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Demonstration Risk Assessment Form

SCIENCE IN SCHOOLS- WE'VE GOT THE POWER

This is a 45-60min long show on the subject of sustainability and features several small and large scales demonstrations. These demonstrations include:

1. Fire in Hand
2. Burning Coal
3. CO^2 Candle Extinguisher
4. Blue Sky
5. Infrared 'Ray' Gun
6. Hero's Engine
7. Hand Crank Generator
8. Hero's Engine with Wind Generator
9. Blowing Wind Generator
10. Solar Panel Explainer
11. Leyden Jar
12. Electroball3000 Explainer and Pass Around
13. Voltaic Pile
14. Electrolysis
15. Igniting Hydrox Bubbles with E-match using Electroball3000

Likelihood		**Severity of impact**		**Current risk**	
Certain	5	Death or total destruction	5	**Multiply Likelihood and Severity of impact to get Current Risk rating**	
High	4	Major injury or damage	4		
Medium	3	Serious injury or damage	3		
Low	2	Minor injury or damage	2		
Very low	1	Negligible	1		

Action Rating	
10 and above	**The work is too dangerous and should not be undertaken**
8 or 9	The work is high risk. Those undertaking the work must be fully competent and experienced for the type of work, equipment to be used and fully understand all risks present.
5 or 6	Moderate risk Workers must be fully competent for the type of work and risks present, or under competent supervision.
4	Low risk. Those undertaking the work must be aware or be made aware of the risks and mitigation measures required.
2 or 3	Slight risk. Those undertaking the work should be aware or be made aware of the risks and mitigation measures required.
1	Insignificant risk. Activity suitable for all workers

ACTIONS NEEDED BY VENUE:

Isolate Smoke/ Fire Alarms in vicinity of demonstrations (if possible)

Ensure presenter knows Fire Evacuations procedures
Ensure 1 x Fire Extinguisher is on Stand-by (only to be used in emergencies- should be either dry powder or carbon dioxide)
Discuss with Presenter is there is a no gun policy at your school as the show using a pretend 'Sci-Fi Ray Gun'

Risk assessed by: Dan Plane
Date of last review: March 2024
Review date: February 2025

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Demonstration 1 : Fire in Hand

Method: Lighter fluid is added to cotton wool (enough to make it slightly damp) in a fire gadget. The lid is closed, and the gadget is held in the presenter's preferred hand. At the appropriate time the presenter flips the lid open in their hand, holds their hand out, palm up, and uses their thumb on the same hand to flick the flint, causing sparks, which ignite the lighter fluid. To extinguish the flames, the lid is flipped closed, snuffing the flames out.

Those at risk	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y		Y		

PPE Requirements

Item		**Item**		**Item**		**Item**	
Flameproof overalls		Gloves contact		High visibility		Waterproof clothing	
Hardhat		Dust Mask		Gloves chemical		Wellington boots	
Hearing protection		Mask chemical vapour/mist		Safety shoes			
		Laboratory Coat		Eye protection			

Hazards and risks	**Mitigation**	**Likelihood**	**Severity of Impact**	**Current Risk**
Fire in hand presents burning risk	Presenter is trained and confident in how to use the equipment in such a way to keep their fingers in a safe position. Demonstration is only to be conducted by presenter.	1	2	2
Hot metal during and after the demonstration could burn hand	The demonstration should only be conducted for up to 10 seconds at a time	1	2	2
Cotton pad could fall out when flicking lid closed to attempt to extinguish the flame. This could start an unwanted fire	Presenters trained and practiced in proper use. A wire is stretched over the pad to keep it in place. Should the pad fall out, it is to be immediately extinguished. Oxygen restriction through smothering is the preferred method as fire extinguisher is likely to move the cotton pad around creating more of a hazard.	1	1	1

Flames present risk to eyes	Flames kept at arms-length by trained presenter. Presenter always in control of placement of flames. The fire is only 15cm high, so isolation of smoke alarms not needed unless they are known to be especially sensitive.	1	1	1
Incorrect use of Lighter Fluid can cause uncontrolled fires/explosions or toxicity Lighter fluid is a flammable liquid (UN1268) Safety data sheet can be found here: https://www.mssd14.org/UserFiles/Servers/Server_57364/File/SDS%20Materials/SDS%20Sheets/Ronsonol%20Lighter%20Fluid.pdf	When setting up the demo (dampening the cotton with lighter fluid), ensure it is being conducted in a well ventilated space. It should not be handled near any naked flames, unless during the demonstration. Hands should be washed after handling lighter fluid/the demo, with extra precautions being taken before eating or drinking. Lighter fluid fires should be extinguished using oxygen restriction, or in an emergency, dry powder or carbon dioxide extinguishers can be used.	1	2	2
Incorrect storage and transportation of lighter fluid can cause uncontrolled fire/explosion.	It will be stored in cool, dry conditions, and kept separate from any oxidizers. Lid is to be securely replaced after use and for storage and transportation The fluid container should be inspected for visual signs of damage at regular intervals. When empty, the fluid container should not be pierced, but can be disposed of in the normal rubbish. If left unattended in a school, it should be left within a locked box.	1	2	2

Demonstration 2: Burning Coal

Method: Approximately 2-3 spatula scoops of potassium chlorate, an oxidizing agent, is placed into a boiling tube in a laboratory clamp and stand. It is then melted and heated with a blowtorch. Once melted, a spatula full of ground charcoal is put into the tube so that it drops into the molten potassium chlorate. It reacts violently with a shrieking noise, creating a bright light and lots of sparks and smoke. The blowtorch used will be fuelled with either Butane or a high temperature gas mix (MAP gas). Note: throughout risk assessment, when referring to butane it also applies to a butane/propane mix.

	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
Those at risk	Y		Y		

PPE Requirements

Item		Item		Item		Item	
Flameproof overalls		Gloves contact	Y	High visibility		Waterproof clothing	
Hardhat		Dust Mask		Gloves chemical	Y	Wellington boots	
Hearing protection		Mask chemical vapour/mist		Safety shoes			
		Laboratory Coat		Eye protection	Y		

Hazards and risks	Mitigation	Likelihood	Severity of Impact	Current Risk
Eye injury via multiple possible causes. Chemical irritant, flames and sparks, and potentially broken glass.	Eye protection must be worn throughout.	1	4	4
A relatively large amount of smoke is produced, which could cause respiratory irritation. The smoke may also set off fire alarms.	The demonstration should be performed only in a well-ventilated environment and with audience members well clear (at least 3 metres). Smoke detectors in the same room should be isolated from the fire alarm system if possible	4	1	4
Burning charcoal particles will be ejected from the boiling tube during the reaction, causing burn injury or the potential to start a fire.	The reaction must be performed behind a 3- sided polycarbonate screen. An exclusion zone is to be created, with audience members at least 3 meters away from the reaction. The clamp and stand must be secure and stable, and the whole demonstration space within the safety screen protected	2	3	6

	with heat-proof ceramic mats. Flammable materials must be kept well clear. If any material does escape the tube, it should be left to burn itself out on the ceramic mats. If the material escapes beyond the ceramic mats, it can be extinguished with a fire blanket, or water, foam, or CO_2 fire extinguisher, which must be on hand.			
The flame produced may cause burn injury	A spatula will be used to drop the coal into the tube. Heat proof gloves are also to be used for inserting the coal, even the gloves compromise dexterity. Presenters are to be correctly trained and be confident in performing the demonstration.	2	2	4
The tube will become extremely hot (around 400°C or more) it will remain hot for some time after the demonstration, risking burning injury.	The tube nor its contents is to be touched during, or immediately after the demonstration. Heavy, heat-proof gauntlets should be worn to handle the boiling tube in the unlikely event it needs to be handled. The entire clamp stand can be moved safely by handling the retort rod once the reaction has finished.	2	2	4
The tube may crack during the process, releasing its contents below.	The reaction must be carried out on ceramic mats. If the tube breaks, the contents should be allowed to burn out and cool in situ. If the potassium chlorate drops whilst still in powder form, carefully gather up and place in another boiling tube and burn off using another portion of charcoal dust.	2	2	4
The blowtorch creates a fire hazard.	The blowtorch/Bunsen must only be used by people trained and familiar with their correct use. The flame must only be on for as long as necessary. If using a blowtorch, the gas must be switched off as soon as the potassium chlorate is ready, and just before adding the charcoal to the tube.	3	2	6

Incorrect handling of potassium chlorate can cause skin and eye irritation, acute toxicity, or a fire/explosion. Potassium Chlorate is an oxidizer, UN1485 therefore precautions must be taking according to the MSDS: PO4840_en_GB_4f4b.pdf (wf-education.com)	Nitrile gloves and goggles should be worn when dispensing the potassium chlorate into the test tube. It will be kept away from food, and hands thoroughly washed before food consumption. All presenters to be familiar with the MSDS.	2	3	6
Incorrect storage of potassium chlorate can cause skin and eye irritation, acute toxicity, or a fire/explosion.	Ri to ensure that potassium chlorate will be sourced from a reputable supplier It will be stored and transported within a sealed container (ideally the one it is supplied in) and separate to fuel sources, the lid can be sealed with tape if needed, though if leaking a replacement container should be sourced. The container will be labelled with the chemical name (Potassium Chlorate) and the appropriate Hazchem information It will always be stored and transported in weights of 1kg of less (mostly even less than 500g) Transport by Land and Sea required no special conditions if quantity is kept to 1kg or below. It will be stored in a cool, dry, well ventilated area, and kept away from sources of heat, radiation, static electricity and food. As a further precaution it will be 'double' boxed i.e. kept in a box within a box such that if a spill occurs in the first, the second will catch the spill. Ideally, this box will be lockable, so if left unattended the potassium chlorate cannot be accessed by others.	2	3	6
Incorrect disposal of potassium chlorate can cause fire/explosion, or cause environmental damage	Allow reaction to complete before discarding boiling tube and its contents in domestic general waste (the ratios used in this reaction should be such that all chlorate will have reacted with the coal)	1	1	1

Incorrect use of butane and butane/propane mix can cause fire/explosion. The gas used will be from domestic canisters: UN 2037 Safety data sheets can be found here; Butane: http://www.farnell.com/datasheets/1801831.pdf Butane/ Propane mix: http://www.partinfo.co.uk/files/2500%20Cartridge.pdf	Butane should only be used in a well-ventilated space. Goggles will be worn when using the blowtorch. The butane used is available domestically, it is used as a lighter refill, however it should still be treated with respect. It will be sourced from a reputable supplier and canisters inspected for damage before use. Butane should be extinguished using oxygen restriction, or in an emergency, either dry powder or carbon dioxide extinguishers can be used.	1	4	
Incorrect storage and transportation of butane and butane/propane mix can cause fire/explosion.	It will be stored in a non-conductive box at a temperature below 50°C and away from sources of ignition. There will be a maximum of 8 canisters stored at one point, but mostly only 4, unless a high number of shows are needed. Due to the butane being domestic canisters and the small volume carried/ stored, no special license or labelling is needed. Ideally the box containing the butane will be lockable, so if left unattended the gas cannot be accessed by others.	1	3	3

Demonstration 3: CO_2 candle extinguisher

Method: 3 tea lights are lit and placed onto a clear box with stepped shelves, one candle on each shelf. Then they pour approximately 200 ml of vinegar and 20g (one heaped teaspoon) of bicarb soda into a 3L jug. Stir quickly and leave to sit still while the reaction settles, and produces CO_2. The presenter then carefully lifts the jug and slowly pours the CO_2 onto the candles (aiming for the bottom step), taking care not to pour the liquid in the jug. The candles should go out, one at a time from the bottom to the top, as the CO_2 fills up the box.

Those at risk	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y		Y		

PPE Requirements

Item		**Item**		**Item**		**Item**	
Flameproof overalls		Gloves contact		High visibility		Waterproof clothing	
Hardhat		Dust Mask		Gloves chemical		Wellington boots	
Hearing protection		Mask chemical vapour/mist		Safety shoes			
		Laboratory Coat		Eye protection			

Hazards and risks	**Mitigation**	**Likelihood**	**Severity of Impact**	**Current Risk**
Lighter can cause unwanted fires or burn injuries	Only presenter to use lighter. Lockable long handled lighter will be used where possible. Lighters to be stored away from flammables and oxidizers	1	1	1
Candles can cause unwanted fires or burn injuries	Only presenter to handle candles. Candles are not moved once lit and never left unattended. Ensure all candles are extinguished before moving on from the demo. Only use tealights with a stable base, and ensure the candle is upright and stable	1	1	1
Vinegar and/or bicarb can spill, causing a slip hazard	Presenter to be wary of slippery surfaces, and verbally warn any volunteers coming up on stage of potential hazard. Clean up at the earliest convenience.	2	2	4

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Demonstration 4: Blue Sky

Method: A fish tank with up to 10 L of water is set on a turntable. With the long side facing the audience, a white torch is shone through the water from the short side. While still holding the torch at the end of the tank, the presenter adds approximately a teaspoon of milk to the water and mixes it around. The beam of light should appear blue. After a brief explanation, the presenter rotates the tank 90 degrees, so that the audience are now seeing the torch directly through the tank. The beam of light should appear yellow.

Those at risk	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y		Y		

PPE Requirements

Item		**Item**		**Item**		**Item**	
Flameproof overalls		Gloves contact		High visibility		Waterproof clothing	
Hardhat		Dust Mask		Gloves chemical		Wellington boots	
Hearing protection		Mask chemical vapour/mist		Safety shoes			
		Laboratory Coat		Eye protection			

Hazards and risks	**Mitigation**	**Likelihood**	**Severity of Impact**	**Current Risk**
Water/milk can spill, causing a slip hazard	Presenter to be wary of slippery surfaces, and verbally warn any volunteers coming up on stage of potential hazard. Clean up at the earliest convenience.	2	2	4
An allergic reaction may occur if anyone is allergic to milk	The demonstration should be conducted by the presenter, and conducted at least 2 meters away from the audience to prevent the audience from coming into contact with milk. If the presenter has a milk allergy, they should inform the Ri and alternative arrangements will be made.	1	3	3
Container may break, leading to large water spill and creating a slip hazard	Containers provided will be made of plastic, to avoid shard of glass from being produced in the event of breakage. Check container for signs of wear prior to each show, and do not use if	1	2	2

	container has cracks in. A bucket should be used to transport water from the tap to the tank, so a slippery tank does not have to be carried across the venue, increasing the risk of water spillage through sloshing or dropping the tank			
The tank could fall off the turn table, causing impact injury	A rubber mat is used between the tank and the turn table, so the tank does not slip, especially when weighed down with water. Presenter should turn the tank carefully	1	2	2
Carrying large volumes of water through the venue may cause risk of manual handling injuries	A bucket will be provided, so a 10L tank of water does not need to be carried over large distances. Correct manual handling procedures should be followed.	1	2	2
Using faulty electrical equipment (torch) can cause electric shocks	Conduct a visual inspection of torch before the show. Do not use if the torch has signs of damage. Store the torch in a cool, dry area.	1	1	1

Demonstration 5: Infrared 'ray' gun

Method: An infrared lamp has been attached onto a toy gun, to give the appearance of a sci-fi ray gun. This 'ray-gun' will then be shone near the audience so that they can feel the heat coming from it.

Those at risk	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y		Y		

PPE Requirements

Item		**Item**		**Item**		**Item**	
Flameproof overalls		Gloves contact		High visibility		Waterproof clothing	
Hardhat		Dust Mask		Gloves chemical		Wellington boots	
Hearing protection		Mask chemical vapour/mist		Safety shoes			
		Laboratory Coat		Eye protection			

Hazards and risks	**Mitigation**	**Likelihood**	**Severity of Impact**	**Current Risk**
Touching the lamp could cause burn injury	The lamp is surrounded with a metal cage, which does not get significantly heated by the lamp. Therefore, the only way for a burn to occur would be to place hands through the metal guard. Audience members will be verbally warned to just "put their hands out to feel the heat" with the gun (which will always be in control of the presenter) moved away from anyone appearing to do otherwise.	1	2	2
Using faulty electrical equipment (heatlamp) can cause electric shocks	The lamp will be inspected before each show and ensured that it is in full working order. Ideally it will be PAT tested or less than 6 months old. A circuit breaker plug will be used to plug this into the extension lead, such that if any electric fault occurs power will be cut to the device.	1	4	4
Loose electrical cables create a trip hazard	Ensure all cables are tidy and tucked away. Where cable could create a trip hazard, they must be taped down. If an extension chord is used to reach the audience in such a way that taping it down	1	2	2

	is not appropriate, the presenter is to be aware of and manage the cable during the demo and tidy it away afterwards.			

Demonstration 6: Hero's Engine

Method: A Hero's Engine is assembled, and the bulb filled just less than halfway with cold water. To fill the bulb, a small section of plastic tubing is used to attach a syringe of water to the opening on the end of one arm of the Hero's engine, and the water squirted in.

For the demonstration, a MAP gas blow torch is aimed at the bottom half of the Hero's engine bulb. As steam is produced and exits via the arms, the bulb will spin round. The presenter should continue to move the blow torch around, and be sure to always be heating glass with water on the other side. The Hero's engine should not be allowed to run dry.

Those at risk	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y		Y		

PPE Requirements

Item		**Item**		**Item**		**Item**	
Flameproof overalls		Gloves contact	Y	High visibility		Waterproof clothing	
Hardhat		Dust Mask		Gloves chemical		Wellington boots	
Hearing protection		Mask chemical vapour/mist		Safety shoes			
		Laboratory Coat	Y	Eye protection	Y		

Hazards and risks	**Mitigation**	**Likelihood**	**Severity of Impact**	**Current Risk**
Touching the hot bulb or coming into contact with the hot water/steam can cause burn injuries	Gloves, labcoat, and eye protection to be worn by the presenter. Presenter to ensure they are trained in and are confident in performing the demo and using the MAP gas torch Before the show, visually inspect the bulb for signs of damage that could result in hot, boiling water leaking out.	1	4	4
Spilt water can create a slip hazard	Presenter to be wary of slippery surfaces, and warn any volunteers coming up on stage of potential hazard. Clean up at the earliest convenience.	1	3	3
The open flame of the blowtorch presents a fire hazard and risk of burn injury	Heat-proof gloves to be used during this demonstration. Ensure that the flame is angled away from other equipment, and no flammable items are nearby	1	4	4

	The blowtorch must be turned off as soon as the demo is complete.			
The spinning Engine could become unstable if spinning too fast, sending steam or broken glass in unpredictable directions. This could cause burn injuries and/or cuts.	Presenter to be aware of the speed of the bulb, and control the speed with the position of the blowtorch. If necessary, the presenter can use their free, gloved, hand to stabilise the base.	2	2	4
Broken glass would present a risk of cuts	Any breakages to be cleared away at the earliest convenience	1	2	2
Incorrect use of propylene/MAP gas (high temperature gas mix) can cause uncontrolled fire/explosion. The gas used will be from domestic canisters: UN1077 Safety data sheet can be found here: https://www.tooledup.com/artwork/ProdPDF/2599. pdf	Goggles will be worn when using the blowtorch. Blowtorch and gas canisters will be sourced from a reputable supplier, but they should be inspected regularly for signs of damage Propylene/MAP fires should be extinguished using oxygen restriction, or in an emergency, dry powder or carbon dioxide extinguishers can be used.	1	4	4
Incorrect storage and transportation propylene/MAP gas (high temperature gas mix) can cause uncontrolled fire/explosion.	It will be stored in a non-conductive box at a temperature below 50°C and away from sources of ignition. There will be a maximum of 2 canisters stored at one point, but mostly only 1. Due to the propylene/MAP gas being domestic canisters and the small volume carried/ stored, no special license or labelling is needed. Ideally the box containing the butane will be lockable, so if left unattended the blowtorch or canister cannot be accessed by others.	1	4	4

Demonstration 7: Hand crank generator

Method A hand cranked generator is used to build up a voltage which lights up an led light. This light is either placed in a top hat or in its own stand on a table. The light is a led in a plastic lightbulb casing. (Note- the 'shorting' plug can be used here so the key and button extension is not needed).

Note: Two different models of generator are in use by various presenters, so not all of the following will apply to every generator. All precautions are covered.

Those at risk	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y		Y		

PPE Requirements

Item		Item		Item		Item	
Flameproof overalls		Gloves contact		High visibility		Waterproof clothing	
Hardhat		Dust Mask		Gloves chemical		Wellington boots	
Hearing protection		Mask chemical vapour/mist		Safety shoes			
		Laboratory Coat		Eye protection			

Hazards and risks	Mitigation	Likelihood	Severity of Impact	Current Risk
The magnet used inside the generator is powerful, and will attract magnetic objects very strongly. This could cause injury to body parts or damage objects caught in the way. This can happen very suddenly and very rapidly.	Ensure that the generator is stored away from other magnets. The operator of the generator (presenter or volunteer) cannot have any medical equipment on them that will be affected by magnetic fields. The demonstration will be performed at least 2 meters from the audience. If presenter cannot operate the generator, they will inform the Ri and other arrangements will be made.	2	3	6
Using faulty electrical equipment can cause electric shock injury	As a voltage is generated there is risk of electric shock. to prevent this, all wires will be fully insulated, and the volunteer will be advised to keep their hands away from the wires. If a shock does occur, it will be minimal current and would cause discomfort rather than harm.	1	2	2

The long wire from the generator to the light may create a trip hazard.	Ensure that these wires are placed away from thoroughfares or inserted only for the short time of this particular demonstration	1	1	1
Due to moving parts, there is a risk of pinch injuries	Presenter to ensure no fingers or loose objects can be caught prior to operating the generator. Loose scarves, lanyards etc. are to be removed.	2	1	2
The generator could slip off the table while being used, presenting a risk of impact injury	The person operating the generator should use one hand to hold the generator in place, or a clamp can be used to fix the generator to the table.	1	2	2
One version of the generator has had a metal cover removed to reveal it's workings, potentially leaving sharp metal edges, which present a cutting risk	In adapting the generator the Ri will ensure sharp edges are filed down to remove the risk	1	1	1

Demonstration 8 & 9: Hero's Engine with wind generator

Method: The Hero Engine (as used earlier) has one arm clamped onto its stand, to prevent it from moving. The opening of this arm is blocked off using a tube, so that no steam escapes from this end.

When ready to perform the demonstration, the water in the Hero Engine is heated with a MAP gas blowtorch. The water will be turned into steam which will be forced out of one of the arms. This will cause the blades of a small wind turbine to rotate. This wind turbine is connected to the same light as used earlier; when the blades on the turbine move quickly enough the LED light will turn on.

Presenter can also blow on the wind generator to have the same effect

Those at risk	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y		Y		

PPE Requirements

Item		**Item**		**Item**		**Item**	
Flameproof overalls		Gloves contact	Y	High visibility		Waterproof clothing	
Hardhat		Dust Mask		Gloves chemical		Wellington boots	
Hearing protection		Mask chemical vapour/mist		Safety shoes			
		Laboratory Coat	Y	Eye protection	Y		

Hazards and risks	**Mitigation**	**Likelihood**	**Severity of Impact**	**Current Risk**
Touching the hot bulb or coming into contact with the hot water/steam can cause burn injuries	Gloves, Labcoat, and eye protection to be worn by the presenter. Presenter to ensure they are trained in and are confident in performing the demo and using the MAPP gas torch Before the show, visually inspect the bulb for signs of damage that could result in hot, boiling water leaking out.	1	4	4
Spilt water can create a slip hazard	Presenter to be wary of slippery surfaces, and warn any volunteers coming up on stage of potential hazard. Clean up at the earliest convenience.	1	3	3

The open flame of the blowtorch presents a fire hazard and risk of burn injury	Heat-proof gloves to be used during this demonstration. Ensure that the flame is angled away from other equipment, and no flammable items are nearby The blowtorch must be turned off as soon as the demo is complete.	1	4	4
The spinning Engine could become unstable if spinning too fast, sending steam or broken glass in unpredictable directions. This could cause burn injuries and/or cuts.	Presenter to be aware of the speed of the bulb, and control the speed with the position of the blowtorch. If necessary, the presenter can use their free, gloved, hand to stabilise the base.	2	2	4
Broken glass would present a risk of cuts	Any breakages to be cleared away at the earlier convenience	1	2	2
Clamp could pinch fingers	Only presenter needs to use the clamp to secure the Hero's engine	1	1	1
Loose electrical cables create a trip hazard	Ensure all cables are tidy and tucked away, or on a table. Where cable could create a trip hazard, they must be taped down	1	2	2
Using faulty electrical equipment can cause electrical shock or burn injury.	As the wires and lights have been made bespoke at the Ri. As they are made, care will be taken to ensure wires are insulated (aside from connection points) All wires will be inspected by the presenter before use to ensure that there are no bare wires and if any are found they will be covered with insulating tape. Note: the voltage and current being generated from this demonstration should only pose a risk of mild discomfort, if any.	1	1	1
Presenter blowing on the wind generator poses a risk of communicable disease spread to the audience.	Presenter to not blow into the audience (perform the demo side on to the audience) Audience to be at least 2 meters away from the demonstration.	1	3	3

Incorrect use of propylene/MAP gas (high temperature gas mix) can cause uncontrolled fire/explosion. The gas used will be from domestic canisters: UN1077 Safety data sheet can be found here: https://www.tooledup.com/artwork/ProdPDF/2599. pdf	Goggles will be worn when using the blowtorch. Blowtorch and gas canisters will be sourced from a reputable supplier, but they should be inspected regularly for signs of damage Propylene/MAP fires should be extinguished using oxygen restriction, or in an emergency, dry powder or carbon dioxide extinguishers can be used.	1	4	4
Incorrect storage and transportation propylene/MAP gas (high temperature gas mix) can cause uncontrolled fire/explosion.	It will be stored in a non-conductive box at a temperature below 50°C and away from sources of ignition. There will be a maximum of 8 canisters stored at one point, but mostly only 4, unless a high number of shows are needed. Due to the propylene/MAP gas being domestic canisters and the small volume carried/ stored, no special license or labelling is needed. Ideally the box containing the butane will be lockable, so if left unattended the blowtorch or canister cannot be accessed by others.	1	4	4

Demonstration 10: Solar Panel Explainer

Method: The presenter selects 6 pupil volunteers and 1 teacher.

The teacher is asked to stand on one side of the stage area and wear a "Sun" hat. They are also given some yellow foam balls.

The pupils stand at the other side of the stage, in two rows of three (Row N and Row P). They are side on to the audience, and facing each other. There is a container of blue balls between the rows, and are given the following instructions:

SUN (Teacher)

- You will throw photons (the yellow balls) at Row N until you run out

N-TYPE SEMICONDUCTORS (Row N)

- You love electrons – you must always have one electron in your hand at all times
- If you lose an electron, you must immediately pick one up from the bucket to replace the one you've lost
- If you get hit anywhere on your body by a ball, you must give your electron to the person in front of you.

P-TYPE SEMICONDUCTORS

- You hate electrons – you must immediately get rid of any electron you are given by putting it in the bucket.

This demonstration shows the role of different semiconductors in a solar panel, and that electrons complete a circuit around the solar panel.

Those at risk	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y	Y	Y		

PPE Requirements

Item		**Item**		**Item**		**Item**	
Flameproof overalls		Gloves contact		High visibility		Waterproof clothing	
Hardhat		Dust Mask		Gloves chemical		Wellington boots	
Hearing protection		Mask chemical vapour/mist		Safety shoes			
		Laboratory Coat		Eye protection			

Hazards and risks	**Mitigation**	**Likelihood**	**Severity of Impact**	**Current Risk**
Throwing objects at each other presents some risk of injury or damage.	Soft foam balls are used so injury is not possible. Presenter should think about positions of volunteers so balls don't knock over any other equipment. Teacher is the only person actually throwing balls, so is trusted to act responsibly.	1	1	1
Balls could hit other objects (such as the hero engine), creating slip/trip hazards, risk of injury from broken glass, unwanted fires etc.	Position the pupils away from hazardous equipment (so hazardous equipment is not in the path of the balls being thrown by the teacher)	1	3	3

Demonstration 11: Leyden Jar

Method: Prepared on the table are:
- Pairs of rubber gloves for the presenter and a volunteer if using.
- An empty 2L plastic bottle with lid.
- A matching lid with a nail through it.
- 2L of water in a jug.
- A funnel.
- Table salt.
- A piece of aluminium foil, long enough to wrap around the plastic bottle, with a strip of tape half on at both ends.

The rubber gloves are worn. Using the funnel, the water is poured into the bottle. A large dash of salt is added, the lid screwed on and the bottle given a shake. The foil is wrapped around the bottle by rolling the bottle over the foil on the table, the tape is used to secure it in place. Then the lid is removed and replaced with the nail-lid. The Leyden jar is now complete and can be charged up by rubbing a silk handkerchief on an acrylic rod and the rod touched to the nail. This can be done repeatedly. For efficiency, a "Fun fly stick" toy is used to charge the Leyden jar by holding the cardboard tube to the nail and running the toy for a couple of minutes. A wire is attached to the foil with tape and when the other end is brought to the nail and a spark is made.

Those at risk	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y	Y	Y		

PPE Requirements

Item		**Item**		**Item**		**Item**	
Flameproof overalls		Gloves contact		High visibility		Waterproof clothing	
Hardhat		Dust Mask		Gloves chemical	Y	Wellington boots	
Hearing protection		Mask chemical vapour/mist		Safety shoes			
		Laboratory Coat		Eye protection			

Hazards and risks	**Mitigation**	**Likelihood**	**Severity of Impact**	**Current Risk**
Spilt water can create a slip hazard	Presenter to be wary of slippery surfaces, and warn any volunteers coming up on stage of potential hazard. Clean up at the earliest convenience.	1	3	3
The Fun Fly Stick (Mini Van De Graaf Generator) builds up a static charge, potentially leading to electric shock	Very weak charge is built up in the Fun Fly Stick, not enough to cause any injury	1	1	1

The Leyden jar can hold significant charge and presents a risk of an electric shock	Volunteer and presenter to wear rubber gloves for insulation. Shock only occurs if foil sides and nail on lid are touched at the same time. Presenter aware of this and will carefully instruct and watch the volunteer. The shock possible would cause significant discomfort but not actually dangerous. The volunteer selected must not have heart conditions.	1	2	2
Deliberately discharging the Leyden jar puts volunteer at higher risk of shock	Volunteer is wearing rubber, insulating gloves, and the presenter is holding an insulated wire to discharge the Leyden jar.	2	2	4
The Leyden jar can undergo dielectric absorption and build up a charge when left alone, presenting a small shock risk	At the end of the demo, presenter should leave the Leyden jar shorted with the wire, to prevent accidental build up of charge	2	1	2
If wet, the charge could spread to not just the Leyden jar, but anywhere that is wet near the Leyden jar	A cloth or paper towel will be on stand-by and any spillages wiped up as soon as they occur so as to keep the table as dry as possible	1	2	2

Demonstration 12: Power shaft

Method: The Electroball 300 is a bespoke piece of equipment with two main components, a 1000µF 16v capacitor and a faraday coil to charge it up. The ball also contains a rectifier bridge to facilitate charging, a key switch (with key trapping), a push button, and a 3.5mm phono jack. The circuit is wired so that if the key switch is on and the button is pressed, then electricity produced by the faraday coil will go directly to the phono socket and whatever is plugged into it, for example an LED. If that circuit is broken at any point, by the switch, button, or if nothing is plugged into the socket, then the capacitor will store up the charge being produced. Any charge stored in the capacitor will be sent to a component when the a component when the circuit is closed again.
During the show, the presenter can demonstrate that shaking the Electroball 3000 will light an LED by having the key switch on and holding the button down as they shake. Then they can remove the LED plug, switch off and remove the key, and pass the ball around the audience so they can see the components and shake the ball to charge up the capacitor.

Note: There are two different pieces of equipment in use by different presenters. The Electroball 3000 and the Powershaft. Both are identical in their workings and only differ in shape. Hence the names are used interchangeably throughout this risk assessment.

Those at risk	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y	Y	Y		

PPE Requirements

Item		**Item**		**Item**		**Item**	
Flameproof overalls		Gloves contact		High visibility		Waterproof clothing	
Hardhat		Dust Mask		Gloves chemical		Wellington boots	
Hearing protection		Mask chemical vapour/mist		Safety shoes			
		Laboratory Coat		Eye protection			

Hazards and risks	**Mitigation**	**Likelihood**	**Severity of Impact**	**Current Risk**
If Electroball 3000 is dropped, broken parts could present a cutting risk	Ball made of Perspex or acrylic. Dropping unlikely to shatter it. Audience members are instructed to handle carefully and to pass (not throw) it if passing to someone else	1	1	1
Internal capacitor holds a charge which could shock via the external contacts	A 3.5mm socket used so fingers cannot make contact with the terminals. A key switch is used to break the circuit between the capacitor and the socket. Presenter turns off and removes the key before passing the Electroball 3000 to audience members. Key cannot be removed unless the switch is off so it cannot accidentally eb left on.	1	1	1

Risk of COVID infection by many people handling the same object	If the pupils are in the same 'COVID bubbles' then it can be passed freely between them (ensuring that it is disinfected before and after going around different audiences). If the pupils are not in the same bubble then the Electroball 3000 will be disinfected and passed onto one volunteer (possibly a teacher) who will shake the ball on the presenter's command.	2	2	4

Demonstration 13: Voltaic Pile

Method: Presenter will have prepared felt pads by soaking them in a sodium bicarbonate solution.

Presenter and/or volunteer construct the voltaic pile from the soaked felt pads, 15-20 discs of copper, 15-20 discs of zinc (Actually steel galvanised with zinc), and an acrylic stand.

A copper disc is placed on the stand first, followed by a felt pad, and then a zinc disc. This constitutes one "cell". This order is repeated, copper> felt>zinc, over and over until the discs run out, being sure to end on a zinc disc.

Wires can be attached to the top and bottom discs using crocodile clips. The bottom copper disc is the positive end, or Cathode, while the top zinc disc is the negative anode.

The voltaic pile should produce enough current to power an LED.

Those at risk	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y	Y	Y		

PPE Requirements

Item		**Item**		**Item**		**Item**	
Flameproof overalls		Gloves contact		High visibility		Waterproof clothing	
Hardhat		Dust Mask		Gloves chemical		Wellington boots	
Hearing protection		Mask chemical vapour/mist		Safety shoes			
		Laboratory Coat		Eye protection			

Hazards and risks	**Mitigation**	**Likelihood**	**Severity of Impact**	**Current Risk**
Spillages of water present a slipping hazard	Any spillages to be cleaned up immediately	1	1	1
Glass jar could break and present a cutting risk	Only presenter to handle glass jar during preshow set up. Any breakages to be cleared up immediately	1	2	2
Discs could have jagged edges from holes drilled in them during fabrication	All discs to be ground down and filed before use to be sure of smooth edges	1	1	1
Placing the cloth pads on could result in stabbing the palm of the hand with the wooden/ plastic shaft	Shaft made to not be sharp, holes/slits pre-placed in pads for ease of use	1	1	1

Risk of electric shock from assembled voltaic pile	Current is extremely low and incapable of producing a shock	1	1	1
Whilst attaching the wire using crocodile clips there is risk of them pinching volunteer if handled incorrectly	Presenter to oversee volunteer, or to handle crocodile clips themselves if volunteer may have difficulty.	1	2	2
Use of chemicals	The only 'chemical' used here is sodium bicarbonate, which is used as the electrolyte. This is safe to handle does not cause any adverse reactions with the metals and so no safety steps are needed.	1	1	1

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Demonstration 14: Electrolysis

Method: Before the show the electrolysis kit is set up as follows:

- A solution of sodium bicarbonate is placed in a gas jar, leaving 2-3 cm of air at the top, with a bung that has 2 carbon electrodes and a rubber hose attached. This assembly is held in a clamp stand.
- There is a conical flask filled with water. The open end of the rubber hose is submerged in this water.
- A bench top power supply is attached to the electrodes using crocodile clips (polarity does not matter, in fact variation between shows will reduce corrosion long term).
- The power supply is set so that current will go to the maximum possible in the circuit (16.5v overall max) and the voltage turned to 32v for one minute. A timer must be set so this is not forgotten about. This will rapidly produce bubbles in the solution which will travel through the hose and bubble through the water in the conical flask. The purpose of this is to remove dissolved oxygen from the water, plus flush out normal air from the gas jar and hose. After 1 minute, the voltage is reduced to somewhere between 4-6v so the bubbles in the conical flask are slow but steady, approximately 1 bubble per second. The apparatus is then left to run throughout the show and used in this part of the show for demonstration purposes only (at this point nothing is set alight)

Those at risk	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y	Y	Y		

PPE Requirements

Item		**Item**		**Item**		**Item**	
Flameproof overalls		Gloves contact		High visibility		Waterproof clothing	
Hardhat		Dust Mask		Gloves chemical		Wellington boots	
Hearing protection		Mask chemical vapour/mist		Safety shoes			
		Laboratory Coat		Eye protection			

Hazards and risks	**Mitigation**	**Likelihood**	**Severity of Impact**	**Current Risk**

The mixture of gases is explosive in any quantity, and does not need ambient oxygen to react, just a source of ignition, no matter how slight. This gas, if confined, could cause the apparatus to explode. There is particular risk of flashback – the gases in the rubber tube igniting and flashing back to the jar. If the water in the conical flask becomes soapy (eg after repeated performances of the demo), the gas mixture may collect in bubbles which could ignite unexpectedly	No more than a few centilitres of the gas mixture should be allowed to accumulate anywhere. The jar must be kept nearly full so as to minimise the headspace inside, and must be sealed with a fail-safe closure (e.g. a bung) that will give way if necessary. The tube must be placed into the conical flask beneath the water line so that it acts as a valve and will aid to prevent flashback. In addition, the tube must be kept away from sources of ignition, which will be present elsewhere in the show. This is especially important to consider when igniting the bubbles – which must not be done until the tube has been placed back into the conical flask of water. The gas mixture that is evolved before the demonstration is performed will be produced slowly, but must be allowed to disperse rather than accumulate anywhere. It is lighter than air, so will escape to the atmosphere from an open flask, and this must be allowed to happen. The water in the conical flask should not be allowed to become soapy, as this will cause the gas to accumulate in bubbles. If this does happen, be aware of the hazard and try to disperse the bubbles frequently, and replace the water as soon as possible	1	4	4
The apparatus includes several wires, including some attached to the electrolysis jar. These may pull on it if snagged.	All wires and cables must be carefully managed and taped down if necessary. They must not be allowed to pull on the apparatus.	2	2	4
Spillages present a slipping hazard	Any spills to be cleaned up immediately	1	1	1
Water and electricity present a shock risk	Water is contained within a sealed unit, should the unit begin to leak, presenter is to disconnect electricity at supply and cease the demonstration.	1	2	2

Demonstration 15: Finale

Method: The Electroball 3000 is circulating in the audience or with a specific volunteer. The electrolysis kit is set up and running as above. A small dish, or upturned paint tin lid is secured in a clamp stand with a small amount of soapy water in it. An e-match is fixed to the clamp stand, so that it is just above and aimed at the soapy water. The e-match is wired into a speaker connector box with a long cable with a 3.5mm phono plug at the end. The end of the cable should be un-plugged. This whole assembly must be close enough to the electrolysis kit that the rubber hose can reach the soapy water.

During the show the Electroball 3000 is collected, optionally with a volunteer. Ear defenders and goggles are worn by the volunteer and the presenter. On the electrolysis power supply the voltage is turned up to max (32v) to increase hydrogen and oxygen production. The hose is taken out of the conical flask and held into the soapy water creating bubbles. Once a dome of bubbles is made, then the hose is placed back into the conical flask of water and the power supply turned back down to 4v or turned off completely. The cable that the e-match is wired to is plugged into the Electroball 3000 at least 2m away. The key is inserted into the Electroball 3000, the audience are instructed to cover their ears and a countdown is begun from 3. The key is turned on 2 and the button pressed after 1, firing the e-match which ignites the hydrogen and oxygen bubbles.

Those at risk	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y	Y	Y		

PPE Requirements

Item		**Item**		**Item**		**Item**	
Flameproof overalls		Gloves contact		High visibility		Waterproof clothing	
Hardhat		Dust Mask		Gloves chemical		Wellington boots	
Hearing protection	Y	Mask chemical vapour/mist		Safety shoes			
		Laboratory Coat		Eye protection	Y		

Hazards and risks	**Mitigation**	**Likelihood**	**Severity of Impact**	**Current Risk**
The Electroball presents its own risks	See separate Electroball Risk Assessment	-	-	-
The Electrolysis apparatus presents its own risks	See separate Electrolysis Risk Assessment above.	-	-	-
E-match produces a small explosion and emits sparks presenting a risk to eyes	E-match is setup before the show by the trained presenter. Goggles worn by presenter and volunteer during demonstration. Minimum distance of 2m to be maintained from the e-match during ignition	1	3	3

The exploding hydrox bubbles will produce a loud noise presenting a risk to hearing	Goggles and ear defenders to be worn by presenter and volunteer. Audience instructed to cover their ears. The presenters are trained in the correct amount of bubbles to produce an appropriate sound for the venue. If needed, a test explosion can be conducted in the venue prior to the shows to ensure the correct amount of bubbles and so associated 'size of explosion' is produced.	3	2	6
Early ignition may result in explosion before precautions are taken risking injury	Presenter to plug e-match into Electroball 3000 last in the set up whilst at a distance of 2m- as described in the method statement. Key switch is only turned on immediately before intentional ignition therefore before that point no current can flow to the e-match therefore no ignition can occur.	1	2	2
Improper handling of E-matches presents risk of injury and accidental fires UN0454 Safety data sheet can be found here; https://respyro.com/wp content/uploads/2018/01 /Electric-Match-NPB.pdf	E-matches are electronic matches, categorized at 1.4s explosives. Goggles will be worn at all times when handling them. They are to be kept away from sources of ignition and static prior to lighting. Hands will be washed after handling before eating. Advised fire fighting method is to flood with water if a small number of pieces are involved. Do not use the suffocation method as the e-matches contain an oxidizer. Once fired, the e-matches can be disposed of in the normal rubbish.	2	3	6

Improper storage and transportation of E-matches presents a risk of injury or fires	As the law dictates they will be stored in their designated UN box, away from members of the public. They will be kept away from heat and open flame and stored in a cool, dry place. A maximum of 100 e-matches will be stored at any one time. Although they are pyrotechnics, no licence is needed as the net explosive content (NEC) is well below the 5kg limit. They should not be left unattended when in public.	2	3	6