.2 **Tool Owner** - As it relates to this procedure, the Tool Owner is the person listed as the "Applicant" on the Equipment Installation Approval Checklist. In the event that a more appropriate party exists, it shall be the responsibility of the "Applicant" to designate the person who will fulfill the responsibilities of the Tool Owner during the installation process.

5.3 **Equipment-Specific** - An item is considered to be equipment-specific if it is installed specifically to accommodate, either wholly or in part, the presence of the equipment being installed or is installed internally to the equipment itself.

5.4 **Hazardous Energy** - Hazardous energy includes, but is not limited to, electrical, mechanical, hydraulic, pneumatic, chemical, thermal, ionizing radiation, non-ionizing radiation, and other types of energy. Lockout/tagout procedures must consider all hazards associated with all types of energy that may be related to the activity to be performed.

5.5 **Hazardous Production Materials (HPM)** - A solid, liquid, or gas associated with semiconductor manufacturing that has a degree-of-hazard rating in health, flammability, or reactivity of Class 3 or 4 as ranked by the National Fire Protection Association (NFPA 704 – 2007) and is used directly in research, laboratory or production processes that have as their end products materials that are not hazardous.

5.6 **Local Dispense Chemical Delivery System** - A local dispense chemical is one that is stored in and/or dispensed from a vessel that is internal to the equipment or is delivered to the equipment from storage vessel(s) located in a dispensing cabinet that is remote from the equipment but located within the fabrication area.

5.7 **Non-HPM** - A solid, liquid or gas that has a degree-of-hazard rating in health, flammability, or reactivity of Class 0, 1 or 2 as ranked by the National Fire Protection Association (NFPA 704 – 2007). Non-HPM chemicals are those that pose minimal, if any, hazards to personnel who may be exposed to them. They are the only chemicals that may be introduced to the equipment upon Part 1 sign-off of the Equipment Commissioning Checklist.

5.8 **Point-of-use** - The point-of-use is considered to be that point on the external surface of the equipment that is nearest to the point of connection of gas, liquid, or vacuum supply lines to the equipment. Point-of-use labels are intended to identify all gas, liquid, and vacuum lines, and electrical cords at the point of connection to the equipment.

6. RESPONSIBILITIES

6.1 The tool owner requesting permission to install a tool in the CNSE Facilities will complete the Equipment Commissioning Checklist.

6.2 Responsible parties for each checklist item are listed in the responsible columns on the checklist. This identifies the group or individual that is responsible for taking action on and ensuring completion of each checklist item. The designated CNSE personnel from the EHS and Facilities Operations Group Departments will review and approve the checklist and required documentation in order to begin/initiate the installation process.

6.3 The groups to be represented on the Equipment Commissioning Sign-off Team are as follows:

- Installation Coordinator (IC)
- Tool Owner (TO)
- Tool Engineer or Equipment Engineer (TE/EE)
- CNSE Tool Hook-up Manager
- CNSE Environmental, Health and Safety (EHS)
- CNSE Code Compliance Manager
- CNSE Facilities Director (see Section 7.5)

6.4 The number of responsible parties will vary depending on the owner status of the tool installed at the CNSE Facilities. The tool may be owned and operated by CNSE Facilities in which case CNSE Facilities are responsible for all checklist items that are marked with an “X”. Or the tool may be owned and operated by an outside company, in this case the tool owner and their respective representatives are primarily responsible for all the checklist items that are marked with an “X”, with the CNSE EHS representatives responsible for verification of each associated checklist item.

6.5 The Equipment Sign-off Team members will meet at the site as necessary to complete their assigned checklist responsibilities. Each checklist item will be verified and initialed by the appropriate responsible group. For checklist items that list more than one party that are responsible for the checklist item, all parties must initial for the group they represent verifying completion of the checklist item. If additional persons or persons other than those listed are responsible for an item, the responsibilities can be reassigned by crossing out the original party and/or adding additional parties under the same responsible box.

7. PROCEDURE

7.1 Equipment Commissioning Checklist: Part 1

Part 1 of the Checklist is designed to ensure the equipment is ready to be energized. Once the equipment is set, leveled, and electrical and facilities connections are made, a review of the installation to that point will be performed using the Part 1 Checklist.

Upon completion of the Part 1 Checklist, electrical power, non-HPM gases, liquids and vacuum, may be supplied to the equipment. Completion of the Part 1 Checklist allows the supplier an opportunity to perform any equipment system checks that are necessary prior to the introduction of hazardous production materials (HPMs) or other hazardous energy sources associated with the equipment.

7.1.1 Electrical Matrix

All sources of electricity to the equipment must be listed in the electrical data matrix. Upon completion of the electrical installation, the actual voltage must be verified before the equipment may be energized. All sources of electricity may be energized upon completion of the Part 1 Checklist.

7.1.2 Electrical Safety Requirements

In general, the electrical portion of the installation must be checked for correct connections, voltages, proper grounding, the presence of lockable disconnects, correct panel, switch, disconnect and tool status indictor labeling, as well as other requirements.

7.1.3 Lockout / Tagout and Hazardous Energy Control

Lockout / Tagout procedures must be developed specific to the equipment being installed. The Tool Owner is responsible for the development of such procedures. Prior to Part 1 sign-off, all hazardous energy sources must be completely locked out.

7.1.4 Access and Clearance Requirements

Work space clearances about electrical equipment and HPM workstations must be verified to ensure that the actual installation meets the distances specified in the design and is compliant with applicable standards. Table 1 illustrates workspace clearances required by the National Electrical Code for electrical equipment that is likely to require examination, adjustment, servicing, or maintenance while energized.

Access and clearances specified by the tool manufacturer for operation and maintenance must also be adhered to.

Table 1 - Work Space Clearances around Electrical Equipment (NEC 1996)

Nominal Voltage to Ground	Work Space Depth*			Minimum Width of Work Space	Height of Work Space
	Condition 1	Condition 2	Condition 3		
0 - 150	3 feet	3 feet	3 feet	30 in. all conditions	78 in. all voltages, all conditions
151- 600	3 feet	3.5 feet	4 feet	30 in. all conditions	
601 - 2500	3 feet	4 feet	5 feet	36 in. all conditions	
2500 - 9000	4 feet	5 feet	6 feet	36 in. all conditions	

* **"Conditions", as described in NEC 110-16, are as follows (see NEC 110-26 for exact phrasing and exceptions):**
Condition 1 - Exposed live parts on one side and no live or grounded parts on the other side of the working space, or exposed live parts on both sides are effectively guarded by suitable insulating materials.
Condition 2 - Exposed live parts on one side and grounded parts on the other side.
Condition 3 - Exposed, non-grounded, live parts on both sides of the work space with the operator between.

7.1.5 Lasers

Equipment that contains lasers must certify compliance with 21 CFR 1010 and 1040, and with ANSI Z136.1. This equipment must be labeled properly, must have properly functional interlocks, have the laser surrounded by protective housing, be reviewed by the CNSE Radiation Safety Officer and be added to the CNSE Facilities Laser Inventory (EHS-00016-F5). Additional protective measures must be implemented in cases where there is open beam exposure potential to class 3B and Class 4 Lasers (see EHS-00048-F1 Requirements for Class 3B and 4 Lasers).

7.1.6 Radiation Requirements

All sources of ionizing (Gamma and X-ray sealed sources) and non-ionizing (Ultra-Violet, Infra-Red, Microwave and Radio Frequency) radiation must be enclosed, interlocked and properly labeled. All sources of ionizing radiation must be surveyed and registered with New York State Department of Health (NYSDOH) by the CNSE Radiation Safety Officer.

Radiation baseline surveys may need to be postponed until the equipment is fully functional. If this is the case, all necessary radiation surveys must be scheduled and executed in a timely manner. See EHS-00016-F3 Radiation Survey Sheet.

7.1.7 Non-HPM Gas/Liquid & Vacuum Facility Lines

All facility lines delivering non-HPM gases or liquids (waters), or supplying vacuum to the tool, should be listed in the boxes provided in this section. Generally accepted abbreviations (e.g. CDA, UPW, etc.) may be entered, if preferred.

7.1.8 Onboard Non-Process Chemical Inventory

The Tool Engineer lists all non-process chemicals used in the tool and/or its peripherals.

7.1.9 Guarding

This is a review of the applicable guards and shields that should be installed on the tool.

7.1.10 Personal Protective Equipment

EHS will assist the Tool Owner in selecting the necessary Personal Protective Equipment for all operation and maintenance tasks associated with the equipment.

7.1.11 Tool Identification

This is a review to ensure the proper identification and a list of emergency contacts is posted on the tool.

7.1.12 Seismic Restraints

Lists the Seismic Data for CNSE and reviews the tool specific requirements.

7.1.13 HPM Delivery System (Liquids and Gases) Process Control Isolation

Prior to the energization of the HPM delivery system Chemical/Gas Services and EHS must apply process control locks to each of the outputs/sticks. Tool Installation must apply process control locks to each of the outputs/sticks that they will be working on.

7.1.14 TGMS Controls and Matrix

Prior to Part 1 sign-off the tool engineer and TGMS controls contractor must agree to the interlocks that will be used to control the flow of gases

and liquids to the tool. The tool engineer must also have a signed TGMS matrix which would be used to determine what TGMS components should be installed and how such components should be controlled.

7.2 Equipment Commissioning Checklist: Part 2

The Part 2 Checklist is used to verify that the equipment is ready for HPM use and other hazards (i.e. radiation, laser, mechanical hazards, etc.) associated with the equipment are ready to be energized. Upon completion of the Part 2 review, the equipment may be approved to become fully functional, and is released for process qualification and commissioning for use at CNSE Facilities.

7.2.1 General

This section covers general safety topics that are not normally mentioned otherwise, such as: whether the ERT Coordinator and ERT Leaders have been informed about the installation and associated emergency procedures; whether an ERT Leader from each shift was provided an opportunity to conduct an orientation tour with a responsible tool / equipment representative; whether any new hazards, equipment or conditions exist that would require the ERT to be trained; whether such retraining has taken place; whether any confined spaces are identified and labeled; whether a noise survey is complete; and whether the work area is adequately illuminated.

7.2.2 Exhaust Ventilation

A listing of all the exhausted outlets with the type of ventilation, monitoring flow devices, if any, and any required set points, must be provided here.

7.2.3 Exhaust Ventilation Requirements

The exhaust ventilation requirements include details to ensure that the exhaust ducts are properly tested, balanced, and labeled. It also ensures that exhaust dusts carrying HPMs have continuous monitoring devices installed. These monitoring devices must be available in the plenum as well as in the tool, they must be tested for proper functionality, must be secured in place and have their set points tested. Where lab hoods or wet benches are utilized a face velocity between 80 – 120 cubic feet per minute must be attained.

7.2.4 Vacuum Pumps

While all vacuum pumps can be checked during Part 1 sign-off, only those vacuum pumps associated with non-HPM gas or liquid, process vacuum, and exhaust ventilation may be energized upon completion of the Part 1 Equipment Commissioning Checklist. All pumps handling toxics,

Pyrophorics, or other HPMs must remain locked-out until completion of the Part 2 sign-off.

7.2.5 Local Dispense and Bulk Chemical Inventory

All chemicals (other than gases) that are supplied to the equipment must be listed in this form. The form asks for an indication of the type of container in which the chemical is stored prior to or during use by the equipment. For the purposes of this procedure, the following definitions apply:

- **A bath** is a container that is normally open on top during normal operation of the equipment.
- **A tank** is any other type of container that is normally completely enclosed during normal operation of the equipment. All bulk chemicals are assumed to originate from a tank.
- See the Definition section of this procedure for explanation of Local Dispense, and Bulk Chemical Delivery Systems.

7.2.6 Chemical Distribution Matrix

All chemicals (HPM or otherwise) supplied to the equipment must be listed in this section.

The chemical dispense unit name and type of chemical that is dispensed must also be listed here.

7.2.7 Local Dispense Chemical Delivery Systems Requirements

The systems requirements ensure that all the supply lines and containment piping are properly labeled and tested and are double contained, where required. It also sets forth requirements for testing and verification of leak detection systems, specific requirements for pressurized chemical containers and access to emergency eyewashes and/or showers.

7.2.8 Bulk Chemical Delivery Systems Requirements

The systems requirements ensure that all the supply lines and containment piping are properly labeled and tested and are double contained, where required. It also sets forth requirements for testing and verification of leak detection systems, specific requirements for HPM delivery lines, HPM shut-off valves and separation of flammable and combustible materials.

7.2.9 Bulk/Non-Bulk/Specialty Gas Distribution Matrix

All bulk/non-bulk/specialty gases (HPM or otherwise) supplied to the equipment must be listed in this section.

The gas cabinet name and type of gas that is delivered must also be listed here.

7.2.10 Gas Delivery Systems Requirements

The gas delivery requirements ensure that gas lines: are labeled; are traced to origin and verified; are double contained; and that gas manifolds and gas cabinets are properly labeled. This also sets forth the requirements to ensure all gas delivery systems internal and external to the tool are leak checked and that the completed Leak Check Checklist is submitted to CNSE Facility Operations Management.

7.2.11 Toxic Gas Detection Requirements

All gases for which monitoring is required must be listed in the Gas Detection Matrix along with the detection system that is used, all sampling point locations, the high and low set points, and the date each sampling point is tested and verified to be functional must be listed here per the requirements set forth in EHS-00031 Toxic Gas Monitoring System (TGMS) Operation and Maintenance Procedure.

EH&S are responsible for ensuring that the TGMS Tool Matrix, Instrument Calibration Schedule and TGMS Zero reading documents have been updated and submitted, As well as verifying the points were selected, placed and labeled correctly.

7.2.12 Drain Matrix

The drain system, the material it is constructed of, the leak check results and whether the piping is properly labeled must be listed in this section.

7.2.13 Chemical Disposal Requirements

List all chemicals drain lines that carry effluent from the equipment in the form provided. HPM drain lines must be leak checked prior to use in accordance with the New York State Plumbing Code.

The tool engineer is responsible for preparing and submitting chemical drain emission calculations to CNSE EHS demonstrating that the concentration of chemical that are being discharged and treated by the water treatment plant are below required permit limit.

7.2.14 Post-Process Exhaust Treatment Systems

Multiple parties are listed in the responsible column for several items in this section. The responsibility for each checklist item depends upon the location of the post-process exhaust treatment systems within the facility. If tool owner is a company other than CNSE both parties listed in the responsible column has responsibilities pertaining to a specific item, both parties will verify the items by initialing the items, whichever apply.

The tool engineer is responsible for preparing and submitting air emission calculations to CNSE EHS demonstrating that the concentration of chemicals/gases that are being discharged are treated effectively by the assigned post process exhaust treatment system.

7.2.15 Fire Detection

All types of fire detection equipment that shall be utilized must be listed in this section.

7.2.16 Fire Protection Requirements

This section applies to all equipment-specific fire detection, monitoring, suppression, and alarm systems. This includes systems internal to the equipment itself and systems that are installed to accommodate, either wholly or in part, the presence of the equipment that is being installed (e.g. sprinklers in the bay ceiling that service the area occupied by the equipment). Installations that are required by the New York State Fire Code that are tied to the Building Fire System must be approved, installed and verified by a New York State certified installation contractor.

7.2.17 Local Fire Suppression System Documentation

This is a checkpoint to ensure the necessary tests and documents have been conducted, and provided by the fire system(s) installers.

7.2.18 Emergency Machine Off (EMO)

The equipment may be powered up to test EMO functionality only after all other Part 1 Equipment Commissioning Checklist items have been verified. The tool must then return to a completely locked-out state until sign-off is approved.

7.2.19 Interlocks

The supplier of the equipment must provide an interlock matrix, listing all interlocks that are specific to the equipment. This matrix should be attached to the Equipment Commissioning Checklist. All interlocks listed

on the matrix must be verified to be functional. Interlocks present on peripheral equipment (i.e. vacuum pumps, exhaust treatment systems, gas detection systems, etc.) are addressed in those respective sections of the Equipment Commissioning Checklist. Section Q of the Part 2 The checklist applies only to interlocks that are internal to the equipment as provided by the supplier. It is important to ensure that any changes to the equipment or the operating system do not affect the functionality of any interlock(s). Interlocks must be re-tested and verified to ensure functionality after every such change.

In case of an alarm, area alarm control panels connected to the gas detection system must have interlocks to stop the gas flow into a gas cabinet. Any other interlocks, like an EMO being pressed or a status signal from the tool or process chamber/module is not mandatory to have connected to the area alarm control panel but will be utilized if connections are available on the system.

7.2.20 HPM Delivery System (Liquids and Gases) Process Control Isolation Lock Removal

Prior to the turn on of the HPM lines from the HPM delivery system Tool Installation and Chemical/Gas Services must remove the process control locks to the lines/sticks that will be turned on.

7.3 Punchlist Items

Any deficiencies that are discovered during the Part 1 and Part 2 reviews that do not directly impact the safety of the equipment or the installation are to be listed in the Punchlist at the end of the Equipment Commissioning Checklist. The party responsible for completing each Punchlist item will be listed in the Punchlist as well. Punchlist items should be completed in a timely manner and must be completed before the checklist is signed off.

7.4 Deficient Checklist Items

All items for which "No" is indicated on the Part 1 or Part 2 checklists must be listed in the "Deficient Items" table at the end of Part 1 or Part 2 as appropriate. Upon completion of the deficient item, the party responsible for its completion will indicate the date of completion and sign the "Deficient Checklist Items" table to indicate the completion of each deficient item.

7.5 Signature Blocks

Successful completion of all checklist items allows approval of the Equipment Commissioning Checklist, whichever applies. Only upon completion of all checklist items, including those designated as Deficient or Punchlist items, may the commissioning be approved. All parties must wait to sign the appropriate signature block until all checklist items, for which they are responsible, are verified. The CNSE Code Compliance Manager and Environmental, Health and Safety Manager must wait until all signatures have been affixed to the checklist. The CNSE Facilities Director has final authority and will sign after all signatures have been affixed.

8. RECORDS

The Equipment Commissioning Checklist serves as documentation of the individual equipment installation projects and will be archived for future reference by CNSE EHS Department.