

Design of Radionuclide Facilities with Special Reference to Radiation Protection.

BIR, 26th January 2005

1. Surviving Inspections – Eddy Rafiqi, Birmingham

A wide ranging presentation covering preparation of, and likely conduct of, inspections from both the HSE and EA. All radionuclide work areas should be clean, tidy and uncluttered and it is wise to check for this prior to inspection. Any poor quality or damaged fixtures or finishes of significance should be noted and action to remediate initiated. Check warning signs and notices are clear and appropriate. There is a useful checklist of documentation to prepare which includes the less obvious QA records, list of incidents and RPA audit reports. HSE inspectors like to see evidence of RPA advice being followed up. HSE will check details of information given by managers and staff during interviews against the radiation safety policy. It is likely they will focus on Controlled Areas, looking for evidence of access control, monitoring and records and wash/change facilities. EA inspection descriptions were quite typical of our own local experience but did not include details of inspection against the new BPM and management conditions which are only just being put into practice.

Useful experiences were recounted and the warning not to volunteer too much irrelevant information struck a chord.

Learning points: Generally a useful guide to surviving an inspection – more-so on the HSE side as these are not experienced as often.

2. Liaising with the EA in Designing facilities & application of BPM - Peter Marsden London.

Persons designing radionuclide facilities for which RSA certificates will be required are encouraged to contact their local EA/SEPA regulator and invite them to become involved in the planning. This will help ensure that certificates are not withheld for failings in design. References were made to sections of the RSA and Schedule1 conditions which have a bearing on design – in particular security, containment and BPM. Examples were given of designs of waste stores and cyclotron and PET facilities, and the concept for decommissioning was raised. The application of BPM to the deployment of radionuclide therapy delay tanks reminded users that waste retention on site creates a different critical group whose doses must be considered as must the risk of system failure and cost.

Learning points: aspects of facility design which can be directly linked to RSA requirements and how the BPM requirements influence planning.

3. HSE View on Facilities & Procedures Required by Regulations 16-19 of IRR99 Mike Nettleton, Bootle

This view is based on the collective experiences of the HSE from 61 hospitals inspected in the year ending April 2004, which included 39 nuclear medicine departments. In general, few were working to an acceptable standard, the main failings being lack of risk assessments, poor contamination monitoring/ records, inadequate washing/changing

facilities and in adequate storage and accounting of sources. The presentation focused on regulations 16-19. On designation of areas (Reg16) there was poor planning and location of controlled areas- designs often leading to staff having to go in and out of adjacent controlled areas with an uncontrolled corridor between. In addition to the failings already listed there was generally poor restriction of access. Local rules (Reg17) tended to be out of date, packed with unnecessary information, included other legislation and were not being reviewed. Dose investigation levels were rarely included and tended to be set too high if they were included. RPSs do not have clear duties and their primary supervisor role is often overlooked. Many were not trained, had insufficient support from management and relied too much on the RPA, where the RPA was an employee. HSE are looking for an RPS for approx. every 30 staff.

In Reg18 “significant risk of contamination” implies that PPE is needed to work there and that spread of contamination might lead to having to extend a controlled area. “Special measures” include monitoring, provision of washing/changing facilities and prohibition of eating and drinking. The approach in hospitals tended to be inconsistent, and should be based on risk assessments. Clashes with other requirements have arisen – e.g. on the provision of sinks/hand-wash basins in radiopharmacies. HSE are now discussing this with the Medicines inspectorate and hope to have resolved the issue soon. On monitoring (Reg19) we were encouraged to use suitable equipment at a suitable frequency and keep records for 2 years.

Recent changes within HSE will mean that there will be 10 specialist radiation inspectors in the non-nuclear sector, instead of the current 5. However, it is likely that only one of these will have had experience working in a hospital. We should not hesitate to challenge our HSE inspector if we felt that they were being impractical.

Learning Points: identified HSE expectations in application of regs16-19 highlighted areas of deficiency - update on recent HSE restructure.

4. Practical Considerations in the Design of Nuclear Medicine Facilities - Marge Girling, Mount Vernon

A highly informative account of experience at 3 DGH sized hospitals, with an important call to ensure RPA involvement as early in the planning as possible in order to provide input to location of building, department and rooms rather than just shielding and finishes.

A useful map of dose contours around a patient was presented, illustrating that for a dose constraint of 0.3mSv/yr (0.15 μ Sv/hr), rooms either need to be very large or include shielding. In adjacent camera rooms the need to protect a camera undergoing QA give rise to a greater shielding requirement than protection of people.

As well as shielding, the presentation covered finishes (including reference to non-slip vs. easy to clean), lighting, hand-wash facilities, ventilation, and layout.

Learning Points: recounting experiences in this way results in a practical guide and good future reference material.

5. Problem Solving in the Design of Nuclear Medicine Facilities – David Williams, Sunderland

There are numerous factors which influence or constrain design, including location and envelope, cost, space, time project management, communication, published design guidance and the experience/expertise of the designers and builders. Shortage of space (estimated to cost £3k/m²) is not helped if equipment manufacturers provide planners with impractically small minimum room sizes. Distance, as a major factor for staff dose reduction, should be used to increase the space available in a nuclear medicine department.

The extent to which local department personnel are consulted on design seems to depend on the size of the project. Smaller projects such as alteration to an existing building or construction of a new building tend to have good consultation, whereas major rebuild or new hospital builds come with many competing priorities resulting in less communication with the local users. The importance of ambience is stressed. Patients have been described as an object on the scene rather than the focus of design and there are great benefits to be had in heeding this warning. Anything that can be done to reduce stress in patients and staff should be considered during design. This could include choice of furniture, lighting and colour schemes to create a relaxing atmosphere. Patient wait areas and corridors could be carpeted. Contamination in these areas rarely happens and is easily remedied by replacing carpet tiles. Staff areas (offices, labs, stores, etc) should be kept separate from patient areas (waiting room, camera rooms) so that the patient doesn't feel disturbed by the number of health professionals around them. In the interest of patient comfort, privacy and anxiety (as well as for radiation protection) it was recommended that we should not put more than one gamma camera in each room.

Learning points: some good design concepts- particularly the emphasis on ambience. Highlighting constraints in the design/build process.

6. A New Nuclear Medicine Department and PFI - John Skrypniuk, Norwich

The experience of one of the earliest large PFIs were recounted with particular regard to nuclear medicine. The Trust, as tenant, pays back the building cost through rent, and the larger the space being provided the higher the rent will be. Pressure on space may therefore require some fundamental justifications – can space be shared, why are so many camera rooms needed why can't the entire service be outsourced? Such issues should be addressed in an "operational policy" which defines the scope and level of service, considers the type and number of rooms needed and describes necessary adjacencies and staff/patient movements. This will ultimately be the basis for the generation of the first draft plan so it is important to take time getting this right and looking to probable future developments in equipment and practice which will need to be incorporated. Although radiation protection should be the responsibility of the PFI at this stage, the operational policy should specify the legal requirements which need to be met, the types of specialist advice which needs to be sought, the external dose rates which are acceptable in each area, and the location of areas where contamination is possible. Once draft plans are produced it is necessary to check these against the operational policy requirements, check room layout and sizes, decide on which areas need to be designated under IRR99 and consider patient and staff flows. Check also the adjacencies outside the department – close proximity to MR scanners, for instance, is not recommended. Also, keep a close eye on storage space,

particularly waste storage as this tends to be under-specified and is often sacrificed to “greater” needs.

Learning points: The whole concept of a department producing an operational policy to define the service and instruct the PFI on what is needed.

7 The Radio Pharmacy - Neil Hartman , Cambridge

A practical guide to radiopharmacy design, covering construction, security, storage, manufacturing, air flow, transportation and waste. With the exception of PET cyclotrons, the radiopharmacy normally has very little external shielding- instead there are numerous shielded areas within the area, including lead lined generator storage, centrifuge and lead glass for the isolators, Perspex shields for beta emitters and lead lined waste storage. ^{131}I deliveries and ^{99}Mo generators can have external dose rates up to $30\mu\text{Sv/hr}$ at 1m (it was noted that the higher activity 75GBq generators have a lower external dose rate than the 30GBq generators due to the use of depleted uranium instead of lead). A lead lined holding area for such deliveries should be provided. Note also that pharmacy requirements for air-flow often contradicts radiation protection requirements.

Learning Points: Some basic radiopharmacy concepts were useful.

8 Designing For Inpatient Therapy Steve Evans, London

Recounted experiences in the design of a three-bed facility in an existing building. The radioactivity was modelled assuming ^{131}I , with the patient excreting 50% of the administered activity on day 1 and 10% on each subsequent day. This was thought to give a conservative estimate as excretion on day 2 is more likely to be in the region of 20%.

Internal walls were constructed of 90mm block-work with plasterboard lining. Between 9 and 23mm lead were added to these walls, depending on adjacent occupancies. 9.5mm lead needed to be added to the floor and ceiling – the latter being achieved via a steel grid to hold the lead in place.

The bedrooms were arranged at the end of the corridor, which was cordoned off to provide a single controlled area comprising the 3 en-suit bedrooms, a monitoring/support room which included waste storage facilities, and a positive pressure lobby. A hand and foot monitor is provided for staff and there is an alarming monitor outside the entrance of the facility. Installed shielding was checked via direct transmission measurements following construction and through routine monitoring during use. Patients are monitored via a probe above the false ceiling, which reads out in the support room. Operationally, contamination is reduced by covering small items such as telephones and door handles with cling film, and larger items such as chairs with sheets.

Dose rates from the external vulcathene waste pipe were $7.5\mu\text{Sv/hr}$ contact and $1\mu\text{Sv/hr}$ at 1m.

Learning points: practical considerations – particularly in the layout of the rooms within a contained facility.

9 Decommissioning - Don Morecombe, GSK

The decommissioning of R& D facilities needs to address the problems of long lived radionuclides, and in particular tritium which is difficult to detect. Whilst these specific problems are not encountered in a nuclear medicine department using short lived gamma emitters, the principles of decommissioning and the lesson learnt are entirely relevant. In particular, decommissioning should be considered at design stage, especially when cyclotrons are used as activation needs to be minimised. During use, adequate records should be kept such that information is available as to what was used where. In addition to IRR99 and RSA93 requirements, users should be aware of the Radioactivity Contaminated Land Regulations which are likely to be drafted for consultation during 2005. Guidance on revocation of RSA authorisations has been included in the EAs RASAG document, and their website also includes useful guidance on the characterisation and remediation of radioactively contaminated land.

Decommissioning should incorporate historical research, the development of a strategy, involvement and approval of the environmental regulator, and determination of the endpoint (i.e. how do you define decommissioning as being completed – e.g. $< 3\text{Bq/g}$). The monitoring and recording regime needs to be defined and routes authorised should radioactive materials need to be disposed of. It is important to be sure that any external contractors employed are suitably experienced and qualified.

Learning Points: A useful overview of the decommissioning process and examples of what can go wrong if not done properly.

10. Designing a PET/CT facility – Peter Jarritt, Belfast

The rapid development of PET/CT, and of the associated technologies, present some specific challenges for radiation protection, not least the higher energy and therefore greater shielding requirements for positron emitters. For ^{18}F the lead HVL is at least five times greater than most nuclear medicine radionuclides, and nearly twice that of ^{131}I . Also, the dose rate at a given distance from a specified activity is at least twice that of other NM radionuclides. This has a direct bearing on staff doses, increasing pressure for larger rooms and requiring special consideration of interference with adjacent gamma cameras. Suggestions to increase the typical FDG injected dose in the UK will accentuate these difficulties.

Recent and planned improvements in detector and scanner design will reduce scan times whilst still requiring long uptake times prior to scan. Pre-scan wait facilities may therefore need to accommodate four or five active patients per scanner rather than the current one, creating a need for more space.

Purpose built shielded equipment in dispensing keeps doses in this area relatively low, though the large amounts of lead needed does create manual handling problems. Surveys have reported staff doses of between 5.5 and $15\mu\text{Sv}$ per patient. An audit in Belfast in 2002 revealed an average staff dose of $26\mu\text{Sv}$ per 7 patient day, 7% from dose preparation and 90% from tasks performed close the patient. Dose reduction techniques such as using cannulae, extra staff training screening of highly dependent patients by the nurse before injection and better use of distance reduced the staff doses during injection by 41% and

whilst helping the patient on and off the scanner by 33%. However, the increase in workload means that staff doses are 27 μ Sv per 8 patient day. Increasing workload further to 20 patients/day probably requires significant increases in the number of staff rotating through PET. HSE have acknowledged this need for dose sharing. Studies to determine whether PET radionuclides interfere with gamma cameras indicate no significant effect on a SPECT scan, but significantly affects intrinsic count rates thus precluding calibration measurements. This with a 45cm brick wall between ^{18}F and gamma camera (dose reduction factor 30).

Learning Points - very useful data on staff doses and dose reduction
Awareness of impact of scanner speed on facility design.