

Ionising Radiation

February 2022

Radioactive Waste Disposal

“Best Available Techniques” A BAT Policy and Guidance for University of Cambridge Departments

Occupational Health and Safety Service
HSD035R (rev 9)



**UNIVERSITY OF
CAMBRIDGE**

CONTENTS

Section	Topic	Page No
1	Introduction	3
2	How to Apply Best Available Techniques	3
	General Approach	
	Practical arrangements with examples	
3	University Approach to Applying BAT – A Three-Tier Approach	5
4	What Departments Need to Do in Practice	6
Appendix	Best Available Techniques – A Template for Departments	8

Note: any references in documentation to BPM (Best Practicable Means – used prior to 2010) should be replaced by BAT (Best Available Techniques). However, there is no significant change in the definition.

EXAMPLE EXTRACT FROM A PERMIT:



Permit with introductory note

The Environmental Permitting (England & Wales) Regulations 2016

**University of Cambridge
University Units
Cambridge
CB3 0JX**

**Permit number
EPR/MB3639DB**

Condition 2.3 - Operating techniques

2.3.1 The operator shall use the best available techniques:

- (a) to minimise the activity of radioactive material kept or used on the premises;
- (b) to minimise the period over which radioactive waste is accumulated;
- (c) to minimise the activity of radioactive waste produced on the premises that will require to be disposed of on or from the premises;
- (d) to ensure that all relevant parts of the premises are constructed, maintained and used in such a manner that:
 - (i) they do not readily become contaminated; and
 - (ii) any contamination which does occur can be easily removed;
- (e) to prevent:
 - (i) the loss of any radioactive material or radioactive waste; and
 - (ii) access to any radioactive material or radioactive waste by any person not authorised by the operator.

2.3.2 The operator shall use the best available techniques in respect of the disposal or radioactive waste pursuant to this permit to:

- (a) minimise the activity of gaseous and aqueous radioactive waste disposed of by discharge to the environment;
- (b) minimise the volume of radioactive waste disposed of by transfer to other premises; and
- (c) dispose of radioactive waste at times, in a form, and in manner so as to minimise the radiological effects on the environment and members of the public.

Radioactive Waste Disposal - Best Available Techniques (BAT)

A guide to implementation, and a framework for achieving compliance within Departments

1. Introduction

Under the conditions of the Permits issued to the University under the Environmental Permitting Regulations 2016, the University is committed to ensuring that *Best Available Techniques (BAT)* are employed to minimise the activity of disposed radioactive waste, minimise the volume of radioactive waste transferred to other premises, and, minimise the radiation effects of such disposals on the environment and on members of the public.

The University Radiation Protection Officer has been appointed to the University as both Radiation Protection Adviser (RPA) under IRR17 and Radioactive Waste Adviser (RWA) under EPR16.

The information in this publication provides a practical way forward for departments to prepare or update local 'BAT' arrangements. The documentation is also available on the web-site of the Safety Office. This document forms part of the overall policy of the University in terms of BAT as set out in the publication "Management of Work with Ionising Radiations" (HSD007R) and practical aspects of waste disposal are covered in the document 'Working Safely with Unsealed Radioactive Sources' (HSD010R).

2. How to Apply Best Available Techniques

a) General Approach

Applying BAT involves comparing options for (radioactive waste) process design and operation, in order to achieve the lowest practicable radiation dose to the public, using practices that are not grossly disproportionate to the levels of risk and the detriments involved in further reducing the risk.

This includes consideration of:

- a) Comparable processes
- b) Technological advances
- c) Economic feasibility
- d) Limits for additional installations in the existing facility and planned extension
- e) Nature and volume of emissions

Thus, the costs of applying BAT to a particular process should not be *grossly* disproportionate to the benefits derived from the process. The techniques should be those that are reasonably accessible to the user.

The hierarchy to be applied is prevention of any public exposure, followed by minimisation of other impacts of any radioactive waste unavoidably created in the process.

Note that BAT does *not* replace ALARP - the two principles must be considered together when planning or reviewing a process involving radioactive waste. In other words, a practice that results in minimal radiation exposure to workers simply by making significant discharges to the environment is likely to be inappropriate in terms of BAT. Similarly, a process that involves minimal discharges, but consequently results in high radiation exposures to workers, is unlikely to be seen as a justified and ALARP process.

The Environment Agency will ask for this evidence at times of inspection, and when new or revised applications are made to the Environment Agency for EPR 2016 Permits (open sources). Evidence of how BAT is employed by 'the user' to minimise public exposure and minimise radioactive waste transfers may also be requested by the Agency. The University clearly cannot complete its obligations in this area without departmental arrangements being in place to complement a central policy. Essential to the function of the overall policy are the local (departmental) organisation, arrangements and review processes, the framework for which is set out in this document.

b) Practical arrangements with examples of current best practice

The requirements for disposal of radioactive waste are set out in *HSD010R Working Safely with Unsealed Radioactive Sources*, and must be followed.

The principle of minimising volume and activity must be followed. Experiments should be optimised, so that the lowest activity is used for the experiment to be effective. Minimum quantities should be ordered, and shared between groups if possible.

Avoid secondary waste where possible. Prompt action in the event of a spill may help minimise volume of contaminated items.

The University design for radioactive facilities must be followed for any new build or significant refurbishment, and advice on standards of facilities is given at the time of audits.

Segregate waste where practicable, but take care not to increase staff doses – safety must be taken into account.

Drain disposals:

- For typical research work involving small amounts of shorter lived radioactive materials, drain disposal is a reasonably practicable option on the basis of adequate dilution, rapid dispersal and environmental assessments. Sub-permits will be agreed and issued to departments allowing disposal to drain where this is considered to be a practicable environmental option. All drains dispose via the local sewerage plant (which has a capacity in excess of 100m³ of effluent / day) and there is no fresh water drinking extraction downstream of the sewerage plant.
- When making drain disposals of waste, a certain amount of dilution is needed for both environmental and safety purposes, and dilution by large volumes of uncontaminated water is reasonably justified for many laboratory processes and washing of glassware.
- Drainage sinks are located with a reasonably short run to main drainage stacks to maximise rapid, copious dilution and for safety purposes.
- Accumulation of liquid waste for decay is not normally allowed (unless specifically agreed with the RWA) due to the risk of leaks and subsequent contamination of facilities.
- The use of sumps and drainage tanks are generally to be avoided, although are sometimes unavoidable (discussed with RWA at planning stages for new buildings).

Solid waste disposals:

- Only radioactive items should be disposed of in the radioactive waste route. Within reason, non-contaminated items must be disposed of to normal waste, but avoid direct handling and if any doubt as to whether items are contaminated, dispose of as radioactive waste.
- Storage of radioactive waste within laboratories is kept to a minimum (normally a week unless otherwise justified), transferred to a secure waste store and records are kept.
- The High Cross long term solid waste decay store is used to minimise activity of waste transferred.

Gaseous disposals:

- Specifically permitted for certain work and covered under a separate BAT assessment in consultation with the RWA.
- Filtration, decay or delay tanks and other abatement measures are used as far as practicable.

Clinical waste, scintillants, solvent or other hazardous materials:

- As for other waste streams, volumes and activities are minimised.
- Disposal of radioactive clinical and biohazard waste must be discussed with the appropriate advisers. Most scintillants and all other solvents require incineration due to non-radioactive hazardous properties.

3. University Approach to applying BAT – A Three-Tier Approach – Users, Departments and the University

BAT is expected to be an embedded philosophy within the management and operational culture of the organisation, and it must be demonstrable that it is as much part of the arrangements and future planning for use of radioactive substances as is the principle of ALARP in restriction of workers radiation exposures.

User level

As part of the risk assessment for work with radioactive substances, all existing ‘users’ must have written evidence demonstrating the decision making processes involved in BAT. Decisions made by users clearly have an impact on both the activity and volume of waste to the environment, so users have a responsibility to consider BAT at the planning stages of any new work. Supervisors should ensure that this is done.

Department level

All departments involved in work with radioactive substances include in their safety policy a statement outlining the Department’s commitment to BAT. Local arrangements are set out in Departmental documentation such as procedures and local rules, and a suggested BAT statement is appended to this document. The Head of Department retains overall responsibility for compliance with Permit conditions including BAT, but Departmental RPSs are appointed to ensure that rules are followed. The University RPA must be consulted over significant new work and radiation audits are carried out to ensure that departments have suitable arrangements in place. The Safety Office issues sub-permits with limits on disposal of waste via various routes and, at time of sub-permit review, disposal options are discussed with departments.

University level

Management of Work with Ionising Radiations (HSD007R) sets out University policy on BAT and this document supports the overall policy. The Safety Office manages a *long term solid waste decay store to aid in reducing activity. The RWA is appointed to advise departments on radiation protection including BAT.* Decisions on BAT are made taking into account knowledge of the (dose) effects to exposed groups of the public. These dose assessments are carried out by the Safety Office on a site-wide basis. The assessments of public exposure, carried out by or on behalf of, the Safety Office, have been calculated from the *highest permitted* disposals from each SITE of the University (Permit limits), and not those from individual departments or groups. Assessments have also been carried out based on *actual* disposals from each site over recent years. Although it is reasonably certain that this practical approach should be acceptable to the Environment Agency, we (and they) have to be assured that the significance of a new, or significantly changed individual piece of research, will not change the validity of the site assessments.

Is there a sensible limit to what we have to do? The Environment Agency state that the costs of applying BAT to a particular process should not be grossly disproportionate to the benefits derived from the process – this requires a balance of detriments in terms of radiation exposure (to the public) against other factors such as time, trouble and money. However, although the environmental (public dose) impacts of the University's activities in terms of radioactive disposals are very low, there is NO lower threshold, below which BAT need not be considered.

However at very low impacts, the effort that should be put in should not be excessive - and in practice the effort needed to achieve a sensible BAT outcome within the University is not difficult.

BAT vs ALARP? In implementing procedures that meet the requirements of BAT, radiation doses to employees and others must not be compromised, and the principles of BAT and ALARP must be complementary and considered jointly when setting up systems for radioactive waste disposal. Remember that the time and effort expended in revising and if necessary producing new departmental documentation should be 'proportional' to the very low environmental and public exposures that actually result from most departmental disposals.

4. What Departments Need to Do in Practice

(a) Users and supervisors must ensure that PRIOR risk assessments include BAT justification and demonstrate an understanding of the impacts of their proposed waste disposal activities.

(b) A BAT Statement/Policy must also be prepared by each department if this is not already covered in existing documentation. A template document is provided to enable departments to develop local arrangements. These arrangements must indicate the actions Departments will undertake in order for reasonable compliance with the principles of BAT to be met. These actions must be embedded in the departmental planning and strategic processes for use and disposal of radioactive substances.

In summary, there must be current and relevant (i.e. regularly reviewed) departmental documentation, and a **BAT CULTURE** that demonstrates:

- **JUSTIFICATION** for particular uses of radioactive substances, and minimisation of the quantities used and waste generated (activity and volume). Consultation with suitable Radiation Protection Advisers should occur as part of this process.
- **DECISION MAKING** - from design of a process, to final disposal, the principle of reducing disposals to the minimum possible (without incurring excessive cost), should be observed and demonstrable. Can waste be abated or decay storage used? Senior departmental management must be involved in the decision making process, and therefore need to be aware of the regulatory needs of EPR and BAT.
- **OPERATIONAL PROCEDURES** - including minimisation of contamination, carrying out monitoring, and, record keeping. Methods of measuring or estimating waste must be robust and reliable. Maintenance of plant and facilities to be appropriate.
- **APPROPRIATE FACILITIES** for work and waste accumulation/disposal within the department including abatement facilities, and decay storage if appropriate.
- **STAFF TRAINING** in management of radioactive substances, particularly waste generation and disposal.
- **REVIEW** - Processes and management arrangements must be considered periodically to ensure that they remain BAT in the light of developments in the work. For instance, are there possibilities of further abatement of discharges, and other continuing improvements to a process?

In practice, MOST of what is required should already be written into departmental Local Rules or other departmental documentation - However departments should regularly review this

documentation, update and clearly cross reference it into a concise BAT departmental policy document as part of Departmental policy and refer to it in the local rules.

Arrangements for BAT should be brought to the attention of users and supervisors of work with radioactive substances (with the authority of the Head of Department)

It is not advised that new and extensively rewritten BAT sections become *embedded* into existing sections of text within local rules, as local rules are specifically provided to meet the requirements of the Ionising Radiations Regulations 2017, in controlled and some supervised areas. BAT considerations are much wider than relating just to these designated areas, and the best Local Rules (and BAT arrangements) are those that are concise and focussed on the main points, rather than extensive documents that are unlikely to be of practical help 'at the bench'. Supporting reference information can often be held as intranet resources or as part of more detailed departmental safety manuals.

Summary of Departmental Actions:

In complying with the above actions, departments will contribute to demonstrating a proportionate response to the BAT requirement. At departmental level there should be a commitment to **"BAT... to become embedded within the management and operational culture of the organisation."** In other words, it is not just a matter of having impressive paper work – users and management must be aware of the BAT requirement and consider it alongside ALARP, when planning processes involving radioactive substances.

- Review/revise existing documentation – does it adequately reflect BAT?
- Assemble written arrangements for BAT, and if necessary, new documentation/procedures, using the template below to include the principles and actions set out above. The written documentation could be appended to Departmental procedures or local rules.
- Use the current forms available from the Safety Office website for new risk assessments and for worker registration.
- Involve all levels of staff in the decision making processes and ensure that the basic principles of BAT are understood.

APPENDIX: EXAMPLE Best Available Techniques Statement - Amend parts highlighted in yellow and other wording as appropriate

University of Cambridge Department of _____

The University of Cambridge is committed to the principles of BAT as stated in Radioactive Waste Disposal "Best Available Techniques": A BAT Policy and Guidance for University of Cambridge Departments HSD035R.

Contents

1. Justification	8
2. General management arrangements:	8
2.a) Operational techniques:	9
2.b) Training and supervision:	9
2.c) Facilities	10
3. Waste routes	10
3.a) Radiological Impact Assessments	10
3.b) Practical waste arrangements	10
3.c) Transfer to the University decay store and onward disposal	11
4. Decommissioning arrangements	11

1. Justification

The Justification of Practices Involving Ionising Radiation Regulations provide generic justification for the use of radioactive materials in research and educational activities. Cambridge University contributes to society through education, learning and research including biomedical research for advancement in science and medicine. Radioactive materials are used primarily as radiotracers in research and teaching and development of techniques for medical diagnosis. Justification continues to be kept under review for individual techniques and, as part of the risk assessment process in planning any new work, individuals must justify use of radioactive materials and consider less hazardous options. All proposed work has been justified on the above basis, and all current users confirm that the technique used for their research work is the only currently available technique given the sensitivity of the results required for the specific research purposes. Users will continue to keep this under review and continue to optimise techniques through development work, peer review and other available information. **More detail required – include individual justification statements for each area of work.**

2. General management arrangements:

As stated in University of Cambridge Health and Safety Policy, corporate responsibility for health and safety including environmental protection lies with the Council and the General Board of the University.

The Director of Occupational Health and Safety is responsible for directing University safety strategy in consultation with the health and safety committee structure, advising senior managers and executive officers of the University on safety matters and ensuring the effectiveness of the University health and safety committee structure and the implementation of the University Health and Safety Policy.

The University has appointed one or more Radiation Protection Advisers under the Ionising Radiation Regulations and Radioactive Waste Adviser under the Environmental Permitting Regulations to be consulted by the University on observance of these Regulations and advise and assist departments on matters relating to the use of ionising radiations.

The appointed RWA is qualified under RPA2000 and has the specific knowledge, experience and competence required for giving advice on the particular radioactive waste management and environmental radiation protection issues relating to work in the building.

The **Department of XXXX** is managed by the Head of Department who has management responsibility for ensuring compliance with Health, safety and environmental legislation, and is responsible for appointing to various safety roles, convening a Departmental Safety Committee, ensuring that regular safety inspections are undertaken, nominating and appointing appropriate individuals to identify hazards and control the risks through the preparation of risk assessments ensuring that there is a policy which sets out Departmental arrangements for:

- reporting accidents and incidents
- assessing and controlling risk
- providing induction and additional training.

Appropriate appointment of RPSs is made according to University policy and with advice from RWA/RPA. Arrangements for control of work, including planning any new work, induction and training are in place and set out in management procedures for the building and local rules for each supervised or controlled area.

Details of RPS Structure

Inspections are carried out by the departments and audits are carried out by the Safety Office monitoring compliance with laboratory standards and other permit conditions. Arrangements will be checked before work starts and the Department will be included in audit schedules.

A system of ordering radioactive materials will be implemented and strict control will be maintained in access to the building. The University procurement process ensures that radioactive materials cannot be ordered from external suppliers by unauthorised, untrained staff. Other acquisitions (mainly short lived materials) into the unit are strictly controlled, carried out by trained staff following written procedures and within the specified limits.

Refer to policy/procedures where the acquisition procedures are covered.

2.a) Operational techniques:

Waste is minimised by minimising activity ordered, sharing stocks wherever possible, planning work by investigating/using optimised techniques, practical training and carrying out dummy runs where appropriate to ensure sufficient training and avoid repetition, avoiding secondary waste by minimising contamination from the work (good laboratory techniques, facilities, regular monitoring and monitoring records). ***Details in section 5 of this document.*** Accident scenarios are documented in contingency plans and rehearsed on a regular basis. On a lab/group basis, written arrangements are in place in ***the Local Rules (specify section)*** for all procedural aspects of the work, both for normal work and reasonably foreseeable accident situations. Appropriate designation of areas under IRR17 ensures appropriate contamination control and minimises risk to the public in any normal work or accident situation.

2.b) Training and supervision:

The University's registration/training system requires training by a combination of taught courses and practical training (using an induction checklist and with reference to written procedures). All radioactive work is supervised by RPSs and their appointment letter includes monitoring compliance with both safety and environmental legislation. Training includes justification, definition of BAT and practical implementation, local procedures for accumulation and waste segregation, packing and record keeping requirements. ***Refer to written specific arrangements – local rules – specify section***

2.c) Facilities

The EA laboratory standards guidance was followed as a reasonable current standard with additional information from the Safety Office (though the EA document is no longer supported by EA, we understand that it is still accepted as a reasonable standard). *Details of bench, floor and wall surface products may be requested.* All products used are of a high quality in terms of cleanability and durability and design decisions represent current good practice. Radiation areas are designed with cleanable surfaces and good ergonomics, and areas are rationalised as far as is practicable (*DESCRIBE areas of work – details of room numbers and work areas*). Facilities are inspected routinely during local inspections and as part of Safety Office Audits. The Department has maintenance arrangements in place and commits sufficient resources to cover any necessary maintenance work relating to facilities and permit conditions. Storage facilities for radioactive materials are secure and as appropriate for each area of work including practical aspects such as temperature considerations. Local management ensures that all facilities, including material and waste storage areas are kept clean, tidy and well organised without accumulation of absorbent materials in areas where unsealed sources are used.

3. Waste routes *Include the following disposal routes as applicable*

Waste routes are decided in consultation with the RWA during planning of new work. The current waste routes for waste arising from work in the Department as follows:

Aqueous liquid waste: disposal to sewer directly from the building (IF KNOWN, outlet reference XXXXX). This is based on the radiological impact assessment and practical implications as outlined below. *IF KNOWN* total water consumption is XXXX cubic meters per annum so copious dilution will be achieved.

Solid waste: transfer for disposal either to the Safety Office decay facility for onward disposal to a contractor for incineration, or to Addenbrooke's hospital for incineration. Storage for decay under central management control minimises the environmental impact of eventual disposal, taking into account social and economic factors. Safety arrangements ensure that risks to staff are very low, and the store is effective in reducing doses to the environment for reasonable running costs.

Organic liquid waste: this is mainly scintillant waste, and is not disposed of to drain due to the hazardous properties of the scintillant materials, but are instead transferred for disposal either to the Safety Office decay facility for onward disposal to a contractor for incineration, or to Addenbrooke's hospital for incineration. As for solid waste, storage for decay under central management control minimises the environmental impact of eventual disposal, taking into account social and economic factors. Safety arrangements ensure that risks to staff are very low, and the store is effective in reducing doses to the environment for reasonable running costs.

3.a) Radiological Impact Assessments

Aqueous waste assessments are carried out by the RWA using the EA's methodology. Aqueous assessments for grouped isotopes are based on the requested permit limits but actual disposals will be lower. Permit limits are requested on the basis of known and reasonably foreseeable use of the building in the medium term (between 1 and 5 years).

3.b) Practical waste arrangements

Aqueous liquid waste

Aqueous liquid waste is disposed of to drain without delay and sink records are kept. A suitable disposal sink has been identified in the relevant work area. As stated in University policy, disposal to drain provides a safe route for disposal of these wastes, subject to any other (e.g. chemical) restrictions applying. Only the designated and labelled sinks or other approved (by the RWA) disposal points may be used. *Further details in section 5 of this document.* Wastes are washed down with plenty of running water and the sink should be monitored both before and after the disposal. Drain disposals must be recorded both on the usage and disposal sheet for the stock solution, AND on a local record kept close to the sink. Aqueous waste is not accumulated for decay prior to disposal to minimise the risk of secondary wastes arising from container leaks, but

there may occasionally be a need to accumulate small volumes of aqueous waste prior to disposal (on RWA approval based on risk assessment).

Solid and organic liquid waste

In laboratories, during work, solid and organic liquid waste is suitably double contained (bags within containers kept on benches or under benches as appropriate (*Details in section 5 of this document*), recorded and suitably labelled. Contamination control procedures are in place (*reference to section of LRs*) and all access to material and accumulated waste is restricted. Accumulated solid and organic liquid waste is then stored (double contained) within labelled containers and held within suitable, restricted access areas which have been identified close to working areas and which meet the laboratory standards requirements in terms of cleanable surfaces (segregation of short-lived, positron emitters and longer lived radioactive waste) (*Details in section 5 of this document*).

Liquid scintillant waste is not disposed of to drain due to the hazardous properties of the scintillant materials (the least hazardous and effective commercial scintillant compounds are used). Small volumes of scintillant waste are also contained within plastic trays/sample holders in addition to double containment provided by the waste containers. When transferred for disposal either to the *Safety Office decay store or to the Addenbrooke's incinerator (state which)*, containment is secure and the material transfer is supervised at all times.

All of the above measures ensure that the generation of primary and secondary radioactive waste is avoided as far as reasonably practicable.

3.c) Transfer to the University decay store and onward disposal *Add specific arrangements*

The store is managed by the Safety Office and operated under the conditions of an EPR permit and is subject to regulatory inspections by the Environment Agency. The use of the decay facility ensures that the activities of solid and organic liquid waste transferred for final disposal are as low as reasonably practicable. The transfer of material to the store is under full management control of the Safety Office, subject to a system of sub-permits (which form a contract between the department and the Safety Office) and subject to written arrangements for monitoring accumulation of waste and onward transfer, so letters of agreements are not considered to be necessary. Under the decay store permit, systems and facilities are in place for appropriate storage of waste and keep records for incoming material and onward transfer to a contractor for incineration after a suitable period depending on the half-life of the material.

4. Decommissioning arrangements

The University decommissioning policy and guidance will be followed in consultation with the RWA. The objective will be to achieve with compliance with relevant legislation at the time of decommissioning (currently to "out of scope" values under EPR16).

5. Detailed operational BAT specific to work

Describe how waste (activity and volume) is minimised at generation

At every step of the procedure, how is the user minimising both the volume and activity of waste that is generated

- Minimising activity ordered based on anticipated workload (and RPS checks)
- Sharing stocks where practical
- Stock/sample containment for storage and movement (or transport) – suitable containment
- Planning work – investigating and using optimised techniques
- Good laboratory techniques and avoiding secondary waste by minimising contamination from the work
- Practical training and carrying out dummy runs where appropriate to ensure sufficient training

- Containment trays, absorbent material (but minimise volume)
- Regular monitoring and monitoring records
- Spill kits, written contingency plans and rehearsal on a regular basis

Describe practical aspects of how waste is accumulated (lab and departmental waste)

- Segregation of waste to minimise accumulation times (long-lived materials not kept for long periods)
- No aqueous liquid accumulations
- Limited periods of solid/scint accumulation
- Accumulation optimised and managed (how?)
- Checks on accumulated waste (note if any conflict with staff doses – ALARP)
- All clearly labelled

Describe practical aspects of waste disposal

- Aqueous waste – dedicated sink, instructions and records
- Exclude entrained solids from aqueous waste (explain how)
- Gaseous – e.g. local filtration, activated charcoal trap

For all aspects of operational techniques...

- Ensure contingency plans in place and rehearsed
- Ensure clear written procedures – local rules (specify relevant sections) for all procedural aspects of the work – detailed instructions!
- Staff training, refresher training (ensure records refer to BAT)



Safety Office
Greenwich House
Maddingley Road
Cambridge, CB3 0TX

Tel: 01223 333301
Fax: 01223 330256
safety@admin.cam.ac.uk
www.admin.cam.ac.uk/offices/safety

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