HSE
Occupational Health & Safety
and Environmental Protection Unit

Safety Form

PERFORMING EXPERIMENTS IN EDUCATION CONTEXTS

Purpose: The purpose of this document is to identify hazards, to control and mitigate risks, and to clarify responsibilities relating to performing experiments in education contexts at CERN (such as science shows, lab workshops, video recordings, events, etc).

TRACEABILITY

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Approved by:	***Date:***

INFORMATION ABOUT THE EXPERIMENT

Name of the experiment: Science of Magical Parties science show

Location: NA - portable science show

Name of person who is responsible: Laura de Vevey
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DESCRIPTION OF THE EXPERIMENT

What is happening, what are the different steps?

- **Preparation**: The guide sets up a safety perimeter around the stage; pours liquid nitrogen into a small dewar; inflates small balloons, ties them on a string and puts them inside the liquid nitrogen; prepares beakers with water, a citric acid solution and a sodium carbonate solution.
- **Introduction:** The organizer welcomes the audience and informs them of the safety measures (staying outside the safety perimeter set around the stage), then narrates the beginning of the show to introduce the guide and the story; the guide greets the audience and asks for help organizing a magical party.
- **Chemical Experiment:** Show how a banner made of pH-indicator paper triangles changes color when interacting with three different liquids: tap water, citric acid solution, sodium carbonate solution.
- **Balloons in liquid nitrogen:** Take out the string of balloons hidden in the liquid nitrogen dewar and watch them inflate on their own; dip an inflated long balloon into the liquid nitrogen and take it out again, to show that the balloons were inflated to start with; introduce liquid nitrogen as a very cold liquid.
- **Ice experiment:** Pour liquid nitrogen into a beaker with water and observe fog and ice forming.
- **Bottle and cap experiment:** Pour liquid nitrogen into a plastic bottle and close it with a cap, then watch the cap pop when enough pressure builds up.
- **Cloud experiment:** Pour liquid nitrogen into a bucket with water to create a large amount of fog, place color LED lights around it, play some music and invite the audience to dance (outside the safety perimeter)

Who is involved in the experiment and what is their status?

Name of person involved	**Status at CERN** (see categories below)	**Role**
Guide	Employed, Associate MoP or External, who has done the training for the Science of Magical Parties science show, general guides training (Introduction course) AND the course Cryogenic Safety - Fundamentals (Training rank code: 10170)	Presenting the show and doing the experiments. Responsible for transporting the show equipment between the storage room and the stage (one box), set up the show equipment on the stage table.

Translator (optional)	Employed, Associated MoP or External, who has done the training for the Science of Magical Parties science show	Translating the show but not participating in any experiments.
Organizer	General public	Announcing the show and safety measures, not participating in any of the experiments.
Participant (optional)	General public	Volunteer from the audience, selected for specific experiments.
Audience	General public	Seated outside of the safety perimeter, not participating in any of the experiments.
SG Technical team	Emp. CERN contrac. who has done the training Cryogenic Safety - Fundamentals (Training rank code: 10170)	Responsible for the transporting and refilling of liquid nitrogen dewar (11L).

☒ Employed or Associated Members of Personnel (MPE & MPA, e.g. staff, students, trainees)
☒ People registered as "External" at CERN (e.g. stagiaires, guides)
F*or externals: Guarantor needs to approve this form since they are responsible for safety!*
☒ General public (e.g. visitors)
☒ Minors (<18 years), if yes, specify minimum age: recommended minimum age for audience and participants is 3 years old. No strict limitation.
☒ Other: contractor's personnel (SG technicians)

How often will the experiment take place (per day and/or per week)?
Occasionally (portable show for special events) – No regular occurences
What is the number of people participating in the experiment?
1 guide, 1 translator (optional), 1 organizer, selected participants from the public (optional, for some experiments only), the public

LIST OF POTENTIALLY HAZARDOUS MATERIALS THAT ARE REQUIRED

For details, please refer to corresponding appendices

☒ Hazardous chemicals – If yes, indicate type and quantity used during the experiment and amount: liquid nitrogen (-196°C, 1 dewar with 11 litres) - *Appendix 3*
☐ Gas – If yes, indicate the type and quantity:
☐ Ignition sources (naked flames, hot surface, sparks, static electricity)
☐ Pressure equipment (> 0.5 bar)
☐ Vacuum equipment (< -0.5 bar)
☒ Heavy objects – If yes, specify: liquid nitrogen dewar - *Appendix 3*
☐ Unprotected sharp edges – If yes, specify:
☐ Magnetic fields – If yes, indicate the type, field strength, quantity:
Note limits for medical implants (<0.4 mT) & exposure for general public and pregnant women (<40 mT)
☐ Hot materials (> 50°C) – If yes, specify:
☒ Cold or cryogenic materials (< 0°C) – If yes, specify: Liquid nitrogen (-196°C, dewar with 11 litres) - *Appendix 3*
☐ Electrical equipment – If yes, specify type, voltage, current, exposed live parts:
☐ RF, microwaves
☐ IR light – If yes, specify power:
☐ Laser – If yes, specify class, wavelength and power:

☐ UV light – If yes, specify wavelength and power:
☐ Radioactive sources/objects – If yes, specify isotope, radiation type and activity:
☐ X-ray sources – If yes, specify energy and dose rate:
☐ Lithium batteries – If yes, specify:
☐ Small items that can be swallowed (only relevant if young children are involved)
☒ Other (e.g. mercury lamps, loud noise, dust of combustible solids, heights, other chemicals, …): citric acid – *Appendix 2*

INFORMATION ABOUT THE EXPERIMENT AND STORAGE LOCATION

What are specific features of a*)* the location where the experiment will take place and b) the location where the equipment is stored that might be relevant? (ventilation, smoke detection, access restriction, fire extinguisher, risk of fire spreading, risk of affecting neighbouring areas in case of accident, evacuation)

a) The Science show takes place in an outdoor or well-ventilated space. The experiments take place on a table at the center of the stage covered with a tablecloth. Access to the stage (+2 meters) is restricted using safety cones and red/white barrier tape which informs people that they are not allowed to access the stage area. Before the show, hazardous materials are hidden from public view: dewars with liquid nitrogen are stored behind the demonstration table.

b) All the material of the Science of Magical Parties science show except liquid nitrogen dewars is stored in a box stored in 81/S-004: surface: 18.8 m2, height: 3.16 m, volume: 59.4 m3, air exchange rate: 30m3/h, smoke detectors: yes - SFDEI-23010, alarm: evacuation message. This room is only accessible to people with the key (SG education team, SG technical team, SG management).

The liquid nitrogen dewars are stored in the gas storage 81/S2-402: surface: 9 m2, height: 3.83 m, volume: 34.47 m3, air exchange rate: 200 m3/h, smoke detectors: yes - SFDEI-23001, alarm: evacuation message. This room is only accessible to people with the key (SG education team, SG technical team, SG management). The gas storage room is clearly labelled with Oxygen deficiency signs and cryogenic product signs. In the gas storage, dewars are placed directly next to the door. This allows to see if a dewar has fallen over directly when entering, allowing the affected person to immediately go out of the room and seek a safe distance to avoid oxygen deficiency hazard. The maximum quantity of liquid nitrogen stored in this room is 3 dewars of 11l each.

Evacuation plan of building 81: https://edms.cern.ch/document/2933003/1
Closest defibrillator: on Level 0, next to 81/R-002
Closest evacuation alarm button: on Level 1, in front of 81/1-003, next to the toilets.

IDENTIFICATION AND HANDLING OF THE RISKS

What are the risks for the people involved in the experiment and how they are handled? (prevention measures, PPE, good practices, emergency and first aid instructions, include storage and transport)

(1) General safety information: at the beginning of the show, the organizer provides important information regarding safety measures. Only the selected participant may come to the stage when invited; nobody else from the public is allowed to come on the stage, nor inside the safety barreers parameter.

For the following experiments – see corresponding appendices

(2) Chemical Experiment – ***citric acid and sodium carbonate***

(3) Liquid Nitrogen

a. **Gas experiments - *balloons, bottle and cap***
b. **Liquid experiments - i*ce, cloud***

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What are the risks for the room/building in which the experiment takes place and how they are handled? (prevention measures, good practices, emergency instructions, include storage and transport)

Emergency instructions and experiment guidelines have been provided to the guides during their training and are shared with the audience at the beginning of the science show.

Transportation: the transport between the storage rooms and the stage is done by the technical team and the guide. They have followed the training Cryogenic Safety - Fundamentals (Training rank code: 10170).

Liquid nitrogen supplies come from a certified liquid nitrogen dewar with a capacity of 120 or 150 liters, located outside of the building 3170-GO-921. In regular intervals (about 1x per week), it is filled by a dedicated CERN supplier. Trained members of the SG technician team take smaller (11 liters) empty open dewars from Science Gateway and fill them at the large dewar (frequency: approx. 2x per week). They then transport the open dewar(s) by foot with the dewar securely mounted on a special trolley to SG. These actions are performed by teams of two technicians. At SG, technicians enter at level -1 and use the elevator (without accompanying the dewar) to bring it to the gas storage (level -2) or to the stage (level 0 and store out of sight under the demonstration table). One technician puts the dewar in the elevator, and the other waits at the destination level to receive it.

Appendices

(3) Chemical Experiment

Description: use of Citric Acid and Sodium Carbonate powders mixed with water to paint acid and basic solutions of pH-indication paper.
Quantity: Citric Acid: 20g in 100ml of water. Sodium Carbonate: 5g in 100ml of water. In a glass beaker.

Only trained guides will prepare and handle the chemical solutions, no public participation.

Hazards	Protective equipment and precaution	Emergency action
Irritation Powder or concentrated solution can cause eyes, skin, throat and respiratory tract irritations	When preparing the solution, use **safety goggles and the spoon provided** Avoid touching your eyes while in contact with the solution. **Avoid creating dust**: don't pour from a height or deliberately blow the powder. Use in a ventilated area. Avoid prolonged contact with your skin, **wash your hands** after preparation. Wear nitril gloves if handling large amounts. **No powder is used during the show**, the bottle should be closed when not in use and away from public view. In case of public participation, **they should not touch the solution, only use pencils provided.**	In case of accidental exposure, use running water/eyewash to rinse the affected area properly for several minutes. Remove lenses if any and continue rinsing. Seek medical advice if irritation persists or is significant, or if breathing difficulty occurs.

(3) Liquid Nitrogen		
Description: Non-flammable, non-toxic, colorless, odorless, cryogenic liquid (77K = -196°C) **Quantity:** 11L dewar, guides handle small quantities up to 2 liters from a smaller dewar.		
Only trained guides can handle liquid nitrogen, no public participation. The operator should wear closed shoes and long trousers, and should not wear any jewelry or metallic accessories on their hands and forearms, and should wear the appropriate PPE (goggles, gloves when handling larger quantities)		
Hazards	**Protective equipment and precaution**	**Emergency action**
Cryogenic burns and frostbite Direct contact with liquid nitrogen or surfaces cooled by it can cause severe frostbite or cold burns, as it rapidly freezes living tissue. Eye injuries: Splashing or vapor from liquid nitrogen can cause serious damage to the eyes, leading to frostbite or even blindness if not immediately treated. Cold gas is invisible but produces cold mist in contact with ambient air.	**Personal protective equipment (PPE):** Always wear appropriate PPE when handling liquid nitrogen. -**Cryogenic gloves** (when pouring liquid nitrogen from the 11L dewar to the 2L dewar) -**Safety goggles** (all the time) -**Closed-toe shoes and long trousers.** In case the presenter exceptionally forgets long trousers, the cryo-apron (stored in LabB storage room 82/1-002 – cupboard B2) can be used to provide protection. This does not cover the feet, so closed shoes are still required. All **jewelry and metallic accessories** on hands and forearms (rings, watches…) must be removed. Lanyards / long chains should also be removed prior to using liquid nitrogen. Never allow liquid nitrogen or cold gas to come into contact with skin and eyes. **Be cautious of condensation** on containers, which may appear harmless but could cause burns. **Avoid inhalation** of vapor or mist.	In case of spillage of larger quantities (> 5L): evacuate all persons from the immediate danger area and call the fire brigade if necessary. Ventilate the area. In case of cold burns (skin or eyes): immediately seek a tap with tepid water. Keep rinsing the affected part with tepid water for minimum 15 minutes and call emergency services.
Asphyxiation In an enclosed space, liquid nitrogen can displace oxygen as it evaporates into nitrogen gas, leading to an oxygen-deficient atmosphere and the risk of asphyxiation.	Science show area and gas storage room are well-ventilated areas to avoid the build-up of nitrogen gas. The gas storage room is clearly labeled with Oxygen deficiency signs and cryogenic product signs. Excess liquid nitrogen is disposed of by allowing it to evaporate in a well-ventilated area. Liquid nitrogen dewars can be transported in goods elevators BUT no person is allowed to use the elevator at the same time.	If exposed to low oxygen concentration: move the affected person into fresh air; if not breathing, give artificial respiration. Call the emergency services.
Explosions from trapped liquid If liquid nitrogen is trapped in a sealed or poorly vented container, it can rapidly expand as it vaporizes, potentially causing the container to explode.	Liquid nitrogen is stored in clearly labeled containers designed for cryogenic liquids (dewar flasks), that can handle extreme cold and that allow for the safe release of pressure.	If you suspect a container may be over-pressurized (e.g., swelling or making an unusual noise), evacuate the area immediately and avoid approaching the container until it has been safely vented or handled by professionals.

Heavy weight A full Nitrogen dewar is heavy, leading to a risk of back strain or injury if not lifted properly.	Transportation is only done by the trained technical team. When liquid nitrogen is transported, approved containers are used, which include safety vents, and they are secured properly to prevent tipping or spilling. When pouring liquid nitrogen from the 11L dewar to the 2L dewar, handle the dewar carefully, don't allow it / cause it to fall.	In case of serious injury, contact the emergency services

(2a) Gas Experiments		
In addition to liquid nitrogen hazard specified in (2)		
Description: take out a string of balloons from liquid nitrogen, push a long balloon into liquid nitrogen and take it back out, pour liquid nitrogen in a bottle and cover with a cap.		
Only trained guides can handle liquid nitrogen, no public participation. The operator should wear closed shoes and long trousers, should not wear any jewelry or metallic accessories on their hands and forearms, and should wear the appropriate PPE.		
Hazards	**Protective equipment and precaution**	**Emergency action**
Noise A balloon can burst unexpectedly due to overinflation or weak spots in the material, potentially causing loud noises	The guide should inform the audience that the balloon may burst and kindly suggest that individuals with sensitive hearing, as well as children, can **protect their ears** by covering them with their hands.	In case of signs of distress (children crying), calmly reassure the person and check for serious signs of distress. Provide assistance if necessary and seek medical attention if needed.
Cryogenic burns The pressure builds up quickly in the bottle, and the gas can produce mist in contact with ambient air. When the bottle cap flies off it could knock the bottle and spill the liquid nitrogen contents.	Handle the balloons carefully as they could be very cold. Before starting the pressure experiment, **remove all liquid nitrogen containers (beakers, small dewar) from the table and place them safely under the table.** Only pour a very small amount of liquid nitrogen into the bottle.	In case of cold burns (skin or eyes): immediately rinse the affected part with tepid water for a minimum of 15 minutes and call emergency services.

(2b) Liquid Experiments		
In addition to liquid nitrogen hazard specified in (2)		
Description: Pour liquid nitrogen into water and show the ice and cloud that forms		
Only trained guides can handle liquid nitrogen, no public participation. The operator should wear closed shoes and long trousers, should not wear any jewelry or metallic accessories on their hands and forearms, and should wear the appropriate PPE.		
Hazards	**Protective equipment and precaution**	**Emergency action**
Cryogenic burns Pouring liquid nitrogen into water will create cold fog and ice	When adding liquid nitrogen to water, do so **slowly** to prevent violent boiling and splashing. **Keep a safe distance** from the fog. Make sure the audience is respecting distancing placed with the safety barriers. **Do not touch** the ice with bare hands, use the plastic ladle provided.	In case of cold burns (skin or eyes): immediately seek a tap with tepid water. Keep rinsing the affected part with tepid water for minimum 15 minutes and call emergency services.