

Integrated Work Document (IWD) Part 1, Activity Specific Information

IWD #: MST-8-3-1698-C135-1		Revision #: 7	Activity/Task Title EML Electrical/Mechanical Maintenance and Repair
Work Document #			Planner/Preparer (Name/Z #/Date) Rodney McCabe / 178257 / 4/18/2019
TA 3	Building 1698	Room C-135	Other Location(s)(TA) as required Building 1698 Room C-108 Service Corridor, Building 32 Rooms 102A and 102D (for utilities)

Activity Description/Overview: This IWD covers work performed by EML staff on equipment in the Electron Microscopy Laboratory area.

The work is divided into 5 tasks:

- A. Electrical/Mechanical Repair
- B. Chemical Movement/Disposal.
- C. EDS Dewar Filling.
- D. Gas Cylinder Exchange
- E. Crane and Hoist Use

Hazard Analysis (HA) Method Used: ☒ Brainstorming ☐ Other:

List Names of HA Team (Attach sheet if necessary): Rodney McCabe, Ben Morrow, Matt Schneider, Roberta Beal

Date HA Performed: 4/18/2019

The RLM approval indicates Integrated Work Management (IWM) has been applied appropriately, work is authorized, workers are qualified, work will be performed in accordance with Environment, Safety, Health, and Quality (ESH&Q)/Security and Safeguards (S&S) requirements and the IWD, and facility safety basis, aggregate hazards, and collocated hazards were appropriately included in the hazard analysis. RLM acknowledges completion of a peer review.

RLM (Signature/Z#/Date) Required: [Signature] 187042 5/29/19

The Facility Operator Director (FOD) approval on Form 2100 indicates work is appropriate to be conducted in this facility (the activity is within the Authorization Basis [AB] and the work is appropriate for the facility), and facility safety basis, aggregate hazards, and collocated hazards will be managed.

Work activities in multiple FOD jurisdictions, e.g., additional facility safety envelopes, require FOD or Representative approval.

FODs or FOD Representatives (Signature/Z#/Date/TA) Required: [Signature] 121975 5/14/2019 [Signature] 180035 6/12/19 TA 3

Subject Matter Expert(s) (SME[s]) Review (Signature/Z#/Date) If Required: [Signature] 121975 5/14/19

[Signature] 317874 1H 5/24/19

Work Tasks/Steps Identify work steps/tasks in sequence when such sequencing contributes to safety, security, and/or environmental protection.	Hazards, Concerns, and Potential Accidents/Incidents Identify both activity and work-area hazards for each task/step.		Controls, Preventive Measures, and Bounding Conditions Specify preventive measures, controls for each hazard (e.g., lockout/tagout points, specific Personal Protective Equipment [PPE], Tamper Indicating Devices [TIDs], alarms, safes, recycle, waste minimization).	
General Training Outline				LANL Lab-Wide training as required in this document. EML Site Specific Walk-through training. Structured Mentoring by EML staff or designated level 3 users on each piece of equipment used.
TASK A: Electrical/Mechanical Repair				
Maintenance of electron microscopes.	<i>Incidental X-Rays</i> Exposure to ionizing radiation (X-rays) during microscope operation.	Microscope interlocks prevent operation when conditions are not appropriate. Staff are trained not to attempt to operate the microscope if any shielding is removed. TEMs and SEMs are surveyed by RP-1 yearly or whenever changes affecting shielding are made. RP-1 must re-survey after any configuration changes affecting shielding.	Each instrument has an operator manual and several have maintenance manuals as well. LANL Procedure P121, Radiation Protection	Radiation-Generating Device (<40 KvP) (Class 1) (2678) or Radiological Worker (114, 115)
Maintenance of electron microscopes and sample prep area.	<i>Chemical Hazards</i> TEM sample holders contain parts of machined Beryllium	Staff must wear gloves while working with Be.	LANL Procedure P101-14 Chemical Management	Chem. Workers Haz Com (4261) Hazardous Waste Generator (2810)

	<p>(Be).</p> <p>If the high-tension tank is disrupted, SF6 gas could leak into the room, presenting a suffocation hazard near the floor. SF6 can decompose to a poisonous gas when exposed to spark or flame.</p> <p>Solvents could be inhaled, ingested, or contact the skin. Solvents include acetone, ethanol, methanol, or isopropanol.</p> <p>Lubricants may contain glycerol, propylene glycol, ethylene glycol, or Fomblin. These may be irritants.</p>	<p>Room is well ventilated and is designed to not trap heavier-than-air gasses. Total drainage of the tank would cover the floor to a depth of only about 1 inch, if there was no ventilation. Electrical outlets are placed three feet high on the wall to minimize spark hazards near the floor. The HT tank is made of thick steel, so events potentially causing a disruption of the tank would likely be much more severe than the disruption, itself. A portable halogen sniffer will be used whenever SF6-containing items are serviced.</p> <p>Staff are trained in proper use of the chemical hood and proper handling of solvents. Wear proper gloves when handling solvents other than water. Use eye or face protection and a lab coat when there is a splash hazard. Methanol is a reproductive health hazard. Consult your ESH POC for a reproductive health hazard review if necessary. Eyewash stations are located at the sinks in the prep area. Safety showers are located next to the perchloric hood.</p>		
Maintenance of all electrical equipment.	<p><i>Electrical Equipment</i></p> <p>Electrical shock. (Supply V, Supply A, HT to electron accelerator) Titan: 288 V 3 phase, 46 A, 300kV TF30: 240 V, 50 A, 300kV 3000F: 480 V 3 phase,</p>	<p>All equipment is commercial and listed by a Nationally Recognized Testing Laboratory and/or approved by an MST ESO. A green sticker designates approved equipment.</p> <p>Appropriate PPE shall be selected and used, as determined by the PPE selection tool, available at the Electrical Safety Program website.</p> <p>All non-facility energized electrical work</p>	<p>Proper precautions will be taken according to the LANL Electrical Safety Program procedure P101-13 at http://int.lanl.gov/safety/esc/</p>	<p>R&D Electrical Worker: Energized (2876) or R&D Electrical Worker: Non-energized for Class 2.1 work only (2899).</p> <p>If required by work: Lockout/Tagout Authorized Worker</p>

	<p>75 A, 300kV Inspect F: 240 V, 30 A, 30kV XL30: 240 V, 35 A, 30kV Helios: 240 V, 35A, 30 kV</p> <p>EPE Technologies, Inc. EPS 3000 UPS: 208 V, 67 A GE LP Series UPS: 204 V, 10 A Toshiba 1400 SXL UPS: 232 V, 75 A Toshiba 4200FA UPS: 288 V, 46.3 A</p> <p>Others 110-240 VAC, amperage varies. Also DC voltages from 5V to 7kV.</p>	<p>must be performed by two LANL-trained energized electrical workers.</p> <p>No facility electrical work is allowed under this IWD.</p> <p>Staff are trained to not attempt to operate the equipment if any shielding is removed unless necessary for repair or testing and diagnostics.</p> <p>Work is performed with equipment de-energized and verified as de-energized. If equipment is cord and plug, positive plug control shall be maintained to ensure a safe state. All work determined to be non-facilities energized work requires a hazard analysis by an ESO. Once energized electrical status is confirmed, work will be performed with the ESO in conjunction with LANL Electrical Safety Program procedure P101-13 and will be performed under IWD 6-3-66-GEN-12, or generated. Proper PPE will be defined during the hazard analysis, and will be required to perform the work.</p> <p>According to Table 4-1 of LANL P101-13, Electrical Safety Program, electrical DC >100 V and >40 mA and 60 Hz AC >50V and >5 mA are above the shock hazard threshold. Items above these thresholds may also have arc flash or thermal burn hazards, so a full hazard analysis with the ESO is required.</p> <p>Manufacturer manuals and schematics are used during maintenance activities.</p>	<p>IWD 6-3-66-GEN-12</p> <p>Major repairs are performed by a factory-trained service engineer. This is covered under the Exhibit F and/or the corresponding IWD for the installation, warranty, or service contract as well as the IWD for EML External Technical Service..</p>	(127)
Repair of plasma cleaner or RF sputter coater.	<i>Non-ionizing Radiation</i>	Interlocks prevent operation when instrument conditions are not appropriate. Staff are trained not to attempt to operate the	The plasma cleaner has a manual for	R&D Electrical Worker: Energized (2876) or R&D

	<p>Exposure to NIR from the plasma cleaner. The South Bay 13.56 MHz unit is capable of 150 W operation if used incorrectly. The South Bay unit requires 5A at 115V. Usual is 10 to 50 W for plasma cleaning in the South Bay and 40 to 45 W in the Fischione unit.</p>	<p>equipment if shielding is removed and not to operate above ~50 W while using the South Bay unit.</p> <p>Positive plug control shall be maintained to ensure a safe state.</p>	operation and simple maintenance.	Electrical Worker: Non-energized for Class 2.1 work only (2899).
<p>Maintenance or testing of vacuum systems that use LN₂ trapping. See task C for EDS Dewar filling as a stand-alone task.</p> <p>Repair or use of hot plate.</p> <p>Repair of vacuum systems.</p>	<p><i>Thermal Hazards</i></p> <p>Skin or eye exposure to LN₂ used for microscope anti-contaminator or sample holder.</p> <p>Skin exposure to hot surfaces, especially hot plates, diffusion pumps, and mechanical pumps.</p>	<p>Staff and users are trained in proper techniques for drawing and pouring LN₂ when trained for each microscope.</p> <p>Cover exposed skin that may potentially come in contact with LN₂. Eye protection or face shield are required when working with liquid nitrogen. Cryo gloves are provided for handling Dewars and items that become cold.</p> <p>Cryogenics can displace oxygen and will expand ~1000x between the liquid and gaseous phases. The safe volume of cryogenics in a room is calculated by $V_s \text{ (liters)} = V_{\text{room}} \text{ (m}^3\text{)}/14$. If the cryogen volume is greater than V_s, contact the ESH POC to evaluate the ventilation.</p> <p>Hot plate has a surface thermometer. Staff are trained not to touch pumps while running or soon after shutdown.</p>	LANL Procedure P101-34 Pressure, Vacuum, and Cryogenic systems	<p>Cryogenic Worker (2720)</p> <p>Approval through MPA-10 required to use the LN₂ filling station on south dock of bldg. 32. (IWD 10-3-3234-DOCK-1)</p>
Maintenance of electron microscopes, ion mills, or coaters.	<p><i>Pressure Sources</i></p> <p>Implosion of vacuum</p>	Electron microscopes are interlocked to shut down when the vacuum is compromised and are designed for high vacuum.	LANL Procedure P101-34	Pressure Systems (2306) or Intermediate & High Pressure

	<p>systems on electron microscopes, ion mills, or coaters.</p> <p>Gas cylinder, regulator, hose, or Dewar failure.</p>	<p>Staff are trained in methods of proper sample insertion and removal.</p> <p>Staff are informed not to splash LN₂ on leaded glass windows due to implosion hazard if glass cracks.</p> <p>Staff are trained in proper methods of gas cylinder use and transportation.</p> <p>An Approved pressure regulator with a pressure relief device is used on all compressed gas bottles.</p> <p>Delivery pressure for all gasses in the EML is less than 80 psi.</p> <p>All gas cylinders are secured in place with straps or chains.</p> <p>Gas cylinders shall be capped without regulators when not in use.</p> <p>Gas cylinders must be transported with approved gas cylinder carts.</p> <p>Protective shoes are required and protective eyewear is recommended when changing gas bottles.</p>	<p>Pressure, Vacuum, and Cryogenic systems</p>	<p>Systems (2300)</p> <p>Gas Cylinders Hazards Requirements (2302)</p>
<p>Maintenance of mechanical of equipment.</p> <p>Movement of equipment.</p>	<p><i>Mechanical Hazards</i></p> <p>Rotating equipment, pinch hazards,</p> <p>Moving of heavy objects.</p>	<p>Staff are trained not to attempt to operate the equipment if any shielding is removed unless necessary for repair or testing and diagnostics.</p> <p>Work is typically performed with equipment de-energized and verified as de-energized.</p> <p>Proper lifting techniques, equipment, and PPE, when required, shall be used.</p>	<p>Manufacturer manuals and schematics are used during maintenance activities.</p> <p>Major repairs are performed by a factory-trained service engineer. This is covered under the Exhibit F and/or the</p>	

			corresponding IWD for the installation, warranty, or service contract as well as the IWD for EML External Technical Service.	
Unattended Operation	<p><i>Unattended operation and work after hours.</i></p> <p>Outages or malfunctions might produce abnormal operating conditions and introduce new hazards (ex: total darkness, failed vacuum systems).</p>	Staff are informed to leave a note giving name, phone number, anticipated return time, on unattended active operations if left unattended for more than 1/2 hour.		
TASK B: Chemical Movement/Disposal				
	<p><i>Chemical Hazards</i></p> <p>Solvents could be inhaled, ingested, or contact the skin. Solvents include acetone, ethanol, methanol, or isopropanol.</p> <p>Acids and other constituents of electropolishing electrolytes could be inhaled, ingested, or contact the skin</p>	<p>Staff are trained in proper use of the chemical hood and proper handling of chemicals. Wear proper gloves when handling chemicals. Use eye or face protection and a lab coat when there is a splash hazard.</p> <p>Methanol is a reproductive health hazard. Consult your ESH POC for a reproductive health hazard review if necessary.</p> <p>Use proper secondary containment when transporting chemical bottles.</p> <p>Flammables are stored in the flammables cabinet in room C-135H. Corrosives are stored in the corrosives cabinet in the service</p>	<p>LANL Procedure P101-14 Chemical Management</p> <p>MSDS in binder between hoods or on-line.</p>	Chem. Workers Haz Com (4261)

	Irritating lubricants could be inhaled, ingested, or contact the skin.	<p>corridor. Mixed electrolytes are stored in the bin below the perchloric hood or in the designated refrigerator in the print darkroom.</p> <p>Good housekeeping is a requirement.</p> <p>For all waste disposal, contact the Waste Management Coordinator.</p>		
TASK D: Gas cylinder exchange				
	<p><i>Pressure Sources</i></p> <p>Gas cylinder, regulator, or hose failure.</p>	<p>Staff are trained in proper methods of gas cylinder use and transportation.</p> <p>An Approved pressure regulator with a pressure relief device is used on all compressed gas bottles.</p> <p>Delivery pressure for all gasses in the EML is less than 80 psi.</p> <p>All gas cylinders are secured in place with straps or chains.</p> <p>Gas cylinders shall be capped without regulators when not in use.</p> <p>Gas cylinders must be transported with approved gas cylinder carts.</p> <p>Protective shoes are required and protective eyewear is recommended when changing gas bottles.</p>	LANL Procedure P101-34 Pressure, Vacuum, and Cryogenic systems	<p>Pressure Systems (2306) or Intermediate & High Pressure Systems (2300)</p> <p>Gas Cylinders Hazards (2302)</p>
TASK E: Crane and Hoist Use				
	<p><i>Electrical Equipment</i></p> <p>Electrical shock.</p>	<p>All electrical equipment is commercial and listed by a Nationally Recognized Testing Laboratory and/or approved by a MST ESO.</p> <p>Overhead crane must be current on electrical inspection and approval before use.</p>		
	<p><i>Mechanical Hazards</i></p> <p>Moving and lifting of heavy objects.</p>	<p>Overhead crane must be current on mechanical inspection and approval before use.</p> <p>All hoists, cranes, rigging, loads and the path of the lift must be inspected before the lift.</p>	All lifts, critical lifts in particular, must be performed and documented according to the	Incidental Crane Operator (122) for non-critical lifts. Qualified Crane Operator (123) for critical lifts as defined in the Cranes,

		<p>Hoists, cranes and rigging must be inspected daily before use.</p> <p>All rigging must be inspected and approved. Appropriate PPE must be worn during lifting; safety shoes, gloves, hardhat when lifting with overhead crane.</p> <p>Trained and qualified riggers and operators are utilized for all lifts.</p>	<p>Cranes, Hoists, Lifting Devices, and Rigging Equipment Procedure 101-25.0.</p> <p>Some hoist lifts are performed by a factory-trained service engineer. This is covered under the IWD for EML External Technical Service.</p>	<p>Hoists, Lifting Devices, and Rigging Equipment Procedure 101-25.0.</p>

Use Form 2100 Continuation Page for additional Tasks/Steps (if needed) or attach pages to clearly communicate ES&H/S&S hazards and associated controls.

**Integrated Work Document (IWD) Part 3,
Validation and Work Release**

IWD #MST-8-3-1698-C135-1

Revision #: 7 **Work Release**

By signing below, I verify this activity is compatible with current facility configuration and operating conditions.

FOD designated Ops Mgr or other facility point-of-contact for work area

Signature/Z#/Date (If required by FOD): _____

Note: For Standing IWD, release may be given concurrently with signatures on Part 2.

By signing below, I have verified the following:

- I have verified authorization by ensuring approval signatures of the RLM and FOD.
- I have jointly conducted a validation walkdown with workers to confirm the IWD can be performed as written, required initial conditions and other prerequisites are in-place.
- The assigned workers are authorized and are qualified to perform the work in a safe, secure, and environmentally responsible manner.
- I have conducted the pre-job briefing, and all workers (including support workers) have been briefed.
- I have ensured coordination with any required FOD work-area representatives (e.g., area work coordinators).

Primary PIC (Signature/Z#/Date) Required: [Signature] 178257 6/13/19

Alternate PIC Signatures **acknowledges** PIC authority is assumed for the first time (Note: Alternate PICs are required to sign only once, but formal handoff includes conferring with previous PIC to obtain all required information associated with the handoff).

Alternate PIC (Signature/Z#/Date) Required: [Signature] 247959 6/13/2019

Alternate PIC (Signature/Z#/Date) Required: [Signature] 132242 6-13-19

Pre-Job Brief Content

- What are the critical steps or phases of this activity?
- How can we make a mistake at that point?
- What is the worst thing that can go wrong?
- What controls, preventive measures, and bounding conditions are needed?
- What work permits are required and how will we meet their requirements?
- What are the handoffs and coordination requirements among workers and multiple PICs?
- Are there hold-points including those that require sign-offs?
- What are the pause/stop work responsibilities and expectations (e.g. for unanticipated conditions or hazards)?
- How would we respond to alarms and emergencies?
- Are there lessons learned from previous similar work?
- Is other information needed to perform this activity in a safe, secure, and environmentally responsible manner?
- Does everyone agree to the work tasks/steps, hazards, and controls and commit to follow them?

Pre-Job Brief Attendance Roster

By signing below as required, I agree to the following:

- I agree to follow the work steps and implement the controls as written as applicable to my work assignments.
- I agree to pause/stop work when conditions or hazards change or when I encounter unexpected conditions during the execution of work, or when work cannot be performed as written, or instructions become unclear during execution.
- I confirm that I am authorized, qualified, and fit to perform the work.

Worker (Signature/Z#/Date)
[Signature] 178257 6/13/19

Worker (Signature/Z#/Date)

Worker (Signature/Z#/Date)
[Signature] 132242 6-13-19

Worker (Signature/Z#/Date)

Worker (Signature/Z#/Date)

Worker (Signature/Z#/Date)

Worker (Signature/Z#/Date)

Worker (Signature/Z#/Date)