

# MME Standard Operating Procedure (SOP)

<b>Name</b>	Zirconium Laser Deposition at ALFa lab Equipment: 1. IPG Photonics Fiber Laser (Model # YLR-1000-IC) – Class IV laser 2. Fadal CNC (Model # 904-1) 3. Sulzer Metco Powder Feeder (Model # Twin-10-C)
<b>Description</b>	<ul style="list-style-type: none"> <li>The 5 axes CNC moves and orients the work piece.</li> <li>The powder feeder deposits Zirconium Powder onto the work piece</li> <li>The laser fuses the powder onto the work piece</li> </ul>
<b>Location</b>	<ul style="list-style-type: none"> <li>E3-2116A</li> </ul>
<b>SOP Creation Date</b>	<ul style="list-style-type: none"> <li>2013-12-17</li> </ul>
<b>SOP Created By</b>	<ul style="list-style-type: none"> <li>Arshad Harooni</li> </ul>
<b>SOP Revision Date</b>	<ul style="list-style-type: none"> <li>2014-03-19</li> </ul>
<b>SOP Revised By</b>	<ul style="list-style-type: none"> <li>Arshad Harooni</li> </ul>
<b>SOP Location</b>	<ul style="list-style-type: none"> <li><a href="https://sharepoint.uwaterloo.ca/sites/MME/MSDS/default.aspx">https://sharepoint.uwaterloo.ca/sites/MME/MSDS/default.aspx</a></li> </ul>
<b>Manual Location</b>	<ul style="list-style-type: none"> <li>E3-2116A</li> </ul>
<b>Equipment Owner</b>	<ul style="list-style-type: none"> <li>Prof. Amir Khajepour</li> </ul>
<b>Authorized Trainers</b>	<ul style="list-style-type: none"> <li>Arshad Harooni</li> </ul>
<b>Support Technicians</b>	<ul style="list-style-type: none"> <li>Jason Benninger</li> <li>James Merli</li> </ul>



Figure 1 IPG Photonics Fiber Laser Console



Figure 2 Fadal CNC



Figure 3 Sulzer Metco Powder Feeder

<b>Significant Hazards</b>	<ul style="list-style-type: none"> <li>Direct beam, specular reflection and diffused reflection from the Class IV laser can permanently damage the eye and skin</li> <li>Cooling water can overheat and pose laser machine malfunctioning and burning hazard</li> <li>Pinch point created by movement of CNC bed</li> <li>Airborne and settled Zirconium powder can create fire/ explosion hazard</li> <li>Wet Zirconium powder has the potential of creating hydrogen gas</li> </ul>
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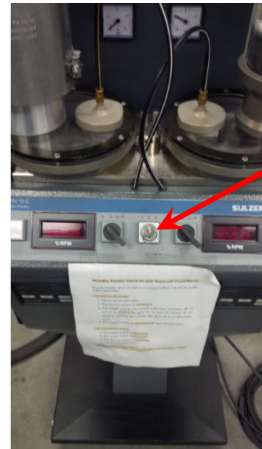
<b>Administrative Controls</b>	<ul style="list-style-type: none"> <li>• Use of this equipment must be approved by equipment owner</li> <li>• The operator must complete the Compressed Gas Training and the Laser Safety Training</li> <li>• The laser must be operated while the cooling water is being circulated</li> <li>• The equipment can only be used by trained students during standard operating hours</li> <li>• Long hair must be tied back</li> <li>• Loose jewelry must not be worn while operating the equipment</li> <li>• Keep clear of the direct and reflected path of the laser beam</li> <li>• Check laser goggles for cracks or damage before use</li> <li>• Ensure that the laser is off before positioning the work piece</li> <li>• The work piece may be hot from the cladding operation. Never use bare hands to grab the work piece immediately after the cladding operation.</li> <li>• Clean the area of Zirconium powder after use. Use the designated brush and dust pan to collect loose Zirconium powder. Do not use shop vac.</li> <li>• Do not let more than 1 gal (3.8 L) of dry Zirconium powder accumulate. Special attention should be paid to powder accumulation in crevices and joints. Monthly inspections will be conducted to check for accumulation of Zirconium. Records of inspection will be maintained.</li> </ul>
<b>Engineering Controls</b>	<ul style="list-style-type: none"> <li>• Warning light outside the room to indicate that the laser is in use</li> <li>• The access door to the room is interlocked such that the laser will not operate when the door is open</li> </ul>
<b>PPE Required</b>	<ul style="list-style-type: none"> <li>• Laser Goggle: OD 5+ @1070nm</li> <li>• NOISH approved N 95 Respirator or better</li> <li>• Gloves when handling hot work piece</li> </ul>
<b>Relevant Standards and Codes</b>	<ul style="list-style-type: none"> <li>• None</li> </ul>
<b>Relevant MSDS</b>	<ul style="list-style-type: none"> <li>• Zr powder (Produced by ATI Wah Chang)</li> <li>• Shell TONNA® OIL V 68</li> <li>• WD-40</li> </ul> <p>MSDS can be found at:  <a href="https://sharepoint.uwaterloo.ca/sites/MME/MSDS/MSDS%20Data%20Sheets/Forms/AllItems.aspx">https://sharepoint.uwaterloo.ca/sites/MME/MSDS/MSDS%20Data%20Sheets/Forms/AllItems.aspx</a></p>
<b>Accident Procedure</b>	<ul style="list-style-type: none"> <li>• Any injury caused by direct beam, specular reflection and diffused reflection should be reported to medical authority immediately. If there was an exposure to the eye, an ophthalmologist should be consulted.</li> <li>• In the case of an injury caused by a pinch point, apply a cold compress. If blood has been drawn, wrap and apply light pressure to the wound. Seek medical attention if necessary.</li> <li>• In the case of burn, soak in cold water for 15 minutes. Seek medical attention if necessary.</li> <li>• In case of a zirconium fire, only attempt to extinguish if safe to do so. If time allows, turn off the laser and the powder feeder.</li> <li>• Small zirconium fire can be extinguished using table salt. Table salt is available in cans labeled “For Metal Fire”. Larger but controllable zirconium fire can be extinguished by Type D Sodium Chloride fire extinguisher. This fire extinguisher is available by the lab’s main door and is labeled “For Metal Fire Only”</li> <li>• Do not use water, type ABC dry chemical extinguisher, B:C dry chemical extinguisher, gaseous-based foam, halon or carbon dioxide to extinguish fire. Inform UW Police or fire department if fire cannot be contained. Inform supervisor.</li> <li>• If the zirconium fire is in the vicinity of water or if wet zirconium powder catches fire, explosion can occur. The room should be evacuated immediately. Inform UW Police and Fire Department.</li> </ul>

**Emergency Shutdown Procedure**

- Hit the emergency stop on the IPG Photonics Fiber Laser Console
- Turn the key on the Sulzer Metco powder feeder to "0" position
- Hit the emergency stop on Fadal CNC



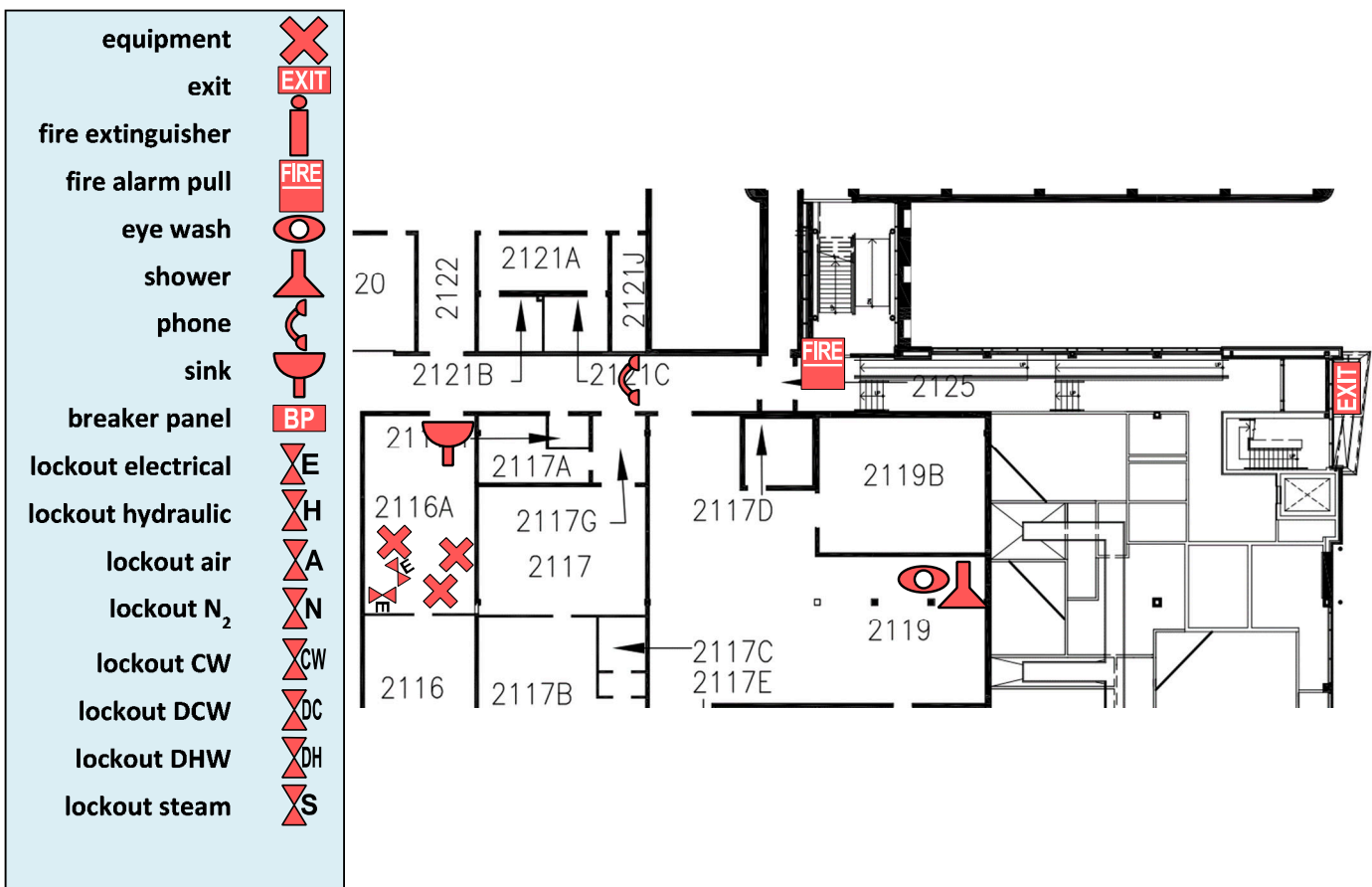
**Laser  
Emergency  
Stop**



**Powder  
Feeder  
Key**



**CNC  
Emergency  
Stop**



**Pre-start Checklist**

- Clean off powder from previous cladding operations
- Ensure that “LASER” toggle is in “OFF” position
- Ensure that “GUIDE LASER” is in “ON” position
- Ensure there is sufficient cooling water in DI water cooling unit.
- Check the lubrication gauge and ensure that there is sufficient lubricating oil
- Ensure there is sufficient coolant for the keeping the Fadal CNC cool during operation

**Start-up Procedure**

- Turn on Laser DI water cooling system and wait for “DI Indicator” light to turn green
- On the IPG Photonics Fiber Laser console, turn the power switch clockwise to “ON” position
- Insert Laser key and turn it to “REM” position
- Turn on the electrical disconnect located on the wall behind the CNC machine
- Turn on the electrical disconnect facing the room E3-2116
- Hold down the green button labelled “CNC Power” for at least 2 seconds
- Turn on the “INSIGNIA” monitor
- Press space bar until “ENTER NEXT COMMAND” appears on the screen
- Enter “CS” for cold start and then press enter
- Press “Jog” button
- Use the hand wheels to orient the chuck into the desired position. Use the bubble level to level the chuck.
- Place the work piece onto the chuck
- Record your name, date, powder composition and time on the “ALFa Sign Up Sheet”
- Turn on Argon gas. Record the pressure indicated on the gauge closest to the cylinder on the “ALFa Sign Up Sheet”.
- Empty the powder feeder hopper of powder and store it in properly marked bottle. Clean the hopper using

compressed air.

- Fill the powder feeder with the desired powder
- Turn the powder feeder key to “1” position
- Turn the rightmost hopper onto “G” (gas only) mode for 30 seconds
- Wear NOISH approved Respirator
- Turn the hopper to “G+P” (Gas + Powder) mode
- Adjust the knob on the right side of the powder feeder to achieve the desired powder feed rate
- Adjust the powder feeder nozzle to ensure that the powder is falling inside the guide laser light zone
- Wear Laser goggle
- Turn on the “Dell” monitor and go to “LaserNet”
- Go to “Control” tab and adjust the laser power
- Press the black “Laser PS ON” button
- Turn the “LASER” toggle to “ON” position for a couple of second
- Wear heat resistant gloves. Check the laser spot size. Make the necessary height or laser power adjustments.
- Turn the “LASER” toggle to “OFF” position
- Select “Stop” button on the LaserNet screen
- Turn the hopper to “0” (off) mode
- Press “Manual” and then space. Make changes to the G-code to achieve the desired cladding path.
- Press “Auto” and “Start” to confirm the cladding path.

### **Operating Procedure**

- Wear Laser goggles and NOISH approved Respirator
- Turn the rightmost hopper onto “G” mode for 30 seconds
- Turn the hopper to “G+P” mode
- Press the black “Laser PS ON” button
- Turn the “LASER” toggle to “AUTO” position
- Press “Start” to obtain the desired cladding

### **Shutdown Procedure**

- Turn the “LASER” toggle to “OFF” position
- Select “Stop” button on the LaserNet screen
- Turn the hopper to “0” mode
- Take off Laser goggles and NOISH approved Respirator
- Wear heat resistant gloves and remove the work piece
- Press “Manual” button.
- Enter “HO” for home position and then press enter
- Press “Start” button
- Record the pressure indicated on the gauge closest to the Argon gas cylinder on the “ALFa Sign Up Sheet”.
- Record time on the ALFa sheet
- Turn off Argon gas
- Turn the powder feeder key to “0” position
- Turn off monitors
- Turn the Laser key to “OFF” position. Remove the key and place it in its designated location.
- Turn the Laser console power switch counter-clockwise to “OFF” position
- Turn off the Laser DI water cooling system
- Turn off the electrical disconnect facing the room E3-2116
- Turn off the electrical disconnect located on the wall behind the CNC machine

## Clean-up

- Clean the area of Zirconium powder after use. Use the designated brush and pan to collect loose Zirconium powder. Do not use shop vac.

## Lockout

### IPG Photonics Fiber Laser

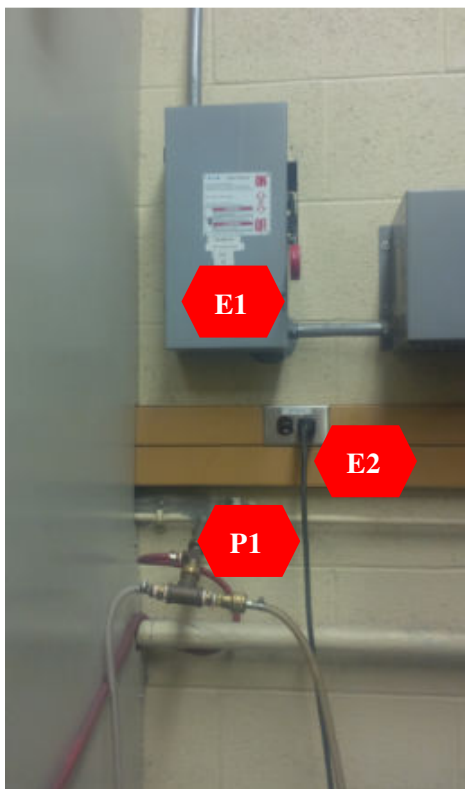
- E3

### Fadal CNC

- E1
- P1

### Sulzer Metco Powder Feeder

- Close **P2** - the main metallic Argon cylinder gas valve
- Turn the powder feeder key to "1" position
- Turn the rightmost hopper onto "G" (gas only) mode until both the pressure gauge on the cylinder indicate a reading of 0 psi
- Disconnect **E2**



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## Maintenance and Repair

### Monthly:

- Use the designated brush and dust pan to collect loose metal powder
- Use scraper, wire brush, wipes and WD 40 to remove clogged metal powder
- Remove and replace oil sorbents
- If the waste is dry, collect in an air tight plastic container. While handling dry zirconium powder, avoid creating a dust cloud.
- If the waste is wet, collect in a vented plastic container.
- Apply chemical waste label on the container. Indicate that the content is flammable on the label.
- Store the waste container in a cool and dry location. The container should be kept away from any source of heat or ignition.
- Take to environmental safety facility for disposal.

### As needed:

- Top-up the DI water in the DI water cooling unit
- Top-up the lubrication oil
- Inform support technician when the Fadal CNC runs low on coolant
- Inform support technician of any problems associated with the equipment.