CLEAPSS SCHOOL SCIENCE SERVICE

Risk Assessment (to meet the COSHH and/or Management Regulations)

Applicant:	Education Manager (schools & colleges)
LEA/school	Royal Society of Chemistry
Operation:	Reaction of sugar with potassium chlorate

Details of operation

A mixture of sugar and potassium chlorate is ignited from a distance, using a wooden splint attached to a metre rule, on a heat-resistant mat inside a fume cupboard.

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

Substance(s) possibly hazardous to health:	(a) Potassium chlorate(V), $KClO_3$ (b) Sugar (sucrose). (c) Decomposition products
Classification under CHIP2 Regulations 1994	(a) oxidising: explosive when mixed with combustible material harmful: harmful by inhalation and if swallowed (b) – (c) ?
Particular risks:	See CLEAPSS *Hazcard 77, Potassium chlorate.* Bretherick's *Handbook of Reactive Chemical Hazards* (4th edition, 1990, Butterworth) states: "Potassium chlorate: Although most explosive incidents have involved mixtures of the chlorate with combustible materials, the exothermic decomposition of the chlorate to chloride and oxygen can accelerate to explosion if a sufficient quantity and powerful enough heating are involved..... *Potassium chlorate with Sugars:* A stoichiometric mixture with sucrose ignites at 159°C and has been evaluated as a rocket propellant. Dry powdered mixture with glucose containing above 50% chlorate explode under a hammer blow. Pyrotechnic mixtures with lactose begin to react exothermically at about 200°C, when the lactose melts and carbon is formed ..."
Maximum exposure limits:	-
Occupational exposure standards:	-

Risk assessment

Potassium chlorate(V) is notoriously unstable. The thermal decomposition of potassium chlorate(V) has been a common activity in school science in the past. Catalysed by manganese dioxide it demonstrates catalysis in a clear and striking manner, although problems have arisen when the manganese dioxide has been impure, or charcoal (very similar in appearance) has been used in its place. Nevertheless, the use of potassium chlorate(V) in schools is well established and guidance on safe use in some contexts is given on the relevant CLEAPSS *Hazcard*.

Any hazardous fumes from the reaction will be controlled by the use of the fume cupboard.

The proposed activity involves the reaction with sugar. The potassium chlorate *Hazcard* states that *These mixtures should not be made at all … sugar …unstable and dangerous mixtures are formed….* In *Safety in Science Education* (DfEE, 1996), the entry for potassium chlorate(V) reads **N** (not recommended) *mixtures with fuels such as sugar and hydrocarbons are dangerous*.

Most education employers use these texts as model risk assessments and thus expect teachers to follow the guidance therein. Nevertheless, the demonstration can be carried out safely provided that stringent safety precautions are observed and most education employers are likely to accept this special risk assessment.

1 **The activity must be carried out only by teachers who should practice it in advance. They must NOT be tempted to increase the scale of the operation.**

2 **Teachers must take steps to prevent theft of the chemicals, in case pupils are tempted to repeat the activity outside school.**

3 **The activity should only be undertaken by chemistry teachers with experience of successfully and safely handling a range of hazardous chemicals and procedures (eg, reduction of copper oxide with hydrogen gas, thermite reaction).**

4 **Wear a full face shield. Use a maximum of 2 grams of sugar and 2 grams of potassium chlorate. Use granulated sugar, NOT the finer caster or icing sugar. The sugar and chlorate are weighed out separately, and then mixed by pouring from one piece of paper to the other a few times. There should be no attempt to grind the potassium chlorate, nor to mix it in any way with the sugar, except by simply pouring the solid. In particular, do not mix or stir with a spatula or wooden splint.**

5 **An explosion is possible. The fume cupboard used must have safety glazing.**

6 **The fume cupboard sash should be as low as practicable. The teacher should ignite the mixture at a distance, using a lighted splint attached to a 1-metre rule.**

7 **Spectators must be standing several metres (at least 3 m) away from the demonstration, and should wear eye protection.**

8 **As impurities can cause an explosion, care should be taken to ensure that the potassium chlorate is reasonably pure (use reagent grade).**

9 **If the mixture fails to ignite, allow it to cool and then destroy the mixture by pouring into cold water, dissolving and flushing away. Any residue on the mat after the demonstration should be similarly washed away.**

10 **If there are any doubts about the chemicals or equipment, about the reliability of the class or the competence of the teacher, the demonstration must not proceed.**

Assessor: Dr Peter Borrows (Director)

If further clarification is required, contact: The School Science Service, Brunel University, Uxbridge UB8 3PH.

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