

Demonstration Risk Assessment Form

SCIENCE IN SCHOOLS- ENERGY LIVE SHOW

April 2021

Demonstrations include:

1. Ethanol Rockets
2. VDG with Barbie, Pie Dishes & Butane Bowl
3. Balloon Popping Race
4. Egg Drop
5. Paint Tin Steam Pop
6. Angle Grinder
7. Butane Bubbles
8. Electromagnet Tug of War
9. Gauss Cannon
10. Hand Generator with Hat
11. Hand Generator with Microdet

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:

1. Isolate Smoke/ Fire Alarms in vicinity of demonstrations
2. Ensure 1 x Fire Extinguisher is on Stand-by (only to be used in emergencies- should be either dry powder, carbon dioxide or water spray (not jet))
3. Ensure presenter knows Fire Evacuations procedures
4. Ensure presenter knows location of nearest fire extinguishers
5. To inform presenter/ Ri (at least 24hr prior to performance time) if any of the attendees suffer allergies to latex, eggs or has a heart condition.

Risk assessed by: Fran Scott
Date of last review: 15/04/2021
Review date: 14/04/2022

Demonstration1: Ethanol Rockets

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 long pipe is used as the rocket launcher. Some designs have holes drilled at certain points the pipe's length and straps attached so it becomes shoulder-mounted.</p> <p>An approximately one litre drinks bottles (made for carbonated drinks- 'kick' bottles work well) has an approx 5mm hole drilled in its base. With your finger over the hole, a small pour of ethanol is added to the bottle (approximately 50ml max, or use 25 sprays of ethanol from the spray bottle). The bottle is then shaken for at least 30 seconds and the excess ethanol poured out by turning the bottle completely upside down and allowing it to flow out from the lid (there may not be any excess if using the spray bottle). The lid of the bottle is then replaced. And the ethanol bottle lid replaced and the bottle of ethanol moved away. The rocket bottle is then wiped dry and tape (air tight gaffer) placed over the hole with the end of the tape turned over for easy removal later. The bottle is then stored away (at least 50cm) from sources of</p>	<p>Working with Ethanol/ Bioethanol</p> <p>UN1170 (they have the same UN number)</p> <p>Safety data sheet can be found here; https://ekofuel.org/sds</p>	<p>The ethanol used will be obtained from a reputable supplier.</p> <p>To extinguish an ethanol related fire any of the following fire extinguishers can be used: Water spray (not water jet), alcohol resistant foam, dry powder or carbon dioxide.</p> <p>Goggles and nitril gloves will be worn. Breathing in of vapours will be avoided.</p>	2	3	6
	<p>Transporting, Storing and Disposing of Ethanol</p>	<p>It will be stored in a non-conductive box (to prevent the build up of static electricity). It will be stored in areas that are well ventilated, cool and dry. It will be protected from direct sun and stored away from sources of ignition with containers kept closed when not in use. It will be kept separate from oxidising agents (potassium chlorate).</p> <p>Excess ethanol will not be disposed of in places where it can add to the water or soil supply, therefore if necessary to be disposed of it will be burnt in a controlled manner, on a fire retardant surface.</p>	2	3	6
	<p>Hot Burn</p>	<p>Burns could occur from either the lighting of the ethanol or contact with the bottle when lighting.</p> <p>To prevent the presenter being burnt they will wear a heat proof glove as they light the ethanol. And although the bottle will be warm after the burning, it will not be hot enough to cause injury. Nevertheless the audience will be warned that the bottle may be hot.</p> <p>Goggles- or preferably a face mask- will be worn by the presenter throughout.</p>	2	2	4

<p>ignition. When ready, the tape is removed and the bottle placed into the pipe launcher, so the hole is facing the side of the launcher away from the opening. Using a long-handled gas lighter (with a gloved hand) the ethanol in the bottle is lit. This causes the bottle to fly out of the pipe. The launcher will be aimed into the space above the audience so that the bottle will fall into the audience space.</p> <p>(A trick to making the ethanol evaporate well is to heat the bottle up just before firing- this can be done using a hairdryer, heat lamp or by putting the bottle under your armpit).</p>	Impact Injury	The bottle is launched out the pipe at speed, however the bottle will be aimed in the area above the audience rather than at the audience themselves. This means a lot of the speed of the bottle will dissipate by the time the bottles fall into the audience (and so won't have enough speed to cause injury). In addition, the audience will be warned to protect themselves if the bottle falls towards them.	2	1	2
	Fire	<p>(Bio)Ethanol vapour is flammable, therefore there is risk of fire. To negate the risks involving flammable materials we will do the following:</p> <ul style="list-style-type: none"> - The ethanol will be stored within the appropriate lidded container. With the lid always being replaced at the earliest opportunity. - Once poured into the bottle rocket and poured back out, both the ethanol bottle and the beaker of excess will be positioned at least 1m away from the launcher. - A fire extinguisher/ fire blanket will be on stand by. - The presenter will position the firing end of the bottle away from their leg, so that the fire fallout goes to the side of the presenter. <p>If ethanol is spilled, it will be mopped up using paper towels, the presenter ensuring that they do not get any on their clothes, ensuring that the paper towels are disposed of in the bin.</p> <p>If the ethanol is spilled in excess onto the clothes of the presenters, they should change clothes before conducting fire-based demonstrations. If not possible they should instead wear a lab coat for all fire-based demonstrations.</p> <p>The presenter will wash their hands after performing this demonstration, before eating.</p>	3	2	6

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		Eye protection	Y		

Demonstration2: Van De Graff Generator with Pie Dishes and Bowl of Butane

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 van de graaf generator is used by the presenter to create some sparks. Then a Barbie doll and some (approx. an 8cm high pile) small metal pie dishes are placed on the large dome of the van de graaf generator. When the van de graaf is switched on the Barbie doll's hair will become separated and the pie dishes will all gracefully fly off.</p> <p>Then the wire normally going to the earthing globe is attached onto the side of a pyrex bowl placed on top of a heat proof pile. This wire has a bare metal wire on its end which goes into the bowl. A second wire is inserted into the top of the VDG and this also has a bare metal end. The presenter sprays butane into the bowl for 7 seconds and then holds the wire coming from the top of the VDG (on the insulated part), turns the VDG on and then holds this wire near the wire in the bowl. This will create a spark within the butane filled glass bowl, causing the butane to light. It may</p>	Electrical fault	Ensure van de Graaff is in fully working order. Ideally the Van de Graaff will either be brand new (less than 6months old) or will be PAT tested.	1	1	1
	Trip hazard	If the wires are trailing over the stage they will be secured with gaffer tape.	1	1	1
	Static Shock	Only the presenter will be on stage when the Van de Graaf is switched on. All the presenters are fully trained in how to use a Van de Graaff generator and will ensure that the earthing globe/ earthing wires are used when necessary. They have no heart conditions or health equipment that prevent them from using such equipment.	3	1	3
	Working with High Voltage Apparatus	As this machine uses high voltage it should not be used near those with pace makers or other electrical based health equipment therefore the audience will be warned that if they do have a pacemaker or other electrical based health equipment to stand back at least 3metres	1	5	5
	Fire	<p>The butane in the bowl burns for 3-10 seconds. It will be ensured that the immediate area is clear of flammable products including the butane aerosol just used. The bowl used will be Pyrex so it can withstand the heat produced by the burn. In addition, the bowl will be placed on a heat proof tile.</p> <p>The butane MUST be squirted into the bowl BEFORE the VDG is switched on to ensure there is no risk of a spark entering the aerosol. The aerosol will then be placed at least 50cm from VDG.</p> <p>If the fire burns for a prolonged period of time (which it shouldn't) a second heat proof tile or lid will be provided to place over the bowl to starve it of oxygen.</p>	1	4	4

take a few attempts and moving along the length of the wire in the bowl.		The fire/ smoke alarms in the venue should be isolated.			
	Hot Burn	<p>Presenter is experienced in this demonstration and has extensively practiced it so knows when to remove hand/ arm to ensure no serious burn occurs. This demo will ONLY be performed by the presenter.</p> <p>The bowl will be allowed to cool before being removed. The audience will not be allowed to touch it.</p> <p>The presenter will wear goggles throughout this demonstration.</p>	2	3	6
	<p>Working with Butane</p> <p>The Butane used will be from domestic canisters: UN 2037</p> <p>Safety data sheet can be found here; http://www.farnell.com/datasheets/1801831.pdf</p>	<p>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.</p> <p>Goggles will be worn when using the blowtorch</p> <p>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.</p>	1	4	4
	Storing and Transporting Butane	<p>It will be stored in a non-conductive box at a temperature below 50°C and away from sources of ignition.</p> <p>There will be a maximum of 8 canisters stored at one point, but mostly only 4, unless a high number of shows are needed.</p> <p>Due to the butane being domestic canisters and the small volume carried/ stored no special license or labelling is needed.</p> <p>Ideally the box containing the butane will be lockable, so if left unattended the gas cannot be accessed by others.</p>	1	3	3

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	Y

Demonstration3: Balloon Popping Race

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
Specially adapted hard hats are placed on the heads of two volunteers. These hats each have a bicycle pump attached with outlets in the top of the hats. 2 confetti-filled balloons are attached onto these two pipe outlets. The 2 volunteers then race to over inflate the balloon until one of them pops.	Latex Allergy	The audience will be warned that the balloons are not latex free and so if a member of the audience has a latex allergy they are not to volunteer for this demonstration	1	3	3
	Over exertion It takes effort to make the balloons inflate to their popping point.	The balloons used will be only 6 inch diameter. If the volunteers seem to be over-exerting themselves at any point, the presenter will pause the activity until recovery has occurred	1	2	2
	Loud noise from balloon popping	The popping balloon making a noise louder than is expected, therefore both volunteers will wear ear defenders (attached to the hard hat)	1	2	2
	Eye Injury from Popping Balloon	As the balloons are in close proximity to the volunteer's eyes, goggles will be worn by both volunteers during this demonstration.	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	Y	Mask chemical vapour/mist		Safety shoes			
		Laboratory Coat		Eye protection	Y		

Demonstration4: Egg Drop

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
The presenter drops different eggs from various heights with the difference in damage to the egg being noted.	Food Allergy	The teacher/ organiser is to notify the presenter/ the Ri at least 24hours prior to the performance if any of the attendees are severely allergic to eggs (i.e. cannot be in the same room as them). If notified of a severe allergy a rubber egg will be used instead. It will be ensured that the presenter does not have a touch allergy to eggs. If they do an alternative food will be found.	1	4	5
	Substance Spill	To avoid the eggs leaving a slippery surface on the stage/ performance area, they will be dropped onto a tray to contain the egg fallout.	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	Mask chemical vapour/mist	Safety shoes	
	Laboratory Coat	Eye protection	

Demonstration5: Paint Tin Steam Pop

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>1-2 tablespoons of water is placed in a 250ml tin can in a heat proof (cork lined) retort stand and clamp. A butane (or gas mix- propylene/ MAP gas) powered blow torch is then used to heat up the water. The water in the can will boil, produce steam until eventually the lid pops off.</p> <p>(note- when referring to Butane it also applies to a Butane/ Propane mix)</p>	Fire. The blow torch produces a sustained flame.	Flammables items will be placed at least 1m away from the blow torch. A fire extinguisher and fireblanket will be on stand by. The smoke alarms in the venue will be isolated if present.	1	5	5
	Impact Injury	As the lid of can becomes a projectile there is risk of injury. To prevent this, the demonstration will be performed at least 2m from the audience. It will be ensured that the lid of the tin is not angled towards the audience. The presenter will not- at any time- place their face over the lid of the can. The lid used is so light that it will not cause injury on impact	1	2	2
	Burn	<p>Burns could result from using the blow torch or by contact with the hot water, steam or can.</p> <p>Those using the blow torch will be fully competent in handling it, it will not be used by a volunteer. The blow torch will be switched off as soon as possible.</p> <p>The tin can will be attached onto a retort stand and therefore if it needs moving whilst cooling, the retort stand will be used to carry it, rather than contact with the can itself.</p> <p>As hot gasses and water may escape from the can when the lid pops off, the presenter will perform the demonstration with the blow torch at arms' length, wearing goggles and a heat proof glove on the hand holding the blow torch with the other hand kept away from the can.</p> <p>By the audience being at a distance of 2m no escaped hot water will reach them</p> <p>In addition, as the arm of the clamp holding the tin can twist slightly, ensure that it is set up in such a way that if it does twist (from the force of the lid popping off) that it twists AWAY from the audience.</p>	2	2	4
	Working with Butane or Butane/ Propane mix	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.	1	4	4



	<p>The gas used will be from domestic canisters: UN 2037</p> <p>Safety data sheets can be found here;</p> <p>Butane: http://www.farneil.com/datasheets/1801831.pdf</p> <p>Butane/ Propane mix: http://www.partinfo.co.uk/files/2500%20Cartridge.pdf</p>	<p>Googles will be worn when using the blowtorch</p> <p>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.</p>			
	<p>Storing and Transporting Butane and Butane/ Propane mix</p>	<p>It will be stored in a non-conductive box at a temperature below 50°C and away from sources of ignition.</p> <p>There will be a maximum of 8 canisters stored at one point, but mostly only 4, unless a high number of shows are needed.</p> <p>Due to the butane being domestic canisters and the small volume carried/ stored no special license or labelling is needed.</p> <p>Ideally the box containing the butane will be lockable, so if left unattended the gas cannot be accessed by others.</p>	1	3	3
	<p>Working with Propylene/ MAP gas (High Temperature Gas Mix)</p> <p>UN1077</p> <p>Safety data sheet can be found here;</p> <p>https://www.tool-ed-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 demonstration have been conducted) before handling the gas, earthing themselves if necessary.</p>	1	4	4



		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 it can be.			
	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			
		Laboratory Coat		Eye protection	Y		

Demonstration6: Angle Grinder

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
An angle grinder is turned on and used to cut into a steel pole of a retort stand.	Electrical fault	<p>Ensure the angle grinder is in fully working order. Ideally, the Angle Grinder will either be brand new (less than 6months old) or will be PAT tested.</p> <p>The presenter will ensure that the lead of the angle grinder is well away from the cutting area so they do not cut the electrical lead by mistake.</p> <p>Ideally a circuit breaker will be used to plug in the angle grinder so if a shorting occurs, power supply will be cut.</p>	1	1	1
	Spinning disc	The disc of the angle grinder should be tightened before each show as a habit to ensure that it never becomes loose	1	2	2
	Trip hazard	If the wires are trailing over the stage they will be secured with gaffer tape.	1	1	1
	Flying sparks	<p>As the angle grinder cuts the steel pole several sparks will be produced. Only the presenter will operate the angle grinder. To prevent these sparks causing harm to the presenter they will wear gloves, labcoat, goggles and ear defenders.</p> <p>The surrounding area can be protected by a fire blanket if needed</p> <p>Please note: although the sparks look hot are not actually that hot and will not burn the surfaces on which they fall.</p> <p>The presenter will position themselves so they are parallel to the audience and so that the sparks from cutting the pole are directed towards the back of the performance area away from the audience.</p> <p>This demonstration will be performed at least 2.5m away from the audience.</p>	3	1	3

PPE Requirements

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

Demonstration7: Butane Bubbles

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 plastic bowl is half filled with water with a little bit of washing up liquid. Butane is dispensed from a domestic canister into that soapy water such that butane bubbles are created. These bubbles are lifted by a holey metal paddle and set on fire using a long handled gas lighter. A volunteer from the audience will be holding the paddle.</p>	<p>Fire. Butane is sustained flame.</p>	<p>The butane will be lit on a fire retardant paddle. It will be lit not overhanging the remaining butane bubbles. Flammables items will be placed at least 1m away from the bubbles. The headspace above the bubbles will be checked for flammable items (3m clearance minimum). A fire extinguisher and blanket will be on stand. The smoke/ heat alarms will be isolated if present.</p> <p>In addition, the table on which this demonstration is performed will be covered in a fire blanket. The volunteer will be wearing a face shield and heat proof gloves and will be verbally warned that the fire will be relatively long lasting and that they are to keep hold of the panel.</p> <p>If the venue ceiling is particularly low, then this demonstration <u>can</u> be performed with the fire blanket on the floor if necessary.</p>	1	5	5
	<p>Burn</p>	<p>The presenter will wear goggles and perform the lighting with a long-handled lighter. The volunteer will wear a faceshield and heat proof gloves and will hold the paddle at arms' length. The presenter will be trained in how the hold the volunteer at the elbow/ hold the paddle to ensure that the volunteer does not move their arms during the demonstration.</p> <p>It will be ensured that the volunteer has no 'dangling' items such as scarf, ties or loose hair. If so, these will be removed or tied back before conduction the demonstration. Alternatively, the presenter's labcoat can be used on the volunteer.</p>	2	2	4



	<p>Working with Butane</p> <p>The Butane used will be from domestic canisters: UN 2037</p> <p>Safety data sheet can be found here; http://www.farnell.com/datasheets/1801831.pdf</p>	<p>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.</p> <p>Googles will be worn when using the blowtorch</p> <p>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.</p>	1	4	4
	<p>Storing and Transporting Butane</p>	<p>It will be stored in a non-conductive box at a temperature below 50°C and away from sources of ignition.</p> <p>There will be a maximum of 8 canisters stored at one point, but mostly only 4, unless a high number of shows are needed.</p> <p>Due to the butane being domestic canisters and the small volume carried/ stored no special license or labelling is needed.</p> <p>Ideally the box containing the butane will be lockable, so if left unattended the gas cannot be accessed by others.</p>	1	3	3

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		Face shield	Y
		Laboratory Coat	Y	Eye protection	Y		

Demonstration8: Electromagnetic Tug of War

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 electromagnet is attached to 2 ropes. 2 volunteers are selected to pull on the ropes and attempt to pull the electromagnet apart.</p> <p>When switched on the electromagnet will stay strong, only when it is switched off will the electromagnet separate.</p>	<p>Volunteers may sustain injury through falling during the tug-of-war, for instance, if a member of the other team suddenly lets go, or if a volunteer loses grip on the rope.</p>	<p>The presenter will be on hand to act as a 'catcher' in the event that any of the volunteers suddenly fall backwards.</p> <p>In addition the volunteers will be instructed to not pull each other and to concentrate on working together rather than as if they are separate teams (it's both teams against the electromagnet). They will also be instructed to take a wide stance to minimise the probability they will fall.</p> <p>Ideally, also a safety rope will be attached between the two elements that come apart, such that if they do come apart they only separate a small distance (the distance of the safety rope)</p>	2	4	4
	<p>Friction burns from rope.</p>	<p>The presenter should instruct the volunteers not to wrap the rope around their arms.</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	
	Laboratory Coat	Eye protection	

Demonstration9: Gauss Cannon

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 stack of 6 drinks can be stacked into a pyramid shape.</p> <p>A bespoke made 'cannon' consisting of a wooden structure with rare earth (neodymium) magnets attached along its length is aimed towards the can pyramid. The cannon is 'loaded' such that two ball bearings are placed between each of the attached magnets. Then to fire the cannon, a ball bearing is gently rolled towards the first magnet. Due to the magnetic attraction, there is a knock on effect throughout the lines of the balls and magnets such that the final ball leaves the cannon at 'speed' and knocks over the can pyramid.</p>	Strong Magnets	<p>The magnets used in this prop are very strong and should be kept away from magnetic objects, especially jewelry and the hand crank generator. The props should be treated with care such that the magnets do not come loose, if they do, they should be re-attached at the earliest convenience.</p> <p>The prop should also be stored and transported wrapped in protective packing to ensure that if magnetic objects are attracted to it during storage or transport they can be easily removed.</p>	1	2	2
	Fall hazards from balls	The ball bearings are small (approx. 50mm dia.) therefore if they fall on the floor they could cause a fall hazard. If the balls do fall on the floor they should be picked up at the earliest convenience.	1	1	1
	Choking hazard	The balls and magnets are both choking hazards. If either are in a position where they are near small children in the audience, they should be picked up and placed out of reach as soon as possible	1	3	3

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			

Demonstration10: Hand Generator and Light

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 key and button extension should be used here and the hand crank held at its base)</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



	Electrical 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
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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 11: Hand Generator with Microdet

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 hand cranked generator is used to build up a voltage which ignites a squib (microdet). The ignition of this microdet (an off-the-shelf pyrotechnic) causes a loud bang.</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 us 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>	<p>1</p>	<p>2</p>	<p>2</p>
<p>Squib (microdet) creates loud explosive noise on ignition</p>	<p>All audience to be advised to cover their ears ahead of explosion. Those with sensitive hearing to be advised to leave the room. Presenter to wear ear defenders.</p>	<p>2</p>	<p>4</p>	<p>8</p>
<p>Squib (microdet) creates an amount of shrapnel on ignition</p>	<p>Protective shield to go in front of squib to protect audience and presenter from cardboard pieces released from the shell. Audience to be at a minimum of 3 meters distance from squib (this is less than the standard as the protective shield is being used)</p>	<p>2</p>	<p>4</p>	<p>8</p>
<p>Working with Microdets (pyrotechnics): Microdets (also known as squibs) are small pyrotechnics. Classification 1.4G (UN0431) http://www.lemaitreltd.com/p/Microdets/0zzjc%5B%5DyA98g http://www.lemaitreltd.com/includes/images/uploads/ecommerce/documents/SDS%20Flash%20Reports,%20Maroons%20and%20Microdets%20(2017)%20-%20u5n52btf.ksd.pdf They are small cardboard tubes filled with aluminium powder, magnesium powder and an oxidizer with a remote igniter.</p>	<p>Microdets to be sourced from a reputable supplier. When handling Microdets, goggles are to be worn at all times and there will be no naked flames, smoking or eating within the immediate area. Hands are to be washed after using, before eating.</p>	<p>2</p>	<p>4</p>	<p>8</p>



	<p>Storage and Transporting Microdets:</p> <p>As microdets are classified as a pyrotechnics there are rules and regulations governing their storage and transport.</p> <p>http://www.legislation.gov.uk/uksi/2014/1638/contents/made</p>	<p>Microdets are classified as category 1.4G (the second lowest – safest- there is).</p> <p>The law states that if NEC (net explosive content) is lower than 5kg then no licence is needed. We will always ensure that the NEC is well below this limit. Each microdet has a NEC of 0.15g, therefore we could need to carry over 30,000 of them to exceed this limit (we normally carry 24 as a maximum)</p> <p>Microdets will always be stored and transported within a corrected labelled (1.4G) UN box. They will be kept in a cool, dry location, away high temperatures, shock, static discharge, vibrations or other physical stresses that might result in a hazardous situation.</p> <p>They, along with the other ‘dangerous goods’, are to ideally be placed in a locked room if left unattended whilst at a venue. If this is not possible then they are to be carried with the presenter and not left unattended.</p>	2	4	8
	<p>Non-Standard Ignition System:</p> <p>As we are using a non-standard ignition system we need to take care to avoid premature ignition.</p>	<p>Premature ignition will be negated with the use of a ‘circuit connecting system’ or an ‘arm key extension’ box. This is a plastic box which is inserted into the hand crank generator, which contains an arm key and switch. Only when the key is in the ‘on’ position and the button pressed, *and* the magnet on the generator spinning will an electric current be able to pass through to the pyrotechnics. So, basically with the key on and magnet turning, until the button is pressed on this ‘circuit connecting system’, no connection will be made between the generator and the microdets and so no ignition will occur.</p> <p>The procedure for working with the microdet will be as follows:</p> <p>BEFORE SHOW:</p> <ol style="list-style-type: none">1. With goggles on, position the microdet in laboratory retort clamp (the microdet will not be	2	4	8



		<p>connected to anything else at this point)</p> <ol style="list-style-type: none">2. The wires from the end of the microdet will be plugged into the 'speaker cable box'.3. The spade connectors on the other end of this 'speaker cable box' will NOT be attached to the generator, instead they will be taped to the table near the generator.4. Ensure the 'arm key extension' box is not plugged into the generator. <p>DURING SHOW:</p> <ol style="list-style-type: none">1. Put goggles on and place the microdet into its firing position on stage. Ensuring the safety screen is between 'the microdet and the audience' and 'the microdet and you'2. Select volunteer and get them onto stage3. Ensuring the microdet and the 'arm key extension' box is NOT attached, show the volunteer how to use the generator. Ensure it is set up for them being either right or left handed.4. Once mastered. Ask the volunteer to step back and give them goggles and ear defenders5. Now, attach the spade connectors and the 'arm key extension' box to the generator6. Ensuring the magnet is HORIZONTAL, and blocking the volunteer from being able to spin the magnet, show that even when the key is 'on' and the fire button is pressed, the microdet does not fire. (i.e. turn key to on and push button = no effect)7. Now invite the volunteer to step forward to generator. Position yourself between the microdet and the volunteer8. Warn the audience of the loud noise and get them to cover their ears.			
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		<p>9. Turn the key to 'arm', volunteer to spin magnet, and when ready push the button to fire the microdet.</p> <p>Notes:</p> <p>-If the volunteer is too small/ young to operator the generator, then the presenter will be in charge of operating the generator, and the volunteer the fire button.</p> <p>-If (for some reason) two volunteers are used, then one volunteer will operator the generator, and the other will push the button with the presenter very much in control of the button-pusher.</p> <p>IN THE EVENT OF A MISFIRE the following procedure will be followed:</p> <ol style="list-style-type: none"> 1. Turn key to unarm position 2. The system is now 'safe' and the audience can stand at ease/ remove hands from ears. 3. Taking the key with you, check all connections working your way from the microdet back to the generator. Remember that more than one connection may be loose. 4. Repeat the firing routine above. 			
	<p>Disposing of Microdets</p>	<p>Once fired the microdets can be disposed of in the normal rubbish.</p> <p>If a misfire occurs and the microdet doesn't fire, it will be disposed of according to advice from the supplier. Therefore it will be immersed in water for 24 hours (ensuring that they are sunk under the surface of the water) and that any paper tops so should be pieced so that the water can easily permeate the device. After which they can be disposed of in the normal rubbish.</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		