Cause Mapping is a Root Cause Analysis method that captures basic cause-and-effect relationships supported with evidence.

**BUNCEFIELD STORAGE DEPOT EXPLOSION CAUSE MAP**

43 employees were injured and significant damage occurred at the Buncefield Storage Depot and neighboring properties when a large butane vapor cloud explosively ignited. The vapor cloud was a result of a tank overfilling during a normal receipt of winter grade petrol, which contains 10% butane. During the incident, the diked wall area around the tank did not contain the hydrocarbon and fire suppression foam as designed, and the local groundwater table was contaminated. The estimated total financial impact of the incident was over $1 Billion.

### Impact to the Goals
- **Safety**: 43 injuries, potential for fatalities
- **Environmental**: Contamination of groundwater
- **Cust. Service**: Disrupted fuel supply to Heathrow Airport
- **Production-Schedule**: Significant loss in production
- **Property, Equip. Mtls**: Major loss in property and equipment
- **Labor, Time**: Emergency response, repair, clean-up, compensation and investigation

### Problem
**Problem(s)**: Tank overflow, explosion and fire, contamination of groundwater

**When**
- **Date**: December 11, 2005
- **Time**: 5:37 AM
- **Different, unusual, unique**: No wind

**Where**
- **Facility, site**: Buncefield Oil Storage Depot, Hemel Hempstead, Hertfordshire
- **Unit, area, equipment**: Hertfordshire Oil Storage East - Tank 912
- **Task being performed**: Receiving unleaded petrol from UKOP South line

### Analysis
**Basic Level Cause Map**

<table>
<thead>
<tr>
<th>Why?</th>
<th>Effect</th>
<th>Cause</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Goal</td>
<td>43 injuries, potential for fatalities</td>
<td>Violent explosion and fire</td>
<td>Large butane vapor cloud</td>
</tr>
</tbody>
</table>

**More Detailed Cause Map**

Add detail as information becomes available.

### Solutions

<table>
<thead>
<tr>
<th>No.</th>
<th>Action Item</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Develop a methodology to determine safety integrity level requirements for overfill prevention systems</td>
<td>Level gauge stuck</td>
</tr>
<tr>
<td>2</td>
<td>Establish a high integrity, automatic operating overfill prevention system that is separate and independent from the tank gauging system</td>
<td>Independent high level switch failed (IHLS)</td>
</tr>
<tr>
<td>3</td>
<td>The sector should put in place arrangements to ensure the receiving site has ultimate control of tank filling</td>
<td>UKOP pipeline is controlled from elsewhere</td>
</tr>
<tr>
<td>4</td>
<td>Review existing standards for secondary and tertiary containment</td>
<td>Bunds (diked area) leaked</td>
</tr>
<tr>
<td>5</td>
<td>Modify design to incorporate a pin to prevent the handle from traveling below the horizontal working position</td>
<td>Padlock required to retain lever in working position</td>
</tr>
</tbody>
</table>

*Corresponds to an action item in the solution table*