WASTE MANAGEMENT IN PIE FACILITIES AT WINFRITH AND WINDSCALE

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1. INTRODUCTION

1.1 AEA Technology carries out programmes of Post Irradiation Examination (PIE) under contract for customers mainly in the British Electricity supply industry. PIE is undertaken on irradiated nuclear fuel assemblies and reactor components primarily from the British Advanced Gas-cooled Reactors (AGR's) but also from other reactor types such as MAGNOX, SGHWR and some overseas LWR's. This paper is concerned with work carried out at facilities on two of AEA Technology's sites: Windscale and Winfrith. Both facilities consist of suites of concrete shielded caves, known as cave lines, in which irradiated and fissile materials can be handled. Each cave line has several operating stations, each fitted with a zinc bromide viewing window and a pair of Master Slave Manipulators.

1.2 PIE programmes are carried out to generate data for use in Reactor Safety and Performance Studies. The work involves both the non-destructive and destructive testing of irradiated fuel elements and reactor components. This includes a wide range of operations such as visual examinations and metrology, the cutting of irradiated fissile material, and fuel pin stress rupture testing.

1.3 As a result of PIE operations radioactive waste is produced. The cost of packing, storing and disposing of this waste contributes significantly to the operating costs for PIE facilities. It is therefore essential that waste management costs are controlled to ensure that the overall cost of operating PIE facilities is minimised. This paper discusses how wastes are managed in the AEA's facilities at Winfrith and Windscale.

2. THE ORIGINS OF ACTIVE WASTES

2.1 Waste originates from the dispersion of irradiated materials, which may be fissile or non-fissile. For both types, specific activities up to 100 GBq/gm are encountered in our laboratories: the predominant long-lived radioisotopes are Cobalt 60 in non-fissile materials, caesium 137 in fissile materials. The potential for generation of active waste depends on how readily the material can be dispersed, and this in turn is determined by the properties of the material and the processes performed on it.

Steel and zircaloy used in fuel element structures do not fragment easily, and cutting methods which avoid the production of fine particles are available. Materials which readily disperse include irradiated $U0_2$, crud which is deposited on LWR fuel, and (for AGR's) graphite sleeves. Particles generated, often of sub micron size, contaminate plant, filters, and equipment. Since contamination is a surface phenomenon, it should be noted that such components can in principle be decontaminated so that the waste can be placed in a lower disposal category.

The periodic removal of equipment from caves for repair and modification, and the routine removal of wastes from caves results in the generation of secondary wastes, at much lower levels, in the Laboratory as a whole.

3. WASTE CATEGORISATION

3.1 For disposal the wastes are categorised into two streams; Low Level Waste (LLW) and Intermediate Level Waste (ILW). LLW disposal limits are defined by the National LLW disposal site at DRIGG in Cumbria. DRIGG is a shallow trench burial site and wastes up to activities of 12 GBq/tonne β/γ and 4 GBq/Tonne α can be accepted. ILW is defined as material which is too active for disposal at DRIGG. At present there is no ILW disposal facility in operation in Britain although a national ILW repository is being planned. Until this repository becomes available ILW is being placed into storage. ILW comprises irradiated and highly contaminated wastes generated within the cave lines. LLW consists of medium to lightly contaminated waste from the cave lines, from workshops and, from decontamination areas. All waste generated in the Laboratory is classified as "active", since the cost of demonstrating that it is free from contamination exceeds the cost of its disposal.

4. *WASTE MANAGEMENT STRATEGY*

The basic waste management strategy adopted by AEA Technology is to minimise the cost of disposal of PIE wastes. To this end, three main approaches have been adopted;

- minimisation of waste generated

- reduction of waste volumes

- maximisation of the proportion of waste disposed of as LLW.

4.1 Minimisation of Waste Generated

The generation of irradiated wastes from activities such as fuel element dismantling is an inevitable outcome of PIE operations. The amount of irradiated waste generated could only be reduced by reducing the amount of fuel elements which are dismantled, and this would be in conflict with the primary function of providing PIE services. The generation of irradiated waste must therefore be accepted as an unavoidable result of PIE. The generation of contaminated wastes however depends upon the contamination levels in-cave, and the amounts of materials exposed to contamination, factors which can be controlled without inhibiting PIE operations. Introducing measures to minimise the contamination levels and reduce the amounts of materials exposed to the contamination will result in reducing both the volume and specific activity of the waste produced. Cost savings will be achieved because the waste disposal volumes will be smaller and a higher proportion of the waste will be suitable for LLW disposal rather than as ILW.

Measures have been taken to implement these principles. Contamination is controlled by examining the processes which produce contamination and modifying them to reduced its dispersion. The worst offenders are fuel pin and irradiated material cutting operations. Cutting operations have been modified to avoid high speed cutting operations such as abrasive wheels which produce fine particulate swarf which is very dispersed. Cutting operations which are preferred are those which produce no swarf, or milling/sawing which produce large particles easily collected at source. Where it is impossible to avoid abrasive cutting for technical reasons, high efficiency filtered extract systems have been installed at the cutting stations to minimise the dispersion of the cutting debris. In recent years studies have indicated that contamination control has been successful; wastes are found to be contaminated with residual contamination from previous PIE programmes and not significantly from current ones.

The control of materials has been achieved by implementing measures to restrict taking unnecessary materials into caves and laboratory areas, since any item which enters these areas will leave it at some stage as radioactive waste. Removing packaging before entry into the controlled area allows disposal of the packaging by the normal refuse system.

By implementing the measures discussed, levels of waste generation have fallen. The volume of ILW has been reduced by about a quarter and LLW by about a third. The quantities of radioactive material associated with waste have also fallen by similar proportions.

4.2 Reduction of Waste Volumes

The costs incurred for the disposal or storage of low or intermediate level radioactive waste are directly proportional to waste volumes. Compaction methods are used to reduce the volume of PIE wastes. ILW comprising irradiated and highly contaminated wastes are remotely compacted in-cave in 200 mm diameter containers to 90 tonnes. LLW is compacted out of cave in 800 mm diameter drums to a force of up to 2000 tonnes. Average volume reductions of between 70 to 80% are achieved by these methods.

When preparing waste for compaction it is important to pack the waste to optimise the volume reductions. Some waste items may require dismantling or cutting to allow them to be packed in the optimum manner for crushing. Large or heavy waste items should be packed in the plane of least resistance to make them easier to crush. It is easier to crush a tube section radially than axially and lengths of solid bar or section should be packed horizontally not vertically. By careful packing the resulting volume reduction after compaction can be significantly increased.

4.3 Maximisation of the Proportion of Waste Disposed of as LLW

Until 1983, ILW from British nuclear sites was disposed of by dumping at sea, so that disposal costs were low, and roughly equal to LLW disposal costs. Waste was categorised simply by its origin; laboratory wastes were LLW, and all waste from caves was classified as ILW. Since ILW is now being stored awaiting a disposal site, and forecast costs for ILW storage, encapsulation, transport and disposal are predicted to be perhaps 2 orders of magnitude greater than for LLW, careful sorting of waste to ensure maximum utilisation of the LLW disposal route is clearly cost effective and is being implemented.

A key factor in identifying LLW prior to disposal is reliable waste assay. The activity of each package of waste must be measured and declared to Quality Assurance standards approved by the LLW disposal Site Operator. The measurement of LLW is difficult because of the low activities involved. Ad hoc assessments used in the the past tend to be pessimistic, erring on the side of caution, such that they are over estimates of the true activity of the waste package. Auditing has revealed that estimates have occasionally exceeded the true value by a factor of 3.

Waste activities are now measured by taking radiation readings of waste packages in standard geometries and multiplying by factors to obtain the activity assay. The factors used depend on the average isotopic make up of the waste, determined by sampling and analysing the waste streams. This system provides a reasonable accurate activity measurement for any individual waste package but may be in error if the range of isotopes differs from the average. Over several waste packages, as would be loaded into a LLW disposal container, the system is more acceptable, since discrepancies are averaged out.

Wastes from the cave lines which are currently disposed of as LLW include large items of equipment and in-cave furniture. These items are often too large to be accommodated in the ILW disposal stream. Decontamination is carried out remotely by swabbing down items, and by chemical methods. Whilst decontamination does allow in-cave wastes to be disposed of as LLW, it also generates secondary wastes such as dirty swabs and liquid effluent which also has to be disposed of.

5. *SUMMARY AND CONCLUSIONS*

5.1 As a result of PIE operations radioactive waste is produced. The waste is categorised into two waste streams; Intermediate Level Waste comprising irradiated and highly contaminated wastes, and Low Level Waste comprising medium and lightly contaminated wastes. The disposal costs of these wastes significantly contribute to the operating costs of PIE facilities.

5.2 In PIE facilities at Winfrith and Windscale a waste management strategy has been adopted to minimise the disposal costs of PIE wastes. The strategy has been implemented using three main approaches;

- Minimising waste generation: The volume and activity of wastes generated as a result of PIE operations has been reduced using contamination control and material control measures. This has achieved cost savings as there are lower volumes of waste generated and the activity of the waste is lower allowing a greater proportion of the waste to be disposed of as LLW.

- Minimising Disposal Volumes: Further cost savings have been achieved by compacting wastes thus minimising the actual disposal volumes.

- Minimising the Proportion of Waste Disposed of as LLW: By carefully sorting wastes and accurately measuring waste activities, in particular wastes generated within the cave lines (hitherto sentenced as ILW), all the wastes acceptable for LLW disposal can be identified. Disposal of these wastes as LLW as opposed to ILW thus maximises the LLW disposal and minimises total costs, since ILW disposal costs are expected to be perhaps a hundred times more expensive than LLW disposal costs.

5.3 Work is in hand to improve the measurement of low level waste. Assessments are being made to decide on the potential cost savings which might be made by sorting ILW stored since 1983, to dispose of that proportion which falls within LLW disposal criteria.