

COMMISSION OF EUROPEAN COMMUNITIES WORKING GROUP  
HOT LABORATORIES AND REMOTE HANDLING  
BARNWOOD CONFERENCE CENTRE: NUCLEAR ELECTRIC, GLOUCESTER  
25TH AND 26TH JUNE 1991

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UK STRATEGY FOR THE MANAGEMENT OF OPERATIONAL WASTES

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J.R. Findlay

SUMMARY

AEA Technology is following a structured programme to develop its strategy for the management of its current stocks and future arisings of operational intermediate level wastes.

The programme for the treatment of liquors and sludges, is outlined. The strategy for solid wastes is more complex due to the diverse nature of the waste streams and the need for treatment procedures to be compatible with the acceptance criteria that will be set for disposal in a national waste repository. The developments that are being followed are described, together with the facilities that are being provided for interim retrievable storage to allow the continued safe operation at AEA sites.

Corporate DRAWMOPS Directorate  
B424, Harwell Laboratories  
Oxon OX11 0RA

13th June 1991

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## INTRODUCTION

1. Operational radioactive wastes generated by AEA Technology are classified under the generalised categories of Low Level Wastes (LLW), Intermediate Level Wastes (ILW) and High Level Wastes (HLW). They have arisen from past activities on the operation of prototype and research reactors, from the associated research and development (R&D) and from fuel development programmes.
2. The disposal route for these materials is, for LLW, to use the existing facilities operated by British Nuclear Fuels plc (BNFL) at the Drigg site adjacent to Sellafield. ILW and later arising of LLW will be sent to the proposed national radioactive waste repository to be operated by NIREX. HLW arisings are primarily restricted to the Dounreay Establishment and are retained in storage for future treatment.
3. \* The major initiatives requiring strategic planning are concerned with ILW where treatment is necessary to prepare the waste in a form suitable for disposal. High integrity storage facilities are also needed until the national repository is available.
4. An assessment is required of the future waste arisings. Account has to be taken of the continuing R&D programmes and the impact of decommissioning programmes, and the possible impact of future programmes.

## WASTE ARISINGS

- Y 2005  
Mar. 2010*
5. An estimate of the arisings of operational ILW has been made up to the time when a national repository is expected to be available and operational. These inventories are based upon the published inventories of waste arisings<sup>(1)</sup>. For the purposes of this study, the wastes have been classified into three main categories:
    - (a) Sludges and liquors - arisings of solid materials such as ion exchange resins and effluent treatment flocs that are stored in the wet condition, and liquors such as reprocessing raffinates.
    - \* (b) Non-contact handled solids (NCS) - solids that require shielding for storage and remote handling methods during treatment.
    - \* (c) Contact handled solids (CS) - solids that can be handled and treated using hands-on techniques in glove boxes or similar facilities. The main arisings are from alpha contaminated material. Some shielding is desirable during storage to minimise radiation doses to operators and to accommodate the build-up of gamma-emitting decay products such as  $^{241}\text{Am}$ .

The timespan considered in the assessment for waste arisings and treatment procedures is from 1991 to 2019. This period has been selected as the timescale on which the majority of operational wastes will have been treated and sent to a national repository which is assumed to be available in 2010. The estimated arisings in these categories is shown in Table 1 quoted in raw waste volumes (m<sup>3</sup>).

## TREATMENT PROCEDURES

6. The procedures used for the treatment of waste and preparing a waste form suitable for disposal, are being developed within the UK. These are based upon the standard containers that are being formulated by UK NIREX Ltd for disposal in an underground repository<sup>(2)</sup>.
7. The proposed containers are designed to fit within transport packagings which will conform to the limitations of the UK road and railway systems.
8. The prime container is a drum of 500l capacity. Four such drums can be loaded into a transport packaging using a lifting framework or 'stillage'. Alternatively, a larger unshielded box with rounded corners of 3m<sup>3</sup> capacity can be used for waste containment. This box then fits directly inside the same standard transport packaging.
9. It is expected that the waste will require to be immobilised within a solid matrix to fulfil transport requirements and repository acceptance criteria. Wherever possible, a standard matrix material is being sought. Matrices based upon Portland cement with additives such as pulverised fly ash (PFA) or blast furnace slag (BFS) to give the required handling and setting properties, are being investigated. The use of cement helps maintain an alkaline environment within the repository during its post closure phase. Alkaline conditions reduce the mobilities of actinide and other species with high toxicities by controlling chemically the equilibrium species of the radioactive elements within the waste.

## WASTE TREATMENT PLANTS FOR LIQUORS AND SLUDGES

- \* 10. The AEA has constructed treatment plants at the Dounreay and Winfrith establishments for the treatment of liquors and sludges, as described previously<sup>(3,4)</sup>. The Dounreay plant is designed to immobilise the existing stocks of liquors that have arisen from the reprocessing of Materials Testing Reactors (MTR) fuel elements. These liquors contain high concentrations of aluminium, and suitable immobilisation procedures, based on a cement matrix, have been developed. The plant is fully shielded for remote operation and is linked to a remotely operated store. The plant is capable also of handling some solid wastes.
11. A similar plant at Winfrith has been built primarily to immobilise the stocks of liquors and sludges currently held in tanks, which have arisen from the operation of the Winfrith Steam Generating Heavy Water Reactor (SGHWR). The arisings are principally ion exchange resins and are again suitable for immobilisation within a cement based matrix. The immobilised product in 500l stainless steel drums, conforming with the NIREX specification, are to be stored in an adjacent drum store until they can be sent for disposal. The plant has an additional capability to handle solid wastes.

## TREATMENT PROCEDURES FOR SOLID WASTES

12. The treatment procedures for AEA solid wastes, both the NCS and CS, are at an earlier stage of development, where there are factors which complicate the development of a suitable strategy.

13. The waste materials are diverse in character having originated from a wide range of R&D and industrial activities. Their accommodation within a single plant or process is thus more difficult. The wastes vary in physical size and form, with substantial differences in chemical composition.
14. A further requirement to be defined before an immobilisation programme can be established, are the criteria to be set for waste acceptance by UK NIREX Ltd for disposal within an underground repository. Clear radiochemical definitions of the waste materials are expected to be needed, supported by chemical data on the stability of the waste form over a prolonged period and the resistance of the container to corrosion, and hence failure, from the internal or external environment. In the case of waste material containing organic materials, particularly those which are cellulosic or oxygenated chains, there is uncertainty over the levels that can be accepted. This limitation originates from the possible long term degradation of these materials within the repository to form complexing agents which may enhance the solubility of radioactive species within the waste.
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#### AEA WASTE MANAGEMENT STRATEGY DEVELOPMENT

15. The strategy being followed within the AEA is to proceed directly with the immobilisation of sludges and liquors at both Winfrith and Dounreay. This strategy conforms with the guidelines recommended both nationally and by the AEA that radioactive wastes should be treated and prepared for disposal in a timely manner when suitable procedures have been developed and are available. The overall hazard of such wastes will be reduced by these procedures.
16. Definition of the strategy for solids is more complex. An overall objective has been set to minimise the construction of further treatment plants and define an overall lowest cost solution. For this to be achieved, differing waste streams will be processed through common plant wherever possible with waste being transported between sites and facilities where this is shown to be beneficial.
17. The definition of future requirements for waste processing is being planned over an extended timescale finishing at the time when a national repository is open and receiving routine arisings without delay. The procedures that will be used are being developed progressively by interaction with those owning or generating waste and the NIREX authorities. As the definition of acceptance criteria is refined within the safety assessment of a national repository, acceptance criteria for the different classes of waste will be established.
18. As this activity will proceed over some years, parallel activities are in hand to examine likely treatment processes that may be acceptable based on current indications. A programme of interim waste storage in stores of high quality with ready retrievability is also being followed to enable site operations to proceed safely without increased risk or hazard.

## DEVELOPMENT OF TREATMENT PROCEDURES

19. With the requirement for using common treatment processes and facilities, there are benefits from using a common matrix for waste immobilisation. Whilst cement matrices are suitable for most waste materials, there is a particular difficulty with metallic aluminium due to its chemical reactivity in alkaline environments. Many waste streams contain aluminium due to its extensive use in MTR fuel elements, experimental rigs and HEPA filters. Recent work has established that aluminium can be successfully immobilised within a cement matrix within limitations on the overall mass and surface area. The long term stability of such matrices has been studied to measure the extent of chemical reaction and the consequent effect within the matrix of strain due to the build-up of reaction product.
20. A further process currently under examination is the use of compaction to minimise waste volume prior to encapsulation. Again both practical and economic studies are encouraging. Substantial volume reductions have been achieved in industrial scale trials on LLW drums. Methods for extending this technology of ILW are being examined. For CS, a compactor is required to handle the 200l drums that are in use throughout the AEA. For NCS, a fully shielded compactor is required and a design study for suitable equipment has been completed. The product resulting from the compaction procedure is a thin disc or 'puck' with a relatively high density. These pucks would then be immobilised in 500l drums or 3m<sup>3</sup> boxes and sent for disposal.
21. The waste characterisation data for these waste forms would be derived from the information and measurements relating to the individual waste packages before compaction. Economic assessments of such waste processing procedures have shown them to be highly effective. A high waste processing rate can be achieved thus minimising radiation exposure to operators. If these waste forms can be shown to be suitable for disposal in a waste repository, compaction processes are expected to be incorporated into the future solids waste treatment plants.

## FACILITIES FOR INTERIM STORAGE

22. Due to the current uncertainties on the provision of plants for solid waste processing, interim storage with wastes in a readily retrievable form is being implemented on AEA sites. As examples, stores that exist or are under construction at the Harwell site are described.
23. A new store for the storage of CS at Harwell has been completed and is in use. The store has capacity to hold 400m<sup>3</sup> of waste in mild steel 200l drums. The wastes are first assayed using passive neutron counting, to determine the actinide content, and stored in defined locations on a rack storage system. The layout of the store is shown in Figure 1.
24. The store has been constructed to resist seismic events. The store environment is heated and ventilated with continuous monitoring for airborne activity and with discharge through tested HEPA filters. The drums are placed in position using a conventional warehouse lift and positioning mobile hoist. Each drum can be visually inspected and retrieved should deterioration occur.

25. Facilities for the interim storage of NCS waste are under construction using handling techniques which are fully remote. The layout of the facility is shown in Figure 2. The wastes, in their individual cans, are received into a head-end cell suite where they are subjected to a comprehensive radiochemical assay. The main storage area is a fully shielded vault where the waste is placed using a remotely operated crane.
26. The head-end input cell is designed to be fully compatible with all the waste output arrangements in the originating facilities on the Harwell site. Standard sizes of unshielded waste cans are used between 10ℓ and 50ℓ capacity and are brought to the facility using fully shielded transport packagings. The waste is introduced into an input cell via a transfer mechanism using double lidded containment. The waste can identification is recorded and subjected to active and passive neutron interrogation and segmented  $\gamma$  spectroscopy. The data so obtained is used for inventory and criticality control purposes and will be used further to determine the radiochemical inventories of the immobilised waste forms to be sent for disposal.
27. Due to the uncertain nature of the future treatment procedures that may be required, no further processing or volume reduction is undertaken at this stage. The individual waste cans are packed into large stainless steel drums of 400ℓ capacity which are then fitted with a sealed lid and sent to the vault section for storage. These larger cans are used to provide a guaranteed containment. The waste is also in relatively large volume units which can be easily retrieved and interfaced with a future processing plant.
28. The vault store itself is a fully engineered reinforced concrete structure with 1.4 metre thick concrete walls and with in-built resistance to seismic events. The store is divided into bays and can accommodate a waste volume of 500m<sup>3</sup> when the waste is stored in the raw condition within the small capacity waste cans. If required at a later stage, the store can also accommodate up to 1000m<sup>3</sup> of immobilised product in 500ℓ drums of the standard NIREX design.

#### CONCLUSION

29. A strategy is being developed by AEA Technology for the management of its operational waste which makes use of existing disposal facilities for LLW. Facilities for the treatment of ILW in a form suitable for disposal within a national waste repository, are being developed. High integrity facilities for interim storage are being provided to allow continued safe operation.

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"next years"

- repository route  
- encapsulation of aluminium

~~landfill / repository~~  
Dounreay granite  
Sellafield 'low level'

AET.

facilities  
procedures

intermediate level waste handling  
provisional costs (NIREX)

TABLE 1

Intermediate Level Raw Waste Volumes

Waste Stream	Current Stocks m <sup>3</sup>	Arising to 2019 m <sup>3</sup>
Sludges and Liquors		
Harwell	20	20
Winfrith	310	360
Dounreay	914	1100
Non Contact Solids		
Harwell	240	520
Winfrith	40	50
Dounreay	830	935
Contact Solids		
Harwell	156	620
Winfrith	88	106
Dounreay	204	814

J R Findlay

14th June 1991



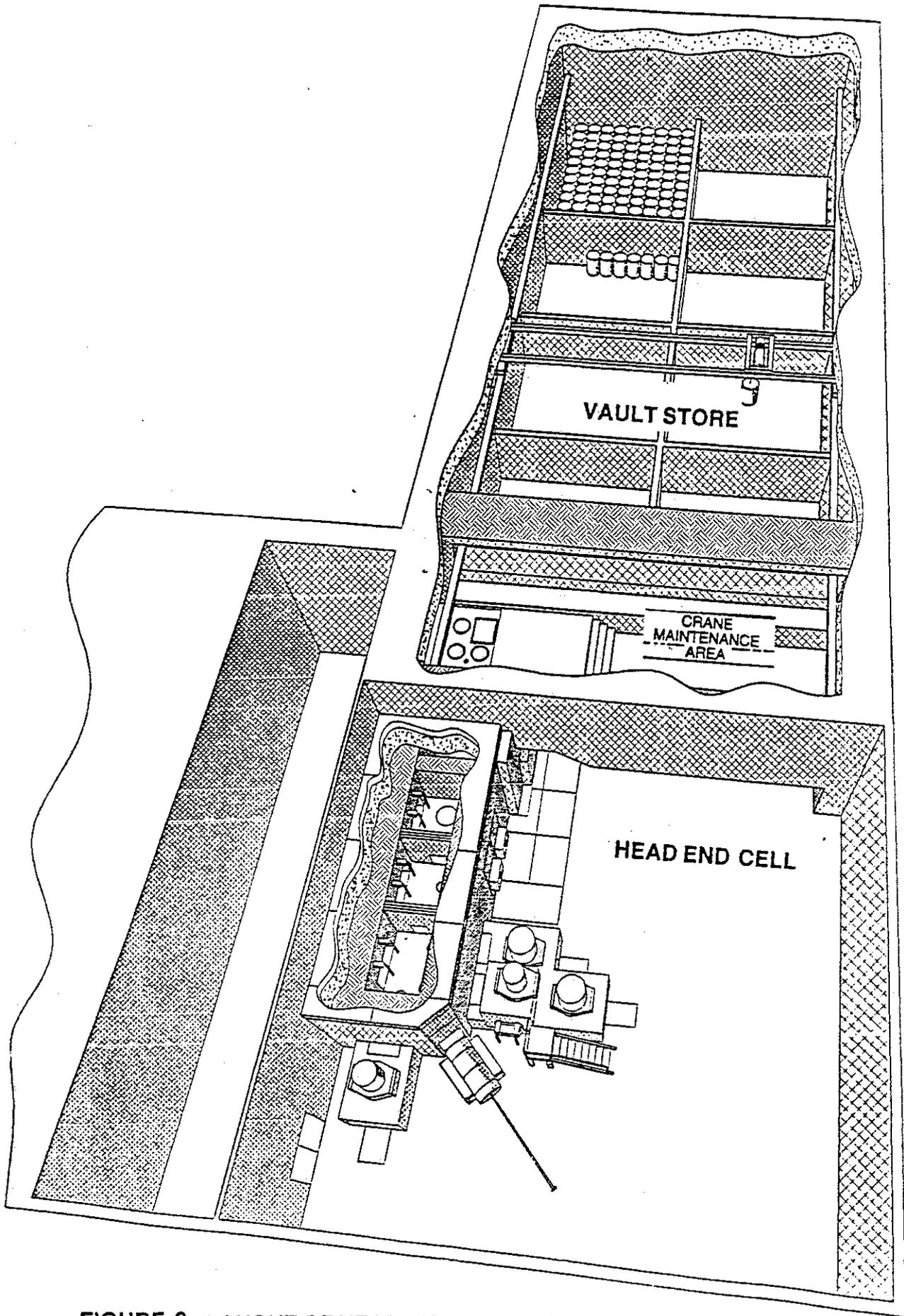


FIGURE 2 LAYOUT OF HEAD END AND VAULT STORE