DECOMMISSIONING OF WESTERN EUROPE'S OLDEST REACTOR THE GRAPHITE LOW ENERGY EXPERIMENTAL PILE (GLEEP) AT UKAEA HARWELL

Ian P Graham, Jon P Fowler,
AEA Technology, Harwell, Oxfordshire, OX11 0RA, UK

INTRODUCTION

The Graphite Low Energy Experimental Pile (GLEEP) was the first nuclear reactor to be built in Western Europe and was designed to operate at a maximum power of 100 kW, although it was generally run at 3 kW. It is situated on the UKAEA Harwell site in the UK and was a natural uranium graphite moderated reactor which operated from 1947 until it was finally shutdown in September 1990 making it Western Europe's oldest and longest serving reactor. Decommissioning of the Facility commenced soon after closure. All the fuel elements, activated and ancillary items have been removed as part of decommissioning, leaving only the graphite block housed within a 1.52 m thick barytes concrete biological shield. This paper reviews the Stage 2 decommissioning experience. A more detailed description of GLEEP and of the fuel removal process is given in Reference 1.

DECOMMISSIONING STAGES

Decommissioning was managed by AEA Technology on behalf of UKAEA. Following Stage 2 Phase 1 decommissioning, formal hand back of the facility from AEA Technology to UKAEA took place on 9 June 1995.

Decommissioning of the reactor has been divided into three Stages;

Stage 1 decommissioning was completed at the end of August 1994 and involved the removal of fuel from the reactor using specially designed equipment (since fuel changes were not part of the normal operation of GLEEP). The tasks carried out during this stage of decommissioning are described in Reference 1.

Stage 2 decommissioning has been divided into two Phases. **Phase 1** was completed in April 1995 and comprised the removal of activated items, such as the absorbers and control rods, from the reactor. In addition, other preparatory operations for Care and Maintenance were carried out such as altering access arrangements and the removal of the control room, leaving only the graphite block and concrete biological shield. The facility is currently in **Phase 2** which is an extended period of Care and Maintenance scheduled to last until the year 2008 although there are several other options which may become more favourable. No operations within the reactor biological shield are scheduled for the extended period of Care and Maintenance and therefore the number of safety related items is much reduced and all of which are passive control systems.

During **Stage 3**, decommissioning and removal of the remaining reactor structures will be carried out, thus allowing unrestricted use of the area.

DESCRIPTION OF STAGE 2 DECOMMISSIONING TASKS

Stage 2 Phase 1 decommissioning was divided into Parts 1 and 2. **Part 1** comprised the removal of all items within the biological shield other than the graphiite block. **Part 2** involved removal of the remaining items outside the biological shield so that only the graphite block and concrete biological shield remained for the extended period of Care and Maintenance.

The major tasks that were carried out during Stage 2 Phase 1 Part 1 are summarised briefly below:

- all activated items, including the absorbers and their mechanisms, were removed;
- the redundant fuel unload equipment was removed;
- exposed holes in the walls and roof of the concrete biological shield were filled with expanding foam and screeded with concrete.

The major tasks that were carried out during Stage 2 Phase 1 Part 2 are summarised briefly below:

- all loose combustible items were removed from the GLEEP area;

- all Low Level Waste (LLW) and Very Low Level Waste (VLLW) stored in the GLEEP area was disposed of in an appropriate manner;
- the GLEEP standard radium-beryllium source was removed from the vertical storage hole and removed for storage as Intermediate Level Waste;
- redundant reactor instrumentation, such as the area gamma monitors and fire detection systems, were removed and disposed of;
- all redundant electrical cabling in the GLEEP area was removed;
- the GLEEP ventilation system was decommissioned and disposed of;
- part of the steel galleries/walkways were removed and the control block was demolished;
- the GLEEP workshop and offices were cleared;
- 'fixed' spots of contamination on the floor of the general GLEEP area at faces A and B were removed using standard decontamination techniques. This area, which is external to the biological shield, is now no longer a Radiologically Designated Area.

WASTE ARISINGS

The majority of waste generated during Stage 2 Phase 1 decommissioning was below the exemption level of 0.4 Bq/g given under the Radioactive Substances Act (RSA93) and could therefore be classified as 'free release' waste. In total, 244 m^3 of 'free release' waste, including graphite and concrete blocks, was packaged into skips and disposed of in an appropriate manner. More skips than anticipated were required due to practical difficulties associated with packing the waste which lead to less efficient use of space.

There were two disposal routes for items of Low Level Waste (LLW) which exceeded the exemption level of 0.4 Bq/g:

- 5 m^3 of LLW was placed in an ISO container and removed pending disposal;
- 2.9 m^3 of LLW was packaged into 10 litre waste drums and removed for storage pending final disposal.

In addition, 25 litres of Intermediate Level Waste (ILW) was generated and removed for storage until a suitable disposal route becomes available. Routine operational waste was also generated, such as gloves, overshoes and coveralls. No liquid wastes were generated during Stage 2 Phase 1 decommissioning.

RADIOACTIVE INVENTORY

Prior to commencement of decommissioning, the fuel elements were the principal radioactive material within the GLEEP Facility with an activity of approximately 15.5 TBq (i.e. about 99.98 % of the total radioactive inventory). Removal of the fuel elements and activated items has reduced the radioactive inventory of the facility to that associated with the graphite block, its associated steel base and support structures and the concrete biological shield.

A detailed estimate of the radioactive inventory of the structure materials in the GLEEP reactor was carried out in April 1993. The estimated total activity associated with each of the remaining reactor components is given below:

Steel Base and Supports for Graphite Block	2.5E10 Bq
Graphite Block	3.0E10 Bq
Lower Biological Shield	1.8E10 Bq
Upper Biological Shield	6.5E9 Bq

The estimated total radioactive inventory of the facility remaining for the care and maintenance phase is therefore 80 GBq composed of activation products as a result of neutron irradiation of its constituent materials. There is no significant surface contamination present within the biological shield. It should be noted that tritium contributes most to the inventory.

DOSES RECEIVED

No member of the decommissioning staff exceeded any individual dose limit and the team as a whole complied with the group average target of 5 mSv. The following whole body dose equivalents were received during Stage 2 Phase 1 operations:

Collective Dose	1.94 man mSv
Individual Average Dose	0.32 mSv
Maximum Individual Dose	0.66 mSv

A comparison of the estimated and actual collective doses received by operators during Stage 2 Phase 1 decommissioning operations is given below. It should be noted that Phase 1 Part 2 operations were performed outside the biological shield area (i.e. < 2 μSv/h) and therefore no dose allowance was made.

Estimated Collective Dose	3.19 man mSv
Actual Collective Dose	1.94 man mSv

The collective dose received by operators was approximately 60 % of that estimated in the Decommissioning Safety Case mainly because operations took less time than expected and operators minimised the time spent in higher dose-rate areas within the biological shield. The predicted dose budget was also a significant overestimate as it took no account of the general reduction in dose rates as activated items were removed.

WORK PROGRAMME

Stage 2 Phase 1 decommissioning was completed in April 1995 although it was scheduled to last until mid-June 1995. This is because more operators were used than originally anticipated, thus allowing certain tasks to be performed in parallel. It should be noted that the Decommissioning Programme assumed that either two or three operators would be used, whereas up to six operators were used in reality.

In addition, personnel used during Stage 2 Phase 1 decommissioning were familiar with the facility, having carried out the fuel unload operations. This shows the importance of using experienced personnel who are familiar with the facility and do not require significant training and direct supervision.

Another reason for the operations being completed ahead of schedule is that certain contract variations were implemented which increased the efficiency of decommissioning. For example, the GLEEP boundary fence was removed thus facilitating vehicular access for removal of the control block and demolition of the control room, etc. The decision not to completely remove the steel galleries/walkways also saved time. This shows the benefit of adopting a flexible attitude to decommissioning.

CONCLUSIONS

Stage 2 Phase 1 decommissioning of the GLEEP Facility was successfully completed in a satisfactory manner ahead of programme. Decommissioning staff received less than the estimated collective dose and the operations met all Regulatory, Statutory and Authority accident risk criteria, dose limits and targets.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Graham I P and Fowler J P. Decommissioning the Graphite Low Energy Experimental Pile (GLEEP) at AEA Technology Harwell. Portsmouth 94 Proceedings of the 17th IRPA Regional Congress, Nuclear Technology Publishing 451-454, (1994).