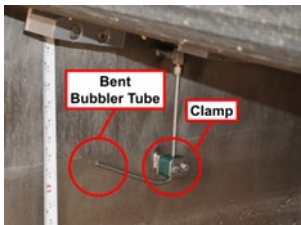


Incident Title		Liquid Nitrogen Release During Troubleshooting Activity	
Incident Type		Asphyxiation	
Date		28 th January 2021	
Country		USA	
Location		Gainesville, GA	
Fatalities		Injuries	Cost
6		10	US\$ 0.25 m (2023) – Ref. 1
Incident Description		<p>New bulk liquid nitrogen (LN₂) tanks and immersion-spiral freezer systems leased from a third party specialty gas supplier were retrofitted in a building (“Plant 4”) to increase capacity on 2 of its 5 production lines (“Lines 2 and 4”). Production from the newly modified Line 4 commenced on 17-Dec-20.</p> <p>Line 4 is a diced chicken production process which includes marinating and cooking steps (raw area) followed by dicing, freezing, and packaging steps (“ready-to-eat” area). The freezing step comprises 2 stages; a conveyor belt carries fully cooked diced chicken into a -196 °C (-320 °F) LN₂ bath (immersion freezer), then the partially frozen product passes into a separate chamber in which internal fans circulate vapourised LN₂ over a multi-tiered spiral conveyor system (spiral freezer). A computer control system runs the freezing process and 10 emergency stop (“E-stop”) buttons are provided to shut down the immersion and spiral freezers and to isolate the LN₂ supply.</p> <p>On the morning of 28-Jan-21, LN₂ overflowed from the Line 4 immersion tub into the (unventilated) freezer room where 2 workers were troubleshooting operational problems (Line 4 shut down, freezer system live). The overflowing LN₂ vapourised, displacing air from the freezer room (cold N₂ vapour heavier than air). The 2 workers died. The release was discovered 30 - 60 mins later. An evacuation was initiated and the LN₂ supply was manually shut off at the outdoor LN₂ tank. Four more workers died during response/rescue activities.</p>	
 <p>Credit: US Chemical Safety Board</p>			
Incident Analysis		<p>Basic cause of the LN₂ release was failure of the immersion freezer LN₂ level control and high LN₂ level interlock systems due to the bubbler tube level sensor being bent above the overflow elevation at the freezer inlet.</p> <p>Critical factors included: 1) Freezer room floor elevation 1.5 m (5 ft) below adjacent rooms, 2) Immersion tub bubbler tube level sensor signal was sole input to level control loop and high level safety interlock (single point of failure), 3) Bubbler tube secured to immersion freezer interior wall with only one support clamp (design required two), 4) Partially enclosed freezer room had no fixed atmospheric monitors (oxygen detectors with alarms) and no mechanical ventilation, 5) All manually-operated E-stop buttons were located inside the (potentially oxygen-deficient) freezer room.</p> <p>Root causes included: 1) Inadequate process hazard analysis (absence of independent LN₂ high level interlock, absence of freezer room atmospheric monitoring and mechanical ventilation), 2) Inappropriate plant layout (freezer room elevation, E-stop button placement), 3) Inadequate fabrication quality control (bubbler tube clamp missing), 4) Inadequate communication/training and absence of warning signs (nitrogen asphyxiation hazard), 5) Inadequate process safety management (inadequate job knowledge, non-conformance to industry guidance, absence of emergency procedures for LN₂ release).</p>	
Lessons Learned		1) Processes using hazardous materials should be designed such that failure of any single component cannot cause a catastrophic incident, 2) Processes using hazardous gases or asphyxiants should have appropriately located, properly tested/maintained atmospheric monitoring/alarm systems.	
More Information		1) “Fatal Liquid Nitrogen Release at Foundation Food Group”, US Chemical Safety and Hazard Investigation Board, Report No. 2021-03-I-GA (2023): https://www.csb.gov/foundation-food-group-fatal-chemical-release-	
Industry Sector		Process Type	Incident Type
Food & Drink		Food Processing	Asphyxiating Gas Release
Equipment Category		Equipment Class	Equipment Type
Safety & Control		Instruments	Level (Bubbler)