CLEAPSS *Supporting practical science & technology*

- in schools and colleges

Special Risk Assessment

(to meet the *COSHH* and/or the *Management of Health & Safety at Work Regulations*)

Applicant:	John Payne
School/Local authority:	Royal Society of Chemistry
Operation:	Preparation and ignition of black powder outdoors as a part of fieldwork on industrial / historical chemistry

Details of operation

*Black powder is made using 1.5 g of carbon, 1.0 g of sulfur and 7.5 g of potassium nitrate. After very careful mixing the product is ignited **out of doors**.*

It is the responsibility of the applicant to inform CLEAPSS if these details of the operation are substantially inaccurate.

Substance(s) possibly hazardous to health:	a) Carbon b) Sulfur c) Potassium nitrate d) Sulfur dioxide e) Carbon dioxide f) Carbon monoxide g) Potassium carbonate h) Potassium sulfide
Classification under CHIP Regulations:	a) Carbon is low hazard. b) Sulfur is not classified but some suppliers give it a highly flammable hazard rating. c) Potassium nitrate is an oxidising agent. d) Sulfur dioxide is toxic by inhalation and may cause burns. e) Carbon dioxide is not classified. f) Carbon monoxide is extremely flammable and toxic g) Potassium carbonate is an irritant. h) Potassium sulfide is corrosive and dangerous for the environment.
Workplace exposure limits (mg m^{-3}):	The WEL for sulfur dioxide is 5.3 mg m^{-3} (LTEL), 13 mg m^{-3} (STEL) (from EH40/2002) The WEL for carbon monoxide is 35 mg m^{-3} (LTEL), 232 mg m^{-3} (STEL)
Particular risks:	There is a risk of fire or explosion if the constituents are ground together. In 1923, the *School Science Review* reported an explosion when the mixture was ground. More recently, the HSE brought a successful prosecution against a college lecturer who allowed post 16 students to grind the mixture. The resulting explosion caused a serious injury to the students. There is also a risk from any attempt to compact the mixture and cause an explosion. The products of burning black powder are not clear-cut. Much of the sulfur combines with the potassium to form potassium sulfide. The odour of sulfur dioxide can be detected above the reaction but levels are very low. However, some asthmatics may be affected. If done with these quantities in an average sized school laboratory the WEL would be approached. Hence these quantities are suitable only for outdoor use. *Safety in Science Education (1996)* and *Hazcard* 82 state that black powder should not be made as it is "illegal without a license". *Safeguards in the School Laboratory (2006*) updated this information by stating that "making gunpowder is severely restricted in law" but it does not say it should not be made. This can be regarded as shorthand that a special risk assessment for making and using black powder is required. *The Manufacture And Storage Of Explosives Regulations 2005* requires that no more than 100 g can be prepared for analysis, testing, demonstration or experimentation without a license. The black powder must not be put to practical use.

Risk assessment

This demonstration must be carried out by an experienced teacher of chemistry. If other teachers wish to do it, they should by instructed by the experienced teacher and rehearse the procedure before performing it in front of students. Some element of student participation may be permissible (see below) but the whole activity must be regarded as a demonstration.

- **Do NOT, under any circumstances, grind the potassium nitrate with the sulfur and carbon – grind them separately.**
- **Do NOT MIX the components in a mortar – it would be too easy to be distracted and grind the mixture inadvertently.**
- **Do NOT use a metal spatula or similar to mix the components. Only mix the components by pouring them repeatedly from one piece of paper to another, until they are homogeneous, or from one plastic bag to another.**
- **Do not confine the mixture in any way.**

Procedure

- With the quantities involved, this demonstration is only suitable for outdoors. Do NOT carry out the demonstration on a windy day.
- The amounts quoted must not be exceeded.
- The teacher should wear goggles or a face shield.
- **The potassium nitrate must be ground by itself without any other chemicals. If the other substances need to be ground then separate mortars and pestles must be used.**
- **The chemicals must be weighed out separately. Pour the powders from one piece of paper (or from one plastic bag) to another until a homogeneous mixture is obtained.**
- The mixture should be placed on a heat resistant mat or equivalent. If desired, a gunpowder trail can be laid to the heap of powder.
- Students should be situated at least 3 m away and wearing eye protection.
- Teacher and students should be upwind of the demonstration area.
- To ignite the black powder, attach a wooden splint to a metre rule, light the splint and apply it to the solid. Once the powder ignites, take 2 steps back.
- Known asthmatics should not come close to the reaction when it is over to smell any products.
- After the demonstration, rinse mortars & pestles with water. Wash any residue off the heat resistant mat with plenty of water.

Possible student involvement

This activity could be demonstrated to students of any age.

With older students, there could be some student assistance in the demonstration. The extent of student participation depends on the number of students and the ability of the demonstrator to supervise them adequately. It also depends on how well known the students are to the demonstrator and her/his assessment of their reliability.

It is essential to ensure the instructions are followed to the letter and that there is no opportunity, for example, for illicit experimentation, theft or simple misunderstanding of the instructions.

- The demonstrator might choose to grind the potassium nitrate her/himself but allow students to grind the sulfur and carbon.

- With more reliable and/or better supervised groups, after the mortars (and any metal spatulas, etc) have been collected in, the demonstrator might permit the students to mix the components by pouring repeatedly from one piece of paper to another (or from one plastic bag to another).

- Once each student had prepared her/his mixture, each could be ignited in turn by the relevant student under the direct, close supervision of the demonstrator. Both would need to be wearing goggles or face shields.

Assessors:

R Worley MSc BSc PGCE — *Lead Chemistry Advisor*
Dr T P Borrows, MA, PhD, CSci, CChem, FRSC — *Director*

If further clarification is required, contact:
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Notes

COSHH stands for *Control of Substances Hazardous to Health*. The regulations require that an assessment of risk should be made before substances hazardous to health are handled.

The substances covered are the reactants, the products and any intermediate or side products that are very toxic, toxic, harmful corrosive or irritant. Just because a substance carries no hazard label does not mean that it is completely safe.

The *Management of Health and Safety at Work Regulations* require a similar risk assessment for substances with other hazard classifications or activities involving hazardous procedures.

WEL stands for *Workplace Exposure Limit*. Exposure should be either at the standard or preferably below. These values represent good practice. Should a substance carry a R45 (May cause cancer),R46 (May cause heritable genetic damage), R49 (May cause cancer by inhalation), R42 (May cause sensitisation by inhalation) or R43 (May cause sensitisation by skin contact) warning then exposure should be reduced to as low a level as is reasonably practicable. There are 2 limits. LTEL stands for long term exposure limit and is averaged over an 8 hour time weighted average (TWA) period. STEL is the short term exposure value and is averaged over a 15 minute TWA period. It is the value more relevant to schools. If a STEL is not specifically prescribed then the STEL for that substance is 3 times the LTEL value.