

Demonstration Risk Assessment Form

SCIENCE IN SCHOOLS- WE'VE GOT THE POWER

MAY 2021

This is a 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. CO² 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. Volatic 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
- 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 and Fran Scott
Date of last review: 12/05/2021
Review date: 11/05/2021

Demonstration: Fire in Hand

Those at risk (please tick)	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y		Y		

Method Statement	Hazards	Mitigation	Likelihood	Severity of impact	Current Risk
<p>Lighter fluid is added to the cotton wool in a fire gadget. enough to make it damp. The lid is closed and the gadget is held in the presenters preferred hand.</p> <p>At the appropriate time the presenter flips the lid open in their hand, and 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.</p> <p>To extinguish the flames, the lid is flipped closed, snuffing the flames.</p> <p>The fire gadget used can be found here: https://www.missionmagic.co.uk/new-fire-from-hand-a-ball-of-flames-appears-in-your-palm-holy-spirit-pentecost</p>	Lighter fluid presents fire risk	Only trained presenters will handle the lighter fluid before the show. Any spillages to be wiped up thoroughly. No naked flames to be near when fluid filling the device.	2	2	4
	Spillages and splashes when filling the gadget with lighter fluid.	Gadget should not be in hand when filling. Minimal amounts of lighter fluid use, with the presenters fully trained in how much lighter fuel to use. (Note- fuel up the device just before starting the show).	2	2	4
	Fire in hand presents burning risk	Presenter is trained and practiced 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 could burn hand	Fire not left going long enough to heat metal enough to burn.	1	2	2
	Cotton pad could fall out when flicking lid closed to attempt to extinguish the flame	Presenters trained and practiced in proper use. Should the pad fall out, it is to be immediately stamped out. In addition, a wire is stretched over the pad to keep it in place.	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 particularly sensitive.	1	1	1
	Working with Lighter Fluid	Lighter fluid is a flammable liquid UN1268 therefore precautions must be taking according to the MSDS: https://www.mssd14.org/UserFiles/Servers/Server_57364/File/SDS%20Materials/SDS%20Sheets/Ronsonol%20Lighter%20Fluid.pdf	Lighter fluid is domestically available, but it should still be treated with respect. It should not be handled near any naked flames, with hands being washed after use, before eating. Suitable fire extinguishing methods include CO2, sand, extinguishing powder. Do not use water. Our preferred method is restriction (to use a fire blanket).	1	2



	Storage and Transport of Lighter Fluid	It will be stored in cool, dry conditions. It will be kept separate from any oxidizers. It will be ensured that the lid is always closed prior to storage. The container should not be pierced. When empty can be disposed of in the normal rubbish. If left unattended in a school, it should be left within a locked box.	1	1	1
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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			

Demonstration: Burning Coal

Those at risk (please tick)	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y	Y	Y		

Method Statement	Hazards	Mitigation	Likelihood	Severity of impact	Current Risk
<p>Approximately 5-6 spatula fulls of potassium chlorate, an oxidizing agent, is placed into a boiling tube in a laboratory clamp and stand. It is then melted and heated close to its boiling point with a blowtorch.</p> <p>Once at this point, a spatula full of ground coal 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 smoke.</p> <p>The blowtorch/ portable Bunsen used will be fueled with either Butane, Butane/ Propane mix or a high temperature gas mix (MAP gas).</p> <p>To save the safety screen needing frequent replacing, cheaper acrylic 'inserts' will be provided which can be attached onto the safety screen via clips.</p> <p>(Note- when referring to Butane, this also refers to a Butane/ Propane mix)</p>	Eye injury via multiple possible causes.	Eye protection must be worn throughout.	1	4	4
	A relatively large amount of smoke is produced. It is not particularly harmful smoke (burnt carbon) but may cause coughing if inhaled in any quantity. 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
	It is possible, though unlikely, that all or some of the content will be ejected from the boiling tube during the reaction. It could then cause burning injury or start a fire.	The reaction must be performed behind a 3-sided polycarbonate screen, with the boiling tube directed so any flaming debris will strike the screen and be contained. The clamp and stand must be secure and stable, and the whole demonstration space within the safety screen protected 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 for any reason this material escapes beyond the ceramic mats, it can be extinguished with a CO2 fire extinguisher, which must be on hand.	2	3	6
	As the coal burns a flame is produced from the boiling tube	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.	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.	Heavy, heat-proof gauntlets should be worn to handle the boiling tube if necessary to do so.	2	2	4



	<p>The tube may crack during the process, releasing its contents below.</p>	<p>The reaction must be carried out above ceramic mats. If the tube fails in this way, the contents should be allowed to burn out and cool in situ.</p> <p>If the power drops whilst still in powder form, carefully gather up and place in another boiling tube and burn off using another portion of coal dust.</p>	2	2	4
	<p>The blowtorch/Bunsen creates a fire hazard.</p>	<p>The blowtorch/Bunsen must only be used by people completely familiar with their correct use. The flame must only be on for as long as necessary. In particular in the case of the blowtorch, the gas must be switched off as soon as the potassium chlorate is ready, and before adding the coal to the tube.</p>	3	2	6
	<p>Working with Potassium Chlorate</p> <p>Potassium Chlorate is an oxidizer, UN1485 therefore precautions must be taking according to the MSDS:</p> <p>https://www.timstar.co.uk/media/wysiwyg/Insights_Lab/SDS/timstar_chemical_sds_PO4840.pdf</p>	<p>Nitrile gloves and Goggles will warn when dispensing the potassium chlorate into the test tube. In addition, it will be kept away from food. With hands washed before food consumption.</p>	2	3	6
	<p>Storage and Transport of Potassium Chlorate</p>	<p>Potassium Chlorate will be stored and transported accompanied by the MSDS (digital version acceptable) and will be stored and transported as advised within.</p> <p>Therefore, the following precautions will be taken:</p> <ol style="list-style-type: none"> 1. It will be sourced from a reputable supplier 2. It will be stored and transported within a sealed container separate to fuel sources, mostly the one it is supplied in. Good practice is to seal this lid with tape after each use. 3. The container will be labelled with the chemical name (Potassium Chlorate) and the appropriate Hazchem 4. It will always be stored and transported in weights of 1kg or less (mostly even less than 500g will be transported and stored) 	2	3	6



		<p>5. Transport by Land and Sea required no special conditions if quantity is kept to 1kg or below.</p> <p>6. It will be stored in a cool, dry, well-ventilated area. And kept away from sources of heat, radiation, static electricity and food.</p> <p>7. 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.</p>			
	Disposing of Used Potassium Chlorate	The ratios used in this reaction are such that the chlorate will have reacted with the coal and so after the reaction has occurred the boiling tube can be disposed off in the normal domestic rubbish	1	1	1
	Working with Butane or Butane/ Propane mix 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%20Cart ridge.pdf	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. Goggles will be worn when using the blowtorch Butane can be extinguished using either water spray, dry powder or carbon dioxide extinguishers, though these will only be used in an emergency, with oxygen restriction being used as our preferred method.	1	4	4
	Storing and Transporting Butane and Butane/ Propane mix	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
	Working with Propylene/ MAP gas	The gas mix used is available domestically (from DIY shops) however it should still be treated with respect. It will be sourced	1	4	4



	<p>(High Temperature Gas Mix) UN1077 Safety data sheet can be found here; https://www.tooled-up.com/artwork/ProdPDF/2599.pdf</p>	<p>from a reputable supplier and canisters inspected for damage before use and transport. The head of the blow torch will always be removed from the bottle for storage and transport.</p> <p>Googles will be worn when using the lit blow torch.</p> <p>High temperature gas mix can be extinguished using dry chemical powder, Carbon dioxide (CO₂), Water fog or Foam. Do not use water jet as an extinguisher.</p> <p>The presenter is to ensure that they are not charged (if electrostatic demonstration have been conducted) before handling the gas, earthing themselves if necessary.</p> <p>The blow torch will only be used in a well-ventilated area. If this is not possible, then it will only be used for the shortest time possible, with the butane torch being used for the demonstrations if it can be.</p>			
	<p>Storing and Transporting Propylene/ MAP gas (High Temperature Gas Mix)</p>	<p>Ideally the canisters will be stored in a non-conductive box and at temperatures not exceeding 49°C/120°F. They will be kept in a cool, dry place out of direct sunlight and away from heat, sparks and open flames.</p> <p>Empty canisters will not be pierced and will be returned to the Ri for appropriate disposal.</p> <p>Ideally the box containing the propylene will be lockable, so if left unattended the gas cannot be accessed by others.</p>	1	4	4

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		

Demonstration: CO² Candle Extinguisher

Those at risk (please tick)	Ri Staff Y	On-Stage Volunteers Y	Audience Y	Non-Ri Workers	Others
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Method Statement	Hazards	Mitigation	Likelihood	Severity of impact	Current Risk
<p>Approximately 200mls of vinegar is poured into a 3ltr jug. Into which approximately 20g or one heaped tablespoon of bicarbonate of soda is added, quickly and briefly stirred around and left to sit still while it produces CO₂.</p> <p>While the reaction takes place, 3 tea lights are lit and placed into a clear box with stepped shelves, one candle on each shelf, and towards the audience side of the box. (The steps should rise from right to left as the audience sees them)</p> <p>When the reaction in the jug has settled down, the presenter carefully lifts the jug and slowly pours the CO₂ that has collected into the box from the near side and in the stage left corner. The candles should go out, one at a time and before the liquid is poured from the jug.</p>	Lighter presents small fire risk	<p>Only presenter to use lighter. And lockable long handled lighter will be used where possible.</p> <p>If lighter is lockable it is to be stored in lockable container with gasses. If not lockable (or lock is unreliable) then it is to be stored away from flammables and oxidizer.</p>	1	1	1
	Candles present small fire risk	<p>Only presenter to handle candles. Candles are not moved once lit and never left unattended.</p> <p>The candles used will be tealights such that they rest in a stable fashion on a flat surface</p>	1	1	1
	Vinegar presents slipping hazard of spilt	Any spillages to be cleaned up at the earlier convenience	1	1	1
	Burn risk from candles/lighter	A long handled lighter will be used to ensure ample distance between the presenter's hand and the lit candles.	1	1	1

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	Eye Protection

Demonstration: Blue Sky

Those at risk (please tick)	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y		Y		

Method Statement	Hazards	Mitigation	Likelihood	Severity of impact	Current Risk
<p>A fish tank with upto 10ltr of water in sits on a lazy susan. With the long side facing the audience a white torch is shone through the water from the short side.</p> <p>While still holding the torch at the end of the tank the presenter adds approximately a teaspoon of milk to the water and swills it around, revealing the beam of light, with a bluish hue.</p> <p>After a brief explanation, the presenter rotates the tank so the short side, at the opposite end of the tank to the torch, faces the audience, revealing a yellowish light.</p>	Water presents a slipping hazard if spilt	Any spillages to be cleared up immediately	1	1	1
	Risk of allergic reaction to milk	Very small amount of milk used, mixed in water, and only handled by presenter. If the presenter is allergic to milk (by touch) they are to inform the Ri.	1	2	2
	Container may break leading to large water spill	Check container for signs of wear prior to each show, and do not use if containers has cracks in.	1	2	2
	The tank falling off lazy susan	A rubber mat is used between the tank and the lazy susan, such that the tank does not slip, especially when weighted down with water	1	2	2
	Carry water through the venue	Often, the supply of water will not be near the performance area, therefore water will need to be carried through the premises. A folding bucket or jugs will be provided for this purpose, so that the tank does not need to be used (as often water sloshes in tanks, causing unnecessary spills)	1	2	2
	Broken tank	The tank used will be made of plastic and so any breakages won't lead to added hazards	1	1	1
	Electrical Hazards	It will be ensured that the torch used will be in full working order.	1	1	1

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	

Demonstration: Infrared ‘Ray Gun’

Those at risk (please tick)	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y	Y	Y		

Method Statement	Hazards	Mitigation	Likelihood	Severity of impact	Current Risk
<p>An off-the-shelf infrared lamp has been attached onto a toy gun, to give the appearance of a sci-fi ray gun.</p> <p>This ‘ray-gun’ will then be shown near the audience so that they can feel the heat coming from it.</p>	Burn from touching hot lamp	<p>The lamp is designed in such a way that it is surrounded with a metal cage. This metal cage does not get significantly heated by the lamp.</p> <p>Therefore, the only way for a burn to occur would be to place hands through the metal guard. And so 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 any children appearing to do otherwise.</p>	1	2	2
	Electrical hazard	<p>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.</p> <p>In addition, 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.</p>	1	4	4

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	Eye Protection

Demonstration: Hero's Engine

Those at risk (please tick)	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y	Y	Y		

Method Statement	Hazards	Mitigation	Likelihood	Severity of impact	Current Risk
<p>An off the shelf Hero's Engine is assembled, and the bulb filled just less than half way 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.</p>	Blow torch flame is extremely hot, presents a burning risk	Blow torch only used by trained presenter. Heat proof gloves used during demonstration	1	2	2
	Steam produced from the Hero's Engine presents a burning risk	Gloves and goggles to be worn by presenter.	2	2	4
	The spinning Engine could become unstable if spinning too fast, sending steam or broken glass in unpredictable directions	Presenter to manage speed with blowtorch position. Can use free hand to stabilise the base if necessary	2	2	4
	Broken glass would present a risk of cuts	Any breakages to be cleared away at the earlier convenience	1	2	2
<p>For the demonstration a MAPP 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.</p> <p>The presenter should continue to move the blow torch around, but be sure to always be heating glass with water on the other side. The Hero's engine should not be allowed to run dry.</p> <p>The Hero Engine being used can be found here: https://www.timstar.co.uk/he180500-hero-s-engine.html</p>	<p>The bulb of the glass could break causing burns</p>	<p>The presenters are fully trained to ensure that the 'bulb' of the Hero engine does not boil dry. With water present in the 'bulb' of the engine, it is much less likely to break. In addition, the blowtorch will be moved around the bulb of the Engine ensuring that it is not focused on just one spot. In addition to all of this, the presenter will wear heat proof gloves.</p>	1	2	2
	<p>Working with Propylene/ MAP gas (High Temperature Gas Mix) UN1077</p> <p>Safety data sheet can be found here; https://www.tooled-up.com/artwork/ProdPDF/2599.pdf</p>	<p>The gas mix used is available domestically (from DIY shops) however it should still be treated with respect. It will be sourced from a reputable supplier and canisters inspected for damage before use and transport. The head of the blow torch will always be removed from the bottle for storage and transport.</p> <p>Googles will be worn when using the lit blow torch.</p> <p>High temperature gas mix can be extinguished using dry chemical powder, Carbon dioxide (CO2), Water fog or Foam. Do not use water jet as an extinguisher.</p> <p>The presenter is to ensure that they are not charged (if electrostatic</p>	1	4	4

		<p>demonstration have been conducted) before handling the gas, earthing themselves if necessary.</p> <p>The blow torch will only be used in a well-ventilated area. If this is not possible, then it will only be used for the shortest time possible.</p>			
	Storing and Transporting Propylene/ MAP gas (High Temperature Gas Mix)	<p>Ideally the canisters will be stored in a non-conductive box and at temperatures not exceeding 49°C/120°F. They will be kept in a cool, dry place out of direct sunlight and away from heat, sparks and open flames.</p> <p>Empty canisters will not be pierced and will be returned to the Ri for appropriate disposal.</p> <p>Ideally the box containing the propylene will be lockable, so if left unattended the gas cannot be accessed by others.</p>	1	4	4

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		Eye Protection	Y

Demonstration: Hand Crank Generator

Those at risk (please tick)	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y	Y	Y		

Method Statement	Hazards	Mitigation	Likelihood	Severity of impact	Current Risk
<p>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 it's own stand on a table. The light is a led in a plastic lightbulb casing.</p> <p>(Note- the 'shorting' plug can be used here so the key and button extension is not needed)</p>	<p>Strong Magnets: The magnet used here is extremely powerful. It will attract magnetic objects very strongly, sufficiently to cause injury to body parts caught in the way. This can happen very suddenly and very rapidly. If two such magnets are allowed to come together, they may cause severe crushing injuries, especially to fingers, which may even be severed. Even if they fly together without trapping fingers they may shatter from the impact and project shards of magnet through the air.</p>	<p>The generator has been built by a respected prop builder and supplied to the Ri with a full users' guide.</p> <p>During transport, storage and when not in use, the magnet will be aligned with the end plates which form the structure of the generator. That way they will stay in place and attract minimal extraneous material.</p> <p>It will also be ensured that the operator of the generator (presenter or volunteer) does not have any medical equipment on them that will be affected by strong magnetic fields. Others will be kept at a distance of 2m.</p>	3	3	9
	<p>Impact Injury: As the generator is weighty, it could cause damage is it falls</p>	<p>The generator will always be placed on a stable table away from the edge</p>	1	4	4
	<p>Lifting Injury: As the generator is weighty, lifting it could cause damage is not undertaken correctly</p>	<p>It will only be lifted by our presenters, all of which are confident in the correct (bending the knees) procedure.</p>	1	2	2
	<p>Electrical Injury</p>	<p>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.</p>	1	2	2
	<p>Trip hazards from trailing wire</p>	<p>As the light will be connected to the generator by a long wire, there is risk of tripping. To negate this risk it will be ensured that these wires are placed away from thoroughfares or inserted only for the short time of this particular demonstration</p>	1	1	1



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		Eye Protection	

Demonstration: Hero's Engine with Wind Generator

Those at risk (please tick)	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y	Y	Y		

Method Statement	Hazards	Mitigation	Likelihood	Severity of impact	Current Risk
<p>The Hero Engine (as used earlier) has one arm clamped onto its stand, so as to prevent it from moving. The hole of the other arm of the Hero Engine has a small section of blocked plastic tubing attached to seal it up. When ready to perform the demonstration the water in the Hero Engine is heated with a MAPP gas blowtorch. The water will be turned into steam which will force 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.</p> <p>The Wind Generator being used is here: https://www.amazon.co.uk/gp/product/B07L3TKYR7/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1</p>	Hero's Engine presents its own risks	See Hero's Engine Risk Assessment	-	-	-
	Clamp could pinch fingers	Only presenter needs to use the clamp to secure the Hero's engine	1	1	1
	As the small generator needs to be held close to the steam and so presents a burning risk	Heatproof gloves to be worn	1	2	2
	Trip hazards from trailing wire	As the light will be connected to the generator by a long wire, there is risk of tripping. To negate this risk it will be ensured that these wires are placed away from thoroughfares or inserted only for the short time of this particular demonstration	1	1	1
	Electrical hazard	As the wires and lights have been made bespoke and are not off-the-shelf there is a risk. All wires will be inspected before use to ensure that there are no bare wires and if any are found they will be covered with insulating tape. In addition, the voltage and current produced by the turbine is not high enough to cause injury	1	1	1
	Working with Propylene/ MAP gas (High Temperature Gas Mix) UN1077 Safety data sheet can be found here; https://www.tooled-up.com/artwork/ProdPDF/2599.pdf	<p>The gas mix used is available domestically (from DIY shops) however it should still be treated with respect. It will be sourced from a reputable supplier and canisters inspected for damage before use and transport. The head of the blow torch will always be removed from the bottle for storage and transport.</p> <p>Googles will be worn when using the lit blow torch.</p> <p>High temperature gas mix can be extinguished using dry chemical powder, Carbon dioxide (CO2), Water fog or Foam. Do not use water jet as an extinguisher.</p> <p>The presenter is to ensure that they are not charged (if electrostatic</p>	1	4	4



		<p>demonstration have been conducted) before handling the gas, earthing themselves if necessary.</p> <p>The blow torch will only be used in a well-ventilated area. If this is not possible, then it will only be used for the shortest time possible.</p>			
	Storing and Transporting Propylene/ MAP gas (High Temperature Gas Mix)	<p>Ideally the canisters will be stored in a non-conductive box and at temperatures not exceeding 49°C/120°F. They will be kept in a cool, dry place out of direct sunlight and away from heat, sparks and open flames.</p> <p>Empty canisters will not be pierced and will be returned to the Ri for appropriate disposal.</p> <p>Ideally the box containing the propylene will be lockable, so if left unattended the gas cannot be accessed by others.</p>	1	4	4

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		Eye Protection	Y

Demonstration: Blowing on Wind Generator

Those at risk (please tick)	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y	Y	Y		

Method Statement	Hazards	Mitigation	Likelihood	Severity of impact	Current Risk
To indicate that the small wind turbine generator can be made to spin just by being blow on it, the presenter will blow onto the small generator making it spin, and so turning the LED light on.	Increased blowing in COVID times	The presenter will ensure that they blow onto the turbine in a direction AWAY from the audience.	1	1	1
	Electrical hazard	As the wires and lights have been made bespoke and are not off-the-shelf there is a risk. All wires will be inspected before use to ensure that there are no bare wires and if any are found they will be covered with insulating tape. In addition, the voltage and current produced by the turbine is not high enough to cause injury	1	1	1

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	Eye Protection

Demonstration: Solar Panel Explainer

Those at risk (please tick)	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y	Y	Y		

Method Statement	Hazards	Mitigation	Likelihood	Severity of impact	Current Risk
<p>The presenter selects 6 pupil volunteers and 1 teacher.</p> <p>The teacher is asked to stand on one side of the stage area and wear a “Sun” hat. They are also given a bucket of yellow foam balls.</p>	Use of volunteers during Covid restrictions	If pupils are within a bubbles with their teachers, this should not be a concern. Balls, buckets, and hats would need to be sprayed with antiviral spray between shows.	1	1	1
<p>The pupils stand in two rows of three, perpendicular to the audience, and facing each other, so that one row has their backs to the teacher, they are given a bucket of blue foam balls between them, and one blue ball to each of the volunteers that are stage left (optionally they could be wearing hats, black on the stage left row and red on the stage right row).</p> <p>The game runs as follows: The Sun (teacher) throws a photon (yellow ball) at the pupils. If a photon hits one of the N-type semiconductors (the stage left row of pupils) they must give an electron (blue ball) to a P-type semiconductor (stage left pupils), who must immediately pu that electron in to the bucket. At the same time the N-type semi conductor must immediately replace that electron with a new one from the bucket.</p> <p>This process is repeated until the teacher runs out of balls.</p>	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 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

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	Eye Protection

Demonstration: Leyden Jar

Those at risk (please tick)	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y	Y	Y		

Method Statement	Hazards	Mitigation	Likelihood	Severity of impact	Current Risk
<p>Prepared on the table are:</p> <ul style="list-style-type: none"> - A pair of rubber gloves for the presenter and a volunteer if using. - An empty 2ltr plastic bottle with lid. - A matching lid with a nail through it. - 2ltr water in a jug. - A funnel. - Table salt. - A piece of aluminium foil, long enough to wrap around the plastic bottle, with a small piece of tape at both ends. <p>The rubber gloves are worn. Using the funnel, the water is poured into the bottle. A large dash of salt is added and 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.</p> <p>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 up by holding the cardboard tube to the nail and running the toy for about a minute.</p> <p>A wire is attached to the foil with tape and when the other end is brought to the nail a spark is made.</p>	Spillages of water will present a slipping hazard	Any spillages to be cleared up at earliest convenience	2	1	2
	The Fun Fly Stick (Mini Van De Graaf Generator) builds up a static charge, could result in electric shock	Very weak charge is built up in the Fun Fly Stick, not enough to cause any damage	1	1	1
	The Leyden jar can hold significant charge and presents a risk of an electric shock	Volunteer 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.	1	2	2
	Deliberately discharging the Leyden jar puts volunteer at higher risk of shock	The shock possible would be more a discomfort than be a dangerous shock. The volunteer selected must not have heart conditions.	2	2	4
	The Leyden jar can undergo dielectric absorption and build up a charge when left alone, presenting a small shock risk	Volunteer is wearing rubber, insulating gloves, and holding an insulated wire to discharge the Leyden jar.	2	1	2
	If wet, the charge could spread to not just the Leyden jar, but anywhere that is wet near the Leyden jar	At the end of the demo, presenter should leave the Leyden jar shorted with the wire, to prevent accidental build up of charge	1	2	2
		A cloth 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			



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		Eye Protection	

Demonstration: Electroball3000 Explainer and Pass Around

Those at risk (please tick)	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y	Y	Y		

Method Statement	Hazards	Mitigation	Likelihood	Severity of impact	Current Risk
<p>The Electroball 3000 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 circuit is closed again.</p> <p>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.</p> <p>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.</p>	<p>If ball is dropped, broken parts could present a cutting risk</p>	<p>Ball made of perspex. Dropping unlikely to shatter it. Audience members are instructed to handle carefully and to pass (not throw) the ball</p>	1	1	1
	<p>Internal capacitor holds a charge which could shock via the external contacts</p>	<p>Socket used so both contacts are not easily reached. A key switch is used to cut off contact between capacitor and socket. Presenter turns off and removes the key before passing the electroball to audience members. Key cannot be removed unless the switch is off.</p>	1	1	1
	<p>Risk of COVID infection by many people handling the same object</p>	<p>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 the audience). If the pupils are not in the same bubble then the ball will be infected and passed onto one volunteer (possibly a teacher) who will shake the ball on the presenter's command.</p>	2	2	4

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	Eye Protection

Demonstration: Voltaic Pile

Those at risk (please tick)	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y	Y	Y		

Method Statement	Hazards	Mitigation	Likelihood	Severity of impact	Current Risk
<p>Presenter will have prepared felt pads by soaking them in a bicarbonate of soda solution.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>The voltaic pile should produce enough current to run an LED.</p>	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 and original 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 to be rounded and smoothed, 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 bicarbonate of soda, 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

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	

Those at risk (please tick)	Ri Staff Y	On-Stage Volunteers Y	Audience Y	Non-Ri Workers	Others
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Method Statement	Hazards	Mitigation	Likelihood	Severity of impact	Current Risk
<p>Before the show the electrolysis kit is set up as follows:</p> <ul style="list-style-type: none"> - 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. - Also in a clamp stand 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 (16v overall max) and the voltage turned to 32v for one minute. A timer should 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 should be reduced to somewhere between 4-6v so the bubbles in the conical flask are slow 	<p>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.</p> <p>This gas, if confined, could cause the apparatus to explode.</p> <p>There is particular risk of flashback – the gases in the rubber tube igniting and flashing back to the jar.</p> <p>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</p>	<p>No more than a few millilitres 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 <u>must be</u> sealed with a fail-safe closure (eg a bung) that will give way if necessary.</p> <p>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. This is especially important to consider when igniting the bubbles – this must not be done until the tube has consciously been placed back into the conical flask of water.</p> <p>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.</p>	1	4	4
	<p>The apparatus includes several wires, including some attached to the electrolysis jar. These may pull on it if snagged.</p>	<p>All wires and cables must be carefully managed and taped wherever possible, and must not be allowed to pull on the apparatus.</p>	2	2	4



<p>but steady. approximately 1 bubble per second. The setup runs like this until needed in the finale.</p> <p>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)</p>	<p>Spillages present a slipping hazard</p>	<p>Any spills to be cleaned up immediately</p>	1	1	1
	<p>Water and electricity present a shock risk</p>	<p>Water is contained within a sealed unit, should the unit begin to leak, presenter is to disconnect electricity at supply and cease demonstration.</p>	1	2	2

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		

Demonstration: Igniting Hydrox Bubbles with E-match using Electroball3000

Those at risk (please tick)	Ri Staff	On-Stage Volunteers	Audience	Non-Ri Workers	Others
	Y		Y		

Method Statement	Hazards	Mitigation	Likelihood	Severity of impact	Current Risk
<p>The electroball 3000 is circulating in the audience or with a specific volunteer.</p> <p>The electrolysis kit is set up and running as above.</p> <p>A small dish, or upturned paint tin lid is secured in a clamp stand with a small amount of soapy water in it.</p> <p>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.</p> <p>During the show the Electroball 3000 is collected, optionally with a volunteer.</p> <p>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. A dome of bubbles is made, then the hose is placed back into the conical flask of water and the power supply</p>	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	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.	Goggles and ear defenders to be worn by presenter and volunteer. Audience instructed to cover their ears.	2	2	4
	Early ignition may result in explosion before precautions are taken	The presenters are trained in the correct amount of bubbles to produce an appropriate sound for the venue. If needed, a test explosion will be conducted in the venue prior to the shows to ensure the correct amount of bubbles and so associated 'size of explosion' is produced.	1	2	2
Working with Ematches	Ematches are electronic matches, categorized at 1.4s explosives. Goggles will be worn at all times when handling them.				
UN0454	They are to be kept away from sources of ignition and static prior to lighting.	2	3	6	
Safety data sheet can be found here;					
https://respyro.com/wp-content/uploads/2018/01/Electric-Match-NPB.pdf					



<p>turned back down to 4v or turned off completely.</p> <p>The cable that the e-match is wired to is plugged into the electroball 3000 at least 2m away.</p> <p>Ear defenders and goggles are worn, and the audience instructed to cover their ears.</p> <p>The key can be inserted into the electroball 3000. a countdown is begun from 3, the key is turned on 2 and the button pressed after 1, firing the e-match which ignited the hydrogen and oxygen bubbles.</p>		<p>Hands will be washed after handling before eating.</p> <p>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 ematches contain an oxidizer.</p> <p>Once fired, the ematches can be disposed of in the normal rubbish.</p>			
	Storing and Transporting Ematches	<p>As the law dictates they will be stored in their designated UN box, sealed with tape, away from members of the public.</p> <p>They will be kept away from heat and open flame and stored in a cool, dry place.</p> <p>A maximum of 100 ematches will be stored at any one time.</p> <p>Although they are pyrotechnics, no licence is needed as the net explosive content (NEC) is well below the 5kg limit.</p> <p>They should not be left unattended when in public.</p>	2	3	6

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		Eye Protection	Y