## Revision Record

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date Revised</th>
<th>Section(s) Affected</th>
<th>Description of Change</th>
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<tbody>
<tr>
<td>INT</td>
<td>June 15, 2009</td>
<td>All</td>
<td>Interim version.</td>
</tr>
<tr>
<td>R000</td>
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<td>R000 not yet released.</td>
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NEH Hutch 1 Liquid Nitrogen Oxygen Deficiency Hazard Analysis

1.1 Introduction

1.1.1 Purpose
This hazard analysis document defines the following through calculation:

1) An approximation of the maximum volume of liquid nitrogen (LN) that can safely be brought into the LCLS Near Experimental Hall (NEH) Hutch 1 without the need for Oxygen Deficiency Monitors. This analysis assumes no other sources (plumbed or other) of nitrogen or other oxygen-displacing gases or liquids are present in this area. These calculations also assume perfect mixing of the air in the NEH Hutch 1 and do not address the potential for microclimates to be created in the Hutch that could create potentially hazardous local oxygen deficiency climates.

2) Based on the results of these calculations, determine the Oxygen Deficiency Hazard Classification as per the ESH Manual Chapter 36.

1.1.2 Applicability
This hazard analysis applies to the NEH Hutch #1.

1.1.3 Conclusion
These calculations have determined 36 Liters as the threshold for the volume of liquid Nitrogen which can be used in NEH Hutch 1 without requiring additional controls and procedures, including but not limited to oxygen deficiency monitoring.

Based upon these calculations, the Oxygen Deficiency Hazard Classification of NEH Hutch 1 depends on the quantity of liquid nitrogen present.

<table>
<thead>
<tr>
<th>Volume of liquid nitrogen present</th>
<th>ODH Classification of NEH Hutch 1</th>
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<tbody>
<tr>
<td>Less than 36 Liters</td>
<td>ODH-0 Classification</td>
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<tr>
<td>Greater than or equal to 36 Liters.</td>
<td>To be determined by ODH Manager in conference with area Line Management</td>
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1.2 LCLS NEH Nitrogen Safety Envelope Calculations

The two sets of calculations below pertain to 36 Liters of Liquid Nitrogen, and 160 Liters of Liquid Nitrogen, respectively, being dissipated in of the LCLS NEH Hutches #1. For questions or clarifications regarding these calculations, please contact Mike McDaniel: hazmat1@slac.stanford.edu (650)-926-5015. If Mike McDaniel is not available, contact the Experimental Facilities Division Safety Officer (XFDSO).

1.2.1 36 L Liquid Nitrogen Spill – No Ventilation Worst Case Calculation

Volume of Room

Approx 34.5 X 32 X 15 feet = 16,560 ft\(^3\) (as per Javier Sevilla)

Exhaust for Room: None (assuming worst case off-normal event)

Liquid Nitrogen (LN) Quantity:

36 Liter Liquid Nitrogen

Assumptions:

- Standard Temperature and Pressure (STP)
- Dewar if full with top open
- Room is 20% occupied with laboratory furniture and equipment. So adjusted room volume is 13,248 ft\(^3\)
- 36 liter LN vessel spills, nitrogen instantaneously vaporizes and distributes throughout room
- Expansion ratio for LN to gaseous state is 710 (As per ESH Manual Chapter 36)
- Air in room is 20.9% oxygen (O\(_2\)) and 79.1% “inert” (78.1% nitrogen, 1% argon) gases in air

36 liters LN spilled X 710 liters gas/liter LN = 25,560 liters gas X 1 ft\(^3\)/28.32 liter = 903 ft\(^3\) nitrogen gas released.

13,248 ft\(^3\) air – 903 ft\(^3\) = 12,345 ft\(^3\) air X 0.209 = 2,580 ft\(^3\) oxygen after spill

19.5% oxygen is required for workplace occupancy. Therefore, 36 Liters of LN is the aggregate amount allowed in the NEH Hutch#1 that, with perfect mixing of air (an
unreasonable assumption), will result in a 19.5% oxygen level. It is recommended that personal or fixed oxygen deficiency monitors be used in combination with other work planning and controls to allow more flexibility by the researchers in this area.

Mike McDaniel 11 May 2009

1.2.2 160 L Liquid Nitrogen Spill – No Ventilation Worst Case Calculation

*Volume of Room*

Approx 34.5 X 32 X 15 feet = 16,560 ft^3

*Exhaust for Room:* None

*Liquid Nitrogen (LN) Storage Quantity:*

160 L Dewar of LN

*Assumptions:*

- Standard Temperature and Pressure (STP)
- Dewar if full with top open
- Room is 20% occupied with laboratory furniture and equipment. So adjusted room volume is 13,248 ft^3
- Dewar spills entire contents, nitrogen instantaneously vaporizes and distributes throughout room
- Expansion ratio for LN to gaseous state is 710
- Air in room is 20.9% oxygen (O2) and 79.1% “inert” (78.1% nitrogen, 1% argon) gases in air


13,248 ft^3 X .209 = 2769 ft^3 oxygen before spill

4011 ft^3 of air is displaced by nitrogen generated in spill

13248 ft^3 air – 4011 ft^3 = 9237 ft^3 air X 0.209 = 1931 ft^3 oxygen after spill

1931 ft^3 oxygen / 13248 ft^3 room volume = 14.6% oxygen now in room

*14.6% oxygen is below the 19.5% oxygen required for workplace occupancy.*