ODH Assessment

Date: 7 April 2008

Location: FEL Mechanical Room (Room 217)

Assessment Author: Mathew Wright

Approval Dana Arenius 4-18-08

Accelerator Division Engineering Department Head: Will Oren 4/18/08
Introduction

The following assessment addresses the risk of oxygen deficiency hazard (ODH) for the FEL (bldg. 18) mechanical room (room 217). The assessment is conducted according to the requirements of Appendix 6500-T3, “ODH Risk Assessment”. The general category of ODH hazard is identified in the facility as warm nitrogen.

The following sections cover the modeling scope and methodology for cryogen dispersion release, a description of the work space, risk assessment, failure rates of components, and requirements.

Model for Cryogen Dispersion Release

The Model for Cryogen Dispersion Release is based on a ½ inch GN2 supply line at 80 PISG supply pressure with a 1/8 inch orifice plate from two 20,000 gallon nitrogen dewars. The maximum possible amount of both nitrogen dewars is approximately 3,400,000 standard cubic feet.

The worst case scenario is if the nitrogen piping is broken and releases the entire contents of both dewars into the mechanical room. Because the volume of potential gaseous nitrogen displaces many times more volume then the room has, the oxygen would be displaced from the room.

The model for an oxygen deficiency hazard is based on the largest quantity of gaseous nitrogen available for use. Failure rate estimates (P_i) are based on JLAB listed equipment rates under EH&S Section 6500. Fatality Factors (F_i) are derived from Figure 3, from EH&S Appendix 6500-T3. The sum of the failure product of the F_i and P_i determined the area classification in accordance with table 6 of Section 6500 of the EH&S manual.

Description of Work Space

The room floor area is 1967.910 cubic feet as noted from the facilities management web page (http://fmw1/areas/JLabSpace.ASP?action=frame_drawing+bldg=18+floor=2). That room is open to room N1 that is on the first floor. Therefore room N1 is assumed to have a ceiling height of twice room 217. There is an office area with desk and work stations on the west side of the room and mechanical equipment on the east side of the room. The main section of the room has hand railing corresponding to the equipment in the central part of the room. There is a single door on the northeast side of room 217 and the northwest side of room N1. There is also a spiral staircase on the south side in the middle of the room.
Gaseous Nitrogen Sources

The gaseous nitrogen ODH source is a 20,000 gallon dewar. Liquid nitrogen is piped from the dewar to an ambient vaporizer. The gas that leaves the vaporizer is then piped to a header. The FEL has a connection to that header that supplies through a 1/8” orifice to different locations at the FEL, including room 217. These dewars represent approximately 3,400,000 standard cubic feet (SCF) of nitrogen gas at 300 Kelvin. If the nitrogen was accidentally released into an unventilated room, the oxygen level would become dangerously low.

Type of Ventilation

In accordance with Appendix 6500-T3, reliable ventilation may be considered a relevant factor in this ODH assessment if the volume of air in the room is replaced with fresh air at a minimum of once an hour. There is no active ventilation for this room. The ventilation that they have for this room is an exhaust fan that people can manually turn on.

ODH Risk Assessment

The ODH class is determined using the “Oxygen Deficiency Hazard Classification” table in Appendix 6500-T3. This table uses the ODH fatality rate (per hour) \( \varphi \). To calculate \( \varphi \) the following equation must be used:

\[
\varphi = \sum n P_i F_i
\]

Where:
- \( \varphi \) = the ODH fatality rate (per hour),
- \( P_i \) = the expected rate of the \( i^{th} \) type of event, (per hour)
- \( F_i \) = the fatality factor for the \( i^{th} \) type event,
- \( n \) = the number of components

<table>
<thead>
<tr>
<th>Component</th>
<th>Event</th>
<th>( n )</th>
<th>( P_i )</th>
<th>( F_i )</th>
<th>( \varphi )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flanges, Closures, Elbows</td>
<td>Leak/rupture</td>
<td>7</td>
<td>3.00E-07</td>
<td>1</td>
<td>2.10E-06</td>
</tr>
<tr>
<td>Pipes &lt; 3&quot;</td>
<td>Rupture</td>
<td>1</td>
<td>1.00E-09</td>
<td>1</td>
<td>1.00E-09</td>
</tr>
<tr>
<td>Manually operated valve</td>
<td>External leak-rupture</td>
<td>4</td>
<td>1.00E-08</td>
<td>1</td>
<td>4.00E-08</td>
</tr>
<tr>
<td>Welds</td>
<td>Leak</td>
<td>22</td>
<td>3.00E-09</td>
<td>1</td>
<td>6.60E-08</td>
</tr>
</tbody>
</table>

\[ \sum \] 2.21E-06
In the case that there is a minimum of one air change per hour in the room, the probability factor $P_i$ is assumed to be $0 \leq P_i \leq 1$ for the ODH analysis. The assessment then does not depend on the value of $P_i$. For all values of probability, when ventilation maintains $O_2$ levels $> 19.5\%$, the fatality factor $F_i$ will always be equal to zero. Therefore $\phi = \sum P_i F_i = 0$ for all values of $P_i$.

<table>
<thead>
<tr>
<th>Component</th>
<th>Event</th>
<th>$n$</th>
<th>$P_i$</th>
<th>$F_i$</th>
<th>$\varphi$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flanges, Closures, Elbows</td>
<td>Leak/rupture</td>
<td>n/a</td>
<td>3.00E-07</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pipes &lt; 3&quot;</td>
<td>Rupture</td>
<td>n/a</td>
<td>1.00E-09</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Manually operated valve</td>
<td>External leak-rupture</td>
<td>n/a</td>
<td>1.00E-08</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Welds</td>
<td>Leak</td>
<td>n/a</td>
<td>3.00E-09</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\sum$</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**ODH Classification**

Because $\sum \varphi > 10^{-7}$ but $< 10^{-5}$, the **ODH classification is 1**.

With one air change an hour $\sum \varphi > 10^{-7}$ but $< 10^{-5}$, the ODH classification is 0.

**Engineering Controls**

Engineering controls are necessary to provide a safe working environment while retaining an ODH 0 posting.

Therefore there must be an interlock between the nitrogen source and the air handling unit. The interlock is to be a fail-closed solenoid valve up-stream and outside of the room that closes when the air handing unit is not working. Normally an orifice plate is installed, as shown in the diagram, but is not required for this analysis because there is already an orifice of 1/8 inch at the gas nitrogen header behind CHL. This will limit the N2 flow rates which allow the ventilation air to maintain $O_2$ levels $> 18\%$. The schematic below is an example of how to meet this requirement.