Liquid Nitrogen Incident Lessons Learned

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USPOULTRY
U.S. POULTRY & EGG ASSOCIATION
The All-Feather Association

Who We Are

USPOULTRY is the world's largest poultry organization. Membership includes producers and processors of broilers, turkeys, eggs, breeding stock, and ducks, as well as allied companies. We have member companies worldwide and 27 affiliated state associations.

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Liquid Nitrogen Incident Lessons Learned

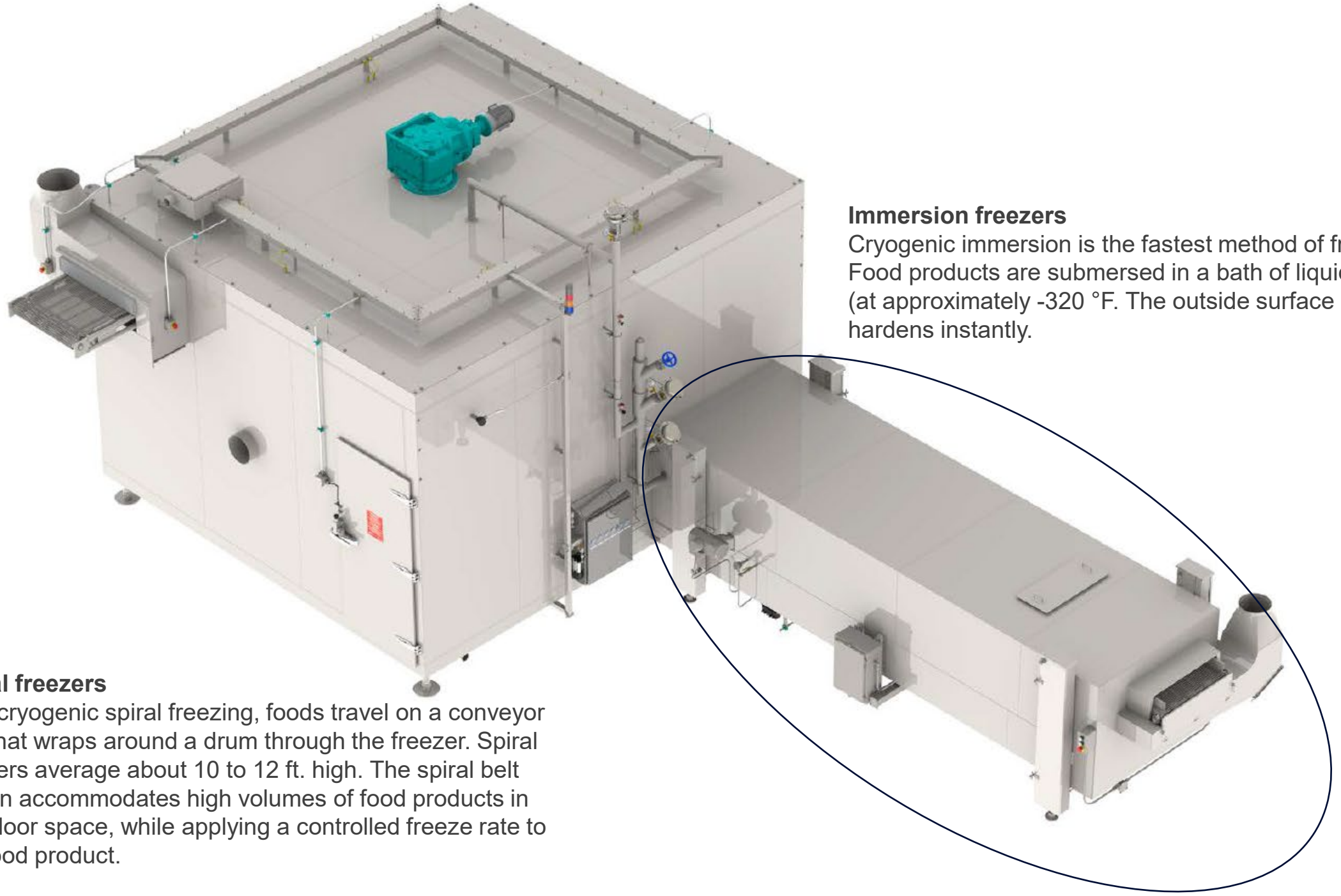
Overview –

- Brief Overview of Foundation Foods Tragedy and CSB Findings.
- Cryogenic Toolkit.
- Development of Tabletop Program.
- Process Hazard Analysis
- Q/A and Collaboration Discussions.

CSB Final Report

Released 12-11-2023

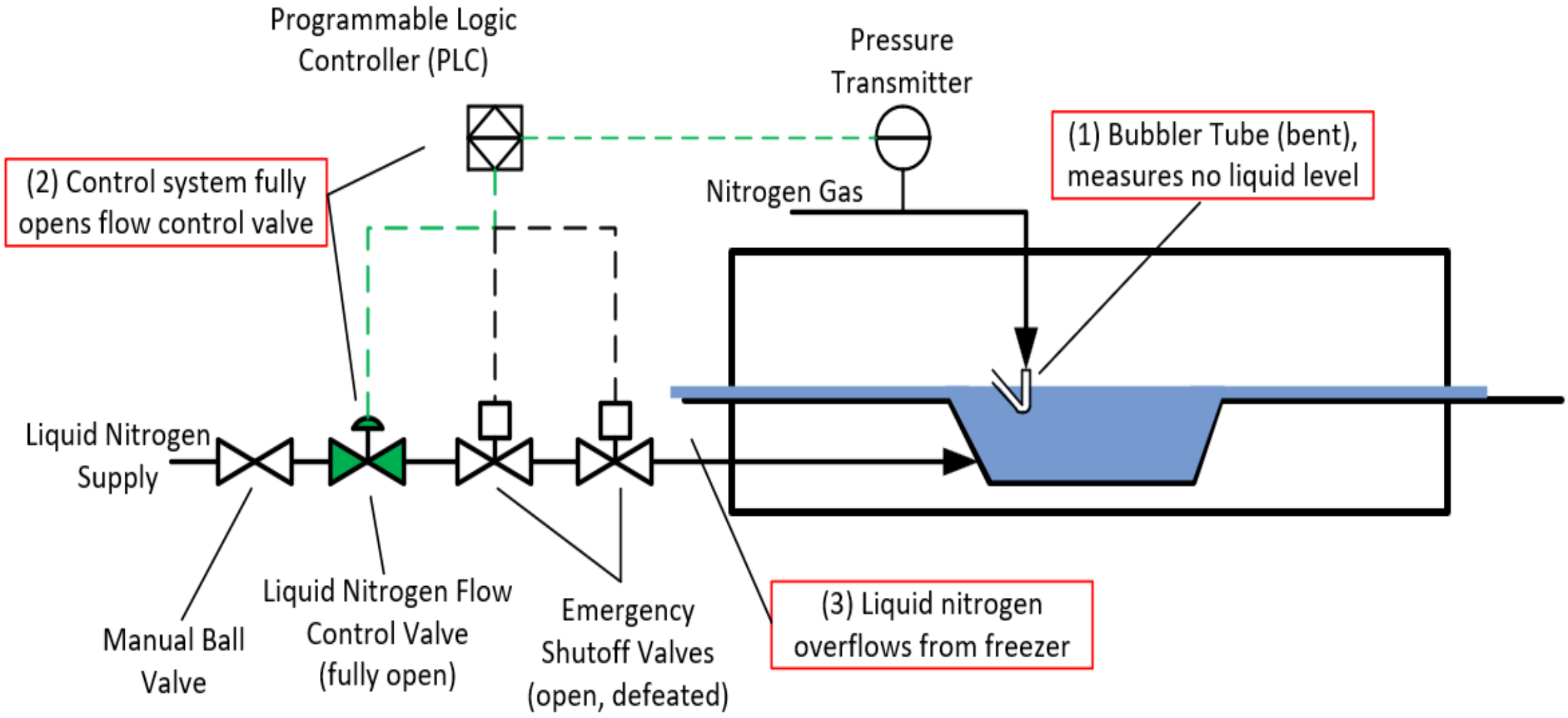
- Catastrophic Liquid Nitrogen release on 1/28/21 that caused 6 fatalities and 4 serious injuries
- 12 Recommendations from Final CSB Report 12-11-2023
- 7 Key Lessons for the Industry

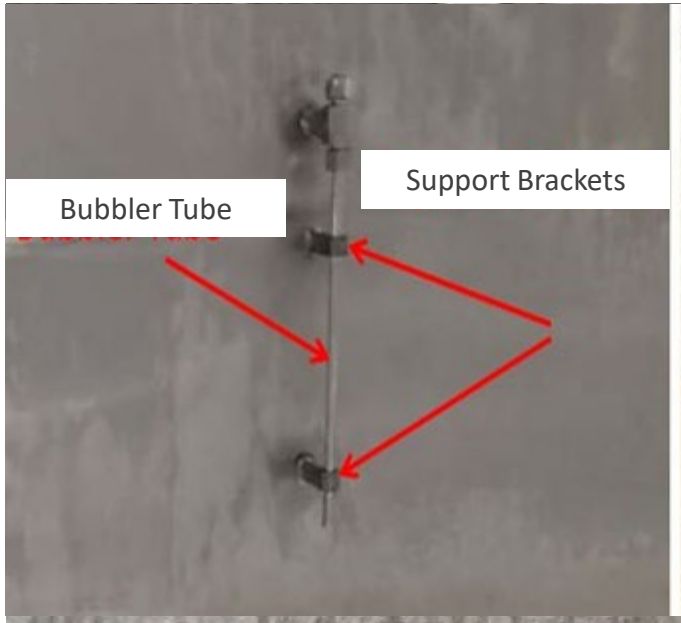


Immersion freezers
Cryogenic immersion is the fastest method of freezing. Food products are submersed in a bath of liquid nitrogen (at approximately -320 °F. The outside surface hardens instantly.

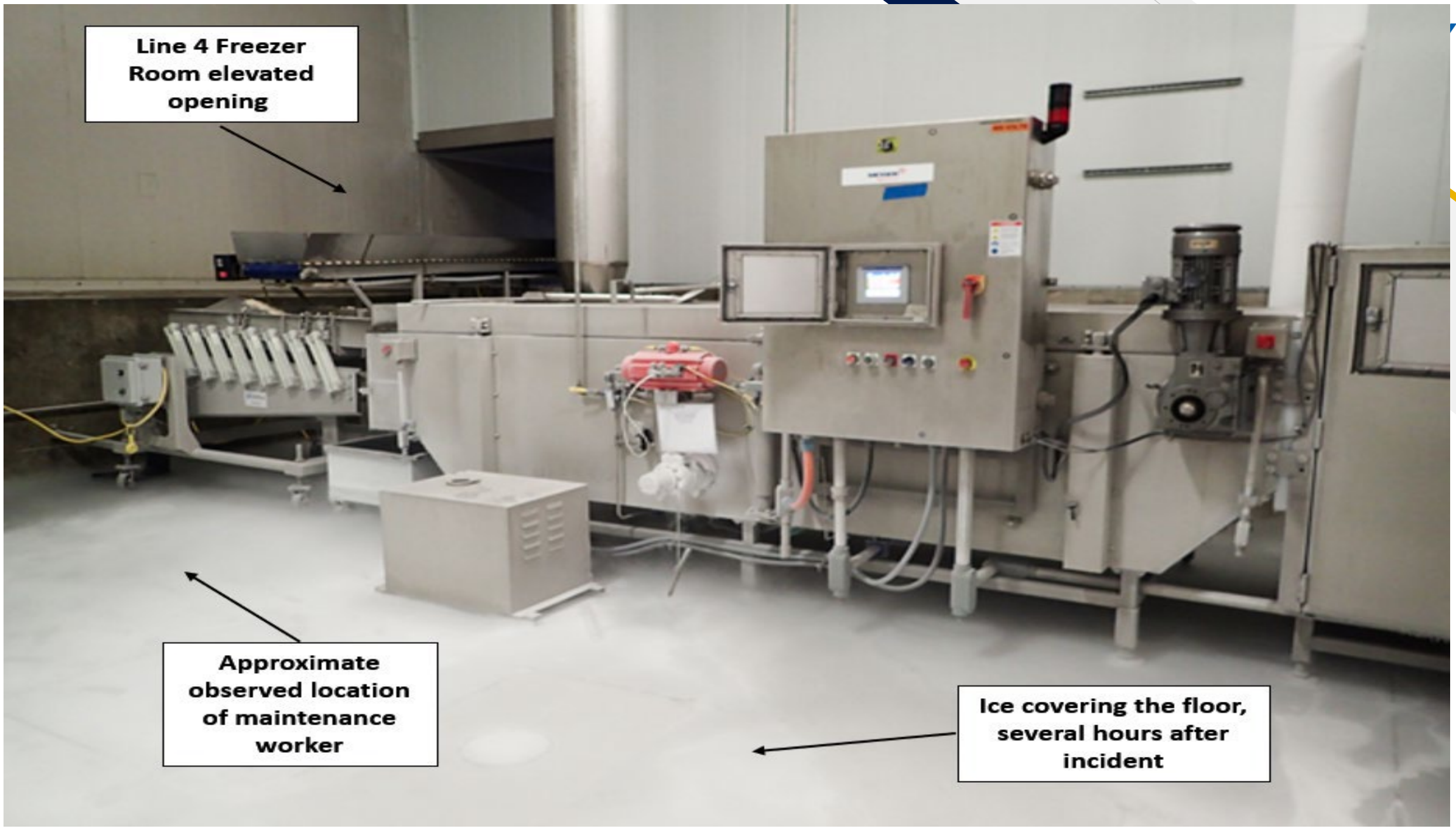
Spiral freezers
With cryogenic spiral freezing, foods travel on a conveyor belt that wraps around a drum through the freezer. Spiral freezers average about 10 to 12 ft. high. The spiral belt design accommodates high volumes of food products in less floor space, while applying a controlled freeze rate to the food product.

Overview of the Disaster





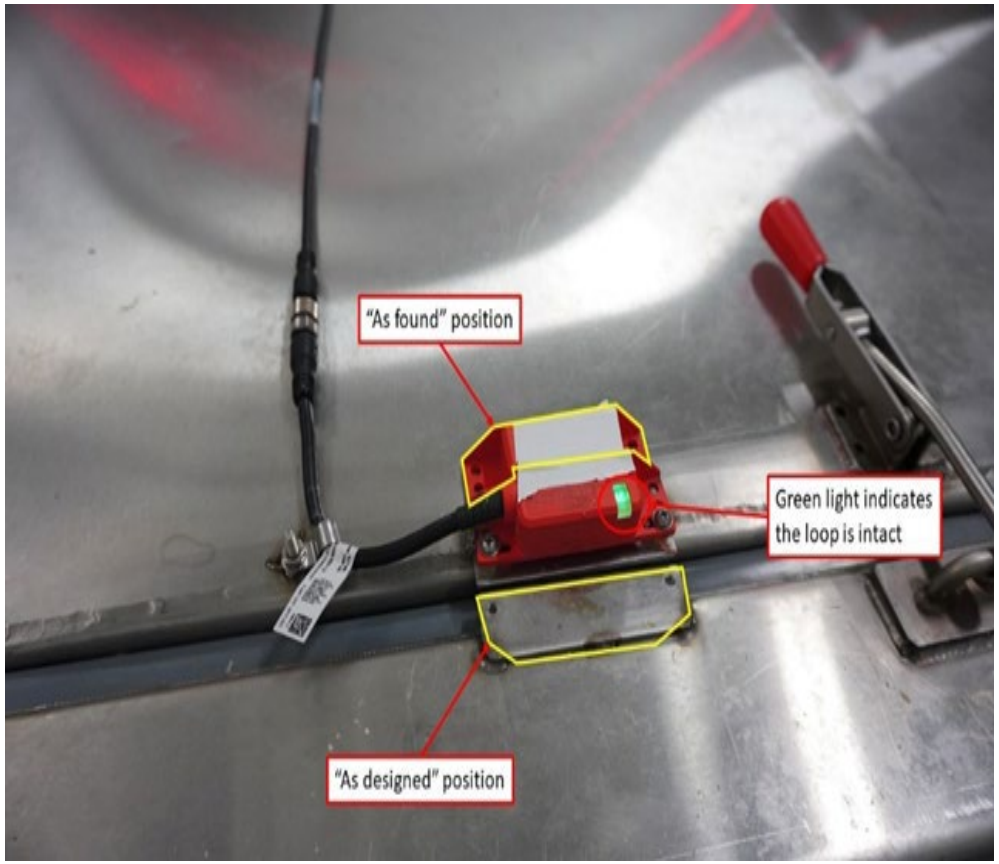
Immersion freezer bubbler tube, as found during the post-incident examination of the freezer. As designed, the tube should be pointing straight downward.


Line 4 Freezer Room elevated opening
Approximate observed location of maintenance worker
Ice covering the floor, several hours after incident

SAFETY ISSUES

The following safety issues contributed to the incident, which include:

- Single Point of Failure;
- Atmospheric Monitoring and Alarm Systems;
- Emergency Preparedness ;
- Process Safety Management System; and
- Product Stewardship.



12 Recommendations from Final CSB Report 12-11-2023

Compressed Gas Association (CGA)

2021-03-I-GA-9

Develop a comprehensive standard for the safe storage, handling, and use of liquid nitrogen in stationary applications, comparable to the guidance presented in CGA G-6.5 Standard for Small Stationary Insulated Carbon Dioxide Systems.

2021-03-I-GA-10

Update P-76 Hazards of Oxygen-Deficient Atmospheres.

Gold Creek Foods

2021-03-I-GA-1

Include in the emergency action program provisions for proactively interacting with and informing local emergency response resources of all emergencies at the former FFG Plant 4 facility to which Gold Creek expects them to respond. At a minimum, Gold Creek should:

a) inform local emergency responders of the existence, nature, and location of hazardous substances at its facilities, including liquid nitrogen.

b) inform local emergency responders of the location of emergency-critical equipment such as bulk storage tanks, points of use, isolation valves, E-stop switches, and any other emergency equipment or systems with which emergency responders may need to interact; and

c) provide local emergency responders with information, such as facility plot plans, engineering drawings, or other information needed to mount an effective emergency response.

International Code Council (ICC)

2021-03-I-GA-12

Update the International Fire Code to:

a) require the use of atmospheric monitoring with cryogenic asphyxiants in accordance with industry guidance such as is contained in CGA P-76 Hazards of Oxygen-Deficient Atmospheres and CGA P-12 Safe Handling of Cryogenic Liquids in addition to CGA P-18 Standard for Bulk Inert Gas Systems; and,

b) include guidance on the adequate safe location of manual shutoff valves and devices such as emergency push buttons used to activate remotely operated emergency isolation valves (ROEIVs) in cryogenic fluid service. At a minimum, this guidance should be harmonized with the requirements of ISO 13850 Safety of Machinery – Emergency Stop Function – Principles for Design.

National Fire Protection Association (NFPA)

2021-03-I-GA-11

Update NFPA 55 Compressed Gases and Cryogenic Fluids Code to:

a) require the use of atmospheric monitoring with cryogenic asphyxiants in accordance with industry guidance, such as is contained in CGA P-76 Hazards of Oxygen-Deficient Atmospheres and CGA P-12 Safe Handling of Cryogenic Liquids in addition to CGA P-18 Standard for Bulk Inert Gas Systems; and,

b) include guidance on the adequate safe location of manual shutoff valves and devices such as emergency push buttons used to activate remotely operated emergency isolation valves (ROEIVs). At a minimum, this guidance should be harmonized with the requirements of ISO 13850 Safety of Machinery – Emergency stop function – Principles for design.

Messer LLC

2021-03-I-GA-2

Update the company product stewardship policy to:

a) include participation by Messer in customers' process hazard analyses (PHAs). The policy should require that these PHAs be conducted in a manner that conforms with CCPS Guidelines for Hazard Evaluation Procedures prior to the startup of a cryogenic freezing process;

b) require verification that proper signage, in accordance with CGA P-76 Hazards of Oxygen-Deficient Atmospheres, is displayed on and/or near equipment; and,

c) require a facility and/or equipment siting review to ensure that emergency shutoff devices, including E-stops, are located such that they can be safely actuated during a release of liquid nitrogen.

2021-03-I-GA-3

Create an informational product that provides Messer customers with information on the safety issues described in this report. In this informational product recommend that Messer customers develop and implement effective safety management systems to control asphyxiation hazards from inert gases based on the guidance published in CGA P-86 Guideline for Process Safety Management, CGA P-12 Guideline for Safe Handling of Cryogenic and Refrigerated Liquids, CGA P-18 Standard for Bulk Inert Gas Systems, and CGA P-76 Hazards of Oxygen-Deficient Atmospheres

Occupational Safety & Health Administration (OSHA)

2021-03-I-GA-4 , 2021-03-I-GA-5, and 2021-03-I-GA-6

Update the Region 4, 5, and 6 Poultry Processing Facilities Regional Emphasis Program to explicitly cover liquid nitrogen freezing processes. At a minimum, the update should encourage practices applicable to managing the hazards of using liquid nitrogen and other cryogenic asphyxiants, including process safety management practices, atmospheric monitoring, employee training and hazard awareness, and emergency preparedness and response.

2021-03-I-GA-7 (On Next Slide)

2021-03-I-GA-8

Develop and publish a Guidance Document (similar to OSHA 3912-03 Process Safety Management for Explosives and Pyrotechnics Manufacturing) for process safety management practices applicable to processes handling compressed gases and cryogenic asphyxiants, including (at a minimum) the practices highlighted in this report.

2021-03-I-GA-7

Promulgate a standard specific to cryogenic asphyxiants. The purpose of this standard shall be the prevention and/or mitigation of hazards arising from the storage, use, and/or handling of these substances. The new standard shall reference applicable national consensus standards, such as those published by the Compressed Gas Association and others, as appropriate. At a minimum, the new standard shall:

a) Address requirements for the design, construction, and installation of process equipment storing or using cryogenic asphyxiants.

b) Require atmospheric monitoring where equipment storing or using cryogenic asphyxiants is located indoors.

c) Require emergency shutdown systems such that equipment storing or using cryogenic asphyxiants may be isolated during a release without endangerment.

d) Address requirements for employee training and hazard awareness specific to cryogenic asphyxiants.

e) Require an emergency action plan in accordance with 29 CFR 1910.38; and,

f) Address requirements for the use of process safety management elements such as process hazard analysis, management of change, procedures, and others deemed necessary through the rulemaking process to prevent and/or mitigate these hazards.

7 KEY LESSONS FOR THE INDUSTRY

1. Processes and equipment that utilize hazardous materials should be designed robustly enough that the failure of a single component cannot result in a catastrophic incident.

2. Facilities that handle hazardous gases or cryogenic asphyxiants should have a functioning atmospheric monitoring and alarm system based on a properly conducted risk assessment. Functioning atmospheric monitoring systems consist of equipment that has been properly designed, installed, maintained, inspected, and tested and will alert personnel of a hazardous atmosphere using audible and visual alarms.

3. Safety leadership begins with management. Designating competent and resourced staff with responsibility over specific safety programs is key to ensuring effective process safety. Management must be knowledgeable and involved in each of these safety programs to provide effective oversight.

7 KEY LESSONS FOR THE INDUSTRY

4. A PHA can only be effective if it is specific to the process it evaluates. Not considering facility-specific scenarios misses opportunities to effectively identify, evaluate, and control hazards. Companies installing equipment into a process at their facility should always perform a PHA considering the hazards introduced by the process, equipment, facility or room layout, surrounding area, and external factors.

5. It is critical for workers to be trained on the hazards of the materials they encounter. Non-flammable, non-toxic chemicals, such as nitrogen, can be incorrectly assumed to be non-hazardous without proper training and hazard communication. Companies handling these materials have an obligation to train and inform their employees.

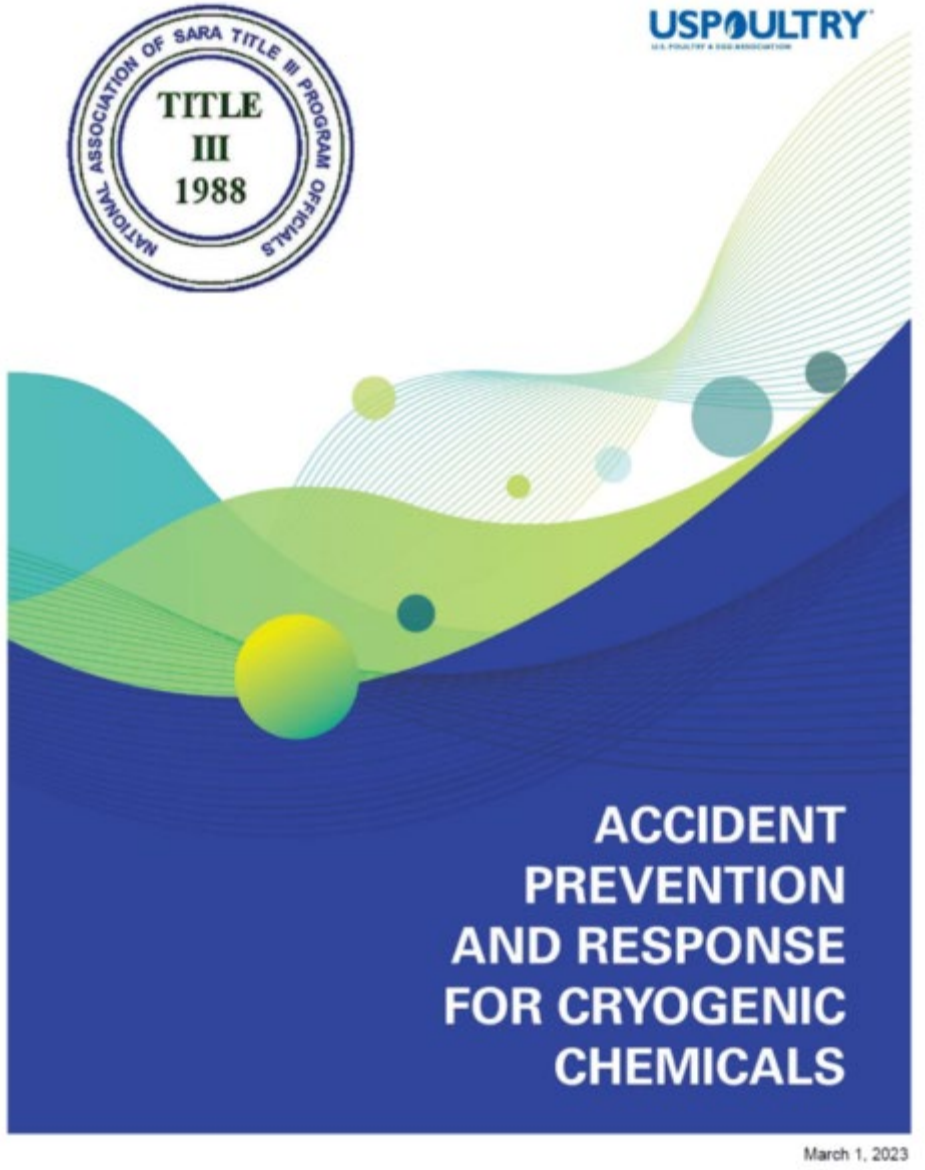
7 KEY LESSONS FOR THE INDUSTRY

6. Food manufacturers are not immune from chemical hazards and process safety risks. Whenever an organization introduces a hazardous chemical into its process, it should implement robust process safety management practices to effectively control the risks, regardless of whether any regulation requires the organization to do so.

7. Regulations are minimum requirements. The need for robust process safety management practices exists wherever hazardous chemicals are manufactured, processed, stored, and used, regardless of their regulatory coverage. Companies must be cognizant of the hazards posed by the chemicals they handle and should implement effective process safety management systems to control process safety risks.

Accident Prevention and Response for Cryogenic Chemicals

- Cryogenic Liquids - Focus on Liquid Nitrogen, Liquid Carbon Dioxide, and Liquid Oxygen.
- Physical Properties – Review of characteristics of chemicals.
- Cryogenic Liquid Uses in Food Processing – How the industry utilizes these chemicals.
- Hazards of Cryogenic Liquids.



Accident Prevention and Response for Cryogenic Chemicals

- Personnel Protective Equipment (PPE) – Eye and Skin thermal protection.
- Safe Handling and Storage Practices – Ventilation and Thermal Expansion.
- First Aid for Cryogenic Exposures – Familiar with treating frostbite.
- Cryogenic Liquid Safety Tools - Air Monitoring.
- Emergency Response Procedures – Evacuation and Control of Vapor Cloud.

Accident Prevention and Response for Cryogenic Chemicals

Emergency Preparedness and Response identified needs:
Identify needs relating to emergency management principles of prevention, protection, preparedness, response, and recovery.

•Develop resources on creating emergency response plans and procedures with Local EMS.

•Create resources and train on performing emergency exercises for various scenarios (Table-top exercises).

•Outline specified training requirements (OSHA, DHS, etc.).

•Develop resources for emergency aid needs so the industry can ensure availability of supplies and equipment.

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Tabletop Exercise Programs

Program Includes:

- Tabletop Exercise Program Overview and Industry Specific Scenarios.
- Facilitator Guide.
- After-Action Plan.

Process Hazard Analysis (PHA) – The method for identifying and evaluating process hazards and the controls needed to reduce those hazards. This analysis is audited every five years and any findings or recommendations must be addressed in a timely fashion. Those corrections must be discussed with any employees that may be affected.

= Nitrogen Flow

Tanks

LIQUID NITROGEN

LIQUID NITROGEN

LIQUID NITROGEN

LIQUID NITROGEN

Refrigeration

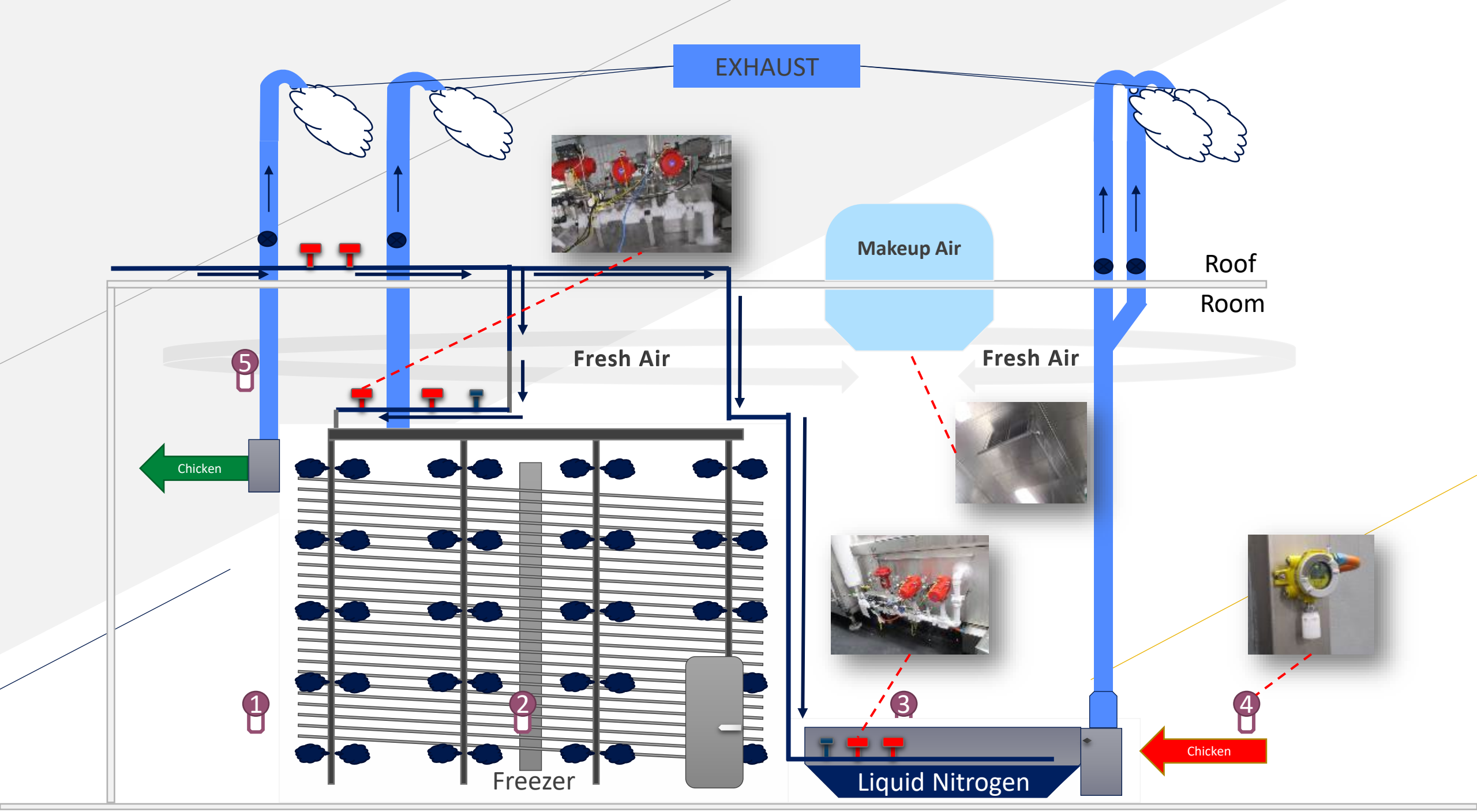
Roof Room

Chicken

Freezer

Liquid Nitrogen

Chicken


EXHAUST
Makeup Air
Roof
Room
Fresh Air
Fresh Air
5
Chicken
1
2
Freezer
3
Liquid Nitrogen
4
Chicken

OXYGEN WARNING LIGHTS

The danger of Nitrogen gas is that, when released, it will reduce the Oxygen level in the room. We test for proper Oxygen levels in the room to ensure safety.

Oxygen Warning Lights are located on the outside of the room.
This allows you to know the room is safe to enter before you enter the room.

Green: Oxygen levels are safe.

Red: Oxygen levels are ***not safe***. **DO NOT ENTER**

Yellow: System fault. Call maintenance to investigate.

Normal Nitrogen Systems

Emergency Stop Triggered by:

- 1 Bubbler Tube
- 2 Emergency Stop Buttons
- 1 Oxygen Sensor

Emergency Stop Makes This Happen:

- 2 Exhaust ventilation fans come on
- 4 Valves Shut Off Liquid Nitrogen Flow
- Lid on the machine remains closed.

Upgraded Nitrogen System

Emergency Stop Triggered by:

- 2 Bubbler Tube
- 6 Emergency Stop Buttons Around Machine
- 5 Oxygen Sensors in the Room
- 1 Overflow sensor
- Personal 4-5 with personal Oxygen Monitors

Emergency Stop Makes This Happen:

- Ventilation in room opens to maximum makup air and speed maxes out.
- 4 Exhaust ventilation fans come on
  - Fans have a generator backup, so they work during a power outage.
- 10 Auto Valves Shut Off - Liquid Nitrogen Flow
  - One per tank, On Roof, In Room
- Lid on machine remains closed.
- Evacuation alarm will sound.
- Lights on the outside of room indicate Oxygen level in the room.

QUESTIONS ?

Thank you for the partnership and your support!

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