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FIR/84 80/74/4	FEP/90 228/1502/1	FEP/90 49/1500/1
FEP/90 18/74/2	FEP/90 49/95/1	FEP/90 1/196/1
FEP/90 64/108/5	FEP/91 394/1500/2	FEP/90 50/1500/1
FEP/86 95/228/1	FEP/89 16/80/8	
FEP/89 10/31/1	FEP/91 16/49/1	

3 May 1991

To: All Chief Officers

Dear Chief Officer

DEAR CHIEF OFFICER LETTER 4/1991

Items

1. False alarms from automatic fire detection systems - Analysis of the AFO system at Poole Hospital.

2. Manual of Firemanship

3. The Road traffic (Carriage of Explosives) Regulations 1989

4. The Highways (Road Humps) Regulations 1990
   The Highways (Road Humps) (Amendment) Regulations 1990

5. Fatality Identification System

6. Fire service procedures for incidents on motorways

7. The electricity at work Regulations 1989

8. Guidance on the use of thermal cutting equipment

9. The Control of industrial major Accident Hazards (Amendment) Regulations 1990

10. The Control of Substances Hazardous to Health Regulations 1988 (COSHH)

11. The Reporting of Injuries, Diseases and Dangerous occurrences Regulations 1985 (RIDDOR)

12. Technical Bulletin 1/1990 - Paragraphs 7.1 - 7.3: Equipment testing procedures

13. Hazrad: Report by the working group on incidents involving Radioactivity.

Yours faithfully

Sir REGINALD DOYLE
Her Majesty's Chief
Inspector of fire Services

FALSE ALARMS FROM AUTOMATIC FIRE DETECTION SYSTEMS - ANALYSIS OF THE AFD SYSTEM AT POOLE HOSPITAL

1. As Chief Officers will know, the high rate of false alarms from Automatic Fire Detection (AFD) Systems tends to undermine the credibility of these systems in warning of genuine fires, and also wastes fire brigade resources. Surveys have been carried out previously in which the causes of false alarms have been assessed by attending fire brigade personnel or by the manufacturers or installers, but the causes are still not always clear, and false alarms remain a problem. This part of the letter gives details of a research project undertaken to determine the technical and other reasons for false alarms and their underlying causes.

Background

2. In 1986 the Home Office, in a joint project with the Fire Research Station and the Department of Health, undertook a programme of research to examine the characteristics of the analogue signals generated by the detectors of the then recently installed AUTRONICA "intelligent" AFD system at Poole Hospital and to look at the possible causes of "noisy" signals and at ways of preventing the consequent false alarms. Data was collected by a computer-based data collection system which was devised by the Fire Research Station and funded by the Home Office. A period of about 25 days of data, spread over 18 months, was collected and analysed by the Fire Research Station. The Department of Health provided general on-the-ground support for the project.

The System Studied

3. The system at Poole Hospital is monitored by four control units. Of the two panels included in this study one unit controls six loops of detectors and the other controls five loops. Data from six of these loops (three from each control unit) was collected. In the Poole Hospital installation the number of devices in each loop monitored varies from 30 to 88.

4. Each device in a loop can be interrogated individually by the control equipment. When interrogated the device sends a reply pulse whose duration is proportional to the output from the device. The system scans the loop, interrogating each device in turn. A single scan of the whole loop takes between five and seven seconds depending on the total number of devices and their current reading. In the Poole Hospital system two basic types of device are used, analogue and switched. Smoke detectors (either photo-electric or ionisation chamber) are of the analogue type, while all the other devices in the system are of the switched type. Switched devices can be heat detectors (fixed temperature or rate-of-rise), manual call points or special inputs (such as

alarms from other systems). The "switch" devices give only three reading levels, corresponding to on, off and fault. Although these three levels should normally be constant, in practice a small amount of "noise" can cause some variability.

5. In the system at Poole Hospital the occurrence of a single reading at the alarm threshold will not give an alarm. To obtain an alarm two consecutive readings must exceed the threshold. For a device connected to a loop, a reading below 32 is taken as a fault. Readings of 112 or greater on two successive scans are taken as an indication that a problem exists (which could be an incipient fire, or could be simply a detector in need of cleaning) and a pre-alarm warning is indicated. Readings of 128 or greater on two successive scans are indicated as a fire alarm.

The Results of the Research

6. At the time the project was undertaken the AFD system at Poole Hospital was still at an early stage of development. Improvements to the systems available to manufacturers have taken place since then and further work would be needed to confirm that the results obtained are typical of those of the analogue addressable systems on the market today. Notwithstanding this, the research has shown that, based on the data obtained from the monitored part of the Poole Hospital system, the false alarm rate for an "intelligent" AFD system can be expected to be very much lower than the average for a conventional hospital AFD system suggested by Department of Health figures (about 1 in 25 years for the Poole Hospital system compared with 1 per 10 years with a conventional system). This low false alarm rate appears to be due to the fact that the Poole Hospital system is both analogue (ie the signals produced by the detectors gave a measure of the smoke density or temperature rather than merely indicating an alarm or normal status) and addressable (ie each detector is identified by a unique address at the control unit), with some minimal intelligence (rather than any sophisticated pattern recognition), including a pre-warning of alarm, low-reading fault warning and the need for two consecutive warnings above alarm level to generate an actual alarm.

7. Methods have been demonstrated for analysing the data to estimate false alarm rates, identifying aberrant detectors and, by implication, recognising where a wrong detector type is present due to incorrect installation or later replacement of a detector head. These analysis techniques have subsequently been incorporated into the software design of the latest commercial systems to help to reduce false alarms to a minimum.

8. Observations have also found two cases of "noise" emanating from detector heads. Long-term drift of detector readings has also been observed, which a system with alarm pre-warning and low-reading fault warning should be able to deal with before the drift is in danger of causing a false alarm or of causing failure to detect a fire.

Further Action

9. The following action is being taken on the results of the research project:

(a) The British Standards Institution is reviewing BS 5839: Part 1 - Code of Practice for installation and servicing fire detection and alarm systems in buildings;

(b) The BFPSA has been approached for the trade's response to the results of the research; and

(c) The Department of Health has also been alerted to the research findings.

10. Brigades will wish to note the results of the study which predicts a much better than average performance from the type of AFD system installed at Poole Hospital.

11. There are no additional cost or manpower implications arising from this part of the letter.

Telephone number of contact: 071-273-2867

FIR/84 80/74/4

MANUAL OF FIREMANSHIP

1. The Manual of Firemanship Book 10 'Fire Brigade Communications and Mobilising' was published on 31 January 1991 and is available from Her Majesty's Stationery Office price £5.95 (ISBN 011 341000 X).

2. Brigades should note that there is a typographical error on page 130 and in the Index of the new Book 10. The reference to BS 5389 should be amended to BS 5839.

3. It is hoped to publish Book 8, 'Building Construction and Structural Fire Protection', later this year.

Telephone number of contact: 071-273-2637

File reference number: FEP/90 18/74/2

pt66.2

THE ROAD TRAFFIC (CARRIAGE OF EXPLOSIVES) REGULATIONS 1989

1. The Road Traffic (Carriage of Explosives) Regulations 1989 came into force on 3 July 1989 with the exception of Regulation 14 which came into force on 3 January 1990. The Regulations cover constructional and operational matters concerned with the carriage of explosives by road including precautions against fire and explosion, prevention of theft and unauthorised access, and supervision of vehicles. Interim guidance on the Regulations was issued to Chief Officers in Dear Chief Officer Letter 4/89, following the explosion of a vehicle at Peterborough on 22 March 1989 which resulted in the death of one firefighter and injuries to over one hundred people.

2. Explosives are classified in accordance with the Classification and Labelling of Explosives Regulations 1983. Annex 1 reproduces Schedule 1 to these regulations with annotations which brigades should find helpful. It will be seen that while no vehicle carrying explosives can be regarded as non-hazardous in the event of a fire or accident, major risk to firefighters will arise when dealing with vehicles carrying Division 1.1 explosives. Placarded vehicles may carry up to 16 tonnes of explosives.

3. The main provisions of the Road Traffic (Carriage of Explosives) Regulations 1989 are summarised below:

(a) <u>Regulation 8</u> requires that, subject to some exceptions, vehicles carrying explosives should be marked front and rear with an orange rectangle and on the sides with an orange diamond in accordance with Schedule 4 to the Regulations which is reproduced at Annex 2.

(b) Under <u>Regulation 10</u>, the driver or attendant of a vehicle must carry written information about the explosives load on the vehicle and have it available at all times. Officers should obtain this information as soon as possible and use it to assess the situation.

(c) <u>Regulation 12</u> describes the procedure to be adopted by the driver of a vehicle used for the carriage of explosives in the event of an accident. Further information on procedures in the event of an accident is given in the Approved Code of Practice that accompanies the Road Traffic (Carriage of Explosives) Regulations 1989, ISBN Number 0 11 885497 6.

4. Officers in charge of incidents will have to use their judgement in deciding what actions to take when dealing with a fire on a vehicle carrying explosives. In making such judgements, officers in charge should be aware of the comments made in the Report of the investigation by the Health and

Safety Executive (HSE) into the Peterborough Explosion. The Report, which was published in October 1990 makes it clear that when tackling fires on vehicles carrying explosives, a distinction must be made between fires that involve the load compartment and those that do not. Where the fire does not involve the load, such as a tyre fire or fire in the vehicle cab, priority should be given to extinguishing the fire before it spreads to the explosives load.

5. The Report goes on to state that where the fire involves the explosives load or is imminently threatening it, every possible effort should be given to the evacuation of the area. Only where this is for some reason clearly not possible, and where the rapid application of water would have a good chance, in the circumstances, of preventing an explosion, should an attack by firefighters be attempted. The HSE have advised the Home Departments that firefighters should not be committed unless they can be protected by an earth bank or other substantial structure at some distance from the vehicle since the incident at Peterborough strongly suggests that an unbuttressed double brick wall may not afford adequate protection.

6. Existing guidance in the Manual of Firemanship, Part 6 (Chapter 45) Section 2, is based on the premise that copious water supplies and a quick and resolute attack on a fire involving explosives will serve to avert danger. Water controls fire by excluding oxygen and by its cooling effect. In their Report, the HSE point out that explosives, by their nature, supply their own combustion oxygen and any cooling effect that might be achieved to the explosives by the application of water will be extremely limited when dealing with a transport incident because the weather resistance of the vehicle and the packaging will prevent the water reaching the explosives themselves. The Manual of Firemanship will in due course be amended to take account of this.

7. Chief Officers will wish to note that the Armed Forces are not subject to the requirement for vehicle marking but the Ministry of Defence, through its Explosives, Storage and Transport Committee, has agreed to adopt a similar placarding system.

8. Item A of Dear Chief Officer Letter 4/89 is hereby cancelled.

File reference: FEP/90 64/108/5

Contact point: (071) 273 3342

ANNEX 1
Item 3
DOOL 4/1991

SCHEDULE 1

Regulation 2(1)

THE DIVISIONS

1 Division	2 Division number
Substances and articles which have a mass explosion hazard.	1.1
Substances and articles which have a projection hazard but not a mass explosion hazard.	1.2
Substances and articles which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.	1.3
Substances and articles which present no significant hazard.	1.4
Very insensitive substances which have a mass explosion hazard.	1.5

Notes on Annex 1

Once fire reaches explosives:

- if Division 1.1 the entire load could detonate at any time without warning. The vehicle and anything else close by will be shattered, pieces flying in all directions like bullets. The blast will severely damage buildings in the surrounding area, causing further injuries. The flash and lobbed firebrands may start other fires.

- if Division 1.2 the load is more likely to burn and explode bit by bit with increasing intensity. The main problem will be flying fragments, possibly of different sizes, some fast, some lobbed and including firebrands, unexploded articles, self-propelled munitions. Some may explode or become armed on impact. There could be secondary fires.

- if Division 1.3 the entire load could burst into flames, often violently, at any time, without warning. The main danger is the intense radiant heat but there could be some explosion effects, flying firebrands as well as flame jetting.

- if Division 1.4 the effects would be much more limited though possibly still creating some hazard at closer distances.

- if Division 1.5 could behave like Division 1.1. Initiation is less likely but it may be a delayed effect.

SCHEDULE 4

Regulation 8

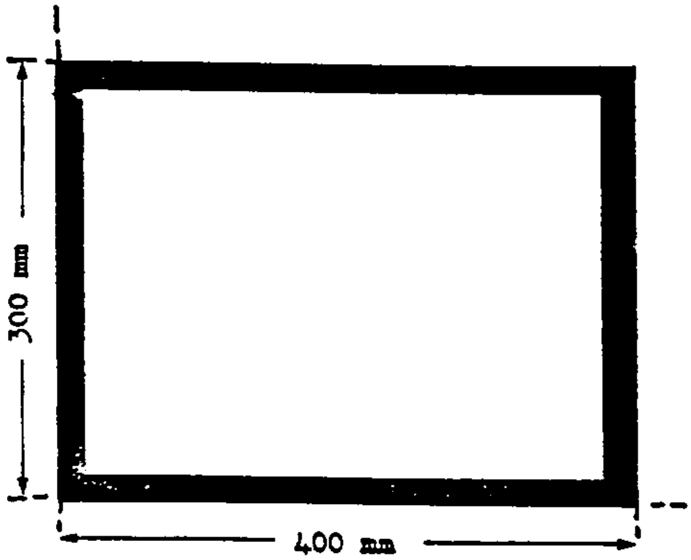
MARKING OF VEHICLES

PART I

REQUIREMENTS

1. At all times when explosives are carried–
   (a) two blank rectangular reflectorised orange-coloured plates conforming to the requirements of paragraphs 2 and 4 shall be affixed, one at the front and the other at the rear of the vehicle,
   (b) two placards conforming to the requirements of paragraphs 3 to 8 shall be affixed, one to each side of the vehicle, trailer, semi-trailer or freight container in which the explosives are actually carried.

2. Each plate referred to in paragraph 1(a) shall–
   (a) be in the form of the following diagram and comply with the measurements in the diagram, and



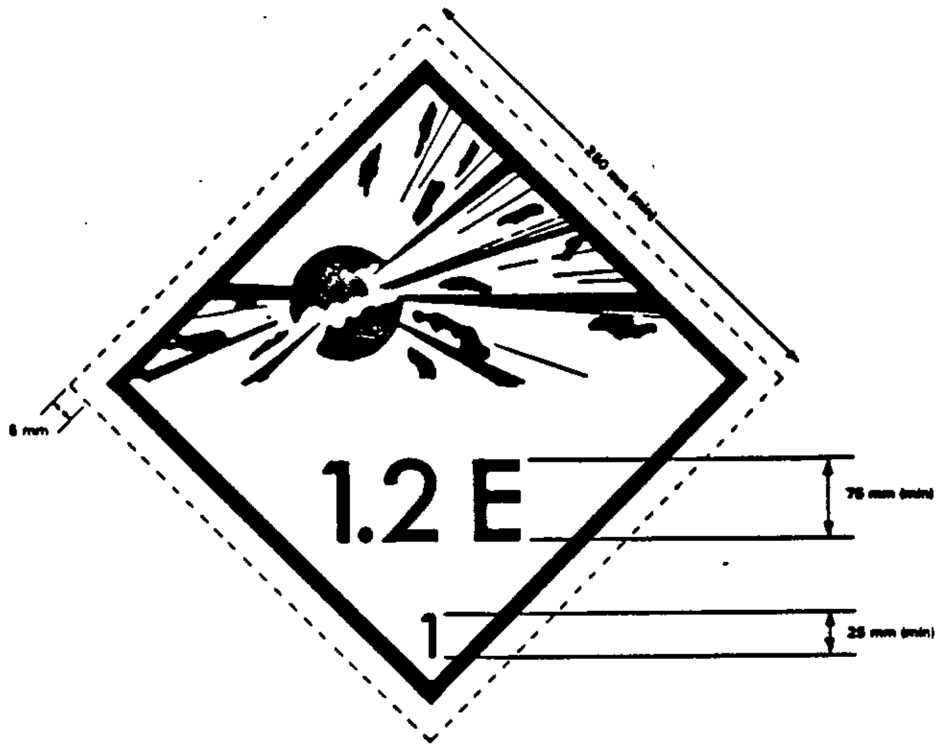
   (b) have a black border not more than 15 millimetres wide.

3. Each placard referred to in paragraph 1(b) shall–
   (a) be in the form of a square set with its side at an angle of 45° to the vertical, and
   (b) have an orange-coloured background with a black border; and any figure, letter or pictograph required by the following provisions of this Schedule shall be in black.

4. Each plate and placard referred to in paragraph 1 shall–
   (a) be clearly visible,
   (b) so far as is reasonably practicable, be kept clean and free from obstruction at all times when explosives are being carried, and
   (c) be completely covered or completely removed when all explosives have been removed from the vehicle, trailer, semi-trailer or freight container on which it was displayed.

5. In the case of explosives in Division 1.1, 1.2 or 1.3 each placard referred to in paragraph 1(b) shall–

(a) be in the form of the following diagram (the Division number "1.2" and the Compatibility Group letter "E" are only examples):



(b) comply with the measurements in the diagram except that larger measurements may be used in which case the measurements shall be increased proportionally;

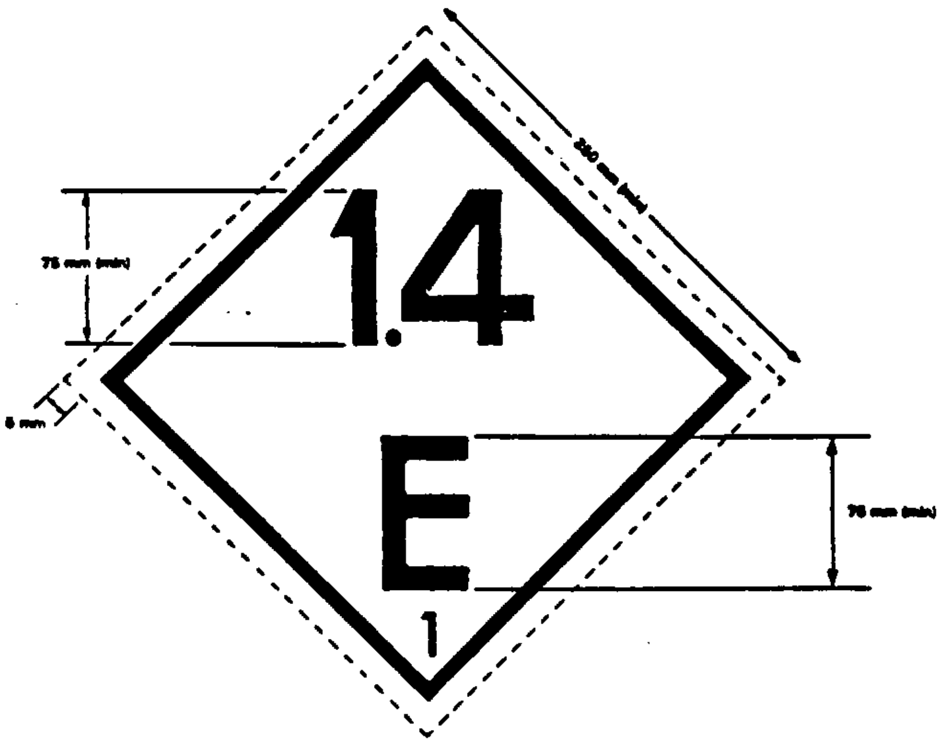
(c) have a pictograph of a bomb blast filling most of its upper half;

(d) have the Division number and Compatibility Group letter appropriate to the explosives being carried written in its lower half; and

(e) have the class number "1" written in its bottom corner below the Division number and Compatibility Group letter.

6. In the case of explosives in Division 1.4 or 1.5 each placard referred to in paragraph 1(b) shall–

(a) be in the form of the following diagram (the Division number "1.4" and the Compatibility Group letter "E" are only examples);



(b) comply with the measurements in the diagram except that larger measurements may be used in which case the measurements shall be increased proportionally;

(c) have the Division number appropriate to the explosives being carried written on its upper half;

(d) have the Compatibility Group letter appropriate to the explosives being carried written on its lower half; and

(e) have the class number "1" written in its bottom corner below the Compatibility Group letter.

7. In the case of a vehicle carrying explosives of different Compatibility Groups, no Compatibility Group letter shall be written on the placards.

8. In the case of explosives which are carried solely in connection with an application for their classification. each placard referred to in paragraph 1(b) shall–

(a) be in the form of the following diagram: and

(b) comply with the measurements in the diagram, except that larger measurements may be used in which case the measurements shall be increased proportionally.

PART II

EXCEPTIONS

9. Part I of this Schedule shall not apply where–

(a) the explosives carried are substances in Compatibility Group G not exceeding 1 kilogram in quantity;

(b) the explosives carried are in Compatibility Group B or are unclassified explosives not exceeding (in either case) 10 kilograms in quantity;

(c) the explosives carried are–

(i) explosives of a type marked with an asterisk in Part II of Schedule 1; or

(ii) smokeless powder in Division 1.3 (being the explosive substance allocated on classification the UN Number 0161),

and the total quantity of all explosives carried in the vehicle does not exceed 100 kilograms;

(d) the explosives carried are in Division 1.4 and (except in the case of explosives in Compatibility Group S) do not exceed 500 kilograms in quantity;

(e) the explosives carried are other than those specified in the preceding provisions of this paragraph and do not exceed a total quantity of 50 kilograms;

(f) the explosives are being carried for or in connection with the carriage of those explosives by sea, if the vehicle or any freight container on the vehicle is placarded in accordance with the appropriate provisions of the International Maritime Dangerous Goods Code issued by the International Maritime Organisation, as revised or re-issued from time to time: or

(g) the explosives are being carried for or in connection with the carriage of those explosives by air if the explosives are packaged and labelled in accordance with the appropriate provisions of the Technical Instructions for the Safe Transport of Dangerous Goods by Air issued by the International Civil Aviation Organisation.

10. While the vehicle is being loaded or unloaded–

(a) paragraph 1(b) of this Schedule shall not apply,

(b) sub-paragraphs (a) and (b) of paragraph 4 of this Schedule shall not apply to the orange-coloured plate at the rear of the vehicle.

THE HIGHWAYS (ROAD HUMPS) REGULATIONS 1990
THE HIGHWAYS (ROAD HUMPS) (AMENDMENT) REGULATIONS 1990

1. Chief Fire Officers will be aware that the above regulations (SI1990 Nos 703 and 1500) came into force on 13 April 1990 and 22 August 1990 respectively. The revised regulations, which supersede earlier regulations, allow greater flexibility in both the siting and shape of road humps.

2. The regulations themselves do not require a Road Highway Authority to consult a Fire Authority when road humps are being proposed for a road. However, in the guidance notes issued to all Local Authorities in England and Wales (Circular Roads 3/90 DOT and Circular 54/90 Welsh Office) the DOT advises that wide consultation with local road users should take place and that the local fire service should always be consulted.

3. A copy of the DOT Traffic Advisory Unit's Advisory Leaflet 2/90 is attached at Annex A.

4. This item is for the information of Chief Fire Officers. There are no cost or manpower implications.

FEP/86 95/228/1
Telephone number of contact 071-273-3942

FATALITY IDENTIFICATION SYSTEM

Introduction

1. In the investigation report by Mr Desmond Fennell OBE QC into the Kings Cross underground fire, the recommendation was made (No 153) that a uniform documentation procedure for handling and receiving fatalities should be considered. All emergency services should agree a common system for identification of fatal casualties and recording the position in which these are found.

2. London Fire and Civil Defence Authority have already introduced a system of tagging bodies and this was proved effective at incidents which have occurred since Kings Cross.

3. The statutory responsibility for body identification lies with the police and coroner's office. Brigades should give every assistance to these agencies in the execution of their duties at fires and other incidents. There will, however, be occasions when fire brigade personnel will be the only service able to reach bodies and casualties because of dangerous structures, toxic gases, working conditions etc, and the following tagging system is recommended for adoption by brigades in order to assist in identification and continuity of evidence.

4. Whilst in itself the fatality identification system (FIS) will not identify the body, the initial information recorded will assist other agencies in this task. In addition, it will enable officers in charge to manage the location, handling and removal of bodies in an accurate, well-documented and professional way. The advice given in the Manuals of Firemanship Book 4, Part 1, Chapter 6, Paragraph 8, and Book 12, Part 1, Chapter 4, Paragraph 6, is still applicable.

Tag construction

5. FIS tags each have a unique serial number measuring 270 x 105 millimetres. A different range of numbers is allocated to each command or division. They are manufactured from a reflective, water impervious material resistant to a high degree of wear and tear without loss of integrity.

6. The tage is perforated at the top and middle and a 5 millimetre diameter hole punched at the bottom (see Appendix A). FIS tags should be completed by using special permanent water resistant marker pens.

7. The non-duplication of numbers is important as experience at previous disasters has shown that it is possible for different bodies to be given the same number. The initials or

name of the brigade should be clearly printed on both sides of the body tag portion of the FIS. Other organisations may then make use of the same FIS number throughout the recording process from incident to coroner's office.

8. The tag is attached to the body or torso by the use of plastic cable/type securing strips and can be connected together to form any length required. The strip must be secured to the body in such a way that the large tag number is face uppermost. It should be firmly fixed to the body and attachment to clothing is to be avoided.

Operational use

9. The officer in charge of an incident will be responsible for initiating use of FIS, where in his professional judgment, the use of body tags will assist in body identification at a later stage.

10. When it becomes apparent to the officer in charge that the incident requires the introduction of FIS, he will nominate an officer (or officers, depending on the number of bodies) to carry out this task. It will be normal for the officer to collect the FIS wallet from the division or brigade control unit and if possible be allocated a personal radio.

11. As soon as operational conditions permit after the discovery of a body the FIS officer should proceed to the location of discovery (or BA entry control point if the discovery is made by a BA crew) to complete the details on the tag. The location of the body should be marked on a sketch plan drawn in the area provided in the FIS folder (see Appendix B).

12. The FIS officer should obtain the following information (where possible) from the crew/firefighter making the discovery and complete as much detail as possible.

(i) Sex Male ( ) Female ( ) Child ( ) Unknown ( )	Identify the sex whenever possible and tick the appropriate box.
(ii) Recorded time	The time of discovery and, if different, the time of recording in brackets (use 24 hour clock).
(iii) Date	The date of the discovery.
(iv) Officer	The rank, name and station number of the individual making the discovery or, where this information is not available, the officer completing the tag.

(v) Location — As exact a location as possible of the area in which the body was discovered. (Use of the plan area of the FIS folder will further assist this task.)

13. The top and bottom parts of the tag should be completed by the FIS officer then the bottom part detached and by use of the plastic securing strip secured to the body. It is quite likely that any clothing on the body may be subsequently removed and therefore should not be used as part of the tag securing procedure.

14. Once the body has been certified and photographed the corresponding boxes can be ticked off. This can be done at a later stage in operations, and must not delay the initial tagging of the body.

15. There will be instances where a body will need to be removed before being certified and/or photographed. Under these conditions the boxes marked NO should be ticked, to identify that these procedures have not been completed.

16. Once all the bodies have been tagged the top parts of the tag should be taken to the control unit and brought to the attention of the officer in charge. It might be useful if the information on the position of bodies found was transferred to the incident diagram if available in the control unit. Reference to the sketch plan in the FIS wallet will aid this task.

17. When a body is being removed from the incident, it is the responsibility of the FIS officer to inform the officer in charge of the incident and liaise with the police as to where the body is being removed to, ie hospital, mortuary, holding area, etc. This information should be recorded on the top part of the tag.

18. The design and reflective nature of the FIS tag will allow the body number to be clearly identified in any subsequent photographs. Experience has shown that this will be extremely helpful in providing evidence and information for accident investigations or public inquiries. It is therefore important that at the conclusion of the incident, top sections of all used FIS tags are to be retained at brigade headquarters to assist in preparation of reports.

<u>Body bags</u>

19. The decision to move bodies other than for urgent operational reasons should only be taken after consultation with the senior police officer in attendance. If it is decided that a body should be removed, the FIS tag is to be completed as previously detailed and then the body may be placed in the body bag.

Conclusion

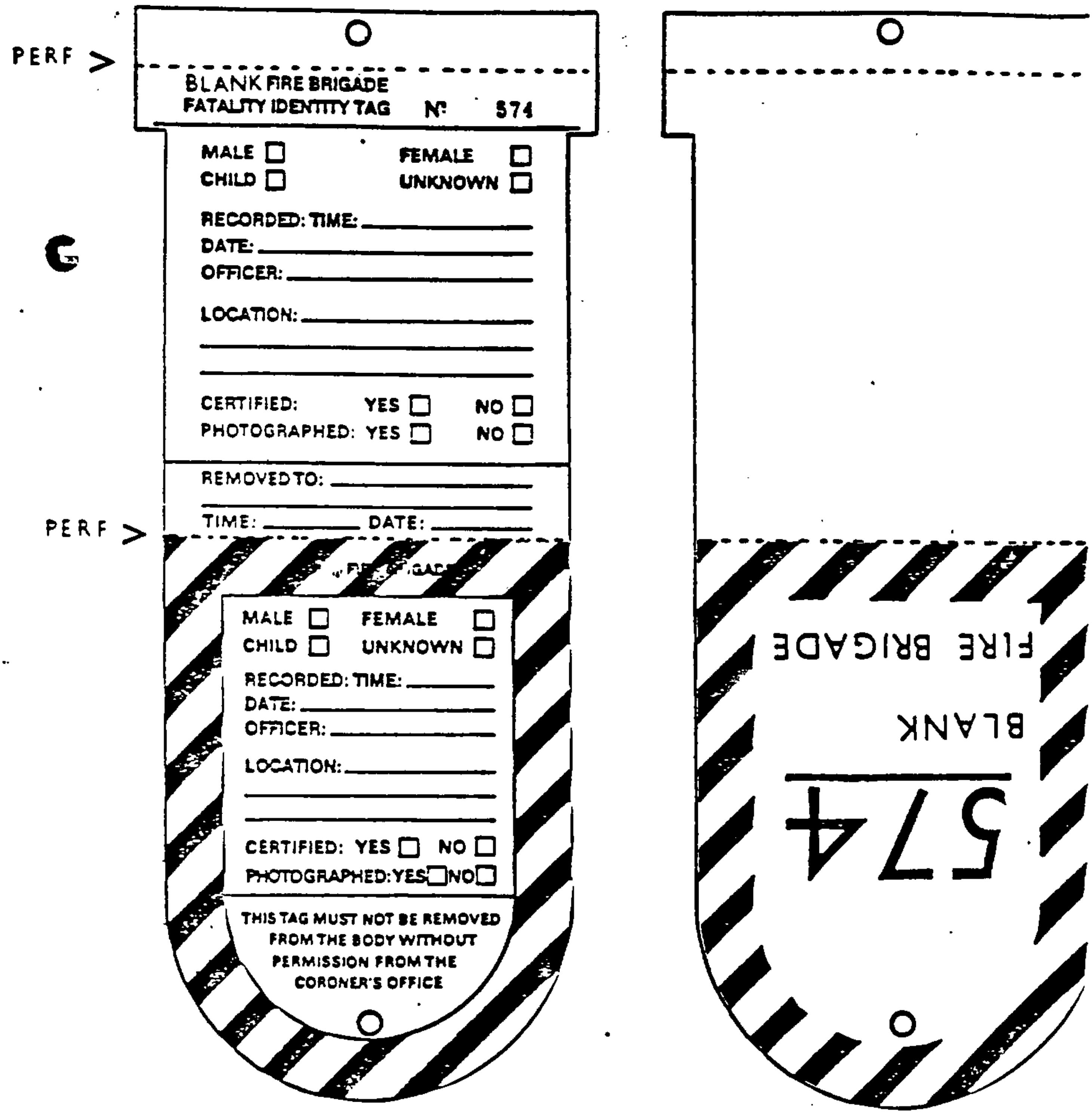
20. There is no mandatory requirement for brigades to provide FIS tags but experience at major disasters has shown the need for this type of system. Consultation has taken place with ACPO and the system has been generally accepted in principle. If brigades decide to adopt this scheme they should liaise with their local constabulary, in order to avoid any confusion or misunderstanding should a major incident occur.

21. There are no manpower implications arising from this guidance. There will be minimal cost implications if brigades decide to adopt the system.

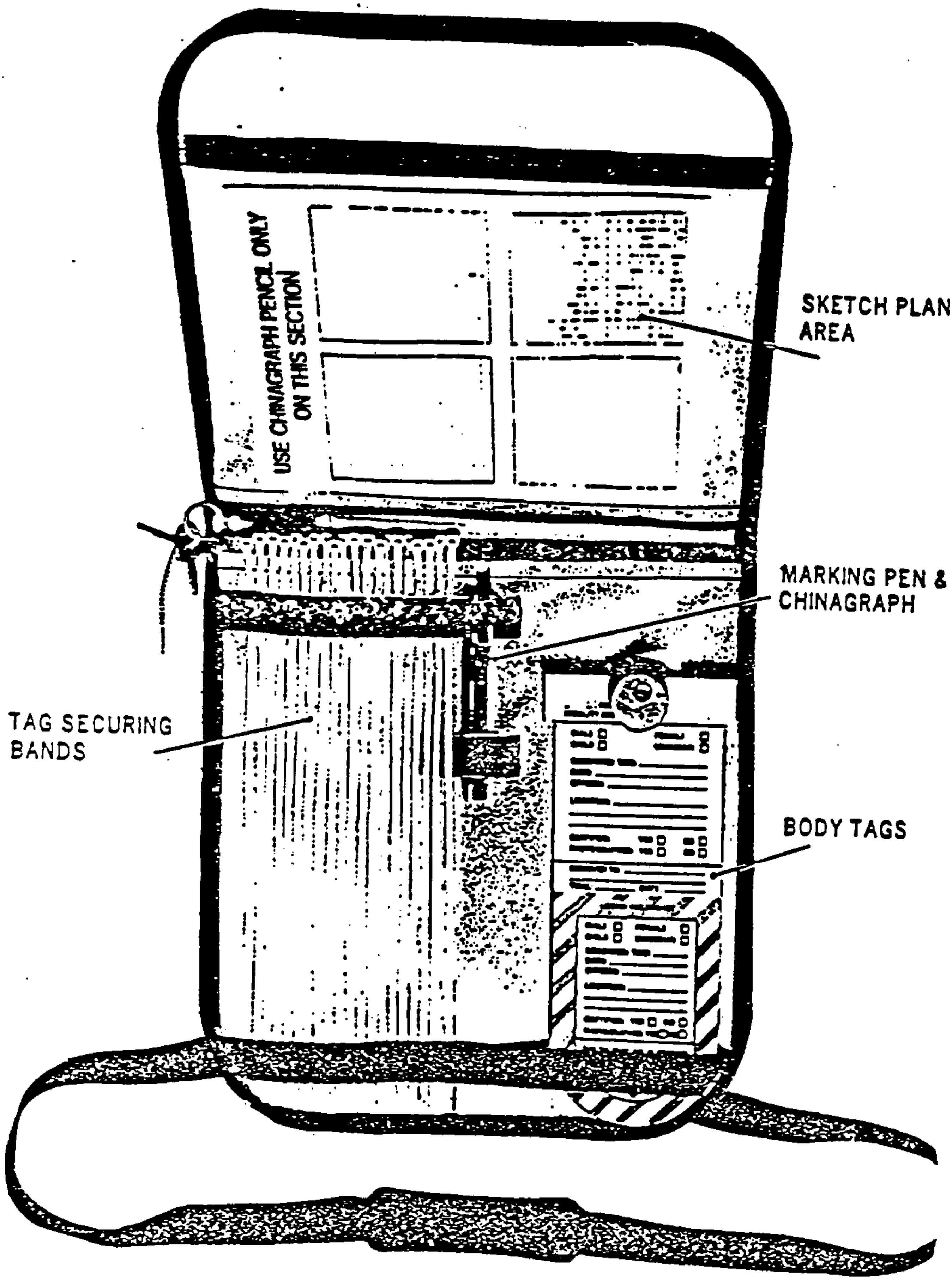
FEP/89 10/31/1

Telephone contact number: 071-273-3942
or 071-273-3501

Appendix A
Item 5
DCOL 4/1991



FATALITY IDENTIFICATION SYSTEM FOLDER



FIRE SERVICE PROCEDURES FOR INCIDENTS ON MOTORWAYS

1. The Police Standard National Motorway Manual 1989 which gives detailed instructions to police officers about procedures on motorways, includes instructions on procedures following accidents on motorways.

2. It has been noted that there are certain discrepancies between the instructions given to police officers and the guidance given to the fire service in the Manual of Firemanship Book 12, pages 57-61.

3. Chief Fire Officers will need to be aware of these discrepancies which are outlined below.

(i) The police cars positioned as a warning to approaching traffic will be 50 metres from the obstruction and not 25 metres as stated in Chapter 3, section 5 and figure 3.3. page 58. When the police are not already in attendance and fire brigade appliances are positioned to warn approaching traffic (section 6(a) (2), page 58) it is recommended that they be placed at a similar distance from the obstruction.

(ii) The following sentence which appears in section 5 page 57 should be deleted:-

"However if the damaged vehicle nearest the approaching traffic is light in colour, the police car may be placed on the hard shoulder, slightly to the rear of the incident with the blue roof warning light flashing and the headlights directed on to the light coloured vehicle".

(iii). Figure 3.3 page 58 shows that coning by the police will begin 100 metres before the obstruction. This should be 100 metres <u>per lane</u>. For example, if the obstruction covers two lanes, then coning will commence at 200 metres.

(iv). If traffic cones are carried and used by the fire service, cone marker lamps should be used in poor visibility or after dark.

(v). Figure 3.3 page 58 shows that where the obstruction occurs in the middle lane of a three lane motorway, the middle and left hand lanes should be cordoned off. The procedure followed by the police which should now be adopted by the fire service is that, where the obstruction is in the middle lane, the middle and right hand lanes should be cordoned off, leaving the inside lane and hard shoulder as running lanes. (In certain circumstances it may be necessary to reverse this procedure, for example, when there are stationary vehicles on the hard shoulder in close proximity to the incident).

(vi). Under no circumstances must an island be formed in the centre of the carriageway with traffic passing in the same direction on either side of the obstruction.

(vii). The Police Motorway Manual observes that excessive use of emergency warning lights at an incident can have an adverse effect on the traffic in the unaffected carriageway. It is suggested that only the rearmost vehicles, protecting the scene, should display warning lights to the traffic in the affected carriageway only.

4. Amendments will be made to the Manuals of Firemanship in due course to bring fire brigade procedures in line with those of the police.

5. This item is for advice only. There are no cost or manpower implications.

FEP/90 228/1502/1
Telephone No of Contact: 071-273-3942

THE ELECTRICITY AT WORK REGULATIONS 1989

1. The Electricity at Work Regulations (SI 1989 No 635) came into force on 1 April 1990. The Regulations are available from HMSO in the usual way. The Health and Safety Executive (HSE) recommend also their 'Memorandum of Guidance on the Electricity at Work Regulations 1989' (ISBN 011 8839 632), which they say reproduces the regulations and in addition provides a commentary.

2. The following guidance deals only with fire service operational matters. A Technical Bulletin on fireground electrical equipment etc is being prepared.

3. References in the Manuals of Firemanship to working in the vicinity of electrical installations etc are also currently being revised, but the guidance itself, including that relating to the rescue of persons in contact with or closely adjacent to electrical wiring or equipment, is sound and remains in force. That guidance should be followed.

4. The Regulations pose no particular difficulties for firefighting or rescue operations and they are compatible with current guidance. Those regulations which are of particular significance to the fire service are examined below.

EXTENT OF DUTIES UNDER THE REGULATIONS

Regulation 3(1)(a)

5. This Regulation provides that:-

> '3 - (1) Except where otherwise expressly provided in these regulations, it shall be the duty of every -
>
> (a) employer and self employed person to comply with the provisions of these regulations in so far as they relate to matters which are within his control'.

6. Attention is drawn to this regulation which provides that an employer is to comply with the provisions of the regulations in respect of 'matters which are within his control'. It will frequently be the case that fire service personnel will attend incidents at premises where it will be the responsibility of the owner/occupier to comply with the provision of the regulations. In these situations, compliance will be largely outside the control of the brigade, however there will remain a responsibility on the brigade to comply with the provisions of the Regulations in so far as they apply to the actions taken by the brigade.

HAZARDOUS ENVIRONMENTS

Regulation 6(d)

7. This Regulation provides that:-

> '6. Electrical equipment which may reasonably foreseeably be exposed to -
>
> ...
>
> (d) any flammable or explosive substance, including dusts, vapours or gases,
>
> shall be of such construction or as necessary protected as to prevent, so far as is reasonably practicable, danger arising from such exposure'.

8. The term 'reasonably practicable' should not be construed as meaning that all hand held radio equipment and hand lamps used in the fire service must in all circumstances be of types certified as safe for use in flammable atmospheres. The term does, however, imply that brigades should make provision of some protected hand held radio equipment and hand lamps for use where it can reasonably be foreseen that such equipment will be exposed to flammable or explosive atmospheres.

9. Non protected hand held radio and hand lamps may continue to be used, but not in circumstances where they will foreseeably be exposed to flammable or explosive atmospheres. In general, such equipment can be considered safe in use at incidents where fire is present.

10. Lamps designed for use with breathing apparatus and breathing apparatus communications equipment (including radio interface equipment) and Distress Signal Units manufactured in accordance with CFBAC specifications or recommendations are protected and can therefore be considered safe in use both at fire incidents and in flammable atmospheres.

WORK NEAR ELECTRICAL EQUIPMENT

Regulation 4(3)

11. Regulation 4(3) states:-

> '4(3). Every work activity, including operation, use and maintenance of a system and work near a system, shall be carried out in such a manner as not to give rise, so far as is reasonably practicable, to danger'.

Regulation 14

12. Regulation 14 states:-

> '14. No person shall be engaged in any work activity on or so near any live conductor (other than one suitably covered with insulating material so as to prevent danger) that danger may arise unless -

(a) it is unreasonable in all the circumstances for it to be dead; and

(b) it is reasonable in all the circumstances for him to be at work on or near it while it is live; and

(c) suitable precautions (including where necessary the provision of suitable protective equipment) are taken to prevent injury'.

13. The requirements of these Regulations will in general be satisfied by observance of guidance contained in the Manuals of Firemanship, existing brigade orders and general brigade training. The principle to be observed is that in most circumstances where there is likely to be an electrical hazard in the course of firefighting or other operations, the electrical supply should be shut off and/or arrangements made to secure the attendance of the electrical supply companies where appropriate for the purposes of isolating equipment. Where, for any reason, necessary isolation is not immediately practicable, officers in charge should exercise judgment as to what urgent tasks, including search and rescue operations, should be undertaken in proximity to any electrical hazard.

14. Other precautions to be taken include where possible the avoidance of the use of water near live electrical wiring or equipment and exceptionally the use of insulated gloves where necessary.

Regulation 15

15. Regulation 15 states:-

'15. For the purposes of enabling injury to be prevented, adequate working space, adequate means of access, and adequate lighting shall be provided at all electrical equipment on which or near which work is being done in circumstances which may give rise to danger'.

16. This regulation is likely to impinge on fire brigade operations mainly in respect of the requirement to provide adequate lighting. Officers in charge may need to consider whether additional lighting is appropriate.

17. There are no manpower or cost implications arising from this item.

FEP/90 49/95/1
Telephone contact number 071-273-3942

GUIDANCE ON THE USE OF THERMAL CUTTING EQUIPMENT

1. PROCESS DESCRIPTION

A variety of thermal cutting equipment has been developed and is now available for use in fire brigades. The processes utilised include flame cutting, arc cutting and thermic lancing or boring. The essential difference between the processes is that flame and arc cutting utilise an electric arc and oxygen to melt the metal whilst thermic lancing or boring utilise the reaction between iron, in the form of mild steel rods contained in a hollow tube, and high velocity oxygen flowing through the tube, which when heated at its tip form oxide and slag with the resultant cutting action.

The processes form a versatile system able to cut both ferrous and non ferrous metals as well as non metals such as concrete, glass, plastics, ceramics and composite materials.

2. PROTECTIVE CLOTHING

Thermal cutting is obviously a potentially dangerous operation involving hazards such as intense light, sparks, spatters of molten metal and toxic fumes. Hence there is a requirement for suitable protective clothing to be worn by personnel who are either using the equipment themselves or who may be in the vicinity of any operation. Such a requirement would apply to both fire brigade personnel and others, for instance medical personnel or casualties who may be trapped.

2.1 RESPIRATORY PROTECTION

Appropriate respiratory protection should be worn at all times by those personnel engaged in operating the equipment. Where necessary, others in the vicinity of operation may also require protection.
Depending upon the circumstances of the incident this protection should comprise either self contained or air-line breathing apparatus, or alternatively a suitable HSE approved respirator or air fed helmet with filter.

Full face mask respirators should conform to British Standard 7355:1990 (EN 136:1989) and half masks to British Standard 7356:1990 (EN140:1990). These should be used in conjunction with a suitable filter conforming to EN141. (NOTE: An equivalent British Standard Number is awaited.) It is essential that when selecting a filter confirmation is sought from the supplier or manufacturer that it is suitable for the intended purpose, given the considerable dust and vapour that may be produced during a cutting operation. When selecting the appropriate respiratory protection it should be recognised that working in a confined space may be particularly hazardous.

Even when working in well ventilated areas certain metal fume, for example oxides of zinc or cadmium may be produced which are toxic even in small quantities. Indeed, it may not always be possible to identify the material being cut and therefore the possibility of such especially toxic fume production should be borne in mind and breathing apparatus used where appropriate.

2.2 EYE PROTECTION

Appropriate eye protection should also be worn at all times by personnel engaged in thermal cutting and other personnel in the vicinity as appropriate.
This eye protection should conform to BS 679: "Filters, cover lenses and backing lenses for use during welding and similar operations", and where appropriate, BS1542: "Equipment for eye, face and neck protection against non ionizing radiation arising during welding and similar operations."

It is probable that a shade number between 4 and 7 according to BS679 will be suitable for equipment likely to be used by brigades, but confirmation of a suitable shade number for the filter should be sought from the supplier of the equipment.

It is possible that in some circumstances both breathing apparatus (or a full face mask) and eye protection may need to be worn and suitable provision should be made for such a situation. Such a provision for example may take the form of a tinted visor which fixes to the BA facemask, or the incorporation of a suitably tinted visor with an anti flash hood. Any such provision of tinted visor to the BA facemask would of course require HSE approval.

2.3 BODY PROTECTION

It is unlikely that firefighting kit will provide adequate protection from molten metal and slag produced during thermal cutting operations.

Accordingly additional protective clothing should be available. This should consist of long sleeved jacket, trousers or apron, gloves or gauntlets and safety shoes with gaiters or foundry type boots.

Where applicable such clothing should conform to BS2653 : "Protective Clothing for Welders."

3. EQUIPMENT

Whilst it is recognised that there are various types of thermal cutting equipment available the following advice is of a general nature and is applicable to all such equipment.

3.1 Brigades should ensure that the suppliers of the equipment provide comprehensive operating and maintenance instructions, together with any special precautions relevant to the particular piece of equipment.

3.2 Where maintenance of the equipment is to be undertaken other than by the supplier this should be conducted by a competent person and where any difficulties are encountered reference should be made to the suppliers or manufacturer.

3.3 Equipment should be visually inspected on acceptance, quarterly and after any use. It is particularly important that close attention should be paid to the condition of the hoses and associated connections for signs of wear and/or damage.

3.4 As with all equipment utilising oxygen, it is essential that scrupulous cleanliness is observed, particularly to avoid any oil or grease contamination, when dealing with any components that may come into contact with oxygen. Personnel should ensure that hands or protective clothing are free from oil or grease contamination, particularly when handling components on the fireground.

3.5 It is essential that training is conducted for operators proposing to use the equipment and this training should encompass not only the use of the equipment, but the safety precautions and any maintenance procedures that are necessary for the safe operation of the equipment.

4. OPERATING PROCEDURES

It is essential that brigades proposing to use thermal cutting should produce a written document covering the operation of the equipment and the items identified below are provided as a guide to those aspects which should be covered.

4.1 Thermal cutting is, as a minimum, a two person operation with one operating the equipment and the other ensuring the safety of the site and available to shut off the oxygen supply in an emergency. Other personnel may of course be present in the vicinity of the operation, for example to render first aid to a casualty, but in such circumstances it must be recognised that protective clothing for these persons may be necessary.

4.2 The working area should otherwise be kept clear of non-essential personnel.

4.3 Where practicable the area of work should be kept clear of combustible material, bearing in mind run off of hot metal and slag may take place. Provision should be made for the channelling or damming any possible slag run off to avoid any potential hazard or damage. Heat conduction along steelwork should also be considered.

4.4 Appropriate fire fighting equipment should be available in the vicinity of the thermal cutting operation.

4.5 A continual assessment of the safety of the working environment should be made to ensure that personnel are not subject to additional hazards eg. the stability of a building may be affected by the cutting of structural steelwork.

4.6 The protection of any casualties from the effects of thermal cutting should be considered and provision made for both respiratory and bodily protection where this is considered necessary.

4.7 The possibility that a leakage of oxygen from the cutting equipment may give rise to an oxygen enriched atmosphere during a thermal cutting operation should be borne in mind. Such an oxygen enrichment of the atmosphere will cause combustible material and protective clothing to both ignite more readily and burn more rapidly and therefore the release of free oxygen from leaks on equipment should be avoided.

4.8 Care should be taken to avoid damage to oxygen hose due to mechanical damage caused by dragging over debris, rough ground etc.

4.9 Thermal cutting should never be conducted on vessels or containers under pressure or which contain flammable solvents or the residue of flammable solvents or in close proximity to such containers.

4.10 Care should be exercised when cutting low melting point metals since excessive spatter may occur and with other metals eg magnesium alloy greater care should be taken since more vigorous reaction may occur.

5. This item is for guidance. There are no cost or manpower implications.

File No: FEP\91 394\1500\2
Telephone contact number: 071-273-3114 or 071-273-3942

THE CONTROL OF INDUSTRIAL MAJOR ACCIDENT HAZARDS (AMENDMENT) REGULATIONS 1990

In my letter of 27 March 1985 (Dear Chief Officer Letter 3/1985, item E), I gave a brief outline of the contents of the Control of Industrial Major Accident Hazards Regulations 1984. These regulations have been amended by the Control of Industrial Major Accident Hazards (Amendment) Regulations 1990 which came into force on 31 December 1990.

Introduction

2. These Regulations amend the Control of Industrial Major Accident Hazards Regulations 1984 ("the principal Regulations") for the purpose of implementing in full in respect of Great Britain Council Directive No 88/610/EEC (the Directive) amending Council Directive No 82/501/EEC (the Seveso Directive) on the major accident hazards of certain industrial activities. The Seveso Directive was implemented in Great Britain by the principal Regulations. The main objectives of the principal Regulations are the prevention of major accidents arising from industrial activities and the limitation of the effects of such accidents both on people and on the environment. The industrial activities covered are defined in terms of process and storage involving specified dangerous substances. This has the effect of embracing most of the chemical and petrochemical industries using substances which have dangerous flammable, explosive or toxic properties.

3. The changes made by the amending Regulations can be summarised as follows:

a. Schedule 2 has been extended to cover 28 named dangerous substances (formerly 9) and 6 categories of dangerous substances and preparations (formerly 2). Its application has been broadened so that it now covers not only isolated storage as before (ie storage not associated with a process activity), but also process - associated storage.

b. The requirements for information to be provided to the public have been strengthened and extended. A new Schedule 8 specified the minimum content of the information to be provided, requires the information to be made publicly available, and to be repeated and updated at appropriate intervals, and gives the public the right to obtain further relevant information.

c. 'Oxidising substances' has been added to the list of indicative criteria in Schedule 1.

The changes to Schedule 2 have the effect of bringing many more storage premises within the scope of the Directive, particularly warehouses.

Main Provisions of the amending Regulations

4. Schedule 1 modified the definitions in regulation 2(1) of the principal Regulations of "dangerous substance" and "industrial activity" to take into account the changed structure and broadened scope of Schedule 2. Schedule 1 also introduces definitions of "preparation" and "further relevant information" which are necessary to give effect to the requirements of the Directive.

5. Schedule 1 to these Regulations also modified regulations 4(demonstration of safe operation) and 6 (industrial activities to which regulation 7 to 12 apply) of the principal Regulations to take into account the changes to Schedule 2. It also replaces regulation 12 (information to the public) which now requires more information about an industrial activity to be given to the public in accordance with the Directive.

6. Schedule 2 to these Regulations amends Schedule 1 to the principal Regulations (indicative criteria) by adding the criterion for "oxidizing substances."

7. Schedule 3 to these Regulations replaces Schedule 2 to the principal Regulations with a new Schedule 2. The Schedule now applies to any storage that is either isolated storage or, with certain exceptions, to storage associated with an industrial installation (within the meaning of Schedule 4 to the principal Regulations). Part 1 of the Schedule contains an expanded list of named substances with threshold quantities for the application of provisions of the principal Regulations, and Part II introduces a list of categories of substances and preparations grouped into 4 entries with threshold quantities similarly specified.

8. Schedule 4 to these Regulations introduces, a new Schedule (8) to the principal Regulations, specifying the information about a site which must be supplied to the public under regulation 12 of the principal Regulations.

9. Schedule 5 to these Regulations makes minor and consequential amendments to the principal Regulations and Schedule 6 introduces new compliance dates and transitional provisions for industrial activities which become subject to certain provisions of the principal Regulations as a consequence of the amendments made by these Regulations.

10. Copies of the Control of Industrial Major Accident Hazards (Amendment) Regulations 1990 (SI 1990/2325), ISBN 0 11 005325 7, can be obtained from HMSO, price £2.00.

File reference number: FEP/89 16/80/8
Telephone number of contact: 071-273 3342

THE CONTROL OF SUBSTANCES HAZARDOUS TO HEALTH REGULATIONS 1988 (COSHH)

A INTERPRETATION OF PARAGRAPH 6 OF THE COSHH APPROVED CODE OF PRACTICE

1. Item 2 of Fire Service Circular 16/1989 gave guidance on inspections under section 1(1)(d) of the Fire Services Act 1947 and the COSHH Regulations 1988. As you will be aware, the COSHH Regulations came into force on 1 October 1989 and require fire authorities, as employers of fire brigade personnel, to adopt a scheme for controlling their employees' exposure to any "substance hazardous to health".

2. The Health and Safety Executive (HSE) has recently issued guidance to HM Inspectors of Factories about the interpretation of paragraph 6 of the COSHH Approved Code of Practice (ACOP) and what constitutes a significant exposure to a substance. The guidance was produced after discussion between the Home Departments and the HSE's National Interests Group (NIG). Details of that guidance are given in paragraphs 3-6 below.

3. The duty to provide information under paragraph 6 of the ACOP rests with the employer or self employed person using the substance. Enquiries made by NIG 12 months after the introduction of COSHH indicate that fire brigades have received only a handful of notifications and that appropriate information is not being passed to them. Factory Inspectors have therefore been advised that as part of their normal discussions with occupiers about the implementation of the COSHH Regulations they may, where appropriate, wish to enquire if information has been notified to the fire service. It is not intended that Inspectors should themselves pass information to fire brigades except in extreme cases - see para 5 below.

4. The guidance explains that it is difficult to give advice in quantitative terms as to what constitutes significant exposure to a substance. There is unlikely to be a need to notify dilute materials. Materials are only likely to be of significance during an incident if they are present in large quantities but equally they may be significant in smaller quantities if they are encountered uncontained in concentrated form or could survive an immediate fire and create a serious hazard in damping down or clearing up operations. NIG suggests that Factory Inspectors should press for compliance with para 6 of the ACOP when significant quantities of the following substances may be present on site:

a) Hydrofluoric acid or phenolic compounds which may penetrate clothing.

b) Fluorine compounds that may break down into hydrofluoric acid in fire conditions.

c) Dross from tin processing which may liberate arsine in the presence of water

d) Sensitising agents (Risk phases 42/43 may cause sensitisation by skin contact and/or inhalation) such as ethylene diamine and isocyanates which may cause no problems except to individuals who have developed or are developing a sensitivity.

e) Vinyl chloride monomer (VCM) where medical surveillance under Regulation 11 is required.

Occupiers of two classes of premises should also be asked by Inspectors to comply with para 6.

f) Premises at which substances which are pharmacologically active and which might have an effect following a single exposure (skin or inhalation), are present, such as the factories or research establishments of pharmaceutical companies.

g) Laboratories and animal houses where category 3 & 4 pathogens may be present.

5. NIG envisage that very occasionally an Inspector may identify a material of such hazard that direct contact is needed with the local fire brigade. In such circumstances it is suggested that Inspectors should adopt a similar procedure to that used for matters of imminent danger on fire precaution matters.

6. NIG has asked for information from Inspectors about cases in which they have triggered notification under paras 4(d) and (e) above or of cases where they feel a need to press employers to notify other substances under this paragraph of the ACOP.

B THE CONTROL OF SUBSTANCES HAZARDOUS TO HEALTH (AMENDMENT) REGULATIONS 1990

7. These Regulations come into force on 1 January 1991. They amend the Control of Substances Hazardous to Health Regulations 1988 ("the principal Regulations") by substituting for Schedule 1 to the principal Regulations the Schedule set out in the Schedule to these Regulations. Schedule 1 specifies maximum exposure limits for certain substances which are hazardous to health.

8. The Schedule introduces new maximum exposure limits for benzene and acrylamide, and an additional maximum exposure limit for man made mineral fibres. Amendments are also made to the existing maximum exposure limits for ethylene dibromide, arsenic and its compounds and for rubber fume. One maximum exposure limit, that for 1-methoxy-2-propanol, has been removed from the Schedule. Copies of the Regulations (ISBN 0 11 005026 6) can be purchased from HMSO, price 95p.

C HSE GUIDANCE NOTE EH40/91: OCCUPATIONAL EXPOSURE LIMITS 1991

9. The Guidance Note gives details of the occupational exposure limits which should be used for the purposes of determining the adequacy of the control of exposure by inhalation of substances hazardous to health. These limits form part of the requirements of the control of Substances Hazardous to Health (COSHH) Regulations 1988. Separate legislative requirements exist for lead and asbestos and these are not covered in detail in the Guidance Note. Exposure to substances hazardous to health below ground in mines and exposure to micro-organisms are also not covered in the Guidance Note.

10. The advice in the Guidance Note should be taken in the context of the requirements of the COSHH Regulations, especially Regulation 6 (assessment), Regulation 7 (control of exposure), Regulations 8 and 9 (use and maintenance of control measures) and Regulation 10 (monitoring of exposure). Additional guidance may be found in the COSHH Approved Code of Practice.

11. This Guidance Note replaces EH40/90. Copies of the Guidance Note (ISBN 0 11 885580 8) can be purchased from HMSO price £5.

File reference: FEP/91 16/49/1
Telephone number of contact: 071-273-3342

THE REPORTING OF INJURIES, DISEASES AND DANGEROUS OCCURRENCES REGULATIONS 1985 (RIDDOR)

1. The purpose of this item is to remind Chief Fire Officers of the guidance in item B of DCOL 10/1987, which states that under RIDDOR all injuries resulting from accidents at work which cause incapacity for more than three days must be reported direct to the enforcing authority.

2. The Health and Safety Executive have expressed concern that accidents to retained or volunteer firefighters reportable under RIDDOR are not being made aware of an absence from the employee's normal work of more than three days following such an accident. Chief Fire Officers should take steps to ensure that all retained and volunteer firefighters are aware of the requirements of the regulations.

3. This item is for advice only. There are no cost or manpower implications.

File Ref: FEP/90 49/1500/1
Telephone number of contact: 071-273-3942

TECHNICAL BULLETIN 1/1990 - PARAGRAPHS 7.1 - 7.3: EQUIPMENT TESTING PROCEDURES

Paragraphs 7.1 - 7.3 of Technical Bulletin 1/1990 on Rope Rescue Equipment have given rise to some queries from brigades about equipment certification and testing procedures so far as ropes are concerned. Chief Fire Officers may find the following information useful.

2. Paragraph 7.1 states that, "No equipment should be used unless the manufacturer is willing to supply proof certification of the Safe Working Load". However, it is not normal practice for rope manufacturers to specify a Safe Working Load for a particular type of rope when purchased on its own, but rather to quote a minimum breaking load for the new rope. In service, this breaking load will be influenced by many factors, for example, a rope being used over an edge or having a knot tied in it.

3. It is for the user of the rope to establish a Safe Working Load given the conditions and environment in which the rope is to be used. It is normal to adopt either a 5 ; 1 or 10 ; 1 factor of safety in order to arrive at a Safe Working Load. Thus if, for example, a minimum breaking load of 2250 kgf was quoted by a manufacturer, a 10 ; 1 factor of safety would result in a Safe Working Load of 225 kg.

4. When purchasing ropes for line rescue purposes, brigades are advised to discuss with suppliers the intended use, particularly where ropes are likely to be used in conjunction with other equipment.

5. Paragraph 7.3 of Technical Bulletin 1/1990 should be deleted.

6. This item is for advice only. There are no cost or manpower implications.

FEP/90 1/196/1
Telephone No. of contact: 071-273-3114 and 071-273-3942

ITEM 13
DCOL 4/1991

HAZRAD: REPORT BY THE WORKING GROUP ON INCIDENTS INVOLVING RADIOACTIVITY

1. At the request of the Joint Committee on Fire Brigade Operations, the Working Group on Incidents Involving Radioactivity has considered the merits or otherwise of the Hazrad scheme for marking buildings containing a radioactive source.

BACKGROUND

2. The Hazrad scheme was developed by Dr R Klein, then of Cambridge University, in conjunction with Cambridgeshire Fire and Rescue Service. Its purpose is to provide immediate operational information to the Officer in Charge of an appliance in the interval between the arrival of the first appliance and the arrival of specialist radiological advice. the building placard consists of the radiation trefoil and three smaller boxes which indicate the external or environmental radiological risk, the internal radiobiological risk resulting from absorption, inhalation or ingestion and the type(s) of radioactive source contained within the building. A scientific paper describing the scheme in detail is reproduced at Annex A.

COMMENTS RECEIVED ON THE HAZRAD SCHEME

3. A number of organisations provided comments on Hazrad. These were considered in detail by the Working Group and are summarised below:

a. National Radiological Protection Board (NRPB)
The NRPB is of the view that the Hazrad scheme adds little to the radiological protection aspects of emergency planning. In a report prepared for the Joint Committee on the Fire Brigade Operations, the NRPB also expressed the view that Hazrad should not be adopted as a national system, partly because it attempts to simplify a complex subject, but primarily because it does not fulfil its objective of providing immediate and up-to-date information and a clear indication of the radiac instrumentation to use at an incident. NRPB is also of the opinion that compliance with the Ionising Radiations Regulations 1985 and the Fire Services Act 1947 should make the Hazrad scheme in its present form unnecessary.

b. Health and Safety Executive
The HSE has not commented on the merits or otherwise of the scheme seeing that as an operational matter for the fire service. It has, however, commented that the scheme is voluntary and not part of the Ionising Radiations Regulations (IRRs) 1985; that the scheme must comply with the Safety Signs Regulations 1980 and the relevant requirements of Part 1 of BS 5378 and that where it is in

use, the operation of the scheme should be monitored to see how often it is used and whether fire crews have benefitted from its operation.

c. Nuclear Installation Services (NIS Ltd)
NIS act as Radiation Protection Advisers to a number of brigades and have expressed support for a logical and national system which identified buildings or rooms with a significant radiological hazard to aid the emergency services. With regard to Hazrad, NIS have offered the following comments:

i. External Radiation Risk
The scheme allows Alpha and Beta sources to be designated as a high external radiation risk (R3). This does not appear logical as Alpha particles have a short range in air, and Beta particles are easily shielded.

ii. Internal Radiation Risk
The Scheme does NOT take hazard into account. It only considers radio toxicity of isotopes. The hazard in a room MUST take into account the quantity of radioactivity in the room as well as the toxicity of the radio-isotope.

iii. Exemptions
Consideration should be given to confirmation of negligible hazard to fire fighters by the use of R-0 or Bio-0 categories.

LEGAL REQUIREMENTS

4. Under Regulation 27 the Ionising Radiations Regulations 1985, the operator or manager of a site where there is a risk from radiation is required to prepare a contingency plan to cover all reasonably foreseeable scenarios. In preparing such plans, operators are required to consult with the local fire brigade and supply the brigade with appropriate information. Similarly, under Section 1(1)(d) of the Fire Service Act 1947, brigades are required to obtain information required for fire-fighting purposes for buildings and property in the area of the fire authority. It could be argued that properly conducted 1(1)(d) inspections together with up-to-date hazard risk data bases negate the need for a building marking scheme.

CONCLUSIONS

5. The Working Group concluded that there was some merit in a building marking system which amplified the information conveyed by the radiation trefoil. In particular, it was recognised that the Hazrad scheme could provide immediate psychological reassurance to the first crews on the scene. However, this could be no substitute for the inspections which are required under Section 1(1)(d) of the Fire Services Act 1947 to obtain information for firefighting purposes about buildings and their contents or for effective training.

6. The Hazard scheme is purely voluntary and relies on a system of self notification by the site operator. There is therefore no way of ensuring that signs display up-to-date and accurate information or that they apply to all buildings. It is therefore possible that fire crews might unwittingly underestimate the risk at a radiation incident because the Hazrad signs have not been kept up-to-date. The Home Departments therefore take the view that if individual Chief Officers decide to adopt the Hazrad scheme, it must complement the information obtained by brigades from regular 1(1)(d) inspections and not be seen as an alternative to those inspections.

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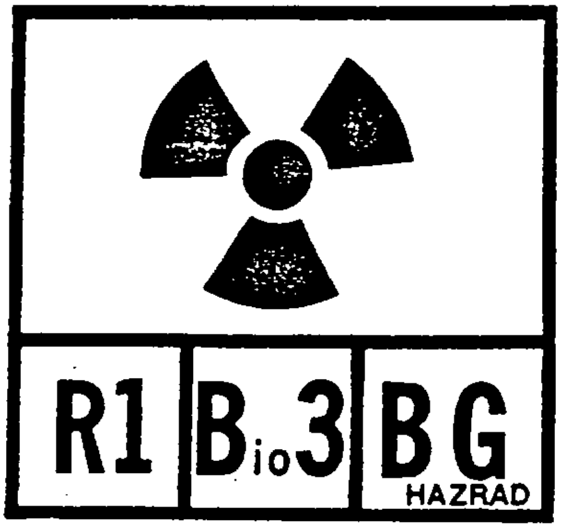
Telephone number of contact: 071-273-3342

Annex A
Item 13
DCOL 4/1991

CAMBRIDGESHIRE FIRE AND RESCUE SERVICE

HAZRAD



AN EMERGENCY ACTION CODE FOR INCIDENTS INVOLVING RADIOACTIVITY

A SCIENTIFIC PAPER BY

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Presented in part at the Peterborough Conference on 2nd February 1988

HAZRAD a scheme for the grading of Radioactive Hazards for operational use by the Fire Brigade, and other Emergency Services.

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FOREWORD

This scheme was conceived to answer, in the most direct and simple manner possible, the three questions asked by the Fire Officer in Charge of an incident involving radioactive materials: what radiological risk does the source represent to Fire Service personnel attending the incident, to civilians located nearby, and to the environment; what protective clothing is necessary; what monitoring equipment should be used. The classification distinguishes between the external and environmental level of risk (category "R") and the radiobiological toxicity resulting from ingestion, inhalation or absorption and causing internal exposure (category "Bio"); it is clear that there is an inter-relationship between these two categories when one considers, for example, the possible contamination of the local water table. This distinction was felt to be necessary because it became apparent in the early stages of the research needed for the scheme, that Fire Brigades were, in general, unaware of the extreme range of biological, i.e., internal, toxicity exhibited by radioisotopes. In this sense radioisotopes differ dramatically from highly toxic biological or chemical materials in that, although both show direct-contact toxicity by ingestion, inhalation or absorption, radioactive materials may have in addition the property of remote toxicity by virtue of their emitted radiations.

The classification also indicates the types of radiation present (A,B,G, or N), and thus which monitoring equipment should be used in the first instance. During the preliminary background investigations, it became increasingly clear that, again in general, Fire Brigades were not aware of the restrictions and difficulties of using monitoring equipment unless the type of radiation was known; nor, indeed, was there a general awareness that certain monitoring equipment, although perfectly adequate for the intended type of radiation, could give an erroneous, or even no response with other types of radiation. A secondary issue that arose form these investigations was the need for an awareness that specialist equipment might be necessary in a particular instance such as, for example, the monitoring of a very soft beta or gamma emitter.

The scheme grew out of these considerations and is primarily directed at the Fire Service as an Emergency Action Code for operational use by the first attendance. It is also intended to encourage informed decision making by the Officer in Charge resulting, in so far as is practically possible in an emergency situation, in a rational distinction to be made between potential, actual and emotional risk, with the aim of exposing those involved in the incident to the lowest practicable radiation hazard, thus fulfilling some of the requirements of the Health and Safety at Work Act (1974) and The Ionizing Radiations Regulations (1985).

INTRODUCTION

Our main aim has been to devise a scheme which is operationally efficient resulting in effective and appropriate action within the time between the arrival of the first appliance and crew at the incident, and the later arrival of an expert in radiological hazards, together with due regard to the safety of the Fire Service Personnel involved in the incident and the general public within the vicinity. Our classification of risk has always tended to be on the conservative side, in keeping with current opinion and that expressed in the Recommendations of the International Commission on Radiological Protection (ICRP), namely that:

> *<<...Whilst the values proposed for the maximum permissible doses are such as to involve a risk which is small compared to other hazards of life, nevertheless in view of the incomplete evidence on which the values are based, coupled with the knowledge that certain radiation effects are irreversible and accumulative, it is strongly recommended that every effort be made to reduce exposure to all types of ionizing radiation to the lowest possible level...>>*

Within the Fire Service decisions must be made, at the time of the incident by the Officer in Charge, which balance the radiological and other risks to his men against operational necessity. These decisions must be firmly based on a factually sound assessment of risk.

Requirements of the Scheme

The requirements of a marking scheme for locations containing radio-active materials (rooms, buildings, containers or transport), are that it must provide the Fire Service and other Emergency Services with immediate operational guidance at the time of the incident and must, furthermore, satisfy the following criteria:

1. *It should be simple without requiring the Fire Service personnel involved to have detailed knowledge concerning radioactive materials.*

2. *It should provide immediate operational information to the Officer in Charge of the incident, without the need for him to refer to Fire Control, or the Risk Card for the premises, or to any other person. This information is required, within the first few minutes, so that immediate action can be initiated safely and with confidence by the Fire Crew, for example in the case where someone is injured or reported to be involved in the incident (the "persons reported" situation). It does not replace information subsequently available from a specialist advisor.*

3. *The Code should provide sufficient information enabling the Officer in Charge to assess the risk to his own men, and the immediate action required to safeguard their undue exposure to ionizing radiation, as well as the safety of the general public and whether immediate evacuation of the surrounding area should be considered.*

4. *The information contained within the Code should represent emergency action information for use within the hopefully short interval between the first attendance at the incident and specialist advice becoming available.*

5. *The Code should not be taken as replacing specialist advice when it becomes available.*

6. *The Code must give information on the external radiological risk (exposure and dose rates, especially for gamma emitters) in such a way that, although simple, it must inform the Officer in Charge of the limits to be placed on working times within the area of the incident, the distance to be kept and the use of shielding if appropriate. It should be remembered that first attendance Fire Crews have very limited shielding available to them.*

7. *The Code must also indicate, in a general way, the level of radio-activity present, since this affects the magnitude of the potential contamination/decontamination problem.*

8. *The Code must indicate the level of radiological risk due to internal exposure, conceivably arising from inhalation, ingestion or contamination of the skin, in terms of the radiobiological toxicity thus indicating the level of protective clothing that is necessary.*

9. *The Code must indicate, in a clear and unambiguous way, which types of radiation are present and therefore what monitoring equipment is required (alpha, beta, gamma and neutron).*

10. *The Code should be applicable to individual radioactive sources, areas within a premises or even the whole premises.*

11. *For a collection of mixed sources, the Code must indicate the highest degree of hazard within each category.*

12. *The Code must be consistent with both current Fire Service operational procedures as well as national/international codes of radiological practice and United Kingdom law.*

13. *The Code, because it is an Emergency Code, must take account of "worst case planning".*

14. *The Code and the information that it imparts must be acceptable to the owners of the premises when displayed, as well as to official bodies such as the Nuclear Inspectorate and the Emergency Services.*

GENERAL CONSIDERATIONS

For the purposes of this document, it is worth summarising briefly the properties of the different types of radiation which are important in the context of Fire Service operations.

Alpha particles, being charged helium nuclei of mass 4 carrying two charges, are biologically the most damaging of all the radiations when present internally. These heavy charged particles are easily stopped, for example by biological tissue, thus depositing their energy over a short distance. Alpha particles have a range in air of only a few centimetres (Table 1), are stopped by a sheet of paper, and therefore represent little external radiation hazard to personnel wearing protective clothing. It requires an alpha particle of at least 7.5 MeV to penetrate the protective keratin layer of the uncovered skin, which is 0.07 mm thick.

Beta particles are electrons or positrons and may have a range in air of many metres (Table 1) depending on their energy. For a point source of beta radiation (unshielded), neglecting self and air absorption, the dose rate at 30 cm (1 foot) is approximately 3Gy/hour (300 rad/hour) for a 37GBq (1 Curie) source. This is mainly a surface dose rate since the range of beta particles in units of g/cm² (thickness multiplied by density) is of the order of the maximum energy (E) in MeV divided by two, i.e., Range = E/2. Thus it requires a beta particle of at least 70 keV to penetrate the non-living protective layer of the skin. 32-Phosphorous, on the other hand, with a beta particle energy of 1.71 MeV, has a range of around 8 to 9 mm in water (d=1) and most soft biological tissues of similar density. It is adequately stopped by 3/8" (10 mm) perspex sheet, and the majority of such an energetic beta emission would be stopped by fire kit and protective clothing (tunic, leggings, boots and splash suit), heavy rubber gloves and the BA face visor. A material of thickness 30 mg/cm² will reduce a flux of 1 MeV beta particles by 30%, and a flux of 0.4 MeV beta particles by between 75% and 80%. Typical commercially available protective clothing in use in the Fire Service has the measured thicknesses as shown in Appendix A. The face visor has an average thickness of around 340-350 mg/cm²; this results in 1-2% of 1 MeV beta radiation reaching the eyes.

Bremsstrahlung radiation may also be emitted when beta particles are absorbed; the intensity of this radiation increases approximately with the energy of the beta particle and the square of the atomic number of the absorbing material. Beta particles of 1 to 2 MeV lose less than 1% of their energy as bremsstrahlung as they pass through light materials such as water, aluminium or glass. 37GBq (1 Curie) of 32P, a commonly used high energy beta emitter, will produce, in aqueous solution stored in a glass bottle, bremsstrahlung of around 0.3 mGy/hour (30mR/hour) at 30 cm (1 foot). When the beta particles from a 37 GBq (1 Curie) source of 90Sr-90Y (0.55 MeV) are absorbed in aluminium, the bremsstrahlung hazard is approximately equivalent to that presented by the gamma radiations from 0.4GBq (12 mCi) of 226-Radium, around 1 mGy/hour (100 mR/hour) at 30 cm (1 foot), with an average energy of 300 keV (Haybittle, 1956).

Table 1. Range of alpha, beta and gamma radiation versus energy.

Energy	0.3MeV	1MeV	3MeV	5MeV	10MeV
Alpha*	0.21cm	0.50cm	1.67cm	3.51cm	10.62cm
Beta*	79cm	381cm	1295cm	2160cm	4000cm
Gamma**	1.7cm	9.1cm	14.5cm	14.5cm	12.2cm

* Range in air - 0.001293 g/cc NTP
** Range in lead - 11.34 g/cc

Range defined as distance required to produce an attenuation of 10^3 (0.1%) of the original flux. Bethe & Askin (1953) Experimental Nuclear Physics, Vol. 1.

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Table 2. Energy deposited in bone by gamma radiation.

Quantum energy	Energy deposited JKg^{-1}/100R
30keV	4.39
60keV	2.91
100keV	1.45
150keV	1.05
300keV	0.938
1MeV	0.922
3MeV	0.928

from the National Bureau of Standards, "Physical Aspects of Irradiation, ICRU Report 10b (1962), Handbook 85, U.S. Government Printing Office, Washington D.C., 1964.

Gamma radiation is an electromagnetic emission composed of photons, and only distinguishable from X-rays by the higher energies involved. Gamma radiation can be very penetrating and its range in air extremely large. A considerable thickness of high density material, such as lead (Table 1), may be required to attenuate high energy gamma radiation. Low energy gamma radiation, typically below 100 keV, deposits larger amounts of energy per gram of irradiated compact tissue than high energy gamma radiation (Table 2). The dose rate experienced at a particular distance from a gamma source is characterised by the <u>specific gamma ray constant</u>, = 19.4. $EF.(\mu K/q)_L$ R/hour/metre²/ Curie, which in the case of a 37 MBq (1 mCi) source of ^{226}Ra would result in a gamma dose rate of 8.25 µGy/hour (0.825 mR/hour) at 1 metre, or 89 µGy/hour (8.9 mR/hour) at 30 cm (1 foot). Within ±20% for a point-source gamma emitter, with an energy between 0.07 MeV and 4 MeV, the exposure rate in R/hour at 30 cm (1 foot) is 6CE, where C is the source strength in Curies and E the energy in MeV, in SI units this relationship being given by 1.6E mGy/hr per GBq. High activity gamma sources may also show scattering phenomena (sky- and ground-shine); for example, a 3.7TBq (100 Curie) 60Co source placed 30 cm (1 foot) behind a 1.2 metre (4 foot) high lead shield will produce sky-shine of about 1mGy/hour (100 mR/hour) at 2 metres in front of the shield, equivalent to an unshielded 11GBq (0.3 Ci) 60Co source at 1 metre.

Neutrons carry no charge; their range in air is large; they have high ionizing capability and they are biologically extremely damaging. Neutron radiation has limited uses in normal civilian practice; this type of radiation is mainly restricted to nuclear power stations and military applications. It will be discussed only briefly in this document.

Two further important properties of radioactive materials must be briefly mentioned because of their relevance to operational decision making. The concept of half-life ($T_{½}$) for the isotope, although important scientifically, has little significance for the Fire Service under emergency operational conditions, unless it is of the order of minutes or seconds, or at most tens of minutes. The half-life may assume importance, however, in considering the problems of contamination and decontamination at a later stage. Of more immediate operational significance, however, is the concept implied by the inverse square law. By creating an awareness of the implications of this simple law, that 10 times the distance means a reduction in dose rate of 100 fold, it is possible for Fire Service personnel to reduce the risk to which they are exposed; however, in emergency and rescue work it may be necessary to be very close to the source, for example, when recovering it, or an individual from wreckage. The realisation that dose rates increase steeply with the nearness to the source, and not linearly as the distance is reduced, is an important operational concept.

The use of shielding, other than that which is readily available on site such as brick or concrete walls and the fire appliances themselves, is not generally applicable to first attendance crews in an emergency situation. A general awareness of the principles of shielding should, clearly, be an integral part of Fire Brigade training: for example, always using gloves to handle suspect material to minimise the skin dose and, preferably, some form of remote handling device (a shovel!!) if *possible: use should be made of available on-site shielding, such as walls, high ground and appliances, while not allowing crews to don breathing apparatus, or rest within line of sight of the source without some form of shielding between them and the source. In addition, of course, and in keeping with good radiological practice, there must be* no smoking, eating or drinking *at the site of a radiation incident.*

Throughout this document activities have been given in both Becquerels and Curies. There is certainly a feeling amongst most practising scientists, probably due to innate scientific conservatism, that the old units Ci, mCi and µCi, have a more practical 'feel' to them! Dose rates are quoted at 30 cm (1 foot) to bring together the Metric and Imperial systems; most firemen, and others, here in the United Kingdom have much more intuitive feel for what distances are in feet rather than metres. The conventional units, in both the SI and traditional systems, for radioactivity and dose are shown below:

Radioactivity:

1 Curie = 3.7×10^{10} Becquerels
= 37 GBq

Dose:

1 Gray = 100 rad
1 Sievert = 100 rem

The HAZRAD SCHEME of CLASSIFICATION for RADIOACTIVE SOURCES

The distinction between the R category, the external radiological risk, and the Bio category, the internal risk or biological toxicity, has been made for important operational reasons as will become clear in the following discussion; it goes almost without saying that, in radiological terms, there is considerable overlap between the two categories.

WORST CASE PLANNING

A very clear distinction must be made between normal situations under which radioactive materials are stored and used, and the circumstances which often apply under emergency conditions.

In the context of Fire and Rescue Service operations we cannot assume, at least in the first instance, that source integrity and shielding have remained intact. The source, the structure within which the source is held, or the surrounding shielding may have suffered damage due to thermal or mechanical stress.

Because of the concept of worst case planning (which a pessimist would define as realism - anything that can go wrong, will go wrong), it is not appropriate to consider, in the first instance, the state of the isotope before, during or after the fire. We assume, until there is firm evidence to the contrary, that due to the circumstances of the incident the source may have been volatilized or dispersed as an aerosol, may be inhaled, appear in run-off water, settle as a dust, or be spread by wind and the convection currents produced by the fire. It is, however, appropriate to consider the physical and chemical characteristics of the radioactive material after the incident has been *brought under control and expert technical advice has become available.*

In a well-aerated fire, with an adequate fuel supply, temperatures may reach sufficiently high levels to bring about distortion and bending of structural steel work; typical colour temperatures for steel are cherry red (770°C), full red (850°C), full bright red (955°C), yellow red (980°C), white (1250°C), and incandescent (1350°C). Although iron and steel require temperatures between 1150 and 1550°C to melt, depending upon the composition, tensile strength is greatly reduced before the melting point is reached (>550°C). Of greater significance, however, is that the ISO Classification (see Table 3) only requires the testing of sealed radioactive sources up to 800°C for one hour, followed by a thermal shock to 20°C (Class 6) as the maximum requirement. This upper limit and the temperatures attained in a 'good' fire (1085 - 1244°C, but see Fire Research Station Note No.15 on fireloadings and ventilation), should be compared with the melting and boiling points of selected metallic elements and alloys as shown in Table 4.

Table 3. Classification of sealed source performance standards

Test	Class 1	2	3	4	5	6
Temperature	*No test*	-40°C (20 min)	-40°C (20 min)	-40°C (20 min)	-40°C (20 min)	-40°C (20 min)
(1h)		+80°C	+180°C	+400°C	+600°C	+800°C
shock to +20°C		-	-	+	+	+
External Pressure	*No test*	25 kPa absolute to atmos	25 kPa absolute to 2 MPa	25 kPa absolute to 7MPa	25 kPa absolute to 70 MPa	25 kPa absolute to 170 MPa
Impact	*No test*	50g/1m	200g/1m	2kg/1m	5kg/1m	20kg/1m
Vibration	*No test*	30min 25Hz-500Hz 5g peak	30min 25-50Hz/5g 50-90Hz/0.635mm 90-500Hz/10g	90min 25-80Hz 1.5mm pk. 80Hz-2kHz/20g		
Puncture	*No test*	1g/1m	10g/1m	50g/1m	300g/1m	1kg/1m

Impact test: *Struck by a flat steel hammer of 25mm diameter, all edges rounded, on a steel anvil.*

Puncture test: *Struck by a pin 6mm long and 3mm diameter with hemispherical end, on a hardened steel anvil.*

This classification has been produced by the International Organisation for Standardisation (ISO) for the safety requirements of sealed radioactive sources under conditions of typical use (ISO.2919). The figures are preceded by the letter C or E to indicate, respectively, whether the source activity is less than, or greater than certain prescribed limits which depend on the toxicity, solubility and reactivity of the radioactive component of the source, i.e., C.65545. Details of the testing procedures are given in ISO.2919 and BS.5288:1976, which is based on USASI/N5.10, ISO.1677, ISO.2919 and ISO/TR.4826-1979(E). A further class (X) can be **used where a special testing procedure has been adopted.**

Table 4. Melting points and boiling points for selected metallic elements and alloys.

Material	*M.Pt.(°C)*	*B.Pt.(°C)*
Americium	**994**	*2607*
Aluminium	**660**	*2467*
Beryllium	*1278*	*2970 (5mm)*
Bismuth	**271**	*1560*
Cadmium	**321**	**765**
Caesium	**28**	**669**
Copper	*1083*	*2567*
Gallium	**30**	*2403*
Gold	*1064*	*3080*
Indium	**157**	*2080*
Lead	**327**	*1740*
Neptunium	**640**	*3902*
Nickel	*1453*	*2732*
Plutonium	**641**	*3232*
Polonium	**254**	**962**
Radium	**700**	*1140*
Silver	**962**	*2212*
Uranium	*1132*	*3818*
Carbon Steel	*1515*	-
Stainless Steel 304	*1427*	-
Cast Iron	*1177*	-
Brass	**932**	-
Beryllium-copper	**927**	-
Nickel-silver 18% A	*1110*	-
Cupronickel 30%	*1227*	-

Values are taken from the Handbook of Chemistry and Physics, 62nd. Edition, 1981-1982. Melting and boiling points below 1000°C are shown in bold type.

The assumption has to be, in so far as Fire Service operations are concerned and until there is firm radiological evidence to the contrary, that the source may have suffered structural and thermal damage, with melting of any lead shielding, resulting in potential contamination of the incident area and hazards associated with an unshielded source. The consequences of ignoring such a necessarily cautious approach in terms of contamination of the environment and the *health risk to the population at large, are potentially so serious that to do so would be grossly irresponsible. Once detailed radiological and dosimetric information becomes available, however, it is then possible to operate within the safety limits prescribed by the actual and defined risks, and not within the more severe potential risk limits.*

Fire Service personnel are often required to work under emergency conditions in which the risk to life is considerably greater than would be considered acceptable for the population at large. This applies, in particular, to the saving of human life. The recommendations which appear below are quoted directly from the International Atomic Energy Agency Technical Report No.152 (Vienna, 1974). The limiting doses proposed in this section would be considered too high in normal Fire Service practice; consequently the accepted operational limits (Home Office JCFBO June 1984 and Manual of Firemanship Part 6(C)) are shown in italics in parentheses next to those suggested in the IAEA Report. Comments are shown in italics within square brackets.

EMERGENCY DOSE CONSIDERATIONS (IAEA TR.No.152)

General Considerations

Dose limits for life saving action should not be unduly restrictive and impede action to save human life. Judgement should be left to the individual in charge of the emergency action to determine the amount of exposure that should be permitted to perform the emergency action [not reasonable to expect the Officer in Charge to do this without expert medical and radiological advice.]

Exposures arising from actions involving the saving of human life are far more justifiable than exposures that may be accrued as a consequence of actions intended to recover deceased victims or to minimise property damage.

The individual involved in the emergency action should carefully examine any proposed action by weighing the risks and consequences of exposure against the benefits to be gained [this relies on either very good expert advice being immediately available, or a detailed radiological knowledge.]

Emergency Exposure Criteria

Basic concept:

Guidance must be based on regard for human life and on conditions existing at the time. Dose restrictions for life saving actions have been deliberately avoided to preclude the possibility of impeding action that may be necessary to save several lives.

The decision-making process should consider the proposed action by weighing the risks of radiation insult, actual or potential, against the benefits to be gained. The exposure probability, biological consequences related to dose, and the number of people involved are the essential elements to be evaluated in making a risk determination.

Since the risk-benefit considerations will vary depending on the nature of the emergency action, the following dose criteria provide guidance for three categories of action, i.e., (1) the saving of human life, (2) the retrieval of deceased victims and (3) actions connected with the protection of property.

Actions connected with the saving of human life:

Decisions should be made by the person delegated the emergency action responsibility [in practice the Officer in Charge of the first attendance; consideration should perhaps be given to transferring this responsibility to Principal Officer level immediately a "Radiation Confirmed" situation is encountered, as well as bringing in the Brigade Radiation Protection Adviser or the NAIR Stage 1 adviser whichever is most readily available.]

When making a decision, the probability of success of the rescue action should be weighed against the element of risk.

Attempts to rescue victims should be regarded in the same context as other emergency action.

Rescue activities should be performed by volunteers. Each emergency worker should be advised of the risk prior to his participation [this raises the very real ethical problem of 'informed consent' so often encountered in human experimental medicine; the concept of volunteers may also pose problems in a uniformed, disciplined Service as it would not be in keeping with Control and Command procedures.]

The level of exposure for the worker should be determined by the individual on-site to whom emergency action responsibility is delegated [under the HSAWA (1974) the problems of delegating responsibility.] *His judgement should be based on the following considerations:*

i) *The expected exposure to be received while performing the action should be weighed in terms of the effects of acute whole-body exposure, or in terms of radioactive material entering the body* [pre-supposes the availability of a degree of expert advice which may not be generally realistic in the first instance.]

ii) *The reliability of any prediction of radiation injury cannot be any greater than the reliability of the measurement of the dose.*

iii) *When the expected exposure, based on physical estimates of the dose rate in the incident area, is expected to exceed 100 rem* [Fire Service recommended maximum levels; 30mGy (3 rad) incident dose, 50 mGy (5 rad) per year,] *the following factors should be considered, as recommended by the National Council on Radiation Protection:*

(a) *When the dose is measured by personnel dosimeters, e.g., pocket ionisation chambers etc., the error may be as great as* $\pm$*25% of the true value.*

(b) *When the dose is calculated from dose rates measured by survey meters, the error may be as great as ±35%.*

iv) *Appropriate devices such as protective equipment and remote manipulators should be used to reduce the element of risk* [in practice the Fire Service would always be wearing positive pressure breathing apparatus, so reducing the respiratory risk.]

Actions connected with the recovery of deceased victims:

Time is no longer a critical factor, therefore the retrieval mission should be well planned. The radiation exposure should normally be controlled within existing occupational exposure guidelines.

In those situations where entry has been made under emergency conditions and where the victims are deceased, retrieval may be accomplished provided the resultant exposure would not be significantly greater than if withdrawal of the rescue team were made without the bodies.

Special remote-recovery devices should be used to retrieve victims located in high radiation areas, particularly if it is determined that direct retrieval by rescue workers would result in exposures greater than the occupational exposure standards recommended by the International Commission on Radiological Protection (ICRP).

In special cases where recovery can only be accomplished by entry of rescue workers into the area, exposures not exceeding 120 mSv (12 rem) [30mGy (3 rad) incident dose; 50mGy (5 rad) per year] *may be received.*

Protection of health and property:

Where the risk of the radiation hazard could bear significantly on the state of health of the public or may result in loss of property, the following criteria should apply:-

i) *A planned exposure up to but not exceeding 120 mSv (12 rem) per year* [30mGy (3 rad) incident dose; 50mGy (5 rad) per year] *or 5(N-18)*[1]*, whichever is the more limiting, may be received by individuals participating in efforts to reduce the risk to people and property. Under very special circumstances these limits may be waived to permit volunteers to receive an exposure up to but not exceeding 250 mSv (25 rem).*

ii) *Where the potential radiation risk from the incident is such that life would be in jeopardy, or that there would be severe effects on the health of the public or loss of property inimical to the public safety, the criteria for saving human life should apply.*

FOOTNOTE

1. *A lifetime dose of 0.05 x age in years in excess of 18 years i.e., 0.05 x (age - 18) Grays.*

CATEGORIES OF HAZRAD GRADING

1. EXTERNAL RADIATION RISK - the R1-3 category

The intention of this category, which is on a scale of R1 to R3 indicating increasing severity of risk, is to give a broad assessment of the external radiation risk. This assessment is made up of two parts; (i) the total activity of the isotope present, and (ii) a factor which for gamma emitters enables one to put an upper limit on permissible exposure.

Classification of Alpha and Beta sources is based on total activity alone. R3 corresponds to activities that are 37GBq (1 Curie) or greater, R2 to an activity less than 37GBq (1 Curie) but greater than 370MBq (10 milliCuries) and R1 to activities that are less than 370 MBq (10 milliCuries). The borderline between categories R2 and R3 corresponds exactly with the recommended value of 37GBq set out by the Joint Committee on Fire Brigade Operations (June 1984, paragraphs V(18), XX(69) and XX(70).

It was not felt appropriate to include an external dose rate term for alpha or beta particles for the following reasons. First, alpha particles have very short path lengths in air (see Table 1) and are readily stopped. Beta particles, on the other hand, although the surface dose rate at 30cm (1 foot) may be very high 80mGy/hour/GBq (300 r/hour/Curie), neglecting self- and air-absorption, (see Appendix B), are rapidly attenuated by the air unless very energetic (Table 1), and are readily stopped by relatively small thicknesses of common materials such as protective clothing (see Appendix A), walls and buildings, high ground and fire appliances.

Gamma radiation and neutrons, however, are much more penetrating. For this reason we have introduced a factor in the R grading by which the total activity is multiplied before deciding whether the category should be R1, R2 or R3. High energy gamma radiation or neutrons may require a considerable thickness of high density material, such as lead or concrete, in order to attenuate the radiation significantly.

For gamma (photon) emitters this factor is given by -

$$F = [(10*GC) + 1]$$

where GC is the specific gamma ray constant in $R/hour/m^2$ ($=0.01$ $Gy/hour/m^2$), obtained from published tables (IAEA Technical Report Series No.152). This means in practice that, if we take 60Co as our reference gamma source, the dose rate at 30cm (1 foot) corresponding to the R3/R2 borderline is 10 mGy/hour (1R/hour), and that for the R2/R1 borderline 0.1 mGy/hour (10 mR/hour). This immediately indicates that, in Fire Service terms of a limiting incident dose of 30 mGy (3 rads), the maximum time allowable for a category R2 incident at the top end of the category, would be 3 hours with much longer times allowable as one approaches the R2/R1 border. The highest risk category, R3, indicates that an absolute maximum of 3 hours at 30cm (1 foot) would be allowed, with the important proviso that the time allowed could be very much *less, maybe by one or two orders of magnitude, depending on the source activity. With situations involving a category R3 grading, it becomes absolutely essential to monitor dose rates continuously during the incident, and to restrict the exposure (dose-rate x time integral) of personnel accordingly. Category R1 represents an extremely limited external radiation risk, with exposure times of greater than 300 hours needed to produce an exposure of 30 mGy (3 rad) for gamma emitters.*

The gamma factor, which ensures that all sources greater than 37 GBq (1 Curie), or with a dose rate greater than 10 mGy/hour (1 rad/hour) at 1 foot, are placed within the R3 category, is relatively insensitive to the value of the specific gamma ray constant: for example, the dose rate at 1 foot for 24Na and 86Rb corresponding to the R3:R2 border differs by only a factor of 3, on the conservative side, even though the specific gamma ray constants differ by 35 fold.

For neutron sources an activity factor of 20 is used, so that 1.85 GBq (50 mCi) corresponds to the R3:R2 border, and 18.5 MBq (0.5 mCi) to the R2:R1 border. For a 1.85 GBq (50 milliCurie) source of 252Cf (an extreme example), the neutron dose corresponding to R3:R2 would be 23 mSv/hour (2.3 rem/hour) at 30cm (1 foot) with a gamma dose rate of 1.6 mGy/hour (0.16 r/hour) at the same distance. For a 241Am:Be neutron source the neutron dose rate for a 1.85 GBq (50 milliCurie : nominal) source would be only 11 μSv/hour (1.1 mrem/hour) at 30cm (1 foot) with a gamma exposure of 12 μGy/hour (1.2 mr/hour) at the same distance, since the nominal activity here refers to the 241Am content. If, however, the neutron flux is normalized for the two sources, then the dose rates are similar for the 252Cf and 241Am:Be sources. It could be argued with some justification that it would be reasonable to quote the "apparent" activity in Curies or Becquerels for neutron sources, based on the neutron flux.

The information that is contained within the R category should be interpretable by the Officer in Charge of the incident, in terms of the following parameters:-

TIME
DISTANCE
SHIELDING

Working times for Fire Service personnel will generally be rather short since these are related to the duration times for breathing apparatus (Appendix C) since in all radioactive incidents breathing apparatus will be worn (J.C.F.B.O., June 1984, XVI(54)). It is recommended that BA wearers are not allowed more than one cylinder change in a "Radiation Confirmed" incident thus limiting their proximity to the source to 2 x 46 minutes at the most. A second but nonetheless important reason for limiting working times, is that tiredness will result in mistakes being made especially in a technically demanding and unaccustomed situation.

The following guidelines are specifically proposed relating times, distances and shielding (TDS) to the categories R1 to R3. We intentionally err on the somewhat cautious side.

TIME

R1 *Greater than 300 hours. Minimal external risk. Monitoring recommended for source location and the control of contamination/ decontamination. Highly unlikely that occupational exposure limits will be reached even for previously exposed personnel.*

R2 *3 to 300 hours depending on source. Recommended maximum exposure time NOT MORE THAN 3 HOURS. Occupational exposure levels may be reached, especially for previously exposed personnel.*
Dose monitoring NECESSARY and the calculation of exposure risk commitment for involved personnel highly desirable. Personal dosimetry may be appropriate depending on the source, but note difficulties of reading QFE under operational conditions (protective clothing, smoke, in the dark).
Attention to contamination of equipment and environment may be necessary. Consider scale of decontamination procedure required.
May be necessary to consider civilian evacuation depending on source type and incident circumstances.

R3 *Exposure times required to reach limit may be considerably LESS THAN 3 HOURS! - could be much less than the BA duration time for a single cylinder with high activity sources. GREAT CARE NECESSARY.*
Dose monitoring by the Officer in Charge and prior calculation of exposure risk commitment, together with QFE personal monitoring, for involved personnel ABSOLUTELY MANDATORY, before personnel are committed to the incident. Occupational exposure times may easily be exceeded.
Civilian EVACUATION desirable and may be essential - also designation of a CONTROLLED AREA by the Officer in Charge. Attention to potential contamination of the environment, personnel involved in the incident, equipment used and other Emergency Service personnel ABSOLUTELY ESSENTIAL, especially with Bio3 sources.
Full Decontamination procedure almost certainly required.

Notes

(a) *for high activity beta sources (R3/ /B) consideration of skin dose necessary.*

(b) *for high activity neutron sources (>R2/ /N) reduce working times by 3 fold, i.e., not more than 1 hour for R2.*

DISTANCE

R1 *Use of the inverse square law, and increased air-absorption for beta particles, becomes increasingly important as the level increases from R1 to R3, as a means of limiting dose rates.*

R2 *Do not have non-committed personnel nearer to the source(s) than absolutely necessary, down-wind from the source(s) or in the drainage line.*

R3 *Rest and BA donning areas should be as far up-wind as practicably possible, and dose rates should be checked. As the risk increases through R3, evacuate increasing numbers of civilian personnel as soon as this can be arranged; this may even be desirable before the NAIR Scheme can be invoked formally since this takes time.*

The highest category, R3, should in general be interpreted by the Officer in Charge to mean that he does not commit men within the potentially contaminated areas, unless human life must be saved, until specialist advice becomes available. Fire fighting and the control of spreading of the fire and possible radioactive contaminants, should be done from outside the affected area if at all possible. It should be remembered, however, that unchecked spread of the fire, with or without explosion, may constitute a greater risk, both radiological and general.

Although a confirmed R3 incident should in most cases be dealt with from outside until specialist advice becomes available, except of course in the case of 'persons reported', there is still a need for initial radiation monitoring from within the premises, i.e., store, laboratory or building, if errors due to shielding by walls and other structural feature are to be avoided.

This initial monitoring may represent considerable difficulties under Fire Service conditions (smoke, darkness and noise) unless the instruments used have illuminated scales and an audible indication of count rate, with an earpiece to exclude extraneous noise, for help in locating the source. It may also be virtually impossible to read personal dosimeters (QFE) adequately under these conditions; in protective clothing the QFE dosimeter would at any rate have to be mounted on the surface, not inside the suit or on the tunic, if it is to be read at regular intervals during the incident.

Initial monitoring should be carried out for all incidents from within the premises, remembering that doors and walls can shield quite effectively. It is only in R3 incidents that this initial monitoring may present severe operational problems because of time of exposure.

SHIELDING

R1 Not usually necessary.

R2 Desirable if available.

R3 Should be considered ESSENTIAL. Use walls and buildings or bunds, and fire appliances as appropriate. Monitor the effectiveness of the shielding achieved.
In the case of high activity beta emitters, e.g. R3/ /B, the surface dose rate may be very high - 80 mGy/hour/GBq, or 300 rads/hour/Curie at 1 foot; protective clothing (see Appendix A for thicknesses and approximate attenuation, and below for requirements), and the use of remote handling devices such as poles, ropes and shovels, may greatly reduce this risk for all radioactive material.

2. THE INTERNAL or BIOLOGICAL RISK - the Bio1 to Bio3 Category

The intention of this category, which is on a scale of Bio1 to Bio3 indicating increasing severity of risk, is to give an assessment of two rather distinct but inter-related risks; first to indicate the biological toxicity of the isotope, judged by the effects of the internal damage caused by inhalation, ingestion or absorption, and the level of risk to which Fire Service personnel, the Public, and the environment at large may potentially be exposed; and secondly the appropriate protective clothing to be used by the Fire Service at the first attendance, taking into account "worst case planning".

It was decided to use three broad categories of toxicity, because this corresponds to the types of protective clothing most commonly available in the Fire Service. It should be pointed out that our recommendations require the obligatory use of positive pressure CABA in all radioactive incidents, in keeping with the JCFBO report, so that respiratory contamination is highly unlikely; thus it is not necessary to consider subdivisions of toxicity such as, for example, whether the isotope/chemical is in Lung Class D, W or Y except in so far that, at a later stage in the incident, it will affect the assessment of the risk to the public at large.

The three categories of protective clothing corresponding to the categories Bio1, Bio2 and Bio3 are shown below, with an indication of the equivalent Clothing Code.

	Clothing Code		Protective clothing required
Bio1	C	Firekit:	helmet, tunic, leggings, rubber boots,* heavy duty gloves positive pressure CABA
Bio2	AC	Firekit:	helmet, tunic, rubber boots,* chemical protection suit positive pressure CABA
Bio3	BC	Firekit:	helmet, tunic gas-tight suit positive pressure CABA (FULL PROTECTIVE CLOTHING)

* NOT Leather Boots

Although it can be argued that, because the Bio classification is in many ways similar to the Clothing Code, it would be simpler not to duplicate systems, we would support very strongly the use of the Bio system for two important reasons. First that it includes the notion of radiotoxicity as well as the protective clothing required; and secondly that experience of talking to Firemen has convinced us that they understand the implied Biological Risk much better in the form of the Bio1 to Bio3 classification. Moreover, the emphasis of the two systems is different. The clothing code is aimed at chemicals that are corrosive or good solvents; whereas the Bio code is aimed at toxicity and relatively few chemicals show the toxicity of Bio3 isotopes.

We have classified the biological toxicity of the individual radioisotopes strictly according to internationally agreed recommendations and published material (IAEA Technical Report Series No.15, Vienna 1963: Aamodt, 1977; Morgan, Snyder & Ford, 1964; NBS Handbook No.69, 1959; NCRP Report No.32, 1966; ICRP No.2, 1959, No.6, 1964). Since we were interested in a broad ranking of isotope toxicity, numerical differences due to the method of assessment are generally less important than the rank order.

The highest category, Bio3, is clear. This category contains the extremely toxic isotopes of the transuranic series. By definition, this category contains all Alpha emitters as well as 90-Strontium, a beta emitter. In terms of rank order in the IAEA Table of Radionuclides classified according to their radiotoxicity (T.R. No.15, 1963), the border between Bio3 and Bio2 occurs at 35-36 (249Bk:154Eu).

To choose a suitable border line between Bio2 and Bio1 is more of a problem. The choice is at any rate, somewhat arbitrary and inevitably leads to apparent discrepancies for isotopes just above or below the line drawn. After considerable thought it was decided to put the *division between Bio2 and Bio1 somewhat less than halfway through the Medium Toxicity (lower B) group corresponding to rank numbers 136-137 (149Pm:96Tc). In terms of isotopes of rank number close to the borderline, this means that 132I, 99Mo, 57Co and 47Ca are classified as Bio2, and 96Tc, 198Au, 111Ag, 202Tl, and 35S as Bio1.*

It is important to stress that our classification into Bio1, Bio2 and Bio3 is rather broad and as such is insensitive to small differences in toxicity, except near the borderlines between classes. Since the division into groups is so broad it is also insensitive to the way that the toxicity is assessed. The table below indicates in a general way how the Bio classification interrelates to the various measures of radiotoxicity, and to the levels for Notification of an Occurrence under Regulation 31(1) of the Ionizing Radiations Regulations 1985 (SI 1333), namely when radioactive material

(a) has been released or is likely to have been released into the atmosphere as a gas, aerosol or dust; or

(b) has been spilled or otherwise released in such a manner as to give rise to significant contamination.

In this context it is perhaps worth pointing out that the Officer in Charge should regard the incident ground as a 'Controlled Area' in the sense of the Ionizing Radiations Regulations 1985, Schedule 6 Part I paragraph 2, since the levels of activity which may occur even in the lowest category R1 are sufficient to ensure designation of a controlled area under the Act.

In practice this means that the Officer in Charge must ensure that (Ionizing Radiations Regulations 1985 8(5)) -

(a) the area is physically demarcated or, where this is not reasonably practicable, demarcated by some other suitable means; and

(b) access to the area is restricted by suitable means

and that <u>any</u> person entering the area is wearing suitable protective clothing, especially breathing apparatus, and is subject to control with respect to time of exposure and radiation dosimetry. This restriction of access is particularly important for:-

(i) additional Fire Service personnel not primarily committed to the incident and not wearing protective clothing.

(ii) members of the other emergency Services, especially the Police and Ambulance Service, who may not be trained in the use of protective clothing.

(iii) any members of the Public, including specialist advisers, who are not wearing protective clothing and are not trained in its use.

In addition there must be an ABSOLUTE PROHIBITION on smoking, eating or drinking, within the Incident Area and by those involved in the incident until they have been decontaminated.

These recommendations, although more detailed, follow closely those suggested by the Joint Committee on Fire Brigade Operations (June 1984, XIX(64)), and are very much in the spirit of the Ionizing Radiations Regulations 1985.

Table 5 Correlation of various measures of radiotoxicity with the HAZRAD Bio classification. The most restrictive values are used, and the ranges quoted approximate. The literature cited can be found in the references section at the end of the document.

Source	*Bio1*	*Bio2*	*Bio3*
(1,12) IAEA Rank	137-236	35-136	1-34 all alphas plus 90Sr
(14) Relative hazard; 226Ra=1	10^{-15} - 0.001 <0.001	0.001 - 0.1 0.001 < RH < 0.1	0.1 - 100 >0.1
(7,8,15,16,18) Quarterly intake (ALI/4) in MBq (in μCi)	4 - 250 (100 - 6400)	0.04-4 (1 - 100)	0.00001 - 0.04 (0.0003 - 1)
(1) I.R.R 1985 Reg. 31(1) Notification in Bequerels (Curies)	2.10^{10} - 2.10^{14} (0.5 - 5000)	2.10^{8} - 2.10^{10} (0.005 - 0.5)	2.10^{5} - 2.10^{8} (0.000005 - 0.005)
(5) Dose inhaled Sv/MBq (rem/μCi) 50 years	0.0001 - 0.03 (0.0004 - 0.1)	0.03 - 3 (0.1 - 10)	3 - 3000 (10 - 10000)
(4) Single intake for 50 mSv to crit. organ in MBq (in μCi:5 rem)	37 - 37000 (1000-1000000)	0.37 - 37 (10-1000)	0.37 - 0.00037 (10-0.01)
(21,22) MPC (air: 40h) KBq/m^3 ($\mu Ci/m^3$)	4 - 200 (0.1 - 5)	0.04 - 4 (0.001 - 0.1)	0.4 - 0.00004 (0.001 - 0.000001)
(21,22) MPC (water: 40h) in MBq/l (μCi.l)	0.4 - 4 (10 - 100)	0.04 - 0.4 (1 - 10)	0.004 - 0.04 (0.1 - 1)
(21) MPBB MBq (μCi)	2 - 40 (50 - 1000)	0.08 - 2 (2 - 50)	0.001 - 0.08 (0.03 - 2)

3. TYPE OF RADIATION PRESENT - A, B, G & N

The letter given in this category signifies the type of radiation present:

A = alpha particles
B = beta particles
G = gamma (photon) radiation
N = neutrons

This category is used to indicate to the Officer in Charge the correct monitoring equipment to be used, and whether personal dosimeters are effective and appropriate (gamma and neutron radiation).

In Cambridgeshire all the monitoring equipment is marked with the appropriate letter(s) so that it can be matched to the HAZRAD code immediately, thus indicating which particular monitor should be used. Each radiation type is not exclusive of the others so that mixed types are possible, for example AN or BG, and all may occur in the classification of a large storage facility, e.g., ABGN. With a large number of Research Institutes and Hospital Departments in the County, we also have available equipment capable of monitoring low energy gamma sources, especially 125I, and thin end-window beta monitors.

OVERALL RISK ASSESSMENT

It is important to be aware that certain combinations of risk in each category represent a greater overall risk than others: for example, an R3/Bio3 grading in the presence of alpha and neutron emitters is a much greater risk than all other combinations.

Although the HAZRAD scheme is extremely straightforward and can be interpreted readily by non-experts, this being its aim, certain combinations should be noted as of particular significance such as high activity beta sources because of the potentially high surface dose rates, and high activity alpha sources because of the high biological risk.

One possible approach to an overall assessment of risk, basically a rule of thumb for use by the Officer in Charge of the incident, is to score the categories and add the individual scores together in order to arrive at a numerical measure of the overall risk. There is no problem with scoring categories R and Bio on a scale of 1 to 3. As a way of approaching the problem of scoring the type of radiation present, we suggest that alpha and neutron emitters are given an arbitrary score of 2 units each, and beta and gamma emitters a score of 1 unit. This simple system would then work in the following way.

A high activity alpha/neutron source, e.g. 252Cf, would score thus -
R3/Bio3/AN = 3 + 3 + 2 + 2 = 10

whereas a low activity Tritium source would score as follows -
R1/Bio1/B = 1 + 1 + 1 = 3

In principle, this method gives a score which lies between 3 and 12, respectively the highest and lowest risks possible, thus indicating in a very general way the overall risk. It has to be said that such a simple scheme has obvious imperfections, so that no significance should be attached necessarily to small differences between overall scores, as for example between 10 and 11, or even perhaps 10 and 12. It is equally obvious, however, that the overall risk involved in handling a situation with a score of 4 is dramatically different from a situation with a score of 11!

SPECIAL CASES

1. Smoke Detectors

The requirements for the registration or exemption of smoke detectors which use sealed radioactive sources as ionization devices, are covered in "The Radioactive Substances (Smoke Detectors) Exemption Order 1980 (S.I. No.953, 1980).

It is important for the credibility of the HAZRAD scheme that the inclusion of individual smoke detectors containing, for example, 241-Americium, in the grading of a premises does not result in an overall category of Bio3 being assigned (e.g., in a public house!) UNLESS there are a very large number of such detectors present, as for instance on the premises of a manufacturer or distributor. We know of only one such instance in Cambridgeshire.

Individual detectors containing 241Am are exempt with an activity up to 40 KBq (1.08 μCi) - Article 4(a) - and other detectors, if attached or fixed to the premises, are allowed a maximum activity of 4 MBq (108 μCi) - Article 4(b). The total number of devices, falling within Article 4(a) of these Regulations and not attached or fixed to the premises, must not exceed 100 - Article 6(1). If the smoke detectors are mobile the total number is limited to 10 - Article 7.

Since in the Fire Brigade practice the sources may be damaged and must be considered so in the first instance, the Notification Procedures in Article 6(2) are relevant. It should be remembered that contamination of the Fire Ground with significant amounts of 241Am, an alpha emitter, will pose a very considerable decontamination problem; this has already happened in at least one incident involving smoke detectors.

In keeping with the levels given in these Regulations, it would seem sensible to classify an area containing radioactive smoke detectors ONLY IF the total number of such detectors exceeds 100, OR the total activity present is greater than 4MBq (108 μCi), especially for 241Am. Sensible storage facilities such as fireproof cabinets and division of the total number of devices into small groups, can be used to reduce and control the risk even in the case where very large numbers are stored. In the case alluded to above the total number stored was in the region of 700.

2. Anti-electrostatic Devices

Anti-electrostatic devices, such as 210Po bar sources, use much higher total activities, 3.7 GBq (110 mCi) plus, and pose a very real risk of contamination as a result of thermal damage (Table 4).

Active static eliminators which contain 210Po , an alpha emitter (Bio 3) with a half-life of 138 days, so that even devices at the end of their useful life of 12 months may present a hazard, are manufactured with the radionuclide encapsulated in a strip of gold and silver mounted in a stainless steel casing. Bars contain 3 GBq (80 mCi) per metre and are produced in lengths up to 2.25 metres, equivalent to 6.7 GBq (180 mCi) of 210Po. Sources produced for use in air guns and blowers contain up to 2.2 GBq (60 mCi) 210Po, whereas discs and semi-circular sources (as manufactured by Amersham International plc) contain up to 0.74 GBq (20 mCi).

These sources represent a very limited hazard under normal conditions of use; however, the situation under the emergency conditions likely to be encountered by the Fire Service may be quite different. The activities contained by single devices of this type should be put into context by comparing them with the level set for Notification of an Occurrence under Regulation 31(1) of the Ionizing Radiations Regulations 1985, which for 210Po is 0.2 GBq (6 mCi).

The need for contingency planning under emergency conditions may be illustrated by quoting directly from the manufacturer's safety instructions ("Safety Instructions for unpacking and use of static eliminator units". Amersham International plc., U.K. HI/7/86/9), namely :-

> *The greatest hazard from alpha emitters is ingestion, because the particles can deposit large amounts of energy to delicate and sensitive organs. Great care must therefore be taken to ensure that the active part of the source remains intact and is not touched so that routes for ingestion are prevented.*

This caveat has heightened relevance in an emergency situation where -

> *If the active metal foil strip inside the static eliminator unit is damaged (e.g., by impact, fire, etc.), involved in an accident or is exposed to adverse conditions (e.g., corrosive environments or abnormal atmospheric or mechanical conditions), which are outside those agreed in writing* [by the manufacturer], *then extreme precautions must be taken. The Competent Person* [in this instance probably the Officer in Charge of the first attendance] *must ensure that the area containing the source is immediately isolated and organised such that personnel are not exposed to abnormal levels of radiation or contamination. The relevant local and national regulatory authorities* [and the manufacturer] *must be informed and further advice should be sought from the appropriate national organisation* [e.g., NAIR].

The point is clear. Anti-static sources containing 210Po must be treated with great care at any incident where they may have been damaged mechanically or thermally.

3. Exit signs containing Tritium-(3H)

Premises should only be classified if EXIT signs are present in large numbers, as for example on a manufacturer's or dealer's premises. In any case the radiotoxicity of Tritium-(3H) gas is low (Biol) and, although the quantity contained in individual EXIT signs is quite large in total activity, mechanical or fire damage is likely to result in loss of the 3H as gas or water-vapour to the atmosphere. Only in exceptional cases involving substantial total activities would the H_2O produced by burning and present in the run-off water, represent a significant hazard to the water table.

4. X-Ray Equipment

X-ray equipment only emits ionizing radiations whilst the source of electrical power is operative.

Hospital X-ray installations and commercially produced X-ray equipment use safety-interlocks and procedures of a very high standard and should present no hazard to the Fire Service if operated correctly and the main power supply has been interrupted; for experimental equipment in Research Laboratories this is perhaps less true. If the main power supply has not been interrupted, however, two hazards exist for firemen, a radiation hazard and a high voltage hazard. The second of these hazards, that of high voltage, may be the more immediately life-threatening.

It should also be remembered that, although X-rays are produced intentionally from medical diagnostic equipment or X-ray crystallographic apparatus, it is also possible to generate X-rays unintentionally from any high voltage source such as an electron microscope, or high voltage cathode-ray tubes such as are found in colour television sets.

In order to incorporate X-ray equipment into the HAZRAD scheme, whilst still keeping a sense of proportion about the potential hazard even allowing for "worst case planning", we would make the following recommendations:

i) that a high voltage flash "  " should appear in the category normally reserved for the level of radiation; and

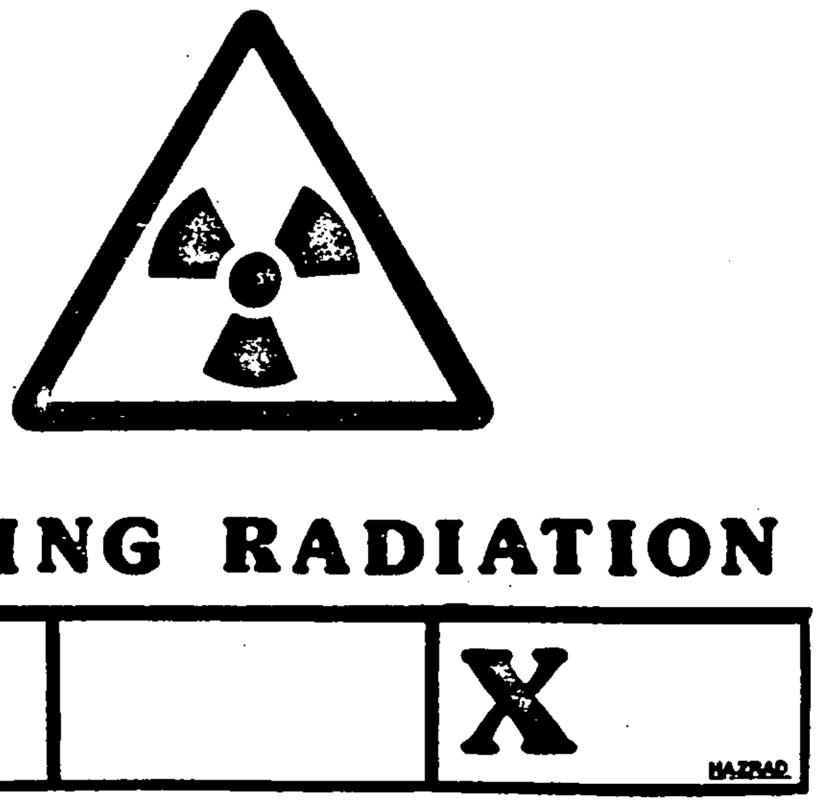
ii) that the Bio category should be left blank; and

iii) that the area containing the X-ray apparatus should be marked with a sign showing an "X" in the category reserved for the type of radiation, and

iv) that an isolating switch for Fire Service use, as done for commercial neon signs, should be placed next to the sign.

This combination would indicate to the Fire Service that there was only an X-ray hazard in the presence of high voltage; the isolating switch would enable them to verify ***independently*** *that the source of power had been removed from the equipment.*

The user of the X-ray equipment might also wish to indicate what the equipment actually was, for example, by using a sign similar to that adopted by the University of Cambridge (see Appendix F), modified to read Ionizing Radiation, with additional comments in the available space. An example is shown below.



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POSTSCRIPT

Whenever a particular procedure is recommended in this document, it should be taken in the sense that the exigencies of the emergency situation may often drastically modify the final decision of the individual in charge. It is absolutely necessary, however, that such decisions are taken after informed risk assessment. It is the purpose of this paper, and indeed the HAZRAD scheme itself, to heighten awareness of this process for radiological risks when the Fire Service is confronted by them.

ACKNOWLEDGEMENTS

It is appropriate that I should acknowledge that the production of this scheme was a team effort involving many people. The scheme was initiated under the previous Chief Officer of Cambridgeshire, Duncan MacCullum, as a result of perceived difficulties in dealing adequately, in so far as the Fire Brigade was concerned, with radiological risks within the University of Cambridge, coming as it did in the period immediately 'post Chernobyl'. The present Chief Officer, Alan Gray, has supported the development of the scheme with great enthusiasm, and the Officers from the Cambridgeshire Fire & Rescue Service most closely associated with this development have been Divisional Officer Roger Muncey, Assistant Divisional Officer Stuart Bartram and Divisional Officer Brian Hibbert. I should also like to thank my son, Daniel Klein, with whom I developed the original microcomputer programme for grading the radioactive risk and producing the HAZRAD code, and also my wife Frances who proof read the final version.

We should also like to thank John Williams, Peter Ward and Robin Rooke, respectively Safety, Radiation and Fire Advisers to the University of Cambridge, for their support and help in introducing the scheme within the University, being as it was the first large organisation to do so.

APPENDICES

APPENDIX A

Attenuation of Beta particles by Protective Clothing

Measured 'thicknesses' are shown with the calculated percentage of the beta flux that passes through the material for beta energies of 0.4MeV and 1MeV. These calculations were derived from data on beta particle attenuation versus 'thickness' in IAEA Technical Report Series No.152, Vienna 1974. Values for the measured 'thickness' are only shown with a standard deviation where considerable differences in thickness were observed.

Protective clothing	*'Thickness' mg/cm²*	*Attenuation to %*	
		0.4Mev	*1MeV*
BA visor	*344±49*	*0.000004%*	*1.7%*
BA face mask	*245±17*	*0.0005%*	*5.4%*
Tunic (single thickness)	*61*	*4.8%*	*48%*
Leggings	*46*	*10%*	*58%*
Chemical Protection Suit	*49*	*8.8%*	*56%*
Gauntlet (heavy duty)	*118*	*0.3%*	*25%*
Fireboots (rubber)	*219*	*0.002%*	*7%*
Surgical Latex Gloves	*15-20*	*42%*	*81%*

It should be remembered that the attenuation achieved with multiple layers of protective clothing is not additive, but multiplicative so that, for example, a splash suit plus leggings plus trousers would give an attenuation of approximately 4.8% x 10% x 8.8% = 0.04% for a 0.4MeV beta flux, and 16% for a 1MeV beta flux.

APPENDIX B

(see IAEA Technical Report Series No. 152, Vienna, 1974)

External dose rates from point sources of beta and gamma emitters may be estimated using the following relationships.

Beta emitters

For a point source, ignoring self-absorption and air-absorption, the dose rate 1 metre from a source of C curies (37C GBq) is approximately 0.3 Gy/hour (30R/hour).

More accurately and allowing for the density of air at STP (0.001293 g/cc), the beta surface dose in air for a point source of C curies, is given by:

* Dose = $(S_a.C)/2.07$ rad/hour at 1 metre

where S_a is the average number of ion pairs produced per centimetre path length in air; this is energy-dependent and the value ranges from 250 (0.05MeV) to 47 (1.50MeV), but lies between 76 and 47 for energies in the range 0.3MeV to 1.50MeV giving the approximate multiplier of 30, good to within approximately ±25% over this energy range.

Gamma emitters

For gamma energies of between 0.07Mev and 2MeV, the following relationship holds good within ±12%:

Dose* (Rads/hour) = 5.64 x C x Sigma (i.Ei) at 30cm (1 foot)
_ 6 CE
Dose* (Rads/hour) = 0.521 x C x Sigma (i.Ei) at 1 metre (3.3 feet)

where C is the activity in Curies (37 GBq) and Sigma (i.Ei) = the sum of the gamma energies (in MeV per disintegration), if more than one gamma is emitted per disintegration.

The term 5.64 x Sigma (i.Ei), or 0.521 x Sigma (i.Ei), equates to the specific gamma ray constant at either 1 foot or 1 metre, respectively.

* Multiply by 0.01 to give Gy/hour.

APPENDIX C

Compressed air breathing apparatus (CABA) Duration Tables - time to whistle - as used by UK Fire Brigades

Cylinder size (litres)	Cylinder pressure at entry (bars) 200	190	180	170	160	150	140	130	120	110	
2240	46	43	40	38	35	32	30	21	18	16	mins
1800	35	33	30	28	25	22	20	19	17	14	mins

Lowest recommended entry pressures shown in bold type.

APPENDIX D

Transport of Radioactive Material (see ACTRAM, HMSO 1987)

Maximum dose rate 1 metre away from the package gives the Transport Index:

Transport Index (TI) = mRem/hour at 1 metre
= 100 x mSv/hour at 1 metre

therefore:

R3:R2 10 mSv/hour (1 Rem/hour) at 1 foot $TI > 100$

R2:R1 0.1 mSv/hour (10 mRem/hour) at 1 foot $TI > 1$

Dose rates at any point on the package surface

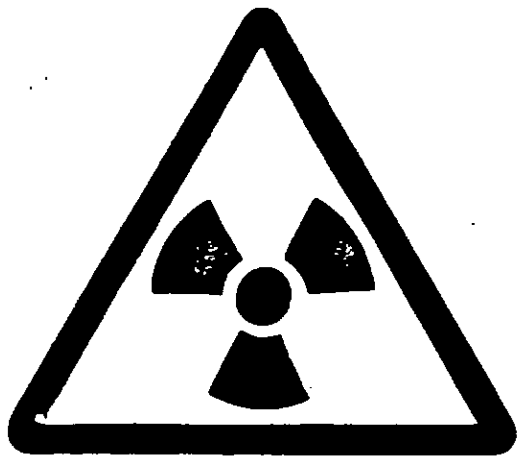
Category		
I-WHITE	TI = 0	< 0.005 mSv/hour (0.5 mRem/h)
II-YELLOW	0 < TI < 1	0.005 - 0.5 mSv/hour (0.5 - 50 mRem/h)
III- YELLOW	1 < TI < 10	0.5 - 2 mSv/hour (50 - 200 mRem/h)

Note that the exposure rates refer to unbroken packaging and shielding.

Proportion of packages transported in each category (Amersham International plc)

Excepted packages	55.0%
I-WHITE	9.0%
II-YELLOW	18.5%
III-YELLOW	17.5%

BUILDING LABEL



RADIOACTIVE MATERIALS

^{3}H TRITIUM.

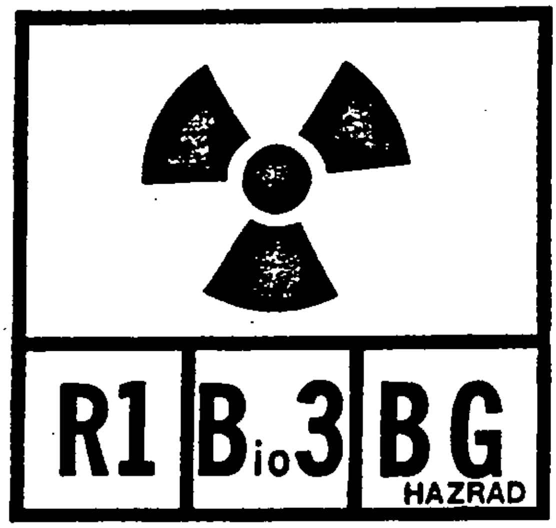
^{14}C CARBON.

^{35}S SULPHUR.

^{32}P PHOSPHORUS.

R1	Bio1	B HAZRAD

BUILDING LABEL



APPENDIX G

Units and Definitions

Becquerel: *The activity of a radioactive isotope expressed in terms of the number of disintegrations per second. One Becquerel is the activity associated with any radioactive isotope undergoing 1 disintegration per second. Activities are commonly measured in multiples of the Becquerel, the kilo-Becquerel (KBq), and mega-Becquerel (MBq), the giga-Becquerel (GBq), or the tera-Becquerel (TBq), being respectively* 10^3, 10^6, 10^9 *and* 10^{12} *Becquerels. 1 Curie is the activity associated with* 3.7×10^{10} *radioactive disintegrations per second. The correspondence between the old and new systems is therefore:*

$$1\ KCi = 37\ TBq$$
$$1\ Ci = 37\ GBq$$
$$1\ mCi = 37\ MBq$$
$$1\ \mu Ci = 37\ KBq$$

Physical half-life: *The time taken for 50% of a statistically large number of radioactive atoms to decay.*

Biological half-life: *The time taken for the number of atoms of a stable nuclide ingested, inhaled or absorbed into the body, to decrease to 50% of the starting level.*

Effective half-life: *The effective half-life will always be less than either the biological half-life or the physical half-life. It is the time taken for the level of a radioactive isotope in the body to be reduced to one half of its original value as a result of radioactive decay and biological elimination. The effective half-life is the reciprocal of the sums of the reciprocals of the radioactive (physical) and biological half-lives:-*

$$\frac{1}{T_{eff}} = \frac{1}{T_{rad}} + \frac{1}{T_{biol}}$$

Critical organ: *That organ of the body in which the injury suffered from either external radiation, or from internal radiation derived from ingested, inhaled or absorbed isotopes, is the most severe, the body taken as a whole. The critical organ is often, as with the thyroid, the organ in which the isotope is concentrated due to its chemical form.*

'Thickness': *The 'thickness' of a material is a measure of its stopping power for radiation and is usually given in* mg/cm^2*; this is simply the product of the density of the material in* gm/cm^3 *and the physical thickness in cm, times 1000. Typical thicknesses in* mg/cm^2 *are shown in Appendix A for various samples of protective clothing.*

Half-value thickness: *This is the thickness of a material required to attenuate the intensity of a parallel beam of radiation by 50%.*

Roentgen: *This unit of X-ray or gamma radiation exposure is a measure of the ionization produced by the radiation in air, and corresponds to an energy deposition of* 8.38×10^{-6} *Joules per gram of air, or* 1.610×10^{12} *ion-pairs per gram of air.*

<u>Gray</u>: For the purposes of health physics it is important to quantify the amount of energy deposited by the radiation in question within the body or organ, since only absorbed energy can cause biological damage. The Gray corresponds to the absorption of 1 Joule per kilogram of irradiated tissue. 1 Gray is equivalent to 100 Rad, the older unit.

<u>Quality factor</u>: Both the Gray and the Rad make no allowance for the type of radiation. Equal doses in Grays from 5 MeV alpha particles and 300 KeV X-rays, for example, would produce very different biological effects. Quantity factors allow an approximate weighting to be applied for the different types of radiation. X-rays and gamma radiation have a QF=1, very soft electrons a QF=2, and fast neutrons and alpha particles a QF=10 (ICRP Publication No.9).

<u>Sievert</u>: The dose equivalent in Sieverts is the product of the absorbed dose in Grays and the quality factor:

$$\text{Sievert} = QF \times \text{Gray}$$

Dose equivalents are usually measured in μSv or mSv, since these lie more within the encountered ranges. The Sievert (Sv) is equivalent to 100 Rem, the older unit. For radiations with a quality factor close to 1, the following relationships are approximately true:-

Exposure (Roentgens) = absorbed dose (Rad) = dose equivalent (Rem)

Absorbed dose (Gray) = dose equivalent (Sievert)

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To :CFOs in England, Wales,
Scottish H&H Dept, FS College
From :Home Office F&E P Dept.
Ref No :03073 1/2
Subject :DCOL Amendments

DCOL 4/1991 Item 6
1 Paragraph 3(iv) of this guidance has given rise to queries from brigades as to whether cone marker lamps (if used) should be amber red or blue. The police use blue "cone insertion beacons" and prefer fire brigades to do the same. However, where brigades have amber cone marker lamps, these are acceptable and should continue to be used until such time as they require replacement.

2 Paragraph 3(v) incorrectly refers to Figure 3.3 page 58 of Manual of

KEY 1 FOR NEXT PAGE, 0 TO EXIT

FR: FINDS000 05-31 11:01 DCOL AMENDS
2/2

Firemanship Book 12. The reference should read Figure 3.4 page 60.

DCOL 4/1991 Item 11
3 In paragraph 2, line 3, after the word "being", the following words should be inserted, "reported because fire authorities are not necessarily being".

Home Office contact: 071-273 3942

END

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