Lessons Learned Converting A Commercial Enclosure to a Uranium Handling Glovebox

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Advanced Manufacturing

INL Initiative
Developing cost competitive techniques to manufacture components made from materials for harsh and extreme environments. Focusing on development of radiological materials, reactor systems, in-pile sensors, and hardened material systems. Applications to include advanced reactor technologies, fossil energy, clean energy, and space and defense systems.
Additive Manufacturing

Why use additive manufacturing?
• Complex Geometries
• Minimize material (weight) while maximizing strength
• Localize material characteristics
• Build with multiple materials
• In-process alloying

Type of Additive Manufacturing
• Powder Bed Fusion
  • Selective Laser Sintering (SLS), Electron Beam Melting (EBM)
• Directed Energy Deposition
  • Powder DED, Wire DED
• Binder Jetting
• Sheet Lamination
Optomec LENS® MR-7

- Directed Energy Deposition (DED) using Laser Engineered Net Shaping (LENS®) technology
- Uses a high power ND: YAG fiber laser to fuse powdered material into three dimensional structures
- Class 1 Laser Enclosure
- Controlled atmosphere (O₂ levels < 10ppm)
- Build area of approximately 12”x12”x12”
- Powder delivery system with 2 hoppers.
- Typically operates at a positive pressure.
Optomec LENS MR-7

Upgrades
- 1 kW laser
- Thermal camera
- Glass viewing window
- Rotational Axis
Operation

- Powder is loaded into the two hoppers on the side of the enclosure.
- Powder is carried to the deposition head and exits through 4 nozzles.
- The laser comes down through the center of the deposition head and creates the melt pool.
- The table and deposition head move to create the 3 dimensional part.
- The finished part is passed out of the enclosure through the transfer port.
Build Pictures
Main objective is to be able to process radiological and pyrophoric material.
  • Must pass Helium leak test
  • Shall operate under a negative atmosphere

Upgrades
• Containment bag
• Powder Separator
• Magnetic/Cooling Plate
• Window Replacement
• Electrical Feed Throughs
• Hopper Relocation
• Side and Back Panel Modification
Primary Containment Bag

- Modified the head of the laser to accept the mounting bracket for the containment bag
- Went through multiple iterations to find a material that would withstand the heat and still be flexible enough to allow movement of head and build table
- Contains all of the overspray, eliminating lengthy cleanups and decontamination issues
Containment Bag Powder Separator

- Argon purge through center nozzle pressurizes containment bag
  - Keeps optics clean
  - Delivers powder to the build area
- Filter on containment bag clogged with particulate
- Designed and installed air/particulate separator
Magnetic/Cooling Plate

- Table added to bring build level with small window
- Magnetic plate secures build to table through containment bag
- Cooling of base plate allows operator to control cooling of part during the build
Window Replacement

- Viewing window is composed of glass (no polycarbonate).
- Very limited viewing area.
Laminated safety glass comprises the containment boundary.
Laser safety window made of polycarbonate provides the protection from the Class IV laser.
Electrical Feedthroughs
Electrical Feedthroughs
Hopper Relocation

- Two hoppers allow for functionally graded material where a switch can be made from one material to the next during the build and for alloying material during the build process
- Material handled, loaded and transferred outside the enclosure
Hopper Relocation
Side and Back Panel

- Studs welded to panel
- Nuts tightened from inside enclosure to seal panel to frame
- No way to reach back of enclosure to tighten nuts if leak occurs.

- New panels fabricated
- Bolts sealed and secured inside glovebox
- Nuts on outside of glovebox allow tightening of nuts
- Can remove panel if required
Questions