Introduction.

This assessment addresses the risk of oxygen deficiency hazard for the Electron Beam Welding Facility (within Building 58). The assessment is conducted according to the requirements of Appendix 6500-T3, “ODH Risk Assessment”. One general category of ODH hazard is identified in the facility. This is a nitrogen gas that can dilute the normal oxygen content with health effects as outlined in Appendix 6500-T3.

The following sections provides a model dispersion release description of the ODH source for the area, a description of the work space, a list of failure modes considered under this assessment, the risk assessment, failure rates of the components, the resultant Area Classification, and required action items.

Model for Cryogen Dispersion Release

The Model for Cryogen Dispersion Release is based on a fully operational electron beam welding facility with standard operating procedures for nitrogen backfilling, chamber inerting, and regeneration. The facility has a permanently installed source of 60-80 PSI gaseous nitrogen which represents a total source capacity of 295,000 standard cubic feet. A one inch GN2 supply line with 60-80 PISG supply pressure pipe with main shutoff valve is located within the electron beam welding room. For this model three nitrogen gas connections are connected downstream of the main valve which service components of the electron beam welder. Two connections have a maximum flow rate of 0.5 scfm and the third is normally 100 scfm. The two smaller gas usage points are for minor operational procedures such as regeneration. The 100 scfm user connection is for inerting the beam chamber and has a normally failed closed solenoid supply valve.
The electron beam welding room is a 10,816 cubic foot room (26’w X 26’l X 16’h). There are no natural vents within the room. The room has a dedicated HVAC system which circulates 1800 cubic feet of room air and has a fresh air makeup of approximately 200 cubic feet. This represents one room air change per hour. This analysis assumes the following conditions are present:

**Model for Cryogen Dispersion Release**

This analysis assumes the following conditions are present:

- The facility HVAC is NOT operational
- No natural ventilation
- The likelihood of the main supply line and sub feeder line rupture
- Leakage of the supply connections/valves from each connection point
- Connection Point Pipe Rupture
- Leakage through closed valves (due to age)
- Operator Error
- Supply Solenoid Controls Failure
- Power Outages

Because the amount of source gas can inert the room, an ODH analysis is required coupled with ODH postings as to the level of ODH classification determined by this analysis.

**Description of Work Space: (see figure 3)**

The enclosed space measures 26’ wide, 26’ long and 16’ in height for a total of 10,816 ft³. The workspace is a single floor level with no upper room storage areas. Access to the workspace is by a double door on the west wall or a single door on the northeast corner. The workspace is equipped with non-opening windows in the west double door and along the east wall. There are no floor conduits that can transport gas to work outside the room. The main gaseous nitrogen source is a single one inch gas line which enters the work space 4’ above finish grade at the center of the north wall. The electron beam chamber is centered in the middle of the work area. The work area has a dedicated HVAC system that does not communicate with other work areas. When operating, the HVAC system circulates approximately 1800 cfm of air and has a fresh air makeup of approximately 200 cfm.
FIGURE 3
Welding Chamber
Gaseous Nitrogen Sources

The source of ODH is gaseous nitrogen. The fatality factors are driven by the nitrogen inventory of the 3000 gallon liquid nitrogen dewar which provides gaseous nitrogen to the test lab. Each gallon of liquid nitrogen can provide 24.6 cubic feet of gas at 70F. The total liquid inventory represents 295,000 cubic feet of nitrogen gas. This large source of gas is connected to the electron beam welding room that only has a volume of 10,860 cubic feet. Only 3325 cubic feet of nitrogen gas leakage into the room is necessary to lower the oxygen level to 16%.

ODH RISK ASSESSMENT

The following are the set of events and the associated probability and fatality factors.

Electron Beam Welding Chamber Room

<table>
<thead>
<tr>
<th>EVENT</th>
<th>SPILL RATE, cfm</th>
<th>SPILL, cf</th>
<th>%O2</th>
<th>P_i</th>
<th>F_i</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve Leak(3)</td>
<td>0.50</td>
<td>295000</td>
<td>0</td>
<td>3x10^{-8}</td>
<td>1.0</td>
</tr>
<tr>
<td>Line Rupture(3)</td>
<td>250</td>
<td>295000</td>
<td>0</td>
<td>3 x 10^{-9}</td>
<td>1.0</td>
</tr>
<tr>
<td>Pipe Weld Leak(15)</td>
<td>0.05</td>
<td>295000</td>
<td>0</td>
<td>4.5 x 10^{-8}</td>
<td>1.0</td>
</tr>
<tr>
<td>Solenoid Control</td>
<td>100</td>
<td>295000</td>
<td>0</td>
<td>1x10^{-8}</td>
<td>1.0</td>
</tr>
<tr>
<td>Power Outage</td>
<td>0</td>
<td>0</td>
<td>21</td>
<td>1x10^{-4}</td>
<td>0</td>
</tr>
<tr>
<td>Operator Failure</td>
<td>100</td>
<td>1000</td>
<td>19</td>
<td>3x10^{-3}</td>
<td>0</td>
</tr>
<tr>
<td>Chamber Backfill</td>
<td>100</td>
<td>500</td>
<td>20</td>
<td>1x10^{1}</td>
<td>0</td>
</tr>
</tbody>
</table>

PRODUCT SUM (F_i x P_i) of Above: 8.8x10^{-8}

ODH Risk Hazard: ODH-0 (less than 10^{-7} in accordance with Appendix 6500-T3, “ODH vitality rate and ODH Classifications”)
ODH Operational Mode Recommendations

- Area is classified **ODH 0**, if the analysis above provides a sum product of \( P_i \times F_i < 10^{-7} \) in accordance with EH+S manual “Appendix 6500-T3, ODH Risk Assessment”.

- A plan to eliminate the backfill bypass timer switch must be developed and implemented in the near future. Until then, a SOP or TSOP **must** be in place to ensure the timer bypass switch has been turned off after each regeneration operation.

- A plan and schedule must be developed to move the current regeneration piping connection for the welder regeneration system. The regeneration system nitrogen source piping is to be moved from downstream piping of the chamber backfill control solenoid to upstream of the chamber backfill control solenoid.

- An installation plan and schedule must be developed to install ODH sensors, alarms horn(s), and warning lights in the near future.

- The Electron Beam Welding Facility must be posted according to the evaluated ODH hazard level (ODH 0).

- In the event of a power outage and the ODH detection system is non-functional, personnel should be equipped with personal ODH monitoring equipment when working in the area.