

AURPO CONFERENCE 2004 BELFAST

1) Storage & Decay: Peter Marsden UCLH, London

A review of the reasons for storing radioactive wastes and the means by which to achieve it as described in the EA Report P3-073/TR: "Agency Practice and Future Policy in Decay Storage of Radioactive Wastes". The risk vs. benefit assessments were covered, highlighting the points to consider for storage and direct disposal. It was noted that there is unlikely to be a better BPEO than storage for decay and that in some countries decay storage is now mandatory. The relative dose saving was illustrated with examples from a university and a teaching hospital.

It was recommended that both solid and liquid wastes of radionuclides with a half life of ≤ 90 days should be stored. The storage period depends on the half life, activity clearance level (SoLa or VLLW) and stored capacity, and one should not simply apply a 10 half life rule.

The store should be remote from public access but close to the point where waste is generated. There should be good security, with restricted access to keys or entry codes. Fire alarms should be fitted and intruder alarms must be considered (see ACPO Guidance). The store should be large enough to allow for regular use without acquiring significant doses and should be able to accommodate waste from a reasonable foreseeable incident.

The store should be of a solid construction with internal surfaces finished for ease of decontamination. If liquid wastes are stored there needs to be means of spill containment. The store should be resistant to the ingress of weather and small animals and be well lit and ventilated. Shelving should be provided, on which to stack secondary containers, and consideration needs to be given to providing shielding.

Secondary containers should be used. These are normally rigid polyethylene or metal bins – whatever is appropriate to any other hazards in the waste (e.g. chemical). The bins may need to be sealed, and should be trefoiled. Each bin should bear a ID which links to a store record. The record should contain:-

ID, radionuclides, activity and reference date, hazards, surface dose rate (if significant), date accumulation began, estimated disposal date and name and contact details of the originator.

Wastes should be segregated by form (solid, aqueous liquid, organic liquid) half life (<6days, 6–71 days, >71 days) and by hazard (pathogenic, toxic, explosive, flammable, sharps, combustible).

Finally, the store needs to be managed by an RPO who collates records, audits the store and arranges disposals. Management includes written procedures for waste sentencing, incorporating calculation of disposal date and details of final monitoring process.

Learning Points:

- BPM for decay storage
- review of storage requirements
- current EA direction on storage.

2) Holding & Disposal of Sealed Sources Bob Russ, Environment Agency

The EC has taken the step to strengthen and harmonise controls on high activity sources and help prevent accidental exposures by introducing this Directive in December 2003, following various serious incidents outside of the EU. UK legislation needs to be introduced before December 2005 – DEFRA lawyers are aiming to have regulations completed by December 2004.

It is felt that there is a reasonable level of control over radioactive sources during their useful life, but there is poor control once the source becomes redundant. The legislation will seek to strengthen control in this area in particular. In the retirement-to-grave period there is a higher

risk of loss, theft or abuse, and this period is often prolonged due to lack of adequate financial provision for disposal.

A HASS source is defined as one having an activity greater than 1% of the A1 value specified in the IAEA Transport Regulations TS-R-1. This adds a level of control above that of the BSS to the highest activity sources.

Prior authorisation of practices involving HAS sources will be required, but this is not intended to be a justification process. The EA will be the competent authority who will have to be satisfied that there are satisfactory management arrangements, including end of life management and financial provision for disposal where necessary.

There will be a standardisation of records kept on HAS sources, including type photographs, and a national register of sources will be set up. Sources will have to be identified by a serial number. Transfers of sources to other organisations will have to be recorded and reported. An annual return will have to be made. Users will be required to keep records of leakage tests, verification of location, and security measures. Prompt return of redundant sources to supplier (or to a recognised organisation for receipt of sources) is expected.

Training and information to HAS source users is already covered by IRR99, but there will be an additional requirement for training of customs and scrapyards workers etc so that they can identify sources which may come their way.

National response arrangements will be made for orphan sources, including controls to detect orphan sources and means to recover them. The finder will no longer face the possibility of having to pay for the disposal of an orphan source.

There will be greater international co-operation in the event of the loss of a HAS source.

EA/SEPA will be required to conduct inspections and non-compliance must attract penalties commensurate with the cost of compliance – ie fines should not be less than disposal costs.

There will be a 2 year transition period for existing sources, running to December 2007, and there will be a review of HASS Directive across Europe in 2010.

Implications in UK are: revision to RSA93, national register of sources in England and Wales, increased pre-registration checks, disposal arrangements to be agreed before registration, changes to RSA registration applications (and increased charges), and an end to the retention of disused sources on users premises. The Waste Closed Source EO will be reviewed but will not disappear.

IAEA Tec Docs 1344 & 1355 were referred to as sources of information on security. Current threats to security include theft, dumping, negligence leading to loss, unauthorised transfer and bankruptcy. It is envisaged that in the UK the current voluntary arrangements between EA and CTSA will evolve into a statutory scheme to enforce CTSA recommendations.

The government has provided funding for a public sector source disposal programme in England and Wales. Money will be given to the EA to manage the recovery and disposal of sources from hospitals and universities. A questionnaire is likely to be circulated, but in the meantime we should compile an inventory and get quotes for disposal. Radium will be included.

Learning Points: description of HASS Directive
understanding of UK implementation of HASS
information on source disposal programme

3) Disposal Routes for Sealed Sources Brian Heaton, Aberdeen

Sealed sources are commonly disposed of via one of two Exemption Orders. The Waste Closed Sources EO allows for disposal without Authorisation but the source must go to an authorised person or back to the source producer. Sources can be accumulated for up to 12 weeks after being declared waste, after which an Authorisation would be necessary. It has

been assumed that the WCS EO does not apply to leaking closed sources, but SEPA has accepted the argument that the source became waste when it started leaking and that it was therefore a closed source before it was waste.

The Testing Instruments Exemption Order specifies two classes of source. Class 1 sources are homogeneous, laminated, sealed, electro-deposited or tritium foil sources of less than 200kBq. Class 2 sources are other than Class 1, with activities less than values specified in a schedule. Class 1 sources can be removed to a waste collection authority (one per week), to an authorised disposal site, or to the manufacturer of the source. Class 2 can only be removed to an authorised site or the manufacturer.

The remainder of the presentation described the experiences of the government funded source disposal scheme in Scotland. Initially it was only applied to hospitals, leaving an inadequate fund of £100k in total for universities. A priority list was therefore drawn up, essentially identifying sources which might be used for dirty bombs (^{241}Am , ^{137}Cs , ^{60}Co , ^{90}Sr) and excluding teletherapy sources (because of weight), radium and tritium. SHEFC refused to sign a contract for the disposal as they did not want to be liable for the sources if disposal failed, so the money was shared out between the universities who then made their own arrangements.

The disposal contract contenders are Safeguard, ACB and Gamma Services. Users should satisfy themselves that these companies have contracts for disposal routes (eg with BNFL, Drigg) and not just authorisations. Some export the sources for recycling and carry out a trans-frontier shipment on the basis that the sources not waste. How far should the user go to ensure that the source is actually recycled? Note that sources being returned to the supplier are exempt from the trans-frontier shipment requirements. It was reported that there are no disposal routes for radium (except small school sources); neutron sources or depleted uranium, though Bob Russ has details of a route for DU to the USA.

Disposal costs seem to be variable and negotiable, but are colossal for leaking sources (eg 27GBq ^{137}Cs source, expected to cost a few thousand pounds, cost over £100k because it leaked).

The closing recommendations were:- be alert to disposal costs when buying new sources, get rid of all sources unless you have a real need to keep them, and negotiate disposal cost.

Learning Points: Review of EOs
 Experiences of government funded disposal scheme
 Practical disposal problems.

4) Training Guidance Note Ian Haslam, Leeds

This presentation demonstrated the on-line training guidance being developed for AURPO. It follows the HSE's 5 steps to safety and is intended to cover training for managers, RPSs safety reps, users, classified workers and others such as cleaners and maintenance/estates staff. It is intended as a tool to help universities devise their own training plan and is not intended as a defining standard. Actual training material may be included or referenced as examples.

Learning Point: Introduction to guidance

5) Background Radiation Mike Thorne

The keynote lecture of the conference was a review of natural and man-made background radiation. Measurements of background radiation early in the 20th century used balloon ascents to show that radiation increased with altitude and led to the conclusion that there was an extra-terrestrial origin. Primary cosmic rays incident on the earth's atmosphere are mainly protons (86%) with some alpha particles (11%) and electrons (2%). Their energy ranges from 1.10^8 to over 1.10^{20} eV. They are thought to originate from our own galaxy but their source is not well understood. Interactions in the atmosphere produce cascades of protons, neutrons, pions and

low-Z nuclei. Distribution is modulated by the earth's magnetic field, concentrating cosmic rays around the poles. Further interaction and decay give rise to muons, electrons, photons, neutrons, protons and charged pions at sea level, where muons account for over 70% of the dose equivalent. The world average dose rate from cosmic rays is $280\mu\text{Sv.a}^{-1}$ from charged particles and photons, and $100\mu\text{Sv.a}^{-1}$ from neutrons.

Cosmic rays also induce radioactivity, particularly in the atmosphere. Largely these contribute little to radiation, except for ^3H , ^{14}C and ^{22}Na which give rise to just over $12\mu\text{Sv.a}^{-1}$ mostly from ^{14}C . It is interesting to note that levels of ^{14}C generated by weapons testing equates to approximately 250 years of natural production.

Naturally occurring radionuclides of terrestrial origin are all around us. Radionuclides in the ^{238}U and ^{232}Th series and ^{40}K contribute most to the external radiation dose and are also present in the body. In particular, the ^{238}U series includes ^{222}Ra which makes a significant contribution to radiation exposure. Average external dose rate is $480\mu\text{Sv.a}^{-1}$ mostly from irradiation indoors, but also there are significant localised variations, rising up to 790mGy.a^{-1} on the monazite sand beaches in Brazil. Internal exposure from an average $4\text{kBq } ^{40}\text{K}$ in the body amounts to $165\mu\text{Sv.a}^{-1}$ for adults. Radionuclides in the Uranium and Thorium series contributes $110\mu\text{Sv.a}^{-1}$ for ingestion and $5.8\mu\text{Sv.a}^{-1}$ for inhalation (excluding Radon). Average doses for Radon inhalation are $1010\mu\text{Sv.a}^{-1}$ indoors and $95\mu\text{Sv.a}^{-1}$ outdoors.

Overall, the world-wide average natural background is $2\text{-}4\text{mSv.a}^{-1}$. Taking an LNT model, this corresponds to an annual risk of 1.8×10^{-4} .

Between 1945 and 1980, over 500 nuclear weapons tests injected radioactive debris into the atmosphere, mostly in the Northern Hemisphere. Effective doses peaked in 1962/63 at $125\mu\text{Sv.a}^{-1}$ in the Northern Hemisphere and $59\mu\text{Sv.a}^{-1}$ in the southern Hemisphere. The world-wide average in 1999 was $5.5\mu\text{Sv.a}^{-1}$.

Learning Points: Good review of sources of natural and man-made background radiation.
Context of various sources in terms of effective dose
Questions validity of mixing high and low LET exposure in a single dose value.

6) Current Status of the Radon monitoring Programme Martyn Green, NRPB

The contribution of Radon to the average background in the UK is significant but varies considerably by region, and from house to house, by up to 3 orders of magnitude (<10 to 10k Bq.m^{-3}). Radon decay products attach to water and dust particles and lodge within the lung. Risk factors are derived from epidemiological data from uranium miners, but radon concentrations in homes can reach the same order of magnitude so the uncertainty due to extrapolation is less than with other radiation exposure studies which are largely based on large acute exposures. The UK average of 20Bq.m^{-3} gives rise to an annual dose of 1mSv and a lifetime risk of lung cancer of 1 in 300. The Action Level set for the Radon Programme is at 200Bq.m^{-3} , equating to a risk of 1 in 30. Statistically, radon accounts for 2000 deaths from lung cancer in the UK every year.

A Radon Affected Area is one where $\geq 1\%$ of homes are likely to exceed the Action Level. Homes in Affected Areas should have measurements made, and new build precautions should be exercised.

Up to mid 2004, 470,000 homes out of 25 million have been surveyed in the UK, and of these 47,000 have been found to have Radon concentration above the Action Level. The latest published maps are in W26 (for England and Wales) and R308 (for N.I.). Mapping is currently in progress for Scotland. The NRPB are currently working with 30 District Councils in England and have a pilot programme running in Wales in Flintshire. Using Devon as an example, the NRPB have provided information to Councils, builders, estate agents and other stakeholders. In the South Hams/Torbay areas they provided information to the media and local population and,

through the Council, offered 28,000 households a free test. 11,000 accepted the offer from which 1,500 are expected to be high. Advice will then be given on remediation and retesting.

A similar regime is ongoing in the west of Northern Ireland, but in the high risk area around Killeel a door-to-door visit strategy has been used resulting in better uptake of tests. There are two main methods of remediation – prevention of entry and dilution. Sealing cracks in the floor is relatively expensive and not very effective as the flow into the building is driven by difference in air pressure which forces air (and radon) in through the fewer remaining cracks. The most effective remedy (reduction factor 9.5) is to create a sump underneath the house and vent it to the outside using an extraction fan. The installation of ventilation fans in the loft or under the ground floor achieves a reduction factor about 2.8.

The Basic, or stage1, remediation for new homes involves a membrane seal across the entire footprint. This requires great care to avoid breaches, particularly when installing services, both at the time of build and in the future. Full, or Stage 2 remediation incorporates sub-floor ventilation as well as the membrane.

Learning Points: Insight into how the monitoring programme operates
Review of remediation process
Update on current mapping

7) Environmental Activity Levels on the UK Mainland - John Tittley Environment Agency

The EA has collaborated with SEPA, HSE and the FSA on this programme to monitor levels of radioactivity in the environment. The objective is to check on quantities discharged, and the results provide reassurance, support regulations, assess public doses, check the food chain and more recently look at doses to flora and fauna. The programme tends to concentrate around nuclear licensed sites for obvious risk reasons, and also allows the agencies involved to recover costs from the users. The results are regularly published in RIFE reports, of which RIFE 8 is most recent, but the 9th edition is due to be released in October.

Of the nuclear sites monitored (totalling 40), Sellafield is the most prominent, where discharge have been detected at some considerable distance from the site. In general, discharges peaked in the 1970s and have declined since, with the notable exception of ^3H , ^{14}C , ^{99}Tc ^{129}I . Environmental dose rates have decreased from $\sim 1.3\mu\text{Gy}\cdot\text{h}^{-1}$ in the early 1980s and now stand at $\sim 210\mu\text{Sv}\cdot\text{a}^{-1}$ in the immediate locale, of which $190\mu\text{Sv}$ comes from ingestion of seafood. Cs concentrated up to $1\text{kBq}/\text{kg}$ have been recorded.

Monitoring of non-nuclear sites was reported for UKAEA (Culham), Rhodia fertiliser plant (now ceased operation) in Whitehaven, and 30 landfill sites. Whilst the results for Culham are below the limit of detection, the measurements around Rhodia are not insignificant. The ^{210}Po content in winkles and crabs was reported as $25\text{Bq}\cdot\text{kg}^{-1}$ and $24\text{Bq}\cdot\text{kg}^{-1}$ respectively. The total dose to a critical group of shellfish consumers is $400\text{-}500\mu\text{Sv}\cdot\text{a}^{-1}$. Combining Rhodia with Sellafield gives the highest regional environment dose of $\sim 620\mu\text{Sv}\cdot\text{a}^{-1}$ in West Cumbria, followed by $79\mu\text{Sv}\cdot\text{a}^{-1}$ in the Ribble estuary and $75\mu\text{Sv}\cdot\text{a}^{-1}$ at Heysham.

Monitoring around landfill sites concentrating on measuring activity in the water. Levels are generally low, but a tritium concentration of $1200\text{Bq}\cdot\text{l}^{-1}$ has been recorded, which is probably due to the disposal of GTLD devices. Doses are $<5\mu\text{Sv}\cdot\text{a}^{-1}$.

Learning Points: Information on the monitoring programme
Rationale for monitoring & RIFE reports
Summary of current results

8) Northern Ireland Environmental Monitoring Programme Robert Lamour, IPRI

Environmental monitoring is just one of the roles of IPRI, who also regulate IPC, radioactive substances, air pollution and have involvement in radiation emergency planning. The monitoring programme covers radon, research (often in collaboration with others) and coastline monitoring. With no nuclear sites in Ireland, the coastline monitoring is assessing the impact of discharges from Great Britain into the Irish Sea. Their conclusions are published in the RIFE reports. Discharges from Sellafield have long been a primary concern and whilst current discharges are typically 1% of the 1970s peak, concerns have been raised about the increase in ^{99}Tc emissions from the processing of magnox fuel.

Several charts of results were presented, showing activity concentrations in various fish species has reduced over time. IPRI have used Generalised Derived Levels as a useful yardstick and have set an investigation trigger if any activity concentration exceeds 10% of GDL. Fish, shellfish and sediments are generally much less than 1% GDL, except for ^{137}Cs in fish and sediments which stand at 2.25% and 4.6% respectively. In the Northern Ireland marine loughs results are also well below 1% except for ^{137}Cs which rises up to 3%. All are well below the investigation level and there are no signs of levels increasing with time. Gamma dose rates on beaches were reported as $0.07\mu\text{Gy}\cdot\text{h}^{-1}$. Through the SNIFFER forum, a significant habits survey has been conducted on 821 individuals in Northern Ireland, looking at seafood consumption, time spent on coastal land and unusual exposures eg to people using seaweed as a fertiliser. The results indicate a hypothetical critical group, eating 99kg of fish, 34kg of crustaceans, 7.7kg of molluscs and 10kg of dulse seaweed in a year whilst spending 1100 hours over coastal sand/mud. This would give an extreme maximum of $18\mu\text{Sv}\cdot\text{a}^{-1}$. A more typical individual would receive a dose between 0.05 and $3\mu\text{Sv}\cdot\text{a}^{-1}$.

Learning Points: Mechanisms of large-scale environmental surveys
 Summary of environmental doses
 Insight into the work of IPRI

9) Radiation from Antiques and Museum Pieces David Hornsey, Bath

Radioactive material was deliberately introduced into artefacts in the early 20th century because of its perceived therapeutic properties. Examples include water tanks containing radium designed to let the radon bubble through the water. However, as antiques are strictly defined as over 100 years old, this presentation relates to artefacts whose radioactive content was not known at the time it was made.

Metal oxides have long been used to provide colouring for porcelain – for example cobalt gives blue, manganese a purple/brown and copper for red or green. Uranium was used as just another metal oxide which produced a large range of colours depending on the concentration used and the firing conditions. The major European supply come from the St. Joachimstahl mines in Austria where dose rates were of the order of $10\text{nSv}\cdot(\text{Bq}\cdot\text{h}\cdot\text{m}^{-3})^{-1}$. Fiesta dinnerware combined uranium and lead to give a bright red/orange colour. Use of this dinnerware could give rise to hand dose of $20\text{-}30\mu\text{Sv}\cdot\text{h}^{-1}$ and body doses of about $3\mu\text{Sv}\cdot\text{h}^{-1}$. Leaching out of acids should give greater cause for concern. Items of vaseline glass are highly sought after. The glass contains uranium to give a luminous effect. Jewellery was also made of uranium glass and surface doses of up to $40\mu\text{Sv}\cdot\text{h}^{-1}$ have been measured for such items.

In instrumentation, thorium has been widely used in optical glass. Early lens grinding techniques produced aberrations and distortions which could be compensated for by raising the Refractive Index of the glass. However, this increased light dispersion. It was then discovered that the addition of rare-earths increased the refractive index with reduced light dispersion. The Lanthanum used contains thorium. There is as much as 28% thorium oxide in some Kodak lenses and a 5 inch diameter lens has a surface dose of $50\mu\text{Sv}\cdot\text{h}^{-1}$. Self irradiation over a period of 40 years will darken a lens by a factor of 4. Such lens were used in aircraft bomb-

sights during the Second World War and would give a considerable lens dose with prolonged use.

The use of radium paints for luminous dials is well documented, and doses of up to $80 \mu\text{Sv}\cdot\text{a}^{-1}$ were reported. 3.7kBq of ^{226}Ra in a watch can impart a gonad dose of $30\mu\text{Sv}\cdot\text{a}^{-1}$ to the wearer. Restorers of clocks and watches should be aware that the common practice of ultrasound cleaning can cause bits of radium paint to chip off the dials. It is interesting to note that the use of radium paints has not been outlawed by the HSE and such use might be justified on the grounds of restoring an artefact to its original state using original materials.

An appropriate reminder was made at this point that the HSE recently prosecuted the Natural History Museum for having rock samples on display which gave a dose rates up to $50\mu\text{Sv}\cdot\text{h}^{-1}$. The NHM pleaded guilty and paid £6k cost.

Learning Points: Interesting review of radioactivity in collectible artefacts
Information on typical dose rates

10) What is a Qualified Expert - Jim Gemmill, SEPA

The roots of the Qualified Expert in the Basic Safety Standard were reviewed. Whilst most BSS references relate to protection of workers (and thus give rise to our RPA), Article 47 refers to environmental matters and health protection of workers and the public and there is a requirement for the QE to be recognised by the Competent Authority in each member state.

QE training is detailed in Annex 1 of 98/C 183/03. A basic syllabus is proposed but it is recognised that it is not possible to have a harmonised set of requirements. The depth and coverage of training is dependent on the level and complexity of advice required. Additional material is therefore proposed for specific areas. The EC advise that training should cover legislation, control of releases, containment and filtration, critical group dose, environmental monitoring, environmental and critical group impact assessment, waste management and decommissioning. To this EA/SEPA have considered adding BPEO, BPM and waste minimisation, impact assessments and waste sentencing.

The QE for RSA93 purposes needs to be based on Article 47 of the BSS and is therefore a narrower definition than given in the BSS. SEPA have already recognised individual QEs in respect of tasks relating to Article 47 and have implemented QE requirements through conditions within authorisations. All new Authorisations contain conditions to ensure that the QE is appointed. All nuclear sites have informed SEPA of their QEs and have supplied CVs to cover the Article 47 requirements. Almost all the recognised QEs are RPAs and recognition is made in relation to specific authorisations rather than accrediting an individual as a QE. EA/SEPA are seeking a common UK approach and have approached RPA2000 with regards a certification scheme for a Radiation Waste Adviser.

Learning Points: Origins of QE for RSA93 vs RPA
How little progress has been made in the QE recognition

11) BPM –What are Inspector Looking For? Adrian Bush, EA

Previous conditions in Authorisations required supervision by a “competent person” but otherwise responsibility was confused. The Chief Executive/Provost/Vice-Chancellor were unaware of their responsibilities and legal liabilities and the person signing the applications for RSA certificates did not necessarily have the authority to do so. The new management conditions put the onus on the user to remove all uncertainty by defining clearly who, within the organisation, has responsibility in the management of radioactive material, what their responsibilities are, and what the lines of communication are. In a university it is particularly important to ensure the Head of Department is clear on their role. Such management

arrangements may be described in an “organogram” which must be available to the EA inspector. The management conditions also require the user to consult a suitable RPA or QE. BPM applies to the Schedule 1 conditions 1 to 4. The rest of the Authorisation refers to “reasonably practicable” rather than “best practicable”.

Condition 1 calls for management systems and structures and resources, RPA/QE consultation, written operating procedures and adequate supervision. This is a comprehensive, wide-ranging condition which has not been fully understood by users and is open to interpretation by local EA inspectors. There should be written procedures for introducing new work and new users, for ensuring compliance with limits, for record keeping and for environmental risk assessments. These procedures should cover normal use, contingencies, design of new builds and decommissioning disused facilities.

Condition 4 calls for audit of systems, equipment and procedures. Organisations often rely on the RPA to conduct this, but the role and scope needs to be well defined. Particular care is needed if the RPA is external and the organisation needs to be clear of the role of the RPO and RPA.

There was a detailed handout to accompany this presentation which refers to an RSA Compliance Rulebook – a stand alone document describing how an organisation meets the Schedule 1 conditions.

Learning Points: Detailed analysis of Schedule 1 conditions
 Emphasis on management & procedures
 Insights into regulator expectations

12) Revision of Report NRPB – M744 Ciaran McDonnell, NRPB

The original M744 provided guidance and data to small users on performing environmental impact assessments to support RSA3 applications. The revised document, due to be available in November, carries the same purpose and covers 35 radionuclides. It does not cover disposal on land, naturally occurring radioactivity, alpha emitters, certain radionuclides such as ⁶⁰Co & ¹³⁷Cs, or foetal doses. It does help us to predict doses to critical groups and adults, children/infants from aqueous and gaseous releases. A brief example was given comparing adults, child and infants doses for a given ¹³¹I concentration:

	Child: adult	Infant : adult
Drinking water	1.4	3.5
milk	2.4	11

Releases to air take in continuous and short term releases from buildings and stacks, looking at dispersion (and subsequent inhalation and external doses) and deposition (and concentrations and food doses).

Releases to water look at sewer maintenance worker doses and sewage treatment worker doses, largely based on the SMART model data as published in the EA R&D Report P288. Once in the river the model looks at irrigation doses (<1µSv.a⁻¹), external gamma doses drinking water concentrations and fish concentrations. The Thames study P3–068/TR gives useful data for a “standard river” which can be scaled for a wide range of scenarios.

Some typical results were presented – eg an ¹³¹I discharge of 240GBq.a⁻¹ results in a dose from drinking water of 1-2µSv.a⁻¹, an external gamma dose of 0.0005µSv.a⁻¹ and 5µSv.a⁻¹ from fish consumption. A 12GBq.a⁻¹ discharge of ³²P gives rise to 40µSv.a⁻¹ from fish consumption.

Marine discharges remain as in the original M744.

Learning Points: Summary of useful publication for EIAs

13) BPM/BPEO a Generic Approach for Universities - Trevor Moseley, Sheffield

BPEO was first recommended by Royal Commission in 1975, and in its application we should consider the environmental impact of all disposal options and choose the one which presents the least damage. Occupational and environmental risks, cost and social implications should all be taken into account. In universities, BPEO will tend to lead us to decay storage of all short lived waste.

BPM refers to the level of management and other control that minimises release of radioactivity into the environment. It is proportionate, so one should not spend excessive time and money for little benefit.

The disposal routes commonly used are gaseous discharge on site, aqueous to drain, solid and organic liquid to incinerator and solid for burial. When assessing the gaseous route, bear in mind that filters in the exhaust will trap some proportion of the radioactivity. This will result in potential dose when the filter is changed, a subsequent disposal via solid waste to incinerator, and ultimately cost. Aqueous discharge to drain is the ultimate low cost route but requires a complex assessment of sewer worker doses, consideration of abstraction of water down river and increasingly complex analyses of doses from fish and other foodstuff consumption.

A generic BPM review was introduced, comprising sections on introduction and scope, justification, operational procedures, facilities, staff training and summary/conclusions. The introduction should cover what is required by BPM and include a list of the Authorisations to which it relates. Under justification, consideration should be given to non-radioactive techniques and choice of radionuclide based on minimum radio-toxicity and cost. It should also include the environmental risk assessment. Operational procedures should cover management structure and responsibilities, waste management procedures, other relevant procedure and mechanisms for record keeping. Under facilities will be design specifications, and maintenance and audit record descriptions. The section on training will describe the training given, who it is given to, and the training records kept. The summary will assess if the current procedures are adequate and if the facilities are fit for purpose. Recommended improvements should be listed, giving completion times and review dates.

Learning Points: Useful quick resume of BPM & BPEO
 Good example of a generic BPM review