Magnox South

Technical Baseline and Research & Development Document Dungeness A

Lifetime Plan 2008/09

TITLE: Technical Baseline and Research & Development Document

Dungeness A Site, Lifetime Plan 2008/2009.

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Contents

1 Introduction

This section of the Lifetime Plan (LTP) submission, the Technical Baseline and Research and Development (TBRD) document is to provide an overview of Dungeness A's technical baseline and research and development work that supports the approach to decommissioning for the remainder of the site's lifecycle.

As part of Magnox South reactor sites overall plan, Dungeness A ceased Generation on 31st December 2006 and is now to enter the defuelling phase, followed by decommissioning and cleanup activities with the site's remaining lifecycle, described in the TBRD document in four phases:

- Defuelling
- Care & Maintenance Preparations (C&M Preps)
- Care & Maintenance (C&M)
- Final Site Clearance (FSC).

1.1 Approach to Decommissioning

Magnox Electric Ltd, as the Site License Company (SLC) operating the Magnox South nuclear licensed sites, including Dungeness A is responsible for developing and implementing decommissioning and waste management strategies consistent with the requirements and overall national strategy of the Nuclear Decommissioning Authority (NDA) (Ref. 1) and in accordance with relevant Government policies (Ref. 2).

This TBRD document represents the Dungeness A, site-specific implementation of the current strategy agreed by Magnox Electric Ltd Board for the Magnox business. Work will also be carried out with the Decommissioning Strategy Organisation (DSO), which has been established in Magnox South to carry out research and development work on key waste management and decommissioning issues. The output of this work will underpin and further develop the current technical baseline strategies to be implemented at Dungeness A.

1.1.1 Decommissioning Principles

The following principles guide development of Magnox Electric's strategies and plans for decommissioning and waste management that are subsequently implemented at the sites including Dungeness A:

- The safety of the public and the workforce, together with protection of the environment, are of paramount importance and will be considered ahead of all other factors.
- Strategies will be compliant with legislation, be in accordance with Government, NDA and Company policy, and take due account of stakeholder views and regulatory and industry guidance.
- The priority associated with Decommissioning and Waste Management Strategies will be informed through evaluation of current Safety and Environment Detriment values and the future reduction of these carried out in line with the NDA prioritisation process.
- Preferred strategies will be identified in a systematic, consistent and auditable manner using best available scientific, engineering and economic knowledge and taking account of socio-economic and political factors, risk and uncertainty. A wide range of options will be

considered. The results of stakeholder engagement will be fed into the decision-making process.

- Strategies will maintain a flexible approach so as not prematurely to foreclose options, thereby maximising the capability to accommodate changes related to, for example, technical and regulatory developments or waste repository availability. However, all strategies will have a clearly identified exit route that is currently capable of implementation.
- Strategies and plans will be regularly reviewed to ensure they remain fit for purpose, learning from experience and taking account of emerging technologies through a continuing Research and Development programme.
- Strategies, plans, processes and technologies will deliver value for money for the liability owner over the remaining lifetime of the reactor sites.
- The quantities of radioactive and otherwise hazardous waste arising during the course of decommissioning will be minimised, as far as reasonably practicable.
- Radioactive waste for which there is no currently available, appropriate disposal route will be placed into a passively safe state. Where it is appropriate to package this waste, it will be placed in a form suitable for interim surface storage consistent with the requirements of the relevant disposal organisation.
- Throughout any decommissioning deferral period the sites, including any remaining radioactive waste, will be managed to maintain a passively safe state that minimises the need for control and safety systems, maintenance, monitoring and human intervention.
- Where any decommissioning or waste management work is to be deferred, appropriate knowledge and records will be retained and maintained throughout the period.

1.1.2 Main Objectives

The approach to decommissioning at Dungeness A has been aligned with Magnox Electric Ltd's key objectives in development and implementation of decommissioning and waste management strategies, which is to;

- Ensure the continued safety of the public, the workforce and the protection of the environment.
- Deliver systematic and progressive reduction of hazards on-site.
- Achieve an appropriate balance in the use of environmental, social and economic resources both now and in the future.
- Clear and de-license the site or to achieve other such end state as agreed.

Dungeness A has developed their detailed TBRD in accordance with the Company's waste management and decommissioning strategy. This is based on the submission to HSE for the quinquennial review (QQR) (Ref. 3) in 2000. The QQR submission was updated in 2005 to a Company Standard, agreed by the Magnox Electric Board in 2005.
It was revised and re-issued in March 2007 and is subject to periodic review and update.

It is recognised that the Dungeness TBRD may not represent the optimum solution in some areas. Therefore the R&D proposals are expected to provide opportunities for acceleration and/or optimisation of the clean-up process. This approach is consistent with industry best practice and current technologies that also take account of stakeholder expectations.

1.2 Current Status

Dungeness A ceased generation at the end of 2006 and moved into Phase 2 of Defuelling & Decommissioning in June 2007. Simultaneously, the site started hazard reduction and entered the first stage of site decommissioning, known as Care and Maintenance Preparations (C&M Preps), whereby all buildings except the reactor buildings and the ILW Store will be removed from site. At the end of this phase, currently scheduled for April 2021, the site will be ready for the long-term passively safe state, known as Care & Maintenance (C&M) phase. This allows time for radioactive decay of activated material associated with the reactors, prior to Final Site Clearance (FSC) of the site. Following the C&M phase, in around 2102 the site will begin full dismantling and remediation in the Final Site Clearance phase, which will result in the site being de-licensed and transformed back to its original condition as a shingle bank by 2111.

The Dungeness A site layout consists of three main areas of decommissioning work:

- Conventional area – containing non-radioactive plant and buildings (turbine hall, cooling water pump house, workshops and offices etc.);
- Radiological Controlled Area (RCA) – including a number of buildings with internal plant and structures that are contaminated with radioactive substances (e.g. cooling ponds, operational waste storage facilities, radioactive effluent treatment plant, active drains, laundry and workshops etc.)
- Two reactor buildings (also within the RCA) – each containing one nuclear reactor of the gas-cooled, graphite-moderated, Magnox type. Each reactor building also houses activated material within the quarter voids.

This document expands on the current baseline for the technical approach to work that has already been planned and costed and on which current plans are based. When opportunities are identified to improve the baseline in terms of cost, schedule, safety and the environment, these activities will also be included in the Research and Development section of the TBRD.

Technical work techniques are governed by environment, health and safety legislation and all work undertaken will comply with the relevant regulations. Dungeness has a comprehensive infrastructure in place including independent verification to ensure high performance standards and that compliance with the requirements is maintained. Expert resource in these fields together with Core Competence, Design Authority, and Intelligent Customer capability is fully maintained. An overview of the work is given below:

1.2.1 Defuelling Phase:

Defuelling is the major site focus following shutdown and involves the removal of all spent nuclear fuel from the reactors and fuel storage ponds and its transfer to Sellafield for reprocessing. All remaining new fuel has been removed from site and returned to Springfields. In addition, a number of hazardous materials, including CO2, Hydrogen, transformer oils etc have been removed from site.

At the time of shutdown the nuclear fuel comprises 99.9% of the entire radioactivity on the site and hence its early removal is in line with the Government Policy aim of reducing hazards and removing the most active and potentially mobile radioactivity on a relatively short timescale.

The end point for defuelling is that all Magnox fuel will have been removed from the site and transported to Sellafield. This includes the removal of all fuel from the reactors, fuel route and

ponds, and the despatch of the final fuel flask to Sellafield. The confirmation of removal of all fuel from the site will need to be agreed with the Regulators before any benefits, such as reduced emergency planning, can be claimed. Introduction and operation of a system of verification of fuel removal is part of the defuelling process. The process wiring diagram for defuelling is shown in Figure 1.

a) *End of life fuel management.* For optimum fuel reprocessing at Sellafield, the plutonium content of the spent fuel is preferred to be above specific levels. This level is only reached in fuel elements after a certain amount of irradiation. The elements at the top and bottom of the core are part of a fuel retention scheme, where selected upper and lower elements have been retained in the core for further irradiation to improve fuel utilisation.
b) *Defuelling safety case.* A defuelling safety case has been written and has completed the internal company approval process including Independent Nuclear Safety Assessment, and agreement of the Nuclear Safety Committee. It has been reviewed by the Nuclear Installations Inspectorate. The Case takes effect after the reactors are shutdown at the end of December 2006, and continues through the defuelling period.
c) *Mods to support the defuelling safety case.* A number of modifications were carried out prior to final permission being granted to commence defuelling. These modifications increased the shutdown margin to a maximum prior to the commencement of defuelling and the margin will increase as the reactor is defuelled. Modifications included insertion of all the boron balls and control rods, for which an Operating Rule suspension approval by the NII was required, the prevention of rod withdrawal by disabling the control rod drives and safety circuits, and the isolation of bulk CO_2 supplies.
   The verification of defuelling is covered in the safety case, and is a rigorous administrative procedure. Software modifications to existing SCADA system with accompanying hardware modifications have been installed and commissioned on both reactors to assist in verification of the empty channels.
d) *Mods to improve fuel route reliability and reduce complexity.* During the defuelling period the fuel route equipment will be required to operate at higher rates than on-load equilibrium refuelling. The reliability of the fuel route equipment will be a key factor in the defuelling performance. Already, two new sets of Flask Leak Detection Equipment have been installed and commissioned.
e) *Programme of cropping FE7s* In order to maintain plant condition and staff SQEP status whilst no defuelling takes place, a programme of cropping the thermocoupled FE7 fuel elements from the reactor standpipes was initiated
f) *Continue fuel dispatch as required.* Fuel flasks will be despatched from the site in accordance with the MOP. There is no intention to empty the ponds before defuelling starts.

1.2.2 C&M Preps Phase:

In the first stage of site decommissioning, C&M Preps, all buildings except the bio-shield in the two reactor buildings and a newly constructed Intermediate Level Waste (ILW) store will be removed from site. The planned work for this phase includes the following:

- The prompt encapsulation of retrieved operational Intermediate Level Wastes (ILW) and placement in an ILW (on-site or regional) store pending the availability of an off-site repository or alternative facility.
- Ponds decommissioning including the removal of fuel and contaminated material and to prepare the facility for demolition.
- Pond Decommissioning associated works including retrieval and decontamination of pond skips and other miscellaneous contaminated items.
- The management of orphan wastes currently stored in skips in the ponds that include Fuel Element Debris (FED) and miscellaneous activated components (MAC).
- The deplanting and demolition of the buildings within the radiological controlled area.
- Deplanting of all reactor building components and structures, back to the bio-shield. Boilers and contaminated primary gas circuits maintained in a lay-down state until disposal path options are established.
- The deplanting and demolition of the buildings within the non-reactor/conventional area of the site.
- Implementation of a management strategy for any contaminated ground.
- Safestore preparations. Preparing the site and the few buildings remaining at the end of the C&M Preps period, for the quiescent C&M period by ensuring the buildings are weatherproof and secure and installing appropriate monitoring and security systems.
- Installation of new Electrical and C&I Overlay systems. The existing systems are complex and cover the whole site. Such systems are reaching the end of their working life in some cases and will not facilitate safe and effective decommissioning progress. New systems will therefore be employed to provide a solid basis for site decommissioning.

To support the work during the C&M Preps period it may be necessary to construct a number of new, mainly temporary, facilities either within existing buildings or as new buildings. These may be necessary for the retrieval, processing, packaging and storage of operational ILW, and for the management of the significant quantities of low level radioactive waste (LLW) that results from the dismantling and demolition work. Such new facilities, other than any ILW store, will be removed at the end of the C&M Preps period. An indication of the main activities and process flows during the C&M Preps phase is provided in Figure 2.

1.2.3 C&M Phase :

Following the period of C&M Preparations, Dungeness A will enter Care and Maintenance (C&M), a defined period where the site will remain in a passively safe, quiescent state, during which no significant dismantling work will be undertaken. This allows the radioactivity on site to decay, therefore allowing the radiological benefits to be accrued from the deferral of final dismantling activities.
The Care and Maintenance phase provides for site surveillance and security, radiological and environmental monitoring and programmed inspection and maintenance of the buildings remaining on site.

The main activities undertaken during the C&M period will be to maintain appropriate monitoring, surveillance, inspection and maintenance of the site to ensure that it remains in a safe and secure condition. Funding is included in the LTP to provide for roof and cladding replacement after a 30 year period. However, as the site will be in a passively safe state, in accordance with the principles of passive safety, the need for maintenance, monitoring and other human intervention is minimised.

The plans for the C&M period at Dungeness A have not yet been finalised, nor have the Regulators approved them, particularly in respect of the level of site occupancy. A cautious approach has therefore been taken and the need for a transitional period at the end of the C&M Preps phase. During this time, it will be necessary to demonstrate the continuing safety and security of the site prior to fully entering the C&M period when site occupancy can be reduced to a minimum level.

During the C&M period, the Dungeness A will remain a nuclear licensed site subject to nuclear licence conditions and independent regulatory scrutiny, to ensure that safety, environmental and security standards remain high.

An indication of the main activities and process flows during the C&M phase is provided in Figure 3.

1.2.4 FSC Phase :

Following the Care & Maintenance period the site will enter the Final Site Clearance (FSC) phase. During this phase the site will be cleared of the reactors and all remaining buildings and the ground will be remediated where necessary and landscaped as required. Any waste will be appropriately treated, packaged and dispatched from site for permanent disposal. The site will then be released from its nuclear site licence and made available for alternative use by 2111. The end-point of the FSC period is assumed to be a de-licensed site with all structures removed to at least ground level. This will allow the site to returned back to its original shingle state; this is especially important since Dungeness is located in the middle of Sites of Special Scientific Interest (SSSI) and a National Nature Reserve (NNR).

Figure 4 shows the waste process.

1.3 General Assumptions

- Government policy and standards, together with the legislative and regulatory environment, remain unchanged, or changes pending have no significant impact.
- Strategies will be optimised against all relevant factors as required by Government Policy.
- Strategies reflect only currently available technologies.
- Sufficient SQEP resource exists nationally to undertake the scope of work.
- Sufficient external licensed hazardous material and special waste disposal facilities will be available to receive all hazardous material requiring removal from the site.
- The National LLW Repository conditions for acceptance continue to apply unchanged; when this facility reaches the end of its working life, an alternative and equivalent site will be available.
- For planning purposes only, a deep waste repository for ILW will be available in 2040. However, the timing of actual waste disposal from any particular site will be some time

after 2040. ILW disposal will be subject to a national prioritisation framework yet to be developed.
- There will be a reasonably practicable interpretation of the 'no danger' clause in the Nuclear Installations Act 1965 (as amended) so as to facilitate delicensing.

The validity and implications of these assumptions are kept under ongoing review.

1.4 Key Site Assumptions

The key assumptions for Dungeness A site include:

- The end-state of the Dungeness A site will be in accordance with the De-licensed specification requirements. Complete removal of all contamination, removal of structures to at least ground level with any below ground level voids made safe with a covering of shingle.

New construction projects:

- Solid ILW waste retrieved as part of C&M Preparations will be containerised, encapsulated and stored in the ILW store until after the national repository is available for receipts.
- The Reactor building cladding will require replacing at 30 year period intervals.

Waste & Nuclear Materials Management:

- A Revised Radioactive Substances Act (RSA) authorisation will be granted for Care and Maintenance Preparations once all fuel has been removed from site.
- A UK National Low Level Waste Repository will be available.
- The National ILW repository will be constructed by 2040 and will be available to accept waste from Dungeness A site in accordance with the repository receipts programme in 2046.
- There will be external licensed hazardous and non-hazardous material and special waste disposal facilities available to receive all hazardous material requiring removal from the site.

The validity and implications of these assumptions are also kept under ongoing review.

1.5 Risk Management Overview

Dungeness A's processes and policies with respect to Risk Management ensure compliance with NDA procedure PCP10. They are intended to develop a risk awareness environment and culture on the site. This supports continual improvement, sharing of lessons learned and good practice throughout the Dungeness A decommissioning programme.

The Dungeness A Risk Management processes incorporate the following elements:

- Identifying risks
- Assessing risks
- Managing risks
- Reviewing risks
- Reporting risks

Specifically the TBRD risk is managed through the following framework:

- Technical risks are identified with respect to the technical maturity of the approach, the uncertainties associated with the task and factors that could influence successful completion.

- Evaluate risk impact and probability of occurrence.
- Development of mitigation plans to minimise risk occurrence or impact and contingency plans should risk materialise during project execution.
- Project cost includes contingency funding relative to the risk associated with project execution.
- The risks associated with a technology and any supporting R&D work are referenced in and managed through the DV for delivery of that work.

2 Technology Successes

To further demonstrate the importance of technology and technical support to the delivery of the Dungeness A Lifetime Plan, this section describes the success achieved at the site during FY 2007/08 which was supported wholly or significantly by technical input.

- MXD Plant
    - Installation of a dedicated CO_2 supply, to remove all requirements for the Main and Diverse CO_2 supplies on site.
    - Completion of the modifications to allow the processing of contents of the FED in the Lug vaults through the MXD plant, reducing the volume of ILW to be dealt with in the future
- Defuelling Plant/Operations
    - Completed modifications to the Charge Machine Control System, with a rigorous administrative procedure to enable defuelling verification.
    - Provision of the Pile Cap dry air supply system to replace the previous pile cap CO_2 supplies
    - Modifications to charge chutes to enable operation on a shutdown reactor
    - Completion of the commissioning of the defuelling process, including defuelling of 64 channels per reactor and commissioning of the new defuelling verification system
- Modifications completed to prevent re-criticality, including disabling of control rod supplies, insertion of all boron balls and isolation of reactor CO_2 supplies
- Removal of Bulk CO_2 storage tanks (4 off) and work progressed to deplant the Main and Diverse CO_2 plants
- Removal of oil from un-required transformers
- Installation of alternative facilities to discharge active effluents and sewage to sea, to allow removal of the CW system from service
- Electrical Overlay Scheme work progressed, including delivery and initial installation of transformer and switchgear, and completion of cable race steelwork for distribution.
- Isolation and deplanting work carried out on un-required plant, including ECN Plant, Boron Dust plant and de-cabling 1A1 Essential Diesel Generator.
- Progressed work to deplant oil system on an un-required blower.
- Updated and refurbished equipment in the DAMAL building, to support site characterisation project.

3 Good Practice

In the past year Dungeness A has both initiated and adopted a number of good practices. These have been shared with other Magnox South Sites through project closeout procedures and peer group meetings. For Dungeness A, this includes the following:

- Implementation of revised QMS and new staff structures optimised for D&D
- Implementation of decommissioning modification procedure MCP 99

4 Technical Baseline Strategy Table s

The Technical Baseline Table for Dungeness A is presented in Tables 1 (work that is progressing in FY 2008-09), 1A (work that is on-hold for FY 2008-09) and 1B (work that has been completed or deleted) in accordance with NDA guidance given in PCP07. The tables provide:

- A description of each major task associated with the current Baseline, with an overview of the proposed technique to be used in carrying out the work.
- Key technical assumptions explaining why the particular techniques have been chosen and where they have been used before.
- Technical and Programme constraints that may limit or delay the application of the technique.
- "Gaps" where further work is required to underpin the proposed processes.

The tables also provides Dungeness A's judgement of Technology Readiness Level (TRL) as a guide to maturity or readiness of the proposed technique or process. NDA has defined the TRL scale between 1 and 9 (see Appendix 1). Justifying a TRL of 9 requires that the technique or process be proven through successful operations and that reliability and maintainability have been demonstrated. If a TRL of 9 cannot be justified, the gap is identified as an R&D requirement.

This development work will then support improvement of the technology maturity categorisation and the subsequent reduction in risk. It will include, for example, pilot and full scale trials, e.g. trials to be conducted on ILW retrieved from the vaults.

This also supports continual improvement in Dungeness A's technical performance with respect to identifying, developing, implementing and sharing good practice for innovations and opportunities to improve the current site baseline in terms of time and cost, safety and environmental impact. This will be incorporated into the developing lifetime plans supporting risk reduction and efficiencies in delivery of work.

The tables are divided into the areas of decommissioning work detailed in the LTP with the DV reference number of the detailed work package.

5 Research & Development (R&D) Table

The Dungeness A R& D requirements in support of the Technical Baseline are presented in Tables 2 (work that is progressing in FY 2008-09), 2A (work that is on-hold for FY 2008-09) and 2B (work that has been completed or deleted) in accordance with NDA guidance given in PCP07.
The R&D requirements are described as:

- Activities needed to underpin the current Baseline (needs or risk management).
- Innovative R&D activities initiated by Dungeness A in support of acceleration and/or further optimisation of the Baseline (opportunities).

The R&D tables set out the technical need, explaining what has to be done and why, putting the technology gap into context. They provide the key outputs expected from the R&D proposals and set out, at high level, how these outputs will be used. In addition, dyes are given when the solution should be in place to allow successful action on the Lifetime Plan (which

will be after the expected R&D delivery date), together with the approximate cost of delivering the completed R&D bounded in four ranges:

Cost band D	<£50k
Cost band C	£50k - £100k
Cost band B	£100k - £1M
Cost band A	>£1M

5.1 Nuclear Research Schedule work

5.1 The Decommissioning Strategies Organisation (DSO) and the Reactor Waste and Decommissioning Technology Group (RWDTG) have a major role of oversight, development and management of Waste and Decommissioning Research and Development (W&D R&D). The group provides strategic direction and oversight of Magnox Electric's generic W&D R&D programme by:

· Directing a coordinated and cost effective R&D programme within "Reactor Sites" in support of radioactive waste management and decommissioning issues.
· Providing an inter-site forum for Magnox Electric Limited for the sharing of technology development work undertaken and led from individual sites. · Directing the balance between longer term R&D and the needs for more immediate individual site demands.
· Providing a strategic input into R&D programmes.
· Overseeing the preparation and delivery of the Licensees' Nuclear Research Schedule (or its replacement) on an annual basis.

The specific generic work that supports Dungeness's site's technical baseline and R&D programme by developing the TRL and the mitigation of technical risks is referenced in the R&D table. More detailed information is contained in the R&D table of the Magnox Electric Limited Waste and Decommissioning Research & Development Programme document.

References

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6	Revised Reactor Decommissioning and Waste Management Objectives and Principles Magnox Executive Team Meeting Paper: ET 701, April 2003.
7	Arrangements for the development of Waste Management and Decommissioning Strategies for Magnox reactor sites: LS/MI/004, 2005
8	Principles and guidance for safe decabling and electrical deplanting during reactor decommissioning: RDU/SAB/G/001, 2000
9	Project strategy overview report for the electrical overlay system project: HINA/PSOR/9125
10	Decommissioning of Liquid Waste Storage Tanks on Magnox Reactor Sites – Consideration of End-points for Care and Maintenance Preparations:

	BNFL.ENVT.SERVS/ET/REP/GEN/0813/03, June 2004
11	Decommissioning of Solid Waste Storage Vaults on Magnox Reactor Sites - Consideration of End-points for Care and Maintenance Preparations: BNFL.ENVT.SERVS/ET/REP/GEN/0812/03, 2004
12	Care & Maintenance Preparations for Magnox Reactor Sites: Recommendations for the decommissioning of underground structures and Services: BNFL.ENVT.SERVS/ET/REP/GEN/0960/04, 2004
13	Best Practicable Environmental for management of Ion Exchange Material at Bradwell, Dungeness 'A', Hinkley Point 'A' and Oldbury 'A': M/TE/MAG/0056/98, 1998
14	Best Practicable Environmental for Management of ILW Sludges stored on Operating Magnox Power Stations: TE/GEN/REP/0010/98, 1998
15	A Review of Wet ILW Management on Reactor Sites: REM(S)034, 2005
16	Review of mobile plant for wet and solid ILW and recommendations to support decommissioning: ES/ET/REP/0261, 2002
17	Wet ILW dewatering and encapsulation plant: ES/ET/REP/TRA/0458/02, 2004
18	Strategy for the Management of Fuel Element Debris at Bradwell, Hinkley Point 'A', Oldbury and Sizewell 'A' Power Stations: RDU/S&A/GEN/REP/0037/00, 2000
19	Bradwell Power Station Radioactive Waste Management Strategy: BRAD/TH/REP/139, 1995.
20	Hinkley Point A Power Station Radioactive Waste Management Strategy: HPA/TECH/HP/14, 1995.
21	Best Practicable Environmental Option for Management of Miscellaneous Activated Components stored on Operating Magnox Power Stations: RDU/S&A/GEN/REP/0007/99,1999
22	BPEO for management of ILW desiccant stored at Magnox power stations: M/TE/MAG/REP/007/99,1999
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27	Generic Specification for entry into Care & Maintenance RS/E&TS/GEN/REP/066/05 January 2006
28	Review of Mobile Plant for Wet & Solid ILW & Recommendations to Support Decommissioning ES/ET/REP/0261 Apr 2002
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30	Wet ILW Dewatering & Encapsulation Plant ES/ET/REP/TRA/0458/02 Apr 2004
31	CDDC Decontamination Manual for Berkeley Power Station Ponds Decommissioning DECOM/06/01 Dec 2001
32	Report of Cooling Ponds Clean-up & Demolition BK/ED/191, 2003
33	Berkeley Power Station Decommissioning Experience BK/RD/69
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35	The Magnox operating Plan (MOP8) ME/P/001 Rev 3 July 2006

Appendix 1 NDA Guidance from PCP-07

Technology Readiness Levels Table (TRL)

Basic Technology Research	Level 1	Basic principles observed and reported
Research to Prove Feasibility	Level 2	Technology concept and/or application Formulated
Technology Development	Level 3	Analytical and experimental critical functions and/or characteristic proof of concept
	Level 4	Component and/or bench validation in laboratory environment
Technology Demonstration	Level 5	Component and/or bench validation in relevant environment
System/Subsystem Development	Level 6	System/subsystem model or prototype demonstration in relevant environment
	Level 7	System prototype demonstration in an operational environment
System Test & Operation	Level 8	Actual system completed and qualified through test and demonstration
	Level 9	Actual system proven through successful operations e.g. through reliability and maintainability demonstration in service

Table 1: Dungeness A Technical Baseline – Works progressing in FY 2008/09

Task / Process ID.	Task/Process description	Preceding task	Technique	TRL	Assumptions	Technical constraints	Gaps (ref to R&D table)	Key reference documents
1)	**Defuelling**	**Overview:** Following cessation of generation, the major constraint to the removal of plant from service is the requirement to maintain fuel condition. The purpose of the defuelling programme is to remove all fuel elements from the two reactors and dispatch to Sellafield by March 2011, in accordance with MOP 8 (approx 617 tonnes @ 31/03/08). This will remove 99.9% of the radiological hazard from the site.						Ref 35
Task 1.1 **10.23.20.** **▪ 23/23207**	Dispatch of fuel to Sellafield	N/a	Defuelling operations are similar to those used during refuelling. Commissioning of new equipment was completed in 2007/08	9	No significant issues at Sellafield causing delays at site.	Removal of stuck fuel elements may require modification to existing equipment		
2)	**Managed Withdrawal**	**Overview:** On cessation of generation, large parts of the plant become redundant. As the defuelling period progresses, and commencement of passive cooling on both reactors, the amount of redundant plant increases to a point when very little operational plant is outside the Inner Security Barrier (ISB). This provides the opportunity to commence decommissioning and demolition of those redundant plant items. Once the passive safety case requirements have been achieved, all plant and accommodation south and east of the ISB becomes redundant, bar a few remaining services that will be required for some time in the future. The managed withdrawal project involves the re-engineering of these plant systems such that the reactor/ISB and a few areas to the west of the site are self-contained. Wholesale isolation of the conventional plant areas can be achieved, thus splitting the site into an operational area inside the ISB, and a conventional demolition project outside the ISB.							
Task 2.2 **10.23.30.** **▪ 23/23172**	Relocation of people	N/A	Provision of temporary accommodation, including telecommunications and IT provisions, in the reactor building itself, or into purpose built temporary modular buildings to the East of the site.	9	Staff will progressively be moved during 2008, from the existing buildings. Planned completion August 2008.	Requires connection to electrical supplies and IT and Telecommunications hubs		
3)	**Electrical Overlay**	**Overview:** The existing electrical supply system at Dungeness A Site is an ageing, complex and widespread system, large parts of which can be made redundant when the passive cooling state has been achieved. The electrical overlay system will be a standalone system which supplies the relevant existing boards and plant required for operation during de-fuelling and decommissioning, via a new dedicated transformer and switchgear and new, dedicated cable routes. This will allow isolations to be achieved on redundant plant and boards and also allow the current Station Transformers to be removed from service and the oil drained.						Ref 9
Task 3.1 **10.23.30.** **▪ 23/23171**	Install Electrical Overlay	N/A	Installation of transformer and switchgear to replace the current station electrical supply route to allow isolation of existing supplies	9		Requires completion of National Grid modifications to 275kV switchhouse and installation of cables.		
4)	**Conventional Plant Area Deplant & Demolition**	**Overview:** Facilities will be surveyed and characterised to assess hazardous material content, scope of work, risk assessments etc prior to demolition. Conventional demolition practices will be used. Recycle and reuse of materials will be maximised..						
Task 4.1 **10.23.35** **- 23/23402**	Hazard removal		Hazards will be isolated and removed, such as electricity, asbestos, mercury etc.	9				

Task / Process ID.	Task/Process description	Preceding task	Technique	TRL	Assumptions	Technical constraints	Gaps (ref to R&D table)	Key reference documents
10.23.30. ▪ **23/23171**								
Task 4.2 **10.23.35** ▪ **23/23403**	Peripheral plant & equipment removal.		Conventional techniques involving both manual and mechanical means as appropriate to the work area.	9	Voidage backfill using inert demolition wastes			
5)	**Solid ILW - Retrieval & Processing**	**Overview:** During the operational lifetime of Dungeness A Power Station, intermediate level waste (ILW) in the form of Miscellaneous Activated Components (MAC) accumulated in the voids of R1 and R2. The MAC is currently classed as ILW and will continue to be stored in the reactor voids until Final Site Clearance. Other miscellaneous ILW will be retrieved, processed and stored in *the ILW Store*.Fuel Element Debris (FED) will be processed using the Magnox Dissolution Plant (MXD). The Solid ILW Project consists of the design, procurement, construction, operation, commissioning and ultimate decommissioning of the necessary plant/equipment to retrieve, process and ultimately encapsulate the above material. The MAC comprises 1400 absorber tubes, 248 stand pipe assembles, 10 control rods, 100 control rod chains, 120 fuel element grabs, 240 fuel element hoist ropes, 160 capsules (switches etc), 700 boron balls, 5 kg titanium, and smaller amounts of other assorted waste. Other miscellaneous ILW comprises Miscellaneous Items from LLAW R4 areas – 4m3, Activated nimonic springs – 1.0m3, IONSIV filters and cartridges – 5.4m3 FED waste forms currently comprise Reactor 1 lugs – 10.9m3 Reactor 2 lugs – 10.3m3						Ref 28
Task 5.1 **10.23.35.** ▪ **23/23405**	Retrieval Process & Equipment	N/A	The MXD plant will process FED from R1 and R2 lug vaults reducing the Solid ILW by a significant amount converting it to a minimal amount of sludge which is stored in ST1 and water which is discharged to sea.	9				
Task 5.2	Retrieval Process & Equipment	**On hold – see Table 1A**						
Tasks 5.3 – 5.8	**Wet ILW Retrieval & Processing**	**On hold – see Table 1A**						
6)	**Pond Skips & Miscellaneous Contaminated Items (MCI)**	**On hold – see Table 1A**						
7)	**Ponds Decommissioning**	**On hold – see Table 1A**						
8)	**Other LLW Waste**	**Overview:** LLW will be disposed of to the LLW Repository. Other miscellaneous contaminated items will be treated on a case by case basis and decontaminated via conventional methods wherever possible with due consideration of ALARP, environmental impact, safety, cost and schedule as appropriate.						
Task 8.1 **10.23.35** ▪ **23/23401** ▪ **23/23402**	The LLW packaging and disposal.	N/A	Waste will be transferred to ISO containers in a waste handling facility	9	A LLW waste handling facility to be available			
9)	**RCA Deplant & Demolition**	**On hold – see Table 1A**						
10)	**ILW Store**	**On hold – see Table 1A**						

Task / Process ID.	Task/Process description	Preceding task	Technique	TRL	Assumptions	Technical constraints	Gaps (ref to R&D table)	Key reference documents
11)	**Contaminated land**	**Overview:** The nature and extent of radioactively contaminated ground (and/or groundwater) varies greatly from site to site (and within sites). Dungeness A will generate sufficient characterisation data for areas of contaminated ground on the site. This will aid the selection of the preferred option(s) to ensure passive safety during Care and Maintenance and takes account of the intention to de-license the site during Final Site Clearance. This also includes sampling of site structures to allow assessment of predicted waste arisings during decommissioning projects.						Ref 5, 23
Task 11.1 **10.23.35** ▪ **23/23313**	Soil and groundwater sampling and characterisation		Non-radioactive (chemical) and Radioactive ground contamination characterisation work is essential. This includes a desk-based review of historical information on historic spills/leaks, contaminated ground management, monitoring and site hydrogeological mapping followed by intrusive and non-intrusive characterisation intrusive methods (e.g. surface radiological surveys, borehole investigations).	9	Further hydrogeological characterisation and a comprehensive sampling and assessment programme of new and existing boreholes will be required.		Adequate characterisation techniques are essential to ensure the correct amount of remediation is performed.	
Task 11.2 **10.23.35** ▪ **23/23313**	Site structures sampling and Characterisation		A site wide characterisation survey of all structures is being undertaken to allow future waste arisings to be estimated	9			Adequate characterisation techniques are essential to ensure the waste arisings can be dealt with appropriately	
Task 11.3		**On-hold – see Table 1A**						
12)	**Back to Bio-shield**	**On hold – see Table 1A**						
13)	**Safe Store Preparations**	**On hold – see Table 1A**						
14)	**Care & Maintenance**	**On hold – see Table 1A**						
15)	**Final Site Clearance**	**On hold – see Table 1A**						
16)	**Site End State**	**On hold – see Table 1A**						

Table 1A: Dungeness A Technical Baseline – Works on hold during FY 2008/09

Task / Process ID.	Task/Process description	Preceding task	Technique	TRL	Assumptions	Technical constraints	Gaps	Key reference documents
5) **10.23.35.** ▪ **23/23177** ▪ **23/23422** ▪ **23/23410** ▪ **23/23363**	**Solid ILW – Retrieval & Processing**	**Overview:** During the operational lifetime of Dungeness A Power Station, intermediate level waste (ILW) in the form of Miscellaneous Activated Components (MAC) accumulated in the voids of R1 and R2. The MAC is currently classed as ILW and will continue to be stored in the reactor voids until Final Site Clearance. Other miscellaneous ILW will be retrieved, processed and stored in *the ILW Store*.Fuel Element Debris (FED) will be processed using the Magnox Dissolution Plant (MXD). The Solid ILW Project consists of the design, procurement, construction, operation, commissioning and ultimate decommissioning of the necessary plant/equipment to retrieve, process and ultimately encapsulate the above material. The MAC comprises 1400 absorber tubes, 248 stand pipe assembles, 10 control rods, 100 control rod chains, 120 fuel element grabs, 240 fuel element hoist ropes, 160 capsules (switches etc), 700 boron balls, 5 kg titanium, and smaller amounts of other assorted waste. Other miscellaneous ILW comprises Miscellaneous Items from LLAW R4 areas – 4m3, Activated nimonic springs – 1.0m3, IONSIV filters and cartridges – 5.4m3 FED waste forms currently comprise Reactor 1 lugs – 10.9m3 Reactor 2 lugs – 10.3m3							Refs: 28,
Task 5.2	Retrieval Process & Equipment		Due to the relatively low volumes of ILW that is to be retrieved prior to C&M, it is planned to encapsulate all of it using the TILWSP facility. The IONSIV cartridges will be resin encapsulated in special cast iron drums in accordance with the current Letter of Comfort. The cast iron drums will then be encapsulated in compliant waste boxes.	5	ILW Store (or equivalent strategy) to be available	National ILW repository availability for long term storage	Progressing generic R&D managed by DSO: Ref MEL W&D R&D programme document	
5) **10.23.35.** ▪ **23/23174** ▪ **23/23404** ▪ **23/23322**	**Wet ILW** **Retrieval & Processing**	**Overview:** The Wet ILW project involves the design, procurement, construction, commissioning operation and ultimate decommissioning of plant and equipment to retrieve mobile waste forms from current storage locations and immobilise into compliant packages to be transported to the *on-site interim ILW store.* The wet ILW waste forms comprise: Pond Water Filtration and Caesium Removal (PWFCR) sludge in Settling Tank (ST2) – 5.5m3.AETP sludge in two Sludge Tanks – 93.4m3. Ion exchange resin in two Settling Tanks (ST3 & 4) – 52.1m3. Magnox Dissolution Plant sludge in one Settling Tank (ST1) – 5.5m3. Desiccant drummed and contained in humidriers – 9.4m3. Technological opportunities in wet waste management and treatment is generic work being progressed by the DSO Ref: Ref MEL W&D R&D programme document. Site specific development work is referenced under 5/6							Refs: 15, 28, 29, 30
Task 5.3	Retrieval Process & Equipment		A conventional sludge handling system will be used to mobilise the waste and retrieve from the current places of storage.	6	LLW sludge experience from Trawsfynydd.		See overview for R&D reference.	

Task / Process ID.	Task/Process description	Preceding task	Technique	TRL	Assumptions	Technical constraints	Gaps	Key reference documents
Task 5.4	Conveyance & Transportation System		The retrieval equipment is combined with a pressurised system used to convey the waste to TILWSP/TRSDU. The pressurised system is used in conjunction with standard pipework.	6	LLW sludge experience from Trawsfynydd who are the lead site for wet waste retrieval and encapsulation.		See overview for R&D reference.	
Task 5.5	Soak Ion Exchange Resin		A process is being designed and developed by British Nuclear Group together with the supply chain to receive the spent resin volumes into a pressure vessel, circulate a caustic solution through the vessel, to pre-swell the resin before encapsulation. This is a requirement to facilitate resin encapsulation in concrete.	5			See overview for R&D reference.	
Task 5.6	Managing Waste Water Arisings		Processed either by the existing AETP or by the alternative plant, which will be sized to meet the expected liquid effluent arisings.	6			See overview for R&D reference.	
Task 5.7	Dewatering & Encapsulation		Equipment (TRSDU and TILWSP) developed and proven over a considerable period by British Nuclear Group will be utilised to dewater and encapsulate the waste streams.	5			See overview for R&D reference.	
Task 5.8	Despatch		A transporter developed to ensure all safety criteria have been adequately catered for. Based on a commercially available vehicle with the necessary modifications for a shielded overpack which will house the compliant waste boxes and interface with the ILW Store.	6	The Dungeness A costs are based on those for Hinkley.		See overview for R&D reference.	

Task / Process ID.	Task/Process description	Preceding task	Technique	TRL	Assumptions	Technical constraints	Gaps	Key reference documents
Task 5.10	Facilities Housing		A structure is proposed to provide weather protection for the modular TRSDU and TILWSP plants, and will be built, by civil construction subcontractors.	5	The Dungeness A costs are based on those for Hinkley factored by the amount of packages to be stored.		See overview for R&D reference	
6)	**Ponds Skips & Misc Contaminated Items**	**Overview:** The scope of work includes retrieval, decontamination, processing and disposal of spent fuel skips and other loose furniture in the ponds and spent pre and post filters. This will lead to a reduction in site hazards. Removal of the equipment from the ponds is critical path and enables the ponds to be decommissioned. The project will utilise standard commercially available products wherever possible in order to reduce design and procurement lead times and reduce the risk exposure to unproven/test products. Industry standard transfer equipment will be used for transferring waste to the decontamination workshop. Technological opportunities in pond skips & miscellaneous contaminated items is generic work being progressed by the DSO Ref: Ref MEL W&D R&D programme document							
10.23.25 ▪ **23/23303**	Removal of the skips from the ponds	All fuel off site	The skips will be recovered from the Ponds and will be decontaminated, to reduce them from ILW to LLW, so they can subsequently be disposed of to the National LLW repository. Preferably, a central processing facility, maybe at Sellafield, would be developed and skips sent empty in flasks towards the end of the defuelling cycle so that all skips in the ponds can be disposed of after defuelling.	4	Decontaminate skips utilising a High Pressure Water Jetting (HPWJ) facility, as trialled at Hinkley Point A. This is a standard proven product from the car industry and has proven very reliable all over the world to date.	This process will remove the paint from the skips, which will then be centrifuged out of the liquid and drummed for disposal. Company level requirement to determine the viability of Sellafield having a skip disposal route.	Research and development will be done to use UHPWJ robotic system for decontamination. Other projects are focussing on melting metal skips for future use as recycled metal in the nuclear market. Metal melt can also be applied to ponds furniture, if viable. See overview for R&D reference Site ref R&D 6/6	
7) **10.23.25.** ▪ **23/23303**	**Ponds Decommissioning**	**Overview:** The scope of the Ponds Decommissioning Project is to remove all of the fuel and contaminated material from the Pond Buildings, to prepare the buildings for demolition followed by demolition of the structures. This includes the pond building and Active Effluent Treatment Plant (AETP). The baseline strategy for this work is based upon the full decontamination, decommissioning and demolition work of the ponds at Berkeley Power Station. Details of the radiological decontamination and decommissioning techniques are referenced, as well as a possible decontamination and demolition strategy study conducted at Dungeness A. All tasks associated with Ponds Decommissioning will be readily achievable using commercially available and proven technologies and methods. ALARP will be applied to all radiation hazard tasks and may result in minor modifications to existing technologies to enhance worker protection. The demolition of the ponds and similar structures is expected to be undertaken under specialist contract. Site specific development work is referenced under 7/9 Table 2B							Ref 32

Task / Process ID.	Task/Process description	Preceding task	Technique	TRL	Assumptions	Technical constraints	Gaps	Key reference documents
Task 7.1	Removal of washdown bay and 50T crane	All fuel off site	Radiological characterisation methods are to be followed by decontamination, then conventional demolition.	9	Successful decontamination			
Task 7.2	Fuel Discharge routes Removal of normal emergency and reserve discharge chutes	Reactor verified as fuel free	Characterisation will occur in parallel with decontamination. After best decontamination effort to reduce radiation hazard, controlled demolition methods are to be used for removal of contaminated piping, typically using bag and cut methods.	7	Standard abrasive methods to be typically used inside piping or ductwork (hydrolasing, grit blasting, or other).	Minimisation of secondary waste during decontamination efforts.	Internal Pipe cleaning / large surface decontamination techniques need development. R&D 7/9	
Task 7.3	Removal of fixed pond furniture	Clean and drain pond	Review and enhance existing methodologies already developed within the project for handling skips and Orphan Waste and to accommodate any differences from these that are associated with Pond Furniture.	6	Pond furniture will be decontaminated using standard decontamination methods to dispose of them to the National LLW repository.	Decontamination via conventional methods will be with due consideration of ALARP, environmental impact, safety, cost and schedule as appropriate.	Development and implementation of the project. R&D 7/9	
Task 7.4	Clean and Drain Pond	All Fuel off site	The pond walls are to be decontaminated as far as practical, before draining to minimise the radiological hazard.	6	The ponds will then be drained and a fixative applied to support further decontamination.	Clearing of the sludge and then the filtration of the drained pond water and the longevity of these filters.	Development work for decontamination techniques for the pond structures, such as UHPWJ, to minimise radiation hazards prior to draining. R&D 7/9	
Task 7.5	Decontaminate Pond Structure	Remove fixed Pond Furniture	The depth of contamination into the concrete will be characterised and removed using scabbling methods as demonstrated at Berkeley Power Station. This waste will be disposed of as LLW to the national repository.	6	The bulk of the contamination from the ponds will be removed.		Demonstrate removal using scabbling methods. R&D 7/9	

Task / Process ID.	Task/Process description	Preceding task	Technique	TRL	Assumptions	Technical constraints	Gaps	Key reference documents
Task 7.6	Removal of pond water filtration and caesium removal plant	Clean and Drain Pond	Characterisation of the equipment and structures will be performed. Decontamination of equipment internals will be done using standard methods	6	Contaminated equipment and piping will be removed and size reduced typically using bag and cut methods.	Develop methods of flushing, hydrolasing or chemical cleaning for decontamination.	Further development work will be undertaken to decontamination techniques for the pond structures. R&D 7/9	
Task 7.7	Demolish Ponds Structure	Decontaminate Pond Structure	Based on the success of the decontamination, an evaluation will be made to determine if either conventional demolition or contaminated demolition will be used.	6	This evaluation will balance cost, schedule, ALARP and BPM	Additional characterisation is required to base the evaluation on.	Determine how much additional decontamination is required for contained demolition. R&D 7/9	
8) **10.23.35** ▪ **23/23176** ▪ **23/23330**	**LLW Waste**	**Overview:** LLW will be disposed of to the LLW Repository. Other miscellaneous contaminated items will be treated on a case by case basis and decontaminated via conventional methods wherever possible with due consideration of ALARP, environmental impact, safety, cost and schedule as appropriate. The existing LLW facility will not be capable of handling the expected volumes and types of waste generated from the decommissioning programme, so the facility must be updated and expanded.						
9)	**RCA Deplant & Demolition**	**Overview:** There are a number of facilities within the RCA that will be deplanted and demolished during C&M Preps. The majority of the plant within the floors of the Reactor Building itself will also be deplanted although the reactor building itself will be left standing. Industry specific techniques will be governed by working in accordance with regulatory requirements. Radiological and other hazard characterisation will be undertaken. Isolations will be made in accordance with the Magnox Electric Safety Rules and Guidance from the Ionising Radiations Regulations (IRRs) Code of Practice. Radiological, chemical and industrial hazards will be removed to enable subsequent deplanting and demolition of the facilities. In the reactor building, sections of plant can be isolated as they cease to be required for operational purposes. However, as the opportunities for the use of wholesale isolation techniques to be used in the turbine hall will be less, and with the additional restrictions imposed by radiological conditions, the decommissioning and removal of plant within the ISB will be more involved.						
Task 9.1 **10.23.20** ▪ **23/23305**	Radiological, chemical and industrial hazard removal.		Radiological decontamination will be undertaken where required using largely abrasive (e.g. grit blasting) methods, to assist in subsequent deplant, demolition and disposal. Also there is potential to fix contamination in place to reduce the potential for airborne contamination	8			R&D 9/10 & 9/11	
Task 9.2 **10.23.35** **-23/23402**	Contaminated and non-contaminated asbestos removal.		Standard industry practices. Where contamination will determine how this waste is	9				

Task / Process ID.	Task/Process description	Preceding task	Technique	TRL	Assumptions	Technical constraints	Gaps	Key reference documents
			managed.					
10.23.20 ▪ **23/23305**	Conventional demolition.		Conventional demolition techniques will be utilised wherever possible under the appropriate control & supervision suitable for contaminated environments.	9				
10)	**ILW Store**	**Overview:** The ILW Store will provide passive, safe and secure long-term storage for packaged ILW on the Dungeness Site until such time as the ILW can be exported for final disposal in a National ILW repository. The ILW is currently awaiting recovery and treatment as outlined above, the majority of the waste being FED, and is all resulting from reactor operations.						
Task 10.1 **10.23.35** ▪ **23/23177**	ILW store design and construction		The Store design is an above ground reinforced concrete box overclad with a standard steel and aluminium cladding system. It will hold 54m^3 of packaged solid ILW and 485m^3 of packaged Wet ILW and be based on a standard civil design.	2	Disposal to a National ILW store assumed to be from 2046	Alternatives to site ILW store to be sought due to coastal conditions.	Progressing generic R&D managed by DSO: Ref MEL W&D R&D programme document	
11)	**Contaminated land**	**Overview:** The nature and extent of radioactively contaminated ground (and/or groundwater) varies greatly from site to site (and within sites). Dungeness A will generate sufficient characterisation data for areas of contaminated ground on the site. This will aid the selection of the preferred option(s) to ensure passive safety during Care and Maintenance and takes account of the intention to de-license the site during Final Site Clearance.						Ref. 23
Task 11.3 **Not scoped - pending characterisation**	Remediation	Sampling and characterisation	Contamination found is managed in accordance with the relevant regulatory regimes mostly administered by the EA. Non-radioactive contamination is not directly relevant to eventual de-licensing of sites, but may influence future land use. The main strategy options include: · Removal of contamination (e.g. by excavation); · Enhanced containment *in situ*; · Monitoring the contamination *in situ* without engineered enhancement.	9	The Company has a contaminated land Intelligent Customer capability that will be consulted on the application of guidance information on contaminated land.	Excavation and removal requires consideration of the options for treatment, storage and disposal of the resulting waste (typically very low activity LLW dominated by Cs137).	Retention of residual contamination in the ground requires a safety case for the duration of C&M.	

Task / Process ID.	Task/Process description	Preceding task	Technique	TRL	Assumptions	Technical constraints	Gaps	Key reference documents
12) **10.23.20** ▪ **23/23423** ▪ **23/23307** ▪ **23/23326** ▪ **23/23305** ▪ **23/23347**	**Back to Bio-shield**	**Overview:** This includes the complete delagging of asbestos (clean and contaminated) from all plant areas inside the RCA. The boilers will be removed and laid down and the ductwork removed. Reactor floor deplanting will have been done, as described above, including the gas circulators.						
	Disconnection of Primary Circuit	Active Plant removal	R1 and R2 Circuit isolation and sealing which consists of separating the gas ducts at the gas valve and sealing The Reactor vessels will then be prepared for safestore by isolation and sealing, welding up pilecap closures and BCD penetrations.	3		The practicality and radiological implications of sealing the circiuts as close to Reactor as possible.	On hold - generic R&D managed by DSO: Ref MEL W&D R&D programme document	
	Removal of Boiler houses		The Boiler house walls will have the upper sections removed initially and then the boilers will be removed through the top / upper sections. Thereafter, the boiler houses will be demolished. The duct cell height will also be reduced, along with the roof over the Pilecap, leading to an overall Reactor building height reduction. A new Reactor Building roof will be installed about 10 metres above the Pilecap.	1		Controlled demolition of the boiler houses.	On hold - generic R&D managed by DSO: Ref MEL W&D R&D programme document	
	Removal of the Boilers	Removal of Boiler houses	R1 and R2 Boilers and Ducts will be removed via the top opened sections of the boiler houses and the Heat Exchangers laid down and prepared for safestore by the addition of blanking over all apertures.	2		Removal of Boilers from top	On hold - generic R&D managed by DSO: Ref MEL W&D R&D programme document	
13) **10.23.20** ▪ **23/23183** ▪ **23/23187** ▪ **23/23165**	**Care & Maintenance Preparations**	**Overview:** The current Lifetime Plan strategy is to create a “Reactor Safestore” that would safely contain an amount of plant and equipment within the existing Reactor building for a period of up to 100 years. The building will be clad in weatherproof sheeting. The end state of the site for C&M Preps is one of much reduced visual impact that will be safe & robust to remain in a quiescent state for the period of C&M. C&M Preps are encompassed within tasks (1) to (12) and in addition include preparation of the site infrastructure and installation of alternate C&I routes.						

Task / Process ID.	Task/Process description	Preceding task	Technique	TRL	Assumptions	Technical constraints	Gaps	Key reference documents
14)	**Care & Maintenance**	**Overview:** The end state of the site following completion of the C&M Preps phase will comprise of the reactor building in safestore which will contain the ILW store, and those services required to operate the site through the C&M period. All other buildings will have been demolished to ground level; voids filled and made safe, and the site partially landscaped to ensure that no hazards, e.g. water hazards, may collect over time. The remaining hazards on the site, the reactors, primary gas circuit components and ILW store will be in a safe, secure, fully contained, protected and robust condition for the duration of C&M to allow radioactivity to decay to lower levels prior to FSC. Packaged ILW will be removed from site to a National ILW repository when it becomes available.							Ref. 12, 24 & 27
Task 14.1 **10.23.20** ▪ **23/23351** **10.23.20** ▪ **23/23167**	C&M	C&M Preps	The site will be in a passively safe state requiring minimal human intervention as most hazards, including those that were the most active and potentially mobile, will have been removed or immobilised. Cladding panels which make up the safe store of the reactor building will be replaced at 30 year periods.	1			On hold - generic R&D managed by DSO: Ref MEL W&D R&D programme document	
15)	**Final Site Clearance**	**Overview:** At the end of the FSC period all of the radioactive structures, including those below ground level, will have been removed from the site and all structures removed to at least ground level with any below ground level voids back-filled where necessary for safety reasons. Any remaining significant ground contamination will have been removed. Finally, the Site will be subjected to extensive radioactivity surveys to confirm that no unacceptable radioactivity remains on or below the site and that the site can be delicensed.						
Task 15.1 **10.23.30.** ▪ **23/23184**	Preparatory Works and Access Reactor Pressure Vessel	Back to Bio Shield	Necessary site infrastructure is re-introduced to the site to support Final Site Clearance including necessary waste handling facilities, services, accommodation, encapsulation plant etc. Remove control rods and other long items from reactor core and surrounding voids. Open access routes into the space between the steel Reactor Pressure Vessel (RPV) and the concrete bioshield. Break through the pile cap and into the RPV.	1	A containment building will be constructed over the pile cap area. All thermal lagging will be removed using conventional industrial procedures. Conventional industrial diamond drilling and cutting procedures will be used	Access into the voids (such as RHF, NCAW, CAW, reel and filter voids) surrounding the reactors may only be possible after the Reactor dismantling has been completed.	On hold - generic R&D managed by DSO: Ref MEL W&D R&D programme document	

Task / Process ID.	Task/Process description	Preceding task	Technique	TRL	Assumptions	Technical constraints	Gaps	Key reference documents
Task 15.2 **10.23.20.** **▪ 23/23186**	Preliminary Reactor Dismantling		Erect containment between the top of the RPV and the newly formed sides of the penetration in the pile cap. Install lighting and Closed Circuit Television (CCTV) in the RPV. Lower two Remote Handling Machines (RHM) through hole at top of RPV onto graphite core. Cutting and size reduction operations to be executed using the RHMs.	1	Remote Handling Machines (RHM) to be used in the RPV are presently based on proprietary equipment such remotely operated Brokk vehicles.		On hold - generic R&D managed by DSO: Ref MEL W&D R&D programme document	
Task 15.3 **10.23.20.** **▪ 23/23357**	Graphite Removal		RHMs to remove the reactor core moderator bricks starting at centre and working outwards. Brick removal to be repeated layer by layer until the base level diagrid is reached.	1	Displaced bricks to be transferred in skips to the pile cap for disposal via the newly constructed waste processing facilities and available waste routes.		On hold - generic R&D managed by DSO: Ref MEL W&D R&D programme document	
Task 15.4 **10.23.20.** **▪ 23/23357**	RPV Dismantling		Sides of RPV cut away down to the diagrid level. Discarded material to be transferred to the pile cap in skips and disposed of via the existing waste facilities and waste routes.	1	The RPV will be cut away using conventional industrial procedures utilising the external scaffolding/staging.		On hold - generic R&D managed by DSO: Ref MEL W&D R&D programme document	
Task 15.5 **10.23.20.** **▪ 23/23357**	Reactor Support Structure Dismantling		Remove the diagrid and remaining steelwork located in the void below the RPV. Discarded material to be transferred to the pile cap in skips and disposed of via the existing waste facilities and waste routes.	1	The removal the diagrid and remaining steelwork will be done using conventional industrial procedures.		On hold - generic R&D managed by DSO: Ref MEL W&D R&D programme document	
Task 15.6 **10.23.20.** **▪ 23/23358**	Radial Shield and Bioshield Removal		Remove the radial concrete shield and then remove the inactive concrete bio-shield. Survey and monitor remaining building structure, decontaminate as appropriate and demolish utilising industry standard techniques.	1	Remove the concrete structures will be done using conventional industrial / demolition procedures.		On hold - generic R&D managed by DSO: Ref MEL W&D R&D programme document	

Task / Process ID.	Task/Process description	Preceding task	Technique	TRL	Assumptions	Technical constraints	Gaps	Key reference documents
16)	**Site End State**	**Overview:** The end-point of the FSC period is therefore assumed to be a delicensed site with all structures removed to at least ground level, landscaped and planted with appropriate locally indigenous flora allowing the site to be made available for any alternative appropriate use.						
Task 16.1 **10.23.36.** ▪ **23/23311**	Contaminated Land	Final Site Clearance	Non-radioactive (chemical) and Radioactive ground contamination characterisation, monitoring and site hydrogeological mapping work will be carried out. Any contamination found will be removed or contained, dependant on the agreed site end state.	3	It is assumed the site end state will be green field, requiring the removal of all contamination.	Excavation and removal requires consideration of the options for treatment, storage and disposal of the resulting waste.	On hold - generic R&D managed by DSO: Ref MEL W&D R&D programme document	
Task 16.2 **10.23.30** ▪ **23/23355**	Landscaping	Final Site Clearance	The land will be landscaped to make it acceptable for future usage.	9				

Table 1B: Dungeness A, Technical Baseline: Works completed or Deleted during FY 2007-08

Task / Process ID.	Task/Process description	Preceding task	Technique	TRL	Assumptions	Technical constraints	Gaps (ref to R&D table)	Key reference documents
1)	**Passive Cooling**	**Overview:** On cessation of generation, heat generation will subside to a point where the boilers can dissipate any generated heat at which point, the gas circulators can be removed from duty. The commencement of passive cooling on both reactors is expected during winter 07/08 and is a key milestone in the reduction of active plant. This will be determined from measurements of reactor temperatures with cooling reduced to a passive level for a sustained period. The timing of entry into a passive cooling state provides the opportunity to commence decommissioning and demolition of those redundant plant areas						Ref. 6 & 7
	Passive Cooling			9			Completed	

Table 2: Dungeness A Research & Development – Work Progressing in FY 2008/09

ID	Task	Technical need - task + gap	Context of why a problem	Target Date	Cost range	Needs / Risks / Opportunity	Site / Generic / NDA issue	Key outputs / Actions
		No Site Specific R&D work is progressing in FY 2008/09						

Table 2A: Dungeness A Research & Development – Work on hold in FY 2008/09

ID	Task	Technical need - task + gap	Context of why a problem	Target Date	Cost range	Needs / Risks / Opportunity	Site / Generic / NDA issue	Key outputs / Actions
5/6	ILW Retrieval and Processing	AETP resins, sands and gravels.	To develop treatment and encapsulation methods for this waste stream, when AETP becomes available for deplanting. Develop easier, faster, safer, with less dose to operators, methods of retrieval, treatment and disposal of AETP waste streams.	2012/14	£100k - £1M	Need	Generic	Identify better options for dealing with AETP waste, especially resins. Carry out small scale encapsulation trials of waste to demonstrate applicability of options.
6/6	Ponds Skips and Miscellaneous Contaminated Items (MCI)	Skip decontamination.	Disposal route for skips not yet identified. At DNA. Hinkley Point A have established a metal smelting route for their skips and are leading on this but Dungeness need to develop a method suitable for use on site after taking into account all other works on other sites.	2010/11	£100k - £1M	Need	Site	Develop methodology and process for dealing with skips after defuelling.
7/9	Ponds Decommission-ing	Ponds structure decontamination	Potential for large cost savings and minimisation of dose to operators. Generic work will take place prior to this and the funding identified will allow Dungeness to take the findings and adapt them.	2011/12	£50k - £100k	Opportunity	Generic	Feasibility study for the option of quicker decontamination methods, which would lead to contained demolition and approval of the Regulators.
9/10	RCA De-plant and Demolition	Reduction of hazard posed by Asbestos	Reactor sites decommissioning will produce large volumes of Asbestos. Development work is being led by Risley to investigate potential new technologies available to reduce the hazard posed by asbestos Being developed centrally	2009/10	£50k - £100k	Opportunity	Generic	Prove TCCT or alternative methods for dealing with asbestos can work and so minimise the hazard and waste quantities.
9/11	RCA De-plant and Demolition	Pilot demonstration of free release of RCA buildings	To establish methods and costs to minimise amounts of decontamination required. Being developed centrally.	2013/15	£50k - £100k	Opportunity	Generic	Easier, faster and safer methods to decontaminate and demolish buildings..

Figure 1

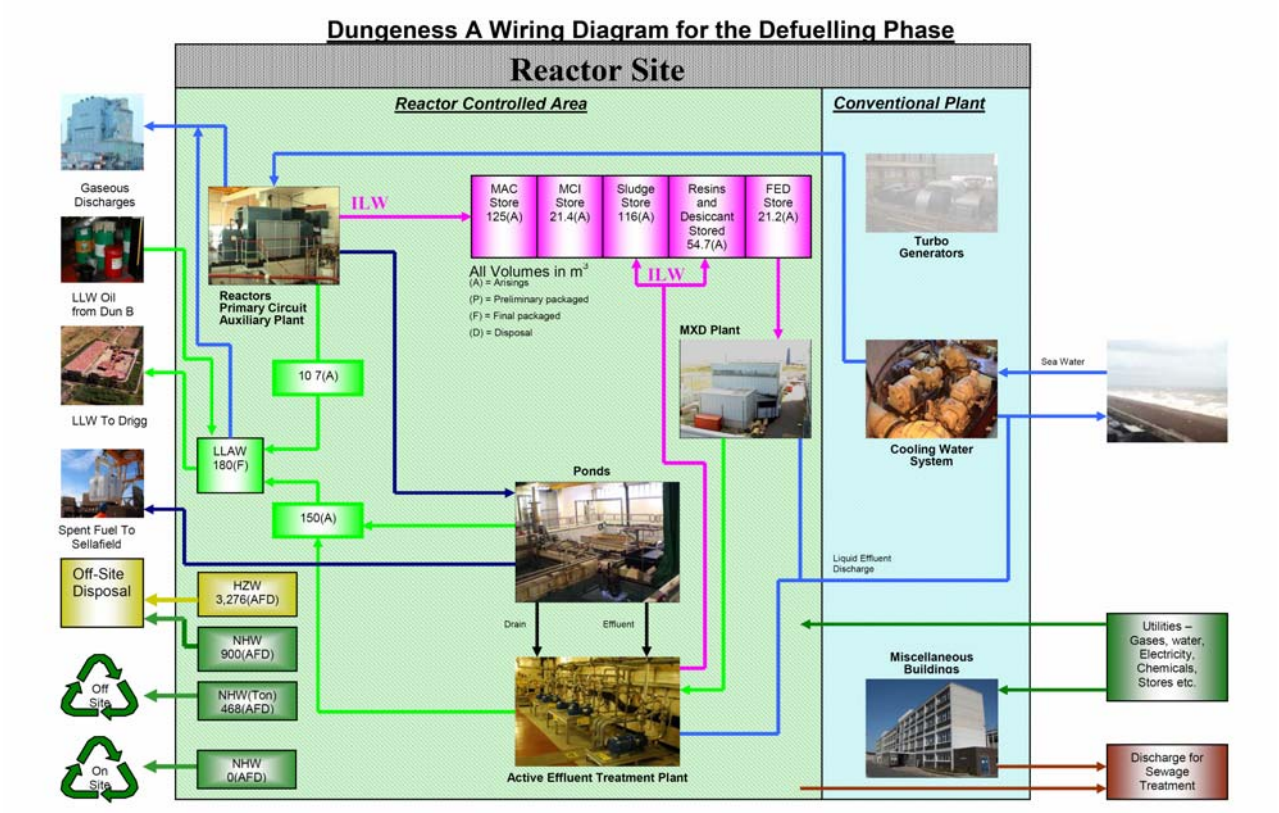

Dungeness A Wiring Diagram for the Defuelling Phase
Reactor Site
Reactor Controlled Area
Conventional Plant
Gaseous Discharges
LLW Oil from Dun B
LLW To Drigg
Spent Fuel To Sellafield
Off-Site Disposal
Off Site
On Site
Reactors Primary Circuit Auxiliary Plant
ILW
MAC Store 125(A)
MCI Store 21.4(A)
Sludge Store 116(A)
Resins and Desiccant Stored 54.7(A)
FED Store 21.2(A)
All Volumes in m3
(A) = Arisings
(P) = Preliminary packaged
(F) = Final packaged
(D) = Disposal
ILW
10 7(A)
LLAW 180(F)
150(A)
HZW 3,276(AFD)
NHW 900(AFD)
NHW(Ton) 468(AFD)
NHW 0(AFD)
MXD Plant
Ponds
Drain
Effluent
Active Effluent Treatment Plant
Turbo Generators
Cooling Water System
Sea Water
Liquid Effluent Discharge
Miscellaneous Buildings
Utilities – Gases, water, Electricity, Chemicals, Stores etc.
Discharge for Sewage Treatment

Figure 2

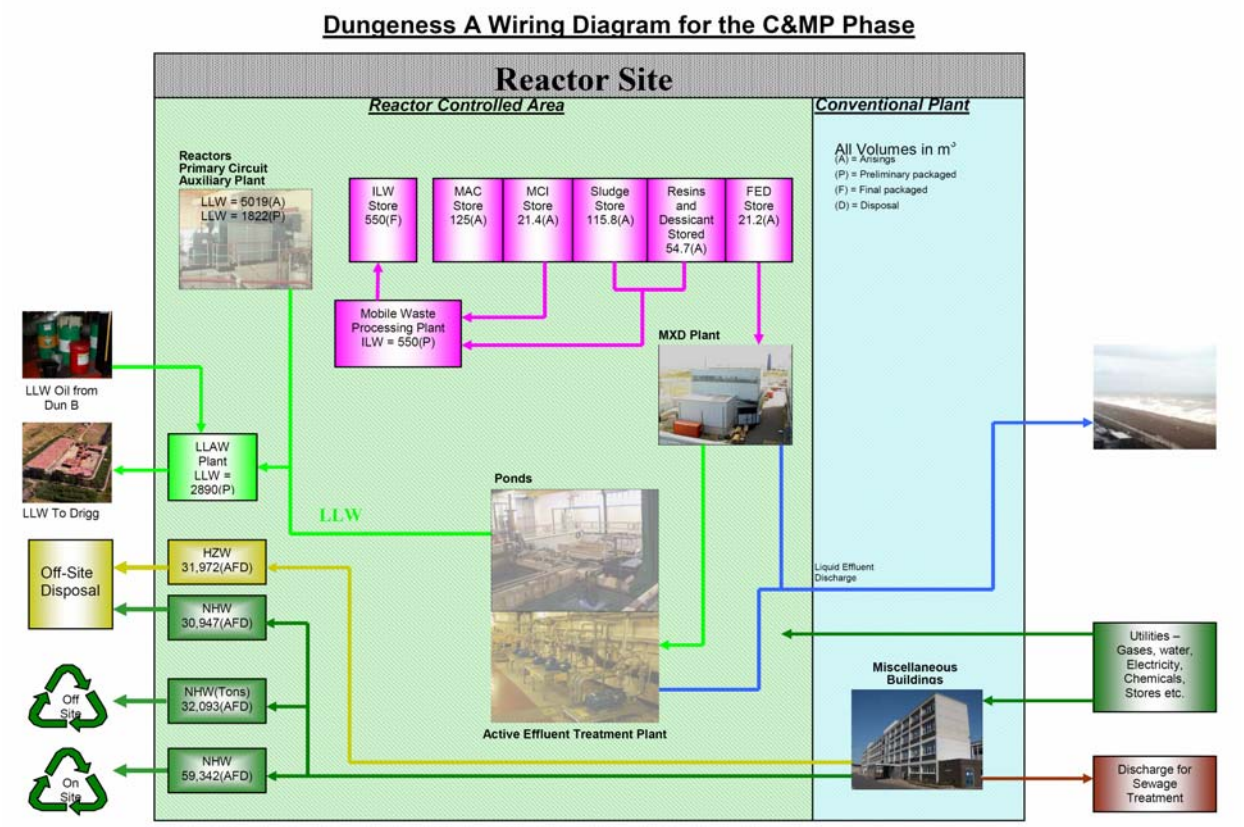

Dungeness A Wiring Diagram for the C&MP Phase
Reactor Site
Reactor Controlled Area
Conventional Plant
All Volumes in m³
(A) = Arisings
(P) = Preliminary packaged
(F) = Final packaged
(D) = Disposal
Reactors
Primary Circuit
Auxiliary Plant
LLW = 6019(A)
LLW = 1822(P)
ILW Store 550(F)
MAC Store 125(A)
MCI Store 21.4(A)
Sludge Store 115.8(A)
Resins and Dessicant Stored 54.7(A)
FED Store 21.2(A)
Mobile Waste Processing Plant ILW = 550(P)
MXD Plant
LLW Oil from Dun B
LLW To Drigg
LLAW Plant LLW = 2890(P)
LLW
Ponds
Active Effluent Treatment Plant
Liquid Effluent Discharge
Off-Site Disposal
HZW 31,972(AFD)
NHW 30,947(AFD)
Off Site
NHW(Tons) 32,093(AFD)
On Site
NHW 59,342(AFD)
Miscellaneous Buildings
Utilities – Gases, water, Electricity, Chemicals, Stores etc.
Discharge for Sewage Treatment

Figure 3

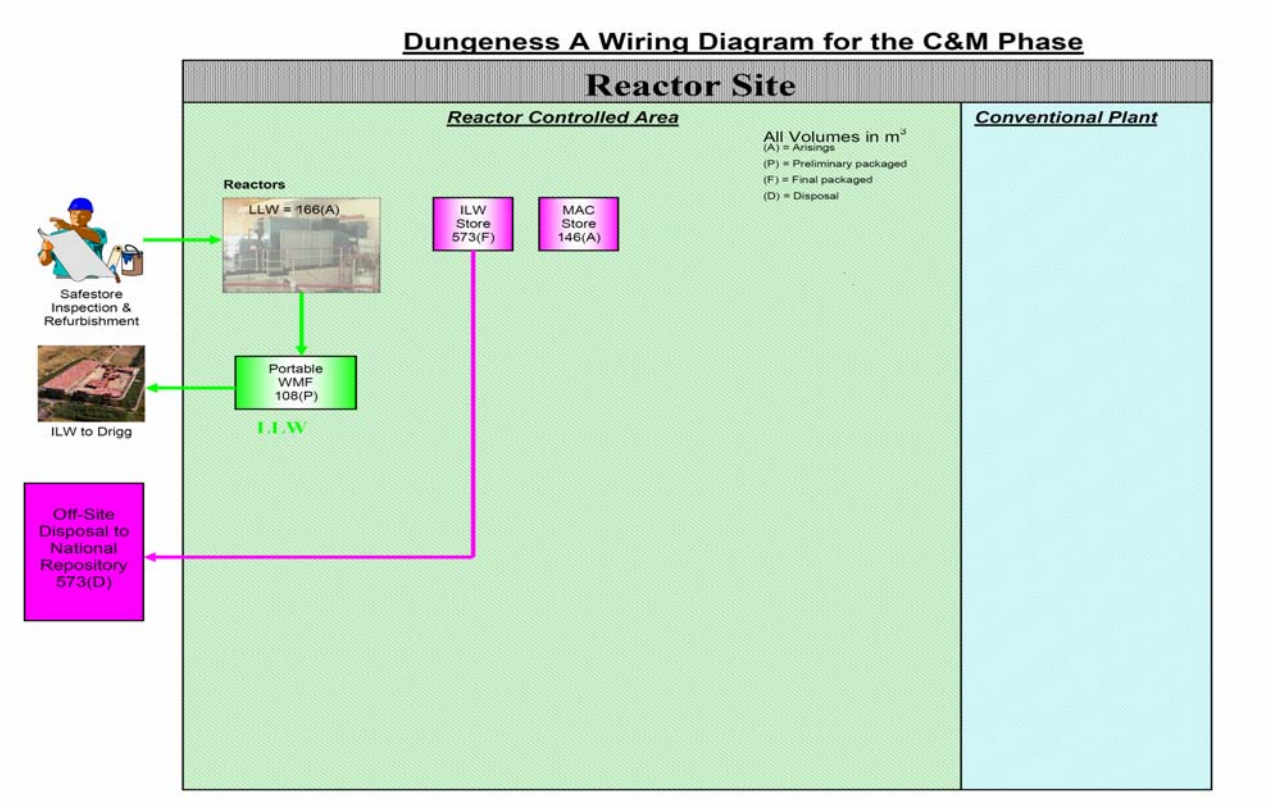
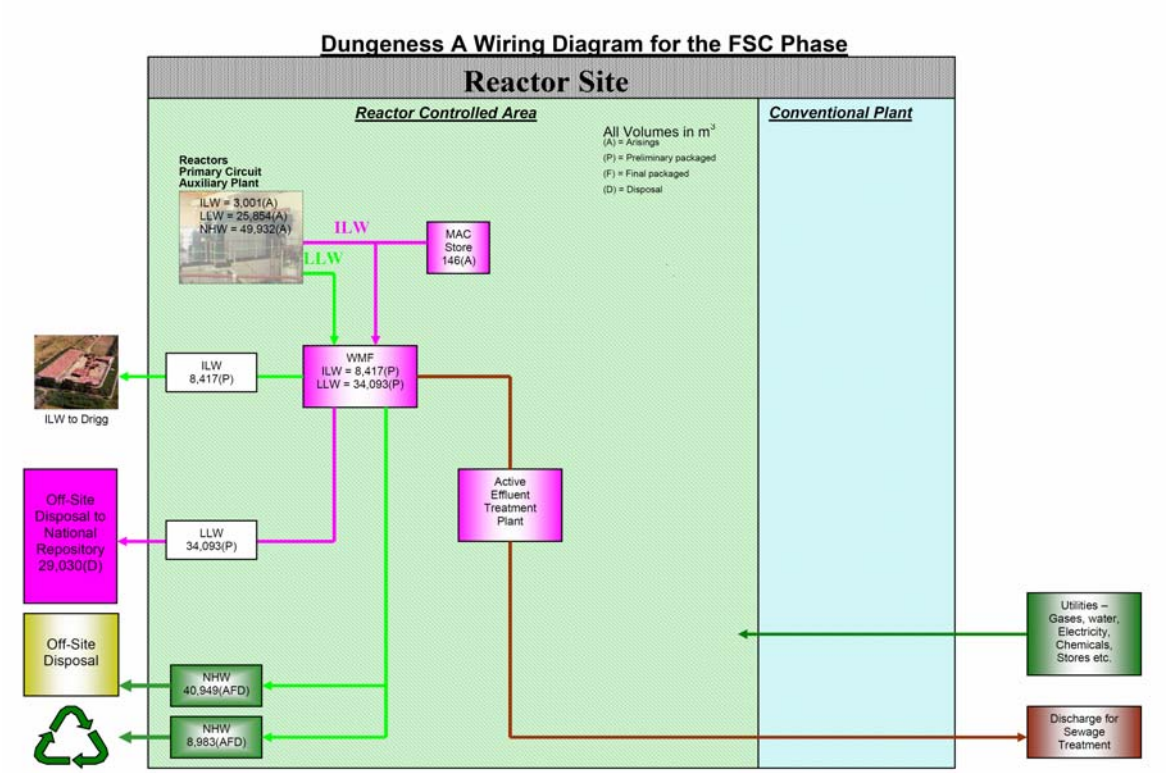

Dungeness A Wiring Diagram for the C&M Phase
Reactor Site
Reactor Controlled Area
Conventional Plant
All Volumes in m3
(A) = Arisings
(P) = Preliminary packaged
(F) = Final packaged
(D) = Disposal
Reactors
LLW = 166(A)
ILW Store 573(F)
MAC Store 146(A)
Safestore Inspection & Refurbishment
Portable WMF 108(P)
ILW to Drigg
LLW
Off-Site Disposal to National Repository 573(D)

Figure 4


Dungeness A Wiring Diagram for the FSC Phase
Reactor Site
Reactor Controlled Area
Conventional Plant
All Volumes in m3
(A) = Arisings
(P) = Preliminary packaged
(F) = Final packaged
(D) = Disposal
Reactors
Primary Circuit
Auxiliary Plant
ILW = 3,001(A)
LLW = 25,854(A)
NHW = 49,932(A)
ILW
LLW
MAC
Store
146(A)
ILW
8,417(P)
WMF
ILW = 8,417(P)
LLW = 34,093(P)
ILW to Drigg
Off-Site
Disposal to
National
Repository
29,030(D)
LLW
34,093(P)
Active
Effluent
Treatment
Plant
Off-Site
Disposal
NHW
40,949(AFD)
NHW
8,983(AFD)
Utilities –
Gases, water,
Electricity,
Chemicals,
Stores etc.
Discharge for
Sewage
Treatment