

Table 1. Air Liquide Post-Incident Actions

<b>Topic</b>	<b>Current Status</b>
Safety Management System	<ul style="list-style-type: none"> <li>• Committed to applying a process safety management system for the nitrous oxide business;</li> <li>• Applying additional resources to existing facilities and rebuild of Cantonment; and</li> <li>• Will apply the hierarchy of controls throughout including hazard reviews, management of change, and corrective actions.</li> </ul>
Inherently Safer Design	<ul style="list-style-type: none"> <li>• Gathering requirements and resources to conduct design review;</li> <li>• Developing plan to train key personnel;</li> <li>• Receiving proposals from inherently safer design safety experts;</li> <li>• Plan includes development of an ongoing inherently safety design component to be used in future hazard reviews; and</li> <li>• Commitment to implement inherently safer design where feasible (practicable).</li> </ul>
Hazard Analysis	<ul style="list-style-type: none"> <li>• Complete for Yazoo City and Maitland;</li> <li>• Increasing the basis for a nitrous oxide decomposition explosion consequence to a severity-level in the criticality matrix 4;</li> <li>• Will apply the hierarchy of controls;</li> <li>• Developing safeguard design and availability philosophy; and</li> <li>• Planning to transition to HAZOP and LOPA.<sup>1</sup></li> </ul>
Apply Lessons from Previous Incidents	<ul style="list-style-type: none"> <li>• Developing plan to use a corporate communication process; and</li> <li>• Will finalize after company investigation of Cantonment incident is complete.</li> </ul>

<sup>1</sup> See [HAZOP, Hazard and Operability Study and LOPA, Layer of Protection Analysis](#), [159].

<b>Topic</b>	<b>Current Status</b>
Apply Industry Safety Standards	<ul style="list-style-type: none"> <li>• Completed gap analysis of CGA G-8.3–2016;</li> <li>• Implementing plan to close gaps at Yazoo City and Maitland;</li> <li>• Developing plan to evaluate ISA-84;</li> <li>• Will incorporate ISA-84 approach in new HAZOP reviews;</li> <li>• Plan developed to train key personnel on safety instrumented systems; and</li> <li>• Adding industry safety standards to an existing program that monitors regulatory updates and changes.</li> </ul>
Management of Change	<ul style="list-style-type: none"> <li>• Implemented an MOC program to nitrous oxide plants (complete).</li> </ul>
Contamination	<ul style="list-style-type: none"> <li>• Developing engineering standard to address material of construction;</li> <li>• Currently testing contamination effect on nitrous oxide decomposition;</li> <li>• Testing program includes lubricants, refrigerants, metals, and metal oxides;</li> <li>• Plan to incorporate testing results into process safety information; and</li> <li>• Commitment to share summary of results with the Compressed Gas Association.</li> </ul>
Process Safety Information (PSI)	<ul style="list-style-type: none"> <li>• Plan developed to apply PSM/RMP program for process safety information to nitrous oxide business.</li> </ul>
Technical Staffing	<ul style="list-style-type: none"> <li>• Assigned an interim subject matter expert to provide additional technical support;</li> <li>• Developing plans and assignments for additional technical subject matter experts;</li> <li>• Obtained approval for additional technical staff resource to focus on process safety; and</li> <li>• Developing an audit tool to ensure long-term commitment to sufficient technical staffing.</li> </ul>

<b>Topic</b>	<b>Current Status</b>
Hourly Staffing	<ul style="list-style-type: none"> <li>• Short term increases in current staffing levels to two operators per shift and will conduct safety review to determine long-term staffing levels and scheduling of tasks in order to improve safe operations; and</li> <li>• Updating training program for operators and drivers.</li> </ul>
Audit Program	<ul style="list-style-type: none"> <li>• Applying Air Liquide audit program; and</li> <li>• Developing a plan to review audit design.</li> </ul>
Safety Interlock Testing	<ul style="list-style-type: none"> <li>• Developing a plan to conduct a safety review of interlock testing all interlock testing procedures; and</li> <li>• Developing a plan to require a safety review of interlock testing procedures for new or modified safety interlocks.</li> </ul>
Run-Dry Safety Interlock	<ul style="list-style-type: none"> <li>• Completed review of run-dry protection systems;</li> <li>• Conducting full engineering assessment to document technical specifications and finalize engineering solution;</li> <li>• Installing redundant systems with independent instrumentation on all nitrous oxide pumps; and</li> <li>• Improvements at other sites for the ground pumps that at similar to pumps at Cantonment (complete).</li> </ul>
Transfer Pumps	<ul style="list-style-type: none"> <li>• Conducting engineering review;</li> <li>• Developing a plan to ensure pump systems meet NPSH guidelines;</li> <li>• Maintaining additional level in some tanks as an interim safety measure;</li> <li>• Developing a plan to have a standard pump and pump design;</li> <li>• Evaluating additional instrumentation through hazard analysis and ISA-84 process; and</li> <li>• Developing a plan for comprehensive electrical grounding and bonding systems.</li> </ul>

<b>Topic</b>	<b>Current Status</b>
Flame Arrestors	<ul style="list-style-type: none"> <li>• Conducted literature review;</li> <li>• Developed preliminary prototype designs;</li> <li>• Developing plan for a comprehensive testing program;</li> <li>• Planning to develop engineering standard, specifications, and written preventive maintenance plan;</li> <li>• Planning to add to critical equipment list;</li> <li>• Planning to develop specific audit tool for periodic evaluation; and</li> <li>• Commitment to share summary of testing results and engineering specification with the Compressed Gas Association.</li> </ul>
Operations	<ul style="list-style-type: none"> <li>• Reviewing pressure relief valve discharge locations;</li> <li>• Reviewing relief valve design;</li> <li>• Reviewing preventive and predictive maintenance;</li> <li>• Developing a plan for engineering modifications to reduce employee exposure to nitrous oxide.</li> </ul>
Electrical Grounding	<ul style="list-style-type: none"> <li>• Developing a program to ensure electrical continuity for tanks and trailers.</li> </ul>