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ISM

SUBMARINE DISMANTLING PROJECT

2012 COEIA MCDA Data Report

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Amendment History

Issue	Date	Details of Amendment	DCCF
V0.1	19 April 11	Draft issued to MCDA workshop invitees for review prior to workshop and comment	000
V1.0	12-May-11	Amended in line with received comments. Version 1.0 issued to MCDA workshop invitees for review and comment prior to the scoring workshop. Significant changes or additional text (since Issue 0.1) shown in red.	000
V2.0	22-June-11	Updated after May 2011 MCDA Scoring Workshop to be consistent with the workshop assumptions. The transportation data in Section 4.3 and Annex C3 was simplified and duplicate text in Annex C was removed. Data provided at (and subsequent to) the Scoring Workshop is labelled accordingly and highlighted in grey boxes.	000
V3.0	May-12	Updated post Public Consultation for the 2012 MCDA conferences. The content of previous grey boxes has been subsumed into the text and new grey boxes created for additional comments and data.	000
V4.0	July-12	Updated post Option Selection Conference held on 12/13 June 2012.	000
V5.0	November-12	Update prior to internal review	000
V6.0	January-13	Version 6 issued following internal review.	

Distribution

MCDA Workshop Invitees

SDP Virtual Team

SDP Scrutiny Meeting Members

Glossary of Terms

Abbreviation	Meaning
AGLV	Area of Great Landscape Value
ALARA	As Low as Reasonably Achievable
ALARP	As Low as Reasonably Practicable
AONB	Area of Outstanding Natural Beauty
AQMA	Air Quality Management Area
BAT	Best Available Technology
BATNEEC	Best Available Technology Not Entailing Excessive Cost (Precursor of BAT. BATNEEC is now a defunct term).
BGS	British Geological Survey
BM	Babcock Marine
BPEO	Best Practicable Environmental Option (Used in Scotland, but has been replaced in England and Wales by BAT)
BPM	Best Practical Means (Note that in England and Wales, the use of BPM terminology has been discontinued and replaced with the use of BAT (see definition above). BPM terminology is still used in Scotland and in Northern Ireland.)
Bq	Becquerel
BSL	Basic Safety Limit
BSO	Basic Safety Objective
CFA	Conditions for Acceptance
CFMP	Catchment Flood Management Plan
CoA	Concept of Analysis
COEIA	Combined Operational Effectiveness and Investment Appraisal
CoRWM	Committee on Radioactive Waste Management
COSHH	Control of Substances Hazardous to Health
DDLP	De-fuel, De-equip and Lay-Up Preparation
DE&S	Defence Equipment and Support
DRDL	Devonport Royal Dockyard Limited
DSM	Director Submarines
DTI	Department of Trade and Industry
EA	Environment Agency
EU	European Union
FSM	Future submarines
GDF	Geological Disposal Facility

Abbreviation	Meaning
H&S	Health and Safety
Ha	Hectare
HAW	Higher Activity Waste
HEPA	High Efficiency Particulate Air (Filter)
HGV	Heavy Goods Vehicle
HMNB	Her Majesty's Naval Base
HPA	Health Protection Agency
IA	Investment Appraisal
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiation Protection
ID	Identification
ILW	Intermediate Level Waste
IPT	Integrated Project Team
IROPI	Imperative Reasons of Overriding Public Interest
ISMs	In Service Submarines
ISOLUS	Interim Storage of Laid up Submarines
LAED	Low Active Effluent Discharge
LLDR	Low Level Dose Rate
LLILW	Long Lived Intermediate Level Waste
LLW	Low Level Waste
LLWR	Low Level Waste Repository
LUSMs	Laid up Submarines
MCDA	Multi-Criteria Decision Analysis
MCP	Maritime Change Programme
MDA	US-UK Mutual Defence Agreement
MDAL	Master Data and Assumptions List
MOD	Ministry of Defence
MoE	Measure of Effectiveness
MPOS	MODs Preferred Option Selection
MRWS	Managing Radioactive Waste Safely
MUFC	Maritime Underwater Future Capability
NDA	Nuclear Decommissioning Authority
NFLA	Nuclear Free Local Authorities
NI	Nuclear Institute
NuLeAF	Nuclear Legacy Advisory Forum
OCF	Other Contributory Factors

Abbreviation	Meaning
OE	Operational Effectiveness
PCBs	Polychlorinated Biphenyls
PCR	Post Consultation Report
PM_{10}	Particulate Matter of 10 microns in diameter or smaller
PP	Proximity Principal
PST	Primary Shield Tank
PW	Packaged Waste
PWR	Pressurised Water Reactor
RAMSAR	Wetlands of International Importance under the RAMSAR convention (Official site of the Secretariat for the Convention on Wetlands was signed in Ramsar Iran, in 1971.)
RC	Reactor Compartment
RIFE	Radioactivity in Food and the Environment
RPV	Reactor Pressure Vessel
RWMD	Radioactive Waste Management Directorate
S&MO	Salvage and Marine Operations
SAC	Special Area of Conservation
SADP	Survey and Docking Period
SCCORS	Scottish Councils Committee on Radioactive Substances
SDP	Submarine Dismantling Project
SEA	Strategic Environmental Assessment
SLILW	Short Lived Intermediate Level Waste
SME	Subject Matter Expert
SPA	Special Protected Area
SQEP	Suitably Qualified and Experienced
SSBN	Strategic Submarine Ballistic Nuclear
SSSI	Site of Special Scientific Interest
SUDs	Sustainable Urban Drainage Systems
Sv	Sievert
SWTC	Sellafield Waste Transport Container (i.e. shielded waste package transport container)
UFF	Used Fuel Flask
UKCP09	UK Climate Projections 2009
URD	User Requirement Document
VLLW	Very Low Level Waste
NRTE	Naval Reactor Test Establishment
WAGR	Windscale Advanced Gas Cooled Reactor

Abbreviation	Meaning
WLC	Whole Life Cost
WWER	Wasser-Wasser-Energie-Reactor (Literally: Water-Water-Energy-Reactor) i.e. Water-Cooled, Water-Moderated Energy Reactor

COMMENT ON THE DIFFERENCES BETWEEN THIS DOCUMENT AND THE 2011 DATA REPORT.

Text inside a grey box with a light perimeter border indicates where changes have been made to the version of the document used for the 2011 MCDA Workshops.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

Text inside grey boxes with a heavy perimeter border indicates where changes have been made to the document after the 2012 weighting and scoring workshops.

Executive Summary

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

This section has been amended to reflect the restructuring of this document to align with the requirements of the 2012 MCDA Workshops.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

Only minor changes were made to the Executive Summary after the 2012 weighting and scoring workshops.

The SDP is charged with selecting and subsequently implementing an optimal solution for dismantling of decommissioned nuclear submarines and management of the waste arisings.

The overall decision making process has three assessment streams, namely the Investment Appraisal (IA), Operational Effectiveness (OE) and Other Contributory Factors (OCF).

This document contains supporting data to inform those involved in the OE assessment process, which will be conducted using Multi-Criteria Decision Analysis (MCDA) techniques. This document is an update of the version used for the 2011 MCDA.

The purpose of the data report is to provide workshop participants with sufficient information:

- to understand the nature of the criteria under consideration and to assign weightings to define their relative importance;
- to provide them with a summary of the relevant technical information and data available to support the scoring of options against each of the criterion; and
- to provide details of the source and audit trail of the technical information provided.

Workshop participants will also apply their own expertise, relevant to the criterion in view, to wherever a judgemental assessment is required and this will be recorded in the notes of the workshops.

Section 1 of this report provides background material, describes the process and summarises the purpose and structure of this report.

Section 2 provides an overview of the options and provides a short technical description of each option.

Section 3 explains the process used to derive the criteria and groups them into 4 categories: Reduction in impact to Government and MOD (POL), Reduction of Impact to Operations (OP), Health and Safety (H&S) and Reduction of Environmental Impact (ENV).

Section 4 discusses each criterion in turn and provides an explanation of the meaning of the criterion, its scope and relevant data (where available) to assist in the consideration of the criterion. References to the sources of the data are provided. Each criterion is further discussed and includes a list of suggested topics for further consideration. Section 4 is supported by Annex A, which contains additional supporting information for some of the criteria.

Section 5 contains the references.

Annex A provides supplementary information on the various criteria.

Table of Contents

1. Introduction

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

The introduction below is very similar to that contained in the MCDA 2011 Data Report. The structure of Section 4 (Data Relevant to the Criteria) has been changed, with the addition of assumptions and public consultation comments.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant amendments were made to this section.

1.1. Background

1.1.1. The overall requirement for the Submarine Dismantling Project is

- "*To dismantle, cost effectively, 27 de-fuelled nuclear submarines by 2050, without exceeding the submarine storage capacity, in a safe, secure, and sustainable manner which upholds MOD's reputation as a responsible nuclear operator; stores Intermediate Level Waste (ILW) until a national disposal route is available; disposes of all other radioactive, hazardous and non-hazardous waste in accordance with legislation and minimises impact upon military capability*" [1.1].

1.1.2. The project scope includes past and current classes of nuclear submarines, 27 in all, 16 of which are already out of service and safely stored afloat at Rosyth or Devonport Dockyard. Whilst the approved project scope does not include disposal of Astute class or the new class of submarines currently known as "Successor", the project is required to retain the flexibility to become "future submarine capable". This means that the dismantling facilities will, wherever possible, be sized and flexible enough to be considered as an option for dismantling of future classes of submarines.

1.1.3. The project includes the interim storage on land of the resultant long lived intermediate level waste (LLILW) until at least 2040, pending the availability of the proposed national Geological Disposal Facility (GDF). For planning purposes long LLILW storage is assumed for up to 100 years in line with CoRWM recommendations [1.2].

1.2. Purpose

1.2.1. This data report has been compiled with the following aims:

- To provide workshop participants with sufficient information to understand the nature and scope of the criteria under consideration.

- To provide workshop participants with a summary of the relevant technical information and data available to support the scoring of options against each of the criteria.
- To provide details of the source and audit trail of the technical information provided.

1.2.2. A draft of the data report was issued prior to the 2012 weighting workshop and the final version prior to the 2012 option selection workshop. The data report is kept under strict configuration control with any amendments or additions being recorded in the document history. The report was updated and re-issued after completion of the 2012 MCDA workshops. Any amendments made subsequent to the revised weighting and option selection workshops were annotated.

1.3. Structure

1.3.1. Section 2 summarises the options.

1.3.2. Section 3 outlines the decision criteria which will be used.

1.3.3. Section 4 discusses each criterion, taking account of the following:

- *Meaning and Scope* -- Description of what the criterion means and what is covered with in its scope.
- *Assumptions* -- Key assumptions (taken from the SDP MDAL) are presented (in Annex A) for each of the four sets of criteria.
- *Data* -- A summary of the technical data and information available from previous and current studies which will assist in the consideration of the criterion. Where applicable, the summary provided in the main body of the data report is supported by further data provided in Annex A.
- *Public Consultation* -- A summary is provided of relevant issues, raised during the 2011/2012 Public Consultation events. Note that the selection of public consultation comments for insertion into this document is not rigorous or exhaustive. Subject matter expertise will be at hand, where required, to augment the selected text.
- *Discussion* -- A discussion of the data for the sole purpose of setting a framework for informed discussion at the workshops. Suggested topics for further discussion at the workshop are included.
- *References* -- List of references from which the data and information were obtained.

2. Summary of Options

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

The detailed technical description of the options contained in the MCDA 2011 Data Report has been removed.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant amendments were made.

2.1.1. The basis of the options considered during the 2011 MCDA workshops is addressed in [2.1 – 2.4].

2.1.2. The options under consideration during MCDA 2012 are listed in the table below taken from [2.5].

2.1.3. **Table 2.1: Summary of Options**

Category (for info)	**Option**	**Description**
Indefinite afloat storage	0	Do Minimum
RC	1D	Reactor Compartment (RC) separation at Devonport, with interim storage at point of waste generation at Devonport, and at a later date size reduction of ILW at Devonport before transfer to the proposed GDF
	1R	RC separation at Rosyth, with interim storage at point of waste generation at Rosyth, and at a later date size reduction of ILW at Rosyth before transfer to the proposed GDF
RPV	2D	Reactor Pressure Vessel (RPV) removal at Devonport, with interim storage at point of waste generation at Devonport, and at a later date size reduction of ILW at Devonport before transfer to the proposed GDF
	3-4D	RPV removal at Devonport, with interim storage at a remote MOD or commercial site and at a later date size reduction of ILW before transfer to the proposed GDF

Category (for info)	Option	Description
	2-4B	RPV removal at Devonport and Rosyth, with interim storage at one of the following: a remote MOD or commercial site, Devonport or Rosyth, and at a later date size reduction of ILW before transfer to the proposed GDF
	9D	RPV removal at Devonport with interim storage at NDA site(s)
	9B	RPV removal at Devonport and Rosyth with interim storage at NDA site(s)
Packaged Waste	5D	RPV removal and size reduction to form Packaged Waste with interim storage at point of waste generation, all at Devonport
	6-7D	RPV removal and size reduction to form Packaged Waste at Devonport with interim storage at a remote MOD or commercial site
	5-7B	RPV removal and size reduction to form Packaged Waste at Devonport and Rosyth, with interim storage at one of the following: a remote MOD or commercial site, Devonport or Rosyth
	8D	RPV removal and size reduction to form Packaged Waste at Devonport with interim storage at NDA site(s)
	8B	RPV removal and size reduction to form Packaged Waste at Devonport and Rosyth with interim storage at NDA site(s)

3. MCDA Criteria

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

Apart from 5-OP (which has been subsumed into 1-OP), the criteria listed below are the same as those contained in the MCDA 2011 report. Cosmetic changes have been made to align this report with the MCDA 2012 requirements.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant amendments were made.

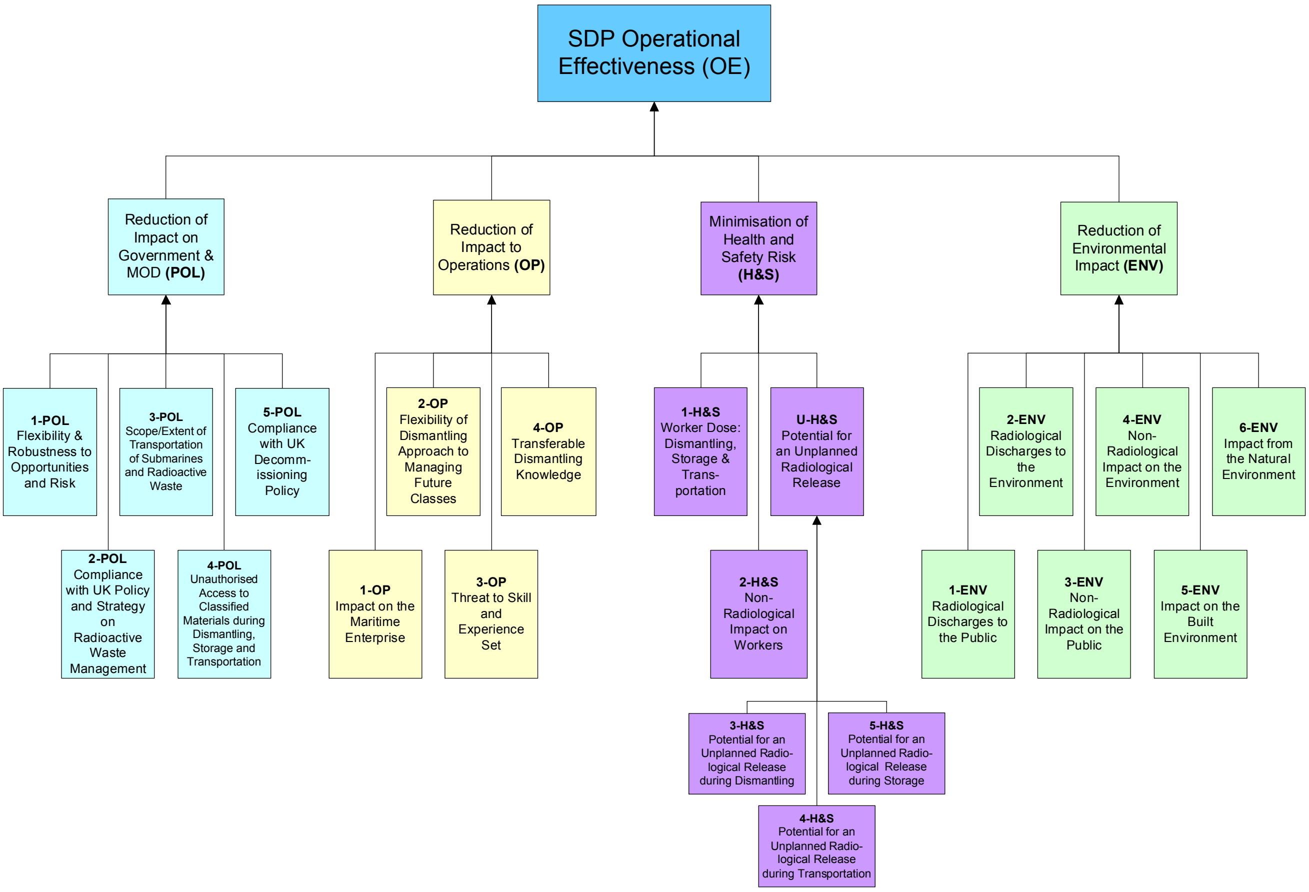
3.1.1. The 2011/2012 MCDA criteria were developed as set out in the CoA (Concept of Analysis) by consideration of:

- Benefits and dis-benefits for Operational Effectiveness of the SDP;
- Assessment of the URD (User Requirement Document) (to ensure all relevant requirements are considered); and
- Assessment of previous studies (including the SEA (Strategic Environmental Assessment) scoping report, the MPOS (MOD's Preferred Option Selection) technical options study and site evaluation study).

3.1.2. At 2011, an initial criteria set was proposed and refined through a series of workshops. Consideration was also given to the definition of the threshold value (minimum requirement) and objective value (ideal performance) for each MCDA criterion [3.1].

3.1.3. The criteria presented within this data report are identical to those provided in the 2011 MCDA report and are summarised in Figure 3.1 and Table 3.1 below.

3.1.4. **Figure 3.1: MCDA Criteria**



3.1.5. **Table 3.1: MCDA Criteria**

Criterion Number	Criterion Title	Criterion Category
1- POL	Flexibility and Robustness to Opportunities and Risk	Reduction in Impact to Government and MOD (POL)
2- POL	Compliance with Extant UK Policy and Strategy on Radioactive Waste Management	
3- POL	Scope/Extent of Transportation of Submarines and Radioactive Waste	
4- POL	Unauthorised Access to Classified Materials during Dismantling, Storage and Transportation	
5- POL	Compliance with Extant UK Decommissioning Policy	

Criterion Number	Criterion Title	Criterion Category
1-OP	Impact on the Maritime Enterprise and Wider MOD Operations	Reduction of impact to Operations (OP)
2-OP	Flexibility of Dismantling Approach to Managing Future Classes	
3-OP	Threat to Skill and Experience set	
4-OP	Transferable Dismantling Knowledge	
1-H&S	Worker Dose: Dismantling, Storage and Transportation	Minimisation of Health and Safety Risk (H&S)
2-H&S	Non-Radiological Impact on Workers	
	Potential for an Unplanned Radiological Release during Dismantling, Storage and Transportation	
3-H&S	Potential for an Unplanned Radiological Release during Dismantling	
4-H&S	Potential for an Unplanned Radiological Release during Storage	
5-H&S	Potential for an Unplanned Radiological Release during Transportation	
1-ENV	Radiological Discharges to the Public	Reduction of Environmental Impact (ENV)
2-ENV	Radiological Discharges to the Environment	
3-ENV	Non-Radiological Impact on the Public	
4-ENV	Non-radiological Impact on the Environment	
5-ENV	Impact on the Built Environment	
6-ENV	Impact from the Natural Environment	

3.1.6. The following sections discuss each of the decision criteria in turn. An explanation is provided of the meaning and scope of each criterion. This is followed by a presentation of available data (with references) relevant to the criterion and a discussion on relevant issues. Each discussion ends with suggestions for further discussion at the workshops. It is emphasised that the purpose of the discussion section is to promote and assist discussion at the workshops, not to stifle creative thinking or to channel the discussion down any one pathway.

3.1.7. Public Consultation Issues

3.1.8. Public consultation raised a number of issues relevant to the MCDA criteria and these are summarised below.

- The key factors that we believe are missing are programme factors. There are no considerations of option discrimination on programme. This is not adequately captured by considerations of lifecycle cost and should be considered separately. There are two programme-related project objectives:

  - To complete dismantling of the 27 submarines and be storing the arising ILW by 2050.
  - To execute the project without exceeding the current submarine storage capacity. From the consultation documents, the second objective appears to be the key programme-related objective, as the documents state that current berthing capacity at Devonport will be reached in 2020 (NI).

4. Data Relevant to the Criteria

4.1. 1-POL: Flexibility and Robustness to Opportunities and Risk

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

The text below has been amended to reflect the updated Risk and Opportunities registers. Public consultation comments and assumptions have been added.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant changes were made to the 1-POL supporting data.

During the weighting workshop It was explained that the majority of the issues contained in this criterion should be addressed elsewhere (e.g. in other MCDA criteria, Whole Life Cost Model, Other Contributory Factors) and it was agreed that this criterion would be eliminated from further consideration. Some examples are provided below.

- ✓ ***1-POL excludes identified risks and opportunities. It addresses the flexibility of options to future opportunities and risks (including future policy, but these have still to be identified. Future opportunities and risks can still be included in the Risk and Opportunities Registers.***
- ✓ ***The 1-POL supporting data addresses the foreclosing of options but it was agreed that this should be covered instead under Criterion 5-POL (Compliance with Extant UK Decommissioning Policy).***

4.1.1. This criterion addresses the flexibility and robustness of the options to take advantage of future opportunities and also the robustness and flexibility of the options to accommodate the realisation of identified and future risks.

4.1.2. Points of consideration include but are not restricted to the list shown in the table below, which were taken from the MCDA 2011 scoring workshop report [4.1.1].

4.1.3. **Table 4.1.1: Issues relevant to 1-POL**

#	TOPIC	ISSUES
A	**Unknowns** (Opportunities)	• Opportunities which have still to be identified.
B	**Technical Dependencies**	• The benefits of some of the opportunities (e.g. whole RPV disposal, disposal of ILW to the LLWR) may be partially

#	TOPIC	ISSUES
	(Opportunities)	reduced or completely negated if the preferred technical option is different to the assumptions made in the formulation of the opportunity.
C	**Time** (Opportunities)	• As the SDP progresses, a point of no return may be reached where some opportunities become irrelevant.
D	**Unknowns** (Risk)	• Risks which have still to be identified.
E	**Time** (Risk)	• As the SDP progresses, the risk profile will change with time.
F	**Flexibility** (Opportunities and Risk)	• The flexibility of current SDP systems for management of opportunities and risks.
G	**Robustness** (Opportunities and Risk)	• Effectiveness and robustness of current SDP systems for management of opportunities and risk.
H	**Future** (Opportunities and Risk)	• Size reduction etc. at as late as stage as possible to take advantage of radioactive decay and take advantage of new or developing technologies…VERSUS: • Size reduction etc. as early as possible to use the existing skill set and ensure that future generations are not burdened with submarine dismantling.

4.1.4. Assumptions

4.1.5. See Annex A, Section A19.

4.1.6. Data: Opportunities (at 2012)

4.1.7. The options should ideally have the ability to take advantage of situations which may develop in the future (i.e. short and long term over the next 50 or so years). The available data consists mainly of those opportunities which are currently contained within the SDP opportunities register.

4.1.8. It is recognised that there may be additional opportunities which have still to be identified but by definition, these are not available to this data report.

4.1.9. The project has a formal process for tracking and managing opportunities should any additional opportunities be identified during the workshop discussions.

4.1.10. The opportunities register [4.1.2] identifies 6 potential opportunities relevant to the dismantling programme. These are discussed below.

4.1.11. **Opportunity 1: Shielded Mini Stores (ID: OP47437)**

4.1.12. This opportunity addresses use of shielded mini stores which would negate the need for a fully shielded ILW interim store.

4.1.13. It may be possible to package long lived and short lived ILW into a self shielded IP-2 box (e.g. the NDA 2m or 4m box or the so called Yellow Box). Alternatively, it may be possible to put localised shielding round a Type B package containing either long lived or short lived ILW. The facilities required to store shielded mini stores will be far less extensive than a shielded ILW store. The ILW store would therefore take less time to design and build and potentially cost a lot less.

4.1.14. A fully shielded interim store may not be required for storage of RCs or RPVs, since a considerable amount of self shielding is already available within these structures. RCs and RPV may also have additional shielding for transportation purposes. This opportunity therefore applies mainly to the packaged waste options. This opportunity would effectively time-out if an RC separation or an RPV removal and storage option was adopted.

4.1.15. **Opportunity 2: FSM Design for Dismantling (ID: OP63667).**

4.1.16. This opportunity addresses linking Future Submarine (FSM) designers with the relevant SDP teams to identify future submarine decommissioning cost drivers and modify the FSM design as appropriate to minimise their impact.

4.1.17. When FSM is decommissioned/dismantled, significant costs may be required to solve technical difficulties. It may be possible to reduce these costs by facilitating interactions between the FSM designers and the SDP Demonstrator teams with a view to designing out the dismantling cost drivers.

4.1.18. This opportunity is understood to be relevant to all of the options, apart from the Do Minimum option.

4.1.19. **Opportunity 3: Disposal of ILW close to LLW Class Boundaries (ID: OP77951)**

4.1.20. This opportunity addresses disposal of ILW to the LLWR, resulting in a reduction or complete removal of the requirement for interim storage of ILW and disposal in the GDF.

4.1.21. There is an opportunity that following the EA review (due in late 2012) of the LLWR post-closure safety case, the revised Waste acceptance Criteria can be extended to consider SDP ILW that is close the LLW boundary.

4.1.22. This opportunity is not relevant to the Do Minimum option, since it does not have a disposal end-point. The opportunity is relevant to the RC separation option and the RPV removal options. The benefits arising from this opportunity would be substantially reduced if the ILW strategy was to produce packaged waste. It is still possible to dispose of packaged waste in the LLWR, following a period of interim storage, however, the costs associated with packaging and interim storage of waste would already have been committed.

4.1.23. **Opportunity 4: Whole RPV Disposal (ID: OP58833)**

4.1.24. This opportunity addresses disposal of a whole PWR 1 RPV in the proposed GDF, following a period of interim storage.

4.1.25. Discussions with RWMD during 2011/2012 have not ruled out disposal of a whole RPV to the GDF. The issues still to be resolved relate to modifications to the GDF to accommodate the range of RPV volumes and masses. Because PWR1s are smaller than PWR2s, direct disposal of PWR1s is considered the less problematic.

4.1.26. The major benefits would include the cost savings, reduced timescales and simplification of the SDP programme by not having to construct and operate a size reduction, packaging and conditioning facility.

4.1.27. This opportunity is relevant to both the RC and RPV options but not to the packaged waste options. This opportunity would effectively time-out if the ILW strategy was to produce packaged waste.

4.1.28. **Opportunity 5: Multi-stream Dismantling (ID: OP59748)**

4.1.29. This opportunity addresses carrying out dismantling on multiple submarines on multiple sites.

4.1.30. An accelerated dismantling programme involving multi-stream dismantling would reduce the number of vessels requiring funded interim storage. This may reduce pressure on available berths as vessels continue to come out of service.

4.1.31. Efficiency benefits may be realised by having SQEP personnel available to work on a number of vessels at any one time. This may allow the 7 Rosyth submarines to be dismantled in a shorter time than currently planned.

4.1.32. Further work is required to determine the feasibility of this opportunity, to dismantle faster than the assumed one submarine per year. The optimum rate of dismantling would need to be determined through the Investment Appraisal process to take account of the discounted cash flows involved.

4.1.33. This opportunity is relevant to all of the options, apart from the Do Minimum option.

4.1.34. **Opportunity 6: Optimisation of the SADP/DDLP/SDP joined up process (ID: OP39282).**

4.1.35. This opportunity addresses work to be carried out prior to the start of the dismantling process.

4.1.36. This opportunity would involve advanced works to be carried out prior to start of the submarine dismantling process to prepare the submarine for dismantling. This could include decontamination of contaminated items to reduce their waste categories, stripping out and disposal of components and recycling materials. There are potential efficiency and cost savings associated with this strategy.

4.1.37. This opportunity is understood to be relevant to all of the options. This opportunity will effectively time out for all of the options if the dismantling process is started without taking advantage of the opportunity to carry out these advanced works.

4.1.38. Data: Risk (at 2012)

4.1.39. The options should ideally be robust and flexible to accommodate the realisation of the mitigated risks identified in the current SDP risk register and also to those risks which may be identified in the future. The project has a formal process for tracking and managing risks should any new risks be identified during the workshop discussions.

4.1.40. The text below provides an overview of the risk management process and the types of risks identified within the SDP. Some additional information is provided in Annex A (Section A1).

4.1.41. There are over 50 risks identified in the SDP risk register. The risks relate to all phases of the project.

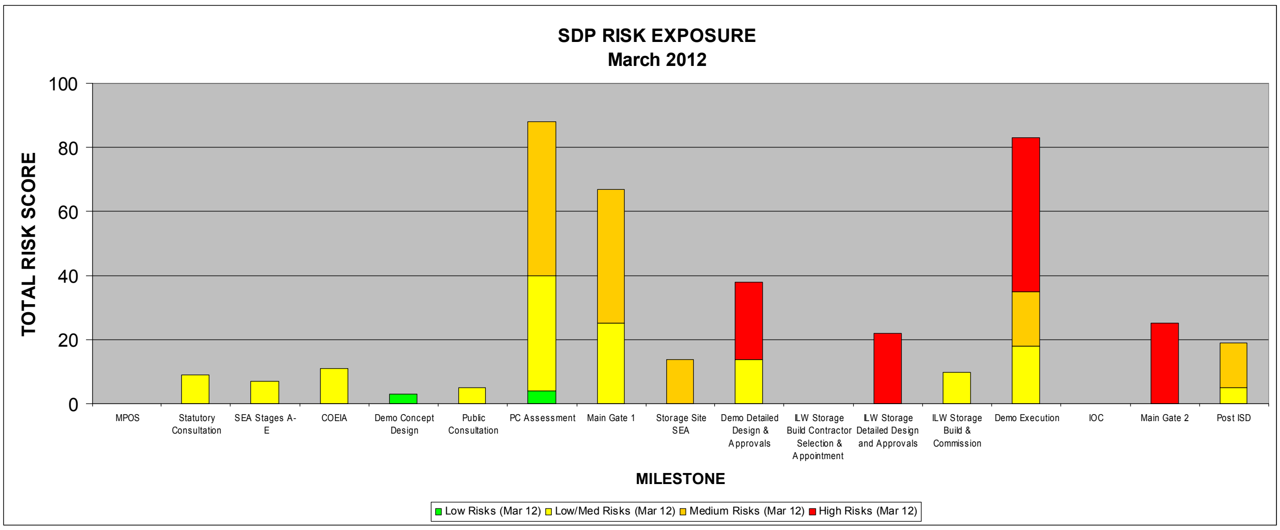
4.1.42. A structured process has been developed within SDP that allows individual risk events and overall project risk to be understood and managed proactively, optimising project success by minimising threats and maximising opportunities.

4.1.43. The risk management process starts with identification of an uncertain event or set of circumstances that, should it occur will have an effect on one or more of the project's objectives. The Risk Owner and Risk Manager carry out a quantitative assessment in terms of probability of occurrence and likely impact pre and post mitigation. The parameters: cost, time and performance are judged against a defined scoring scheme. Risk planning is conducted to consider the appropriate action required to manage the risk. Actions to prevent or reduce the probability and/or impact of the risk are identified and carried out.

4.1.44. The figure below shows the SDP Risk Exposure Graph at March 2012. The bars in the figure show the total level of risk exposure against the key milestones.

4.1.45. The green boxes in the figure indicate low risk; the yellow boxes indicate low to medium risk; the brown boxes indicate medium risk; and the red boxes indicate high risk.

4.1.46. **Figure 4.1.1: SDP Risk Exposure Graph**



4.1.47. Public Consultation Issues

4.1.48. Public consultation raised a number of issues relevant to this criterion and these are summarised below. Note that some of these are more ethical in nature and where they effectively contradict government policy, they should be considered within the OCF analysis and not MCDA process.

Equity and Fairness

- The most frequently quoted reason for taking action now was in support of intergenerational equity. As the current generations had built and used the submarines, it was their responsibility to dispose of them in the safest possible way rather than to leave later generations to deal with the problem. To do otherwise ran counter to the principles of sustainability.

- Inter-generational equity…is…to what extent the option is open to future developments (positively in term of technology development and negatively in terms of further regulatory and societal constraint (NI).

- There may be no such thing as a solution to many nuclear waste problems and burying nuclear waste in a deep geological repository could simply be removing choices for future generations rather than removing the problem for them. It would be better to bequeath future generations a well managed surface or near surface store than a leaking geological repository which they can do nothing about (NFLA).

- There is a balance between avoiding leaving a legacy for future generations to deal with and committing future generations to take actions which they may not wish to take….Options which might avoid size reduction of the RPV…are intrinsically preferable to others. Such deferral may also leave options open for other disposal practices.

- SCCORS notes …that MOD believe that developing a solution now, rather than leaving future generations to do so, is the responsible course of action. SCCORS notes however that there is a balance between avoiding leaving a legacy for future generations to deal with and committing future generations to take actions which they may not wish to take. In this respect it is noted … that the Geological Disposal Facility (GDF) is anticipated to be available at the earliest in 2040 …that storage facilities will be designed to hold waste for up to 100 years, to protect against any changes to the GDF timescales. It can be concluded that future generations will necessarily be involved in managing the current legacy of nuclear waste (SCCORS).

- Even if RCs can be transported, stored etc.…this still leaves a legacy issue (NI).

Technical Maturity

- Many significant technological achievements have been the result of a perceived commercial need and significant investment has often been made in order to get technology to a level of maturity at which it can be used, such as the advent of the PC. By comparison, such developments rarely happen by way of the pure research and development programmes of industry and the university sector. Secondly, during the period that work is delayed by the prospect of future developments, the submarines' infrastructure will degrade further possibly exacerbating the problem from that of its current state; this is a common thread of many legacy issues in the nuclear power industry. Thirdly, during this period much of the existing expertise and knowledge base will retire and/or will die.

Dismantling Option

- A wider range of comments were relevant to opportunities and risks linked to technology choice. These are summarised in Section 8 of the 2012 SDP Public Consultation Report [4.1.3].

- On the other hand, the reduced flexibility and delayed investment of the RC option results in greater risks in the face of budget constraints. The RPV option represents the best balance between making progress and reducing risk whilst leaving opportunities open. The PW option is the most intrusive but the complete process would be proven and removes liabilities earlier.

ILW Storage

- Siting processes for radioactive waste should …be able to accommodate change in response to future events (NI). Comments on risks are mainly concentred with the risk of GDF delays and its implications including for the desirability of flexibility. These are summarised in Section 10.2 of the Post Consultation Report (PCR). The main themes included the suggestion that the risk of GDF being unavailable seemed seriously underestimated and the consequences for communities hosting storage facilities was not thought through (RC option perhaps most vulnerable because they are less flexible).

- Some suggested that risks associated with the GDF availability meant that the programme start date should be delayed until the position was clearer, so that its location could be taken into account and any waste form constraints or opportunities were known.

- 2-POL covers consistency with policy frameworks and an OCF addresses policy risks, but there were comments on Scottish ILW policy in particular which are relevant to this criterion. These are summarised in Section 12.4 of the PCR. The main themes included the suggestion that common underpinnings might be expected between explicitly Scottish ILW policy and attitudes to military ILW leading to a conclusion that proposing ILW storage at Rosyth would be high risk.

Storage and Disposal

- The likelihood of appropriate technology development occurring … is low and uncertain. There are offsetting factors such as degradation in material condition and knowledge and expertise that are more certain and almost certainly more costly. The regulatory environment is likely to change in a more rather than less constraining way. All the experience over the 50 year history of the nuclear sector, is of the regulatory requirements and environmental requirements becoming more not less stringent. Therefore, we believe that the conclusions of the Technical Options Study in terms of discounting the RPV removal and storage option, remain valid (NI).

- Comments on Opportunity (Whole RPV Disposal) are summarised in Section 8.6 of the Post Consultation Report (PCR). The main themes includes the benefits of dose reduction (covered under 1-H&S), the loss of ability to segregate LLW/VLLW (covered under 2-POL), potential stakeholder issues with disposing whole RPVs, and the relative likelihood of it being available.

4.1.49. Discussion

4.1.50. Note that the opportunity element of this criterion could be in conflict with the IAEA waste management principle of intergenerational equity [4.1.4] which promotes the concept of dealing with issues in real time and not leaving them to future generations. However, government guidelines recognise that it may be appropriate to delay particular operations to benefit from new or developing technologies or from further development of existing best practice, or to take advantage of radioactive decay.

4.1.51. The fact that the risk register is a living document and that all of the risks are being managed in a professional manner suggests a degree of robustness to risk within the SDP. However, this is not easy to quantify.

4.1.52. Discussion is required on a number of issues, including:

- Are any of the current opportunities contained in the opportunities register considered important enough to influence the strategic direction of the SDP?
- Are there any new (as yet undefined) opportunities which should be considered at this stage?
- Are there any risks contained in the risk register considered important enough to influence the strategic direction of the SDP?
- Are there any new (as yet undefined) risks which should be anticipated and considered?
- Where does SDP stand in relation to the potential conflict between early and deferred initial dismantling?
- Are the two elements of this criterion (i.e. opportunities and risk) complementary or in conflict?
- What are the issues arising from the Public Consultation comments?
- Does this criterion discriminate between the options?

4.2. 2-POL: Compliance with Extant UK Policy and Strategy on Radioactive Waste Management

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

The revised text contains only minor changes. Some material has been moved into Annex A. Public consultation comments and assumptions have been included.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant changes were made to the 2-POL supporting data shown below.

The word "Extant" was added to the title of 2-POL. The 2-POL data shown below addresses the foreclosing of options, but it was agreed that this should be covered instead under Criterion 5-POL (Compliance with Extant UK Decommissioning Policy). Transport and the proximity principle are not addressed under this criterion, but are covered instead under 5-POL. SDP wastes will be covered under UK rather than Scottish Government policy. Advice from ONR and the EA indicates that radioactive waste arises at its point of generation, i.e. at the submarine dismantling yard.

4.2.1. This criterion addresses the ability of the options to comply with UK policy and strategy on radioactive waste management. It includes management of LLW and ILW arising from submarine dismantling. Note that de-fuelled submarines do not contain high level waste (HLW), which is therefore not addressed here.

4.2.2. Points of consideration include but are not restricted to the list shown in the table below, which were taken from the MCDA 2011 scoring workshop report [4.1.1].

4.2.3. **Table 4.2.1: Issues Relevant to Criterion 2-POL**

#	TOPIC	ISSUES
A	**Waste Hierarchy**	• Compliance with UK Policy and strategy: • Waste prevention. • Waste minimisation. • Reuse. • Recycling. • Disposal. • VLLW, ILW, LLW.
B	**Time**	• The onset of deterioration during interim storage could complicate the dismantling process leading to increased quantities of

#	TOPIC	ISSUES
		primary and secondary wastes including LLW.
C	**Storage times**	• The longer the storage periods. the greater the radioactive decay.

4.2.4. LLW in the UK is described in the LLWR waste acceptance criteria [4.2.1]. It is radioactive waste which has activities greater than those of Very Low Level Waste (VLLW) and with an alpha activity of less than 4 GBq per tonne and a beta/gamma activity of less than12 GBq per tonne.

4.2.5. ILW in the UK is radioactive waste which has activities greater than those of LLW, i.e. has an alpha activity of greater than 4 GBq per tonne and/or a beta/gamma activity of greater than12 GBq per tonne.

4.2.6. Data relevant to policy and strategy are presented below. More details are provided in Annex A (Section A2).

4.2.7. Assumptions

4.2.8. See Annex A, Section A19.

4.2.9. Data: UK Policy and Strategy

4.2.10. The *Policy for the Long Term Management of Solid Low Level Radioactive Waste Management in the United Kingdom* [4.2.2] provides a statement for Government Policy on the long term management of the UK's solid LLW. The policy amends or replaces relevant parts of the Review of Radioactive Waste Policy: Final Conclusions (Cm-2919) White Paper published in July 1995 [4.2.3].

4.2.11. This policy statement covers all aspects of the generation, management and regulation of solid LLW. Management of the UK's higher activity radioactive waste has been considered by CoRWM who presented their recommendations to Government on 31 July 2006 [4.2.4]. See Annex 2, Section A2 for more details.

4.2.12. Due to the large range of LLW types, government policy does not aim to be prescriptive but to provide a high level framework within which individual LLW management decisions can be taken flexibly to ensure safe, environmentally acceptable and cost-effective management solutions that appropriately reflect the nature of the LLW concerned.

4.2.13. The policy statement differentiates between the definitions for VLLW (low and high volume disposals) and the need for controls on the total volumes of VLLW in the high volume category being deposited at any one particular landfill site.

4.2.14. LLW Management Plans for the management of all radioactive waste, including LLW, must be developed by waste managers. All nuclear licensed sites should have a plan for the management of LLW holdings and predicted future arisings that is part of a wider integrated waste management strategy. Strategic Environmental Assessments (SEA) will be required by European Directive 2001/42/EC for certain plans and programmes and an environmental impact assessment may be required for projects under Directive 85/337/EC.

4.2.15. LLW management plans must take into account all current and anticipated future arisings of LLW and their radiological and non-radiological properties. Plans must be developed with regulatory and stakeholder involvement and take into account best practice. Generally, plans should be developed and agreed with regulatory bodies in advance of the production of new LLW.

4.2.16. The objective for LLW management plans should be to deal with potential arisings at the highest practicable level of this hierarchy. Some LLW has hazardous or toxic properties which must be taken into account in its disposal and incineration may be considered as a treatment or disposal option for some combustible LLW.

4.2.17. MOD's management strategy [4.2.5] explains that Scottish Government Policy for Higher Activity Wastes (HAW) (i.e. HLW, ILW and some LLW that is not suitable for disposal in the LLWR) is long term management in near-surface facilities, whereas in England and Wales it is geological disposal. However, Scottish Government Policy is not applicable to the waste produced from the dismantling of redundant nuclear submarines, if this was undertaken in Scotland.

4.2.18. The *UK Strategy for the Management of Solid Low Level Radioactive Waste from the Nuclear Industry* [4.2.6] is developed from UK policy. The aim is to provide a high level framework within which LLW management decisions can be taken flexibly to ensure safe, environmentally acceptable and cost-effective management solutions that reflect the nature of the LLW concerned. To deliver this aim, three strategic themes have been developed:

- The waste hierarchy (see Annex A, Section A2 for more details).
- The best use of existing LLW management assets.
- The need for new fit for purpose waste management routes.

4.2.19. UK ILW policy and strategy are not as well developed as the UK LLW policy and strategy. There are currently no disposal facilities in the UK for ILW and none will be available until at least 2040.

4.2.20. The three main recommendations of the 2006 report by the Committee on Radioactive Waste Management (CoRWM) [1.2] are listed below.

- Geological disposal is currently the best form of long term management for the UK's higher activity radioactive waste.
- There should be a commitment to the safe and secure interim storage of the waste during the period it will take to plan and construct the geological disposal facility.
- The UK should look to develop partnership arrangements, linked to appropriate involvement and benefit packages, with local authorities/communities as a means of securing facility siting.

4.2.21. Issues relevant to this criterion, taken from the 2004 UK Government statement on the decommissioning of nuclear facilities [4.2.7] are listed below.

4.2.22. The Government recognises that decommissioning operations may involve two or more separate stages spanning a number of decades. It may also be appropriate to delay particular operations to benefit from new or developing technologies or from further development of existing best practice, or to take advantage of radioactive decay.

4.2.23. The strategy should take into account all relevant factors…including minimising waste generation and providing for effective and safe management of wastes.

4.2.24. Strategies should harness the benefits of radioactive decay and should maximise the amount of materials suitable for re-use of recycling.

4.2.25. Through best practical means (BPM) strategies, the volume of radioactive waste created should be minimised, particularly the volume of ILW.

4.2.26. Public Consultation Issues

4.2.27. Public consultation raised a number of issues relevant to this criterion and these are summarised below.

ALARA

- The principles of ALARA means that dose/discharges should be minimised. This argues for RC separation.

Waste Management Hierarchy

- The use of the waste hierarchy tends to be used to promote recycling, but in the context of radioactive material, it is rarely possible to recycle all of the material. There is a…conflict between the potential environmental benefits to be gained from metal recycling and some important principles of radiological protection.
  - It breaches the principle to “concentrate and contain” radioactivity rather than “dilute and disperse” it throughout the environment.
  - It breaches the ALARA principles - all reasonable steps should be taken to protect people from radiation, even when emissions are below the legal limits. (NFLA and SCCORS).
- The principle of waste minimisation…should…be supported (NLFA).
- The extent to which an option minimises the amount of ILW should be considered (NI).

Deferral of Size Reduction

- Options which might avoid size reduction of RPV, with its consequent mobilisation of some of the radionuclides still present in the RPV, are intrinsically preferable to others. Such deferral may also leave options open for other disposal practices (SCCORS).
- In principle…double handling of waste should be kept to a minimum.

Proximity Principle

- Wastes should ideally be managed on-site where produced (or as near as possible to the site) in a facility that allows monitoring and retrieval of the wastes (NLFA).

Other Radioactive Waste Management Initiatives

- Other radwaste management initiatives should be accorded only "moderate" significance. If NDA was unable to deliver its aspiration for waste store consolidation, or Government were unable to deliver or the GDF falls through, there would be highly significant impacts on options for managing submarine ILW (NuLeAF).

Planning Policy

- The re-use or extension of existing facilities is likely to be a more publicly acceptable solution than the construction of new facilities. At Dounreay, the local objections to the LLW facility turned on the issue of encroaching onto previously undeveloped land, and in West Cumbria for the siting of new reactors, the public objected to the use of land which was not at Sellafield. As the two most recent examples in the UK, these demonstrate the problematic nature of Greenfield sites (issues which aren't exclusive to nuclear sitings, but common to most Greenfield planning applications) (NI).

Scottish Policy

- Scotland's political position on nuclear issues makes it untenable for Scotland to be involved any further than dismantling the 7 submarines already there.

- MOD are exploring the possibility that the GDF might be able to accept Reactor Pressure Vessel's (RPV) without them being cut-up, hence providing some preference for options which defer size reduction.

BAT

- The EA will require the constractor to use BAT (the implication is …"whichever options is chosen").

LLW Policy

- Dismantling must happen in order to adhere to the Government's solid LLW Policy and the "Presumption to Early Solutions" Principle contained therein.

MRWS

4.2.28. The timescales fro GDF mean there is "no need to rush" into dismantling. The dismantling timetable should be driven by disposal – right to left.

4.2.29. Discussion

4.2.30. All of the SDP options need to comply with UK policy and strategy. They need to satisfy the waste management hierarchy. The current hierarchy has LLW at its head, but it is logical to assume that it should also include ILW.

4.2.31. The main issues are listed below.

- Avoiding any unnecessary creation of wastes.
- Reducing waste arisings to a minimum by appropriate design and operation of the waste management processes and equipment.
- Making effective use of techniques such as waste characterisation, sorting and segregation, volume reduction and decontamination.
- Minimising the quantity of LLW for disposal by recycling.
- Minimising the quantity of ILW by decay storage (if applicable).

4.2.32. Discussion is required on a number of issues, including:

- Does the Do Minimum option comply with these policy and strategy requirements?
- Are any of the options in conflict with national LLW and ILW management policy and strategy?
- What are the issues arising from the Public Consultation comments?
- Are any of the options in conflict with the waste hierarchy?
- Does this criterion discriminate between the options?

4.3. 3-POL: Scope/Extent of Transportation of Submarines and Radioactive Waste

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

At the 2011 MCDA, it was agreed that there were different types of transport, like for example, transport of submarines by sea or transport of packaged waste by land. These are referred to as transportation sets. At MCDA 20122, the numbers of inter-site transport sets involving submarines, RCs, RPVs and waste packages was regarded as an acceptable measure of transport and the data provided in this section is based on this definition.

Other transportation data provided in the 2011 data report was deemed to be confusing and has been removed.

Public Consultation comments and assumptions have been added.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

Some changes were made to the 3-POL supporting data as a consequence of the workshops. LLW transportations (previously excluded) were included

in the revised text and the number of transportation "sets" for each option and the transportation scoring scales were amended accordingly.

The proximity principle was covered under this criterion only. The importance to the general public of transportation of waste was emphasised at the workshops.

4.3.1. This criterion addresses the scope/extent of transportation of submarines and radioactive waste (LLW and ILW). The scope includes transportations of whole submarines, RCs, RPVs and/or radioactive wastes, which may need to be transported by rail, road and/or sea between the sites used for dismantling, interim storage and disposal.

4.3.2. The emphasis is on transportation of ILW and LLW. Transport of other materials (e.g. VLLW, hazardous wastes) and submarine hulls to the shipbreaker's yard (after initial dismantling) are excluded from this criterion. Transportation of these other materials are common to all options and tend not to discriminate between the options.

4.3.3. Points of consideration include but are not restricted to the list shown in the table below, which were taken from the MCDA 2011 scoring workshop report [4.1.1].

4.3.4. **Table 4.3.1: Issues Relevant to 3-POL**

#	**TOPIC**	**ISSUES**
A	**Numbers**	• The numbers of individual movements of submarines, RCs, RPVs or packaged waste (referred to as transportation "sets").
B	**Distance**	• Overall distance of transported items.
C	**Objects**	• The complexity of objects (submarines, RCs, RPVs. packaged waste) to be transported and the associated transport mode (i.e. sea, rail, road) and requirements (e.g. dimensions and weight).

4.3.5. Assumptions

4.3.6. See Annex A, Section A19.

4.3.7. Data: Numbers of Inter-Site Transportations

4.3.8. The table below breaks down each option into its component sub-options. For each sub-option, the types and numbers of inter-site transportation "sets" are determined. The highest sub-option value is taken as the option value and these are indicated by the underlined numbers.

4.3.9. **Table 4.3.2: Numbers of Inter-Site Transportation Sets**

Category	Option #	Details of Transportations	TOTALS
0	#0	The Do Minimum option does not involve any transportations.	**0**
RC: 1D	#1D	• Whole submarines transported from Rosyth to Devonport. • Packaged LLW transported from the initial dismantling site to the LLWR. • Packaged ILW transported from the size reduction facility at Devonport to the GDF.	**3**
RC: 1R	#1R	• Whole submarines transported from Devonport to Rosyth. • Packaged LLW transported from the Initial Dismantling site to the LLWR. • Packaged ILW transported from the size reduction facility at Rosyth to the GDF.	**3**
RPV: 2D	#2D	• Whole submarines transported from Rosyth to Devonport. • Packaged LLW transported from the initial dismantling site to the LLWR. • Packaged ILW transported from the size reduction facility at Devonport to the GDF.	**3**
RPV 3D/4D	#3D/4D	• Whole submarines transported from Rosyth to Devonport • Packaged LLW transported from the initial dismantling site to the LLWR. • RPVs transported from Devonport to the interim store at the remote Commercial or MOD site. • Packaged ILW transported from the size reduction facility at the remote Commercial or MOD site to the GDF.	**4**
RPV: 2-4B	#2B (a)	• Packaged LLW transported from the initial dismantling site to the LLWR. • Packaged waste transported from the size reduction facility at Devonport to the GDF.	**2**
	#2B (b)	• Packaged LLW transported from the initial dismantling site to the LLWR. • RPVs transported from Devonport to Rosyth. • Packaged ILW transported from the size reduction facility at Rosyth to the GDF.	**3**
	#2B (c)	• Packaged LLW transported from the initial dismantling site to the LLWR. • Packaged waste transported from the size reduction facility at Rosyth to the GDF.	**2**
	#2B (d)	• Packaged LLW transported from the initial dismantling site to the LLWR. • RPVs transported from Rosyth to Devonport.	**3**

Category	Option #	Details of Transportations	TOTALS
		• Packaged ILW transported from the size reduction facility at Devonport to the GDF.	
	#3B/4B (a)	• Packaged LLW transported from the initial dismantling site to the LLWR. • RPVs transported from Devonport to the interim store on the remote Commercial or MOD site. • Packaged ILW transported from the size reduction facility at the remote Commercial or MOD site to the GDF.	**3**
	#3B/4B (b)	• Packaged LLW transported from the initial dismantling site to the LLWR. • RPVs transported from Rosyth to the interim store on the remote Commercial or MOD site. • Packaged waste transported from the size reduction facility at the remote Commercial or MOD site to the GDF.	**3**
PW: 5D	#5D	• Whole submarines transported from Rosyth to Devonport. • Packaged LLW transported from the initial dismantling site to the LLWR. • Packaged ILW transported from the interim store at Devonport to the GDF.	**3**
PW: 6D/7D	#6D/7D	• Whole submarines transported from Rosyth to Devonport. • Packaged LLW transported from the initial dismantling site to the LLWR. • Packaged waste transported from the size reduction facility at Devonport to the interim store at the remote Commercial site or MOD site. • Packaged ILW transported from the interim store at the remote Commercial site or MOD site to the GDF.	**4**
PW: 5-7B	#5B (a)	• Packaged LLW transported from the initial dismantling site to the LLWR. • Packaged waste transported from the interim store at Devonport to the GDF.	**2**
	#5B (b)	• Packaged LLW transported from the initial dismantling site to the LLWR. • RPVs transported from Devonport to the size reduction facility at Rosyth. • Packaged ILW transported from the interim store at Rosyth to the GDF.	**3**
	#5B (c)	• Packaged LLW transported from the initial dismantling site to the LLWR. • Packaged ILW transported from the interim store at Rosyth to the GDF.	**2**

Category	Option #	Details of Transportations	TOTALS
	#5B (d)	• Packaged LLW transported from the initial dismantling site to the LLWR. • RPVs transported from Rosyth to the size reduction facility at Devonport. • Packaged ILW transported from the interim store at Devonport to the GDF.	**3**
	#6B/7B (a)	• Packaged LLW transported from the initial dismantling site to the LLWR. • Packaged waste transported from the size reduction facility at Devonport to the interim store at the remote Commercial site or MOD site. • Packaged ILW transported from the interim store at the remote Commercial site or MOD site to the GDF.	**3**
	#6B/7B (b)	• Packaged LLW transported from the initial dismantling site to the LLWR. • RPVs transported from Devonport to the size reduction facility at Rosyth. • Packaged waste transported from Rosyth to the interim store at the remote Commercial site or MOD site. • Packaged ILW transported from the interim store at the remote Commercial site or MOD site to the GDF.	**4**
	#6B/7B (c)	• Packaged LLW transported from the initial dismantling site to the LLWR. • Packaged waste transported from Rosyth to the interim store at the remote Commercial site or MOD site. • Packaged ILW transported from the interim store at the remote Commercial site or MOD site to the GDF.	**3**
	#6B/7B (d)	• Packaged LLW transported from the initial dismantling site to the LLWR. • RPVs transported from Rosyth to the size reduction facility at Devonport. • Packaged waste transported from Devonport to the interim store at the remote Commercial site or MOD site. • Packaged ILW transported from the interim store at the remote Commercial site or MOD site to the GDF.	**4**
PW: 8D	#8D	• Whole submarines transported from Rosyth to the size reduction facility at Devonport. • Packaged LLW transported from the initial dismantling site to the LLWR. • Packaged waste transported from Devonport to the interim store at the NDA site.	**4**

Category	Option #	Details of Transportations	TOTALS
		• Packaged ILW transported from the interim store at the NDA site to the GDF.	
PW: 8B	#8B (a)	• Packaged LLW transported from the initial dismantling site to the LLWR. • Packaged waste transported from the size reduction facility at Devonport to the interim store on the NDA site. • Packaged ILW transported from the interim store on the NDA site to the GDF.	**3**
	#8B (b)	• Packaged LLW transported from the initial dismantling site to the LLWR. • RPVs transported from Devonport to the size reduction facility at Rosyth. • Packaged waste transported from the size reduction facility at Rosyth to the interim store on the NDA site. • Packaged ILW transported from the interim store on the NDA site to the GDF.	**<u>4</u>**
	#8B (c)	• Packaged LLW transported from the initial dismantling site to the LLWR. • Packaged waste transported from the size reduction facility at Rosyth to the interim store on the NDA site. • Packaged ILW transported from the interim store on the NDA site to the GDF.	**3**
	#8B (d)	• Packaged LLW transported from the initial dismantling site to the LLWR. • Packaged waste transported from the size reduction facility at Devonport to the interim store on the NDA site. • Packaged ILW transported from the interim store on the NDA site to the GDF.	**3**
9D	9D	• Whole submarines transported from Rosyth to Devonport. • Packaged LLW transported from the initial dismantling site to the LLWR. • RPV transported from Devonport to the interim store on an NDA site. • Packaged ILW transported from the NDA site to the GDF.	**<u>4</u>**
	9B (a)	• Packaged LLW transported from the initial dismantling site to the LLWR. • RPVs transported from Devonport to the interim store on an NDA site. • Packaged ILW transported from the NDA site to the GDF.	**<u>3</u>**
	9B (b)	• Packaged LLW transported from the initial dismantling site to the LLWR.	**3**

Category	Option #	Details of Transportations	TOTALS
		• RPVs transported from Rosyth to the interim store on an NDA site. • Packaged ILW transported from the size reduction facility on the NDA site to the GDF.	

4.3.10. The above table lists the numbers of transport sets within each option and highlights (underlines) the highest value of the various sub-options. These underlined values are shown in the summary table below.

4.3.11. **Table 4.3.3: Numbers of Inter-Site Transportation Sets for each Option**

Category (for info)	**Option**	**Description of Option**	**Number of Transport Sets**
Indefinite afloat storage	0	Do Minimum	**0**
RC	1D	Reactor Compartment (RC) separation at Devonport, with interim storage at point of waste generation at Devonport, and at a later date size reduction of ILW at Devonport before transfer to the proposed GDF.	**3**
	1R	RC separation at Rosyth, with interim storage at point of waste generation at Rosyth, and at a later date size reduction of ILW at Rosyth before transfer to the proposed GDF. (**OE Comparator only**)	**3**
RPV	2D	Reactor Pressure Vessel (RPV) removal at Devonport, with interim storage at point of waste generation at Devonport, and at a later date size reduction of ILW at Devonport before transfer to the proposed GDF.	**3**
	3-4D	RPV removal at Devonport, with interim storage at a remote MOD or commercial site and at a later date size reduction of ILW before transfer to the proposed GDF.	**4**
	2-4B	RPV removal at Devonport and Rosyth, with interim storage at one of the following: a remote MOD or commercial site, Devonport or Rosyth, and at a later date size reduction of ILW before transfer to the proposed GDF.	**3**

Category (for info)	Option	Description of Option	Number of Transport Sets
Packaged Waste	5D	RPV removal and size reduction to form Packaged Waste with interim storage at point of waste generation, all at Devonport.	**3**
	6-7D	RPV removal and size reduction to form Packaged Waste at Devonport with interim storage at a remote MOD or commercial site.	**4**
	5-7B	RPV removal and size reduction to form Packaged Waste at Devonport and Rosyth, with interim storage at one of the following: a remote MOD or commercial site, Devonport or Rosyth.	**4**
	8D	RPV removal and size reduction to form Packaged Waste at Devonport with interim storage at NDA site(s).	**4**
	8B	RPV removal and size reduction to form Packaged Waste at Devonport and Rosyth with interim storage at NDA site(s).	**4**
RPV	9D	RPV removal at Devonport with interim storage at NDA site(s).	**4**
	9B	RPV removal at Devonport and Rosyth with interim storage at NDA site(s).	**3**

4.3.12. **Whole Submarine Transportations**

4.3.13. Salvage and Marine Operations Integrated Project Team (S&MO IPT) were tasked by DISM SUSM to produce a top level options paper reviewing the methodologies available to support the potential movement of submarines around the UK. Their report concluded that the two principal methods would be heavy lift vessel and wet towing, but that additional work is required to produce an optimised transportation methodology [4.3.1].

4.3.14. Russia has experience of transporting (fuelled) nuclear submarines by heavy lift vessel. The first such transportation took place in 2005, with UK (S&MO IPT) as the technical lead. Note that none of the SDP transportations will involve fuelled submarines.

4.3.15. **RC Transportations**

4.3.16. The USA, Russia and France all have experience of transportation of nuclear submarine RCs.

4.3.17. **RPV Transportation**

4.3.18. The feasibility of transportation of RPVs has been addressed by Babcock [4.3.2] and Nuvia Ltd. [4.3.3]. The latter report acknowledges that since no new information has come forward since the 2004 BNFL report [4.3.4] and the 2010 Babcock Marine report [4.3.2], the conclusions of these reports remain valid. The former report [4.3.2] indicates that transportation of RPV packages is physically feasible as demonstrated by similar successful operations in the UK (WAGR heat exchangers), Germany (RPV from the Rheinsberg PWR WWER-70 reactor) and the US (RPVs from the La Crosse Boiling Water reactor, the Connecticut Yankee reactor, the Yankee Rowe reactor, and the Shippingport reactor). These involved loads which were longer and heavier than a submarine RPV and utilised road, rail and sea (barge) transportation for distances which ranged from several miles (UK) to 1100 miles (US). In some cases steel overpacks were used and the RPV was grouted inside the overpack.

4.3.19. The UK Used Fuel Flask (UFF) is a Type B flask (Design number GB/3337A/B(M)F), about 4 metre high, 2.4 metres diameter and weighs 74 tonnes, dimensions which are not too dissimilar to those of an RPV. The UFF may be useful analogue to the transportation of an RPV, recognising that the potential radiological hazard of an RPV is far lower than that of used fuel. Work has started on the design of a package for transport of whole RPVs.

4.3.20. **Packaged Waste Transportation**

4.3.21. Packaged LLW will be transported to the LLWR and packaged ILW to the GDF. There is previous experience of transportation of packaged LLW and ILW by road and rail in the UK and worldwide.

4.3.22. UK policy was and still is to store ILW at or near the point of origin. Hence there has been no incentive to develop overpacks for transportation of packages within the UK. Some designs of overpacks are available from RWMD but they still need to be manufactured and tested. Hence MOD may need to manufacture and test an overpack for transportation of the $3m^3$ boxes. Although this is relatively unknown territory for MOD, RWMD has the necessary SQEP resources to make this a low risk activity from both technical and regulatory perspectives.

4.3.23. It might be argued that packaged waste is at its most vulnerable during transportation. However, this is partly dispelled by a 2010 report [4.3.5] on transportation accidents and incidents. This report (together with the references in the report) contain descriptions of the number of accidents and incidents involving shipments of radioactive materials over the period 1958 to 2009. Many of these involve small packages containing radioisotopes, which are not relevant to the SDP. During 2009, 32 accidents and incidents occurred, 8 of which involved irradiated nuclear fuel flasks. None of these 32 reported events resulted in any significant radiation doses to workers or members of the public.

4.3.24. **Submarine Hull Transportation**

4.3.25. Once the ILW and LLW components and other materials have been removed, the submarine hull will be made safe and then transported by sea from the cut-out or dismantling site to the ship-recycling yard. If the RC has been separated then transportation may be more difficult as the unit will no longer be intact.

4.3.26. A submarine hull will probably be transported by single transfer to the ship-recycling yard. This mode of transportation will be common to all of the options and hence is not addressed in the table above.

4.3.27. Public Consultation Issues

4.3.28. Public consultation raised a number of issues relevant to this criterion and these are summarised below.

Avoid Transport where Possible

- The Proximity Principle argues against towing submarines with waste onboard (NFLA and widespread support among public).

- Transporting waste to NDA storage facility fails to meet the PP. Unnecessary transport of radioactive and other hazardous waste…is… opposed (NFLA).

- There is little information about the risks associated with transporting decommissioned submarines.

Relationship to ILW Storage Location

- Some support for POWG storage in order to avoid transport.
- The ability to safely transfer the RPV to the interim storage facility should be the determining factor in identifying the location for interim storage and the location for removing the RPV from the submarine.

- In order to ensure sustainability there should be a link between the sites chosen to dismantle the submarines and the location of proposed storage, recycling and disposal as transporting 100s of miles may not be the most environmentally friendly option.

- Economic and environmental implications of transporting the waste have not been adequately considered other than for the RC option.

- Full consideration of the potential impacts of transporting the waste (to an NDA facility)…. must be assessed before this option can be taken forward. (Copeland Borough Council)

Scoring

- It is unclear why the expert scoring workshop agreed that 2 sets of transportations should merit a score of 5 while 3 sets of transportations should merit a 6 (See Operational Effectiveness paper, PD-7).

- This closeness of scores (effectively across all options) has the effect of minimising the discriminatory impact of the transport criterion in the MCDA.

- This is potentially significant as it raises a question over the robustness of the conclusion that options involving ILW storage at the point of generation show no net advantage.

- Transport as a factor may be "double jeopardy" as the proximity principle is already implicitly included within "Compliance with UK Policy".

Mode

- Rail is preferred over road transport but it is noted that PWR2s may be too large (various local authorities made this response).

- Sea – Shipping movements cause disruption to the Torpoint ferry timetable. If radioactive material is being moved by sea the expected additional security and safety precautions have the potential to cause substantial disruption, depending on the frequency of the operation and when it takes place. (Torpoint Ferry Service).

Other

- It is important that the MOD recognises the strategic importance that improved rail connectivity has to the success of the Submarine Dismantling Project and to submarine maintenance work. The maintenance of high quality rail links with the rest of the network is a high priority for the Council. The Council would seek assurance that the rail links will remain a strategic national asset for at least the life of the project (Plymouth City Council).

4.3.29. Discussion

4.3.30. The total number of transport sets associated with each option is regarded as an indicator of the total number of miles travelled per option. The latter can only be determined once the locations of the initial dismantling site(s), Interim Storage Facility, Size Reduction Facility and the proposed GDF have been determined.

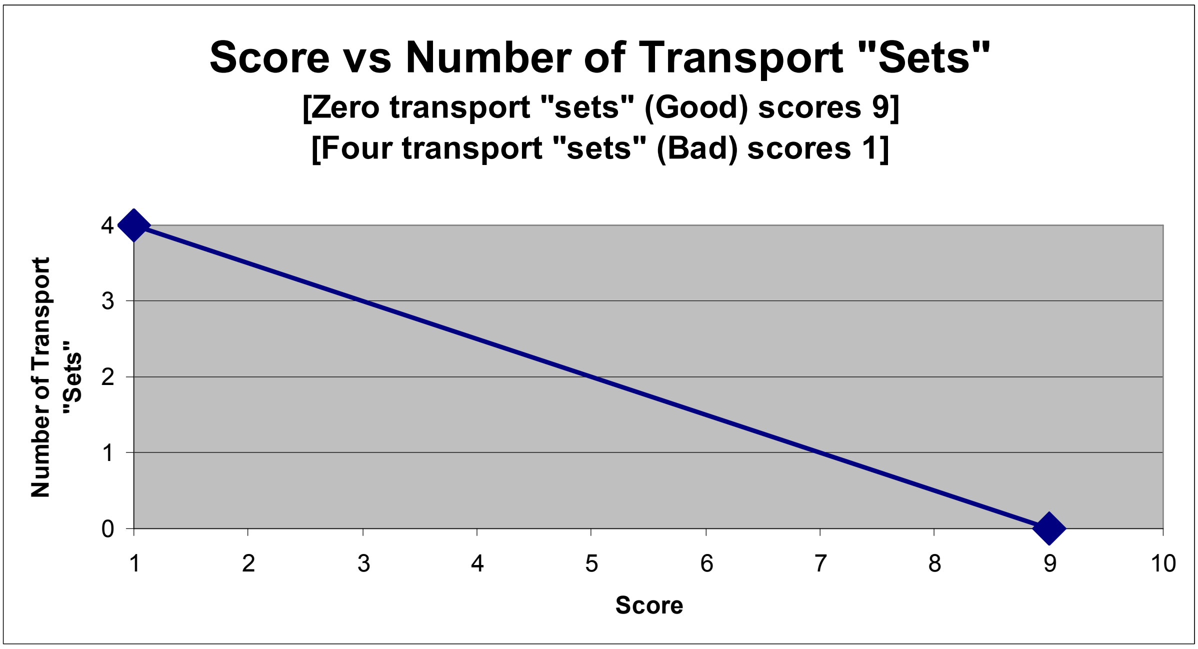
4.3.31. Approvals for inter-site transportation of NDA ILW boxes (e.g. $3m^3$ boxes) should be relatively straightforward, since such transportations are part of the UK strategy for the management of civilian nuclear industry waste.

4.3.32. Inter-site transportation of large items like RCs or RPVs are less common in the UK but approvals (at least for RPVs) may also prove to be straightforward.

4.3.33. Table 4.3.2 and 4.3.3 above indicates that the numbers of transport sets range between 0 (Do Minimum) and 4. There are only three values: 0, 3 and 4.

4.3.34. At the 2011 MCDA the numbers of transport sets was accepted as a measure of transport. The graph below plots the range of transport sets against scores. Thus zero transport sets is considered the best that can be achieved and is given the highest score. Four transport sets is considered the worse that can be achieved and is given the lowest score. Note that a linear scale is assumed.

4.3.35. **Figure 4.3.1: Score versus Number of Transport Sets (Linear Scale)**



4.3.36. Extrapolation of the above graph provides scores (x-axis) corresponding to the numbers of transportation sets (y-axis) and these are indicated below.

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

At the 2012 Scoring workshop, it was agreed that the scores contained in the figure above could form the basis for the scoring of the options. A non linear scale was also suggested and scores for both of these are summarised in the table below. Both sets of information were presented to the meeting but the actual scores were determined by the attendees.

4.3.37. **Table 4.3.4: Guidance on Scores**

Number of Transport Sets	Suggested Scores on Linear Scale	Suggested Scores on Non Linear Scale
0	9	9
3	6	5
4	3	1

4.3.38. Discussion is required on a number of issues, including:

- Is the total number of inter-site transportation sets for each option an acceptable indicator of the scope/extent of transportations?
- Should any of the transportations be weighted for scoring purposes?

- What are the issues arising from the Public Consultation comments?
- Does this criterion discriminate in a meaningful way between the options?

4.4. 4-POL: Unauthorised Access to Classified Materials during Dismantling, Storage and Transportation

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

No major changes have been made. Issues arising from Public consultation and assumptions have been added.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant changes were made to the 4-POL supporting data as a consequence of the workshops.

4.4.1. This criterion addresses the security of RCs, RPVs and packaged waste produced during the process of dismantling a submarine and during subsequent storage and transportation operations.

4.4.2. The criterion addresses issues relating to access by unauthorised persons to classified materials (e.g. submarine plant) and classified documentation (e.g. reports) which could lead to unauthorised disclosure of sensitive information.

4.4.3. The bilateral US-UK Mutual Defence Agreement (MDA) was signed by the respective governments in 1958 [4.4.1]. The MDA allows for an exchange of information and material on nuclear technology between the UK and US governments. Inadvertent disclosure would be prejudicial to the UK's international relations.

4.4.4. A classification system is in place to prevent unauthorised disclosure of the designs, technologies and materials addressed in the MDA [4.4.2]. The system is also intended to prevent the unauthorised disclosure of information related to trends in naval reactor design, which could be of value to others.

4.4.5. The system classifies submarine components and relevant information and this informs the level of security protection required. The higher the classification, the higher the level of security required.

4.4.6. Points of consideration include but are not restricted to the list shown in the table below, taken from the MCDA scoring workshop report [4.1.1].

4.4.7. **Table 4.4.1: Issues Relevant to 4-POL**

#	TOPIC	ISSUE
A	**Time**	• The length of time the material remains in a classified form that would allow deduction by unauthorised persons of original constructs and shapes. • This varies between options. Vulnerability is considered directly proportional to time (as defined above).
B	**Shape**	• The level and extent of destruction of original shapes during the dismantling process. This varies between options. The more shape destruction, the less the vulnerability to unauthorised disclosure.
C	**Transportation**	• The vulnerability of classified materials during inter-site transportation. • Vulnerability is considered directly proportional to the extent of transportations. • Note that the scope and extent of transport are covered under 3-POL.
D	**Location**	• Locating classified material on only one site is considered a less vulnerable option than locating it on multiple locations. • The extent of multiple locations varies between the options. • Currently not able to specify how many sites will be used. • Perception that MOD site are more secure than commercial sites.
E	**Access**	• The ease of accessibility to the site and the ease of direct access to classified materials.

4.4.8. Assumptions

4.4.9. See Annex A, Section A19.

4.4.10. Data

4.4.11. Security plans for submarine dismantling and waste transportation are not yet available.

4.4.12. An outline security plan for an interim MOD ILW store is contained in [4.4.3]. The main points are summarised below.

4.4.13. The study [4.4.3] assumes that a storage facility for ILW packages could be located on a number of MOD sites or on an external site. Security is regarded as a key consideration for any store siting option. In accordance with MOD's procedures, the contents of the store will be given a security classification commensurate with the contents of the waste packages.

4.4.14. The study addresses the security of an NDA approved $3m^3$ box inside the ILW store. It assumes that the ILW will be packaged into $3m^3$ boxes which will then be grouted until full. The lid will be welded in place forming a homogeneous sealed container. It may be that the nature of this package could allow a lower classification to be applied. Because the contents will not have been completely shaped destroyed, it is unlikely that the security classification of the box will reduce with time.

4.4.15. it may be possible to view the contents of the box by suitable radiography equipment. However, attempting to interrogate such packages by X-rays and attempting to extract the material from these boxes may not disclose sufficient data to justify a high security classification.

4.4.16. None of the boxes will contain Special Nuclear Material. The boxes will contain irradiated material and the gamma emissions from the Co-60 will emit radiation which will decrease with time. This radiation will result in dose rates external to the package which will decrease with distance and the amount of shielding between the box and the point of measurement.

4.4.17. The store may not necessarily be sited inside a secure MOD perimeter fence.

4.4.18. To maintain its original classification status, the ILW needs to be made secure from damage due to deliberate physical attack, theft or other authorised removal of contents. The ILW also needs to be made secure from theft or acquisition of classified information on the box and from unauthorised access to the ILW and the radiological threat to personnel that this could present. Threats from fire, seismic event, flood or aircraft impact are recognised through risk management but are not included in this study.

4.4.19. The study [4.4.3] identifies and discusses measures which could be included in a security strategy.

4.4.20. Public Consultation Issues

Weighting

- Safety should be weighted highest; environment and security also need high weighting. Cost must not be given undue weight and must not outweigh safety.

Storage

- Contingency plans for storage of ILW. A hundred years to maintain safety and security is a minimum; it should be longer.

Storage Site

- Security benefits were cited as a reason for supporting the NDA site storage option.
- A signficant number regarded the MOD site storage option as the only acceptable one for security reasons.

RC Separation

- Arguments for separating the Reactor Compartment to minimise the security risk.

4.4.21. Discussion

4.4.22. The scope of this criterion includes the work carried out during the survey and docking period (SADP), the de-equip, de-fuel and lay up preparations (DDLP), separation and size reduction of RCs, removal and size reduction of RPVs, packaging of waste and subsequent storage and transportation and disposal operations. These are discussed below.

4.4.23. The SADP and DDLP pre-dismantling activities, together with the separation of an RC and/or the removal of an RPV from a submarine will be conducted under secure MOD supervision on a Nuclear Licensed site with a high level of security. There will be differences associated with the timing of these operations. For example, removal of an RPV could be performed either immediately or after prolonged storage of an RC.

4.4.24. If the size reduction and waste packaging facility is also located on a Nuclear Licensed site under MOD supervision, a similarly high level of security would be enforced.

4.4.25. In the event of dual site dismantling, it is assumed that there will be equivalent security at both sites.

4.4.26. Shape destruction of classified materials prior to storage is desirable. The sooner this happens, the less the vulnerability of these materials to unauthorised persons.

4.4.27. The RC separation and storage option allows many of the internal submarine shapes to remain intact for prolonged periods, therefore this could be considered the most vulnerable option.

4.4.28. The RPV removal and storage options allow less of the internal shapes to remain intact for long periods, hence it may be possible to discern some information from them. This could be regarded as a less vulnerable option compared to the RC.

4.4.29. The RPV size reduction and storage options allow the waste to be immobilised and packaged, (but not completely shape destroyed) sooner than for the RC separation and RPV removal options. On this basis, the packaged waste options could be regarded as less vulnerable than RPV removal and storage options.

4.4.30. No matter which option is chosen, systems and procedures will be put in place to protect classified materials from unauthorised exposure. Recycling the LLW, possibly by smelting to produce metal ingots is currently being considered. It will be ensured that where required, classified LLW components are either shape destroyed and/or mixed with LLW from other submarines to minimise the vulnerability of these materials to unauthorised persons.

4.4.31. Security procedures will be put in place for the control of classified materials for all of the options. The costs of these will this be addressed within the Investment Appraisal.

4.4.32. It might be argued that the submarine components listed above are at their most vulnerable during transportation. However, this is partly dispelled by a 2010 report [4.3.5] on transportation accidents and incidents, reported under Criterion 1-POL. Risks will be partially mitigated during transportation by deployment of appropriate control measures such as MOD escorts.

4.4.33. As stated previously, there is considerable experience of transportation of packaged waste by road and rail in the UK and worldwide. For example, loads containing radioactive fuel are transported by sea from the UK on behalf of the civil nuclear industry. Russia continues to transport submarines and submarine RCs by sea.

4.4.34. It is assumed that the transportation security plan will include police/military escorts during transport and other measures to protect the submarine components.

4.4.35. The transport data contained in Criterion 3-POL may be relevant to this discussion.

4.4.36. Discussion is required on a number of issues, including:

- Assuming that security plans are put in place for each option, does this narrow the differential between the options?
- Does this criterion discriminate between the options?

4.5. 5-POL: Compliance with Extant UK Decommissioning Policy

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

The MOD Nuclear Liabilities Management Strategy has now been published and excerpts from this document have been inserted. Issues arising from Public consultation have been added.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant changes were made to the 5-POL supporting data as a consequence of the workshops.

The word "Extant" was added to the title of 5-POL. The flexibility inherent in the UK decommissioning policy was recognised. The best option was considered to be the one which provides the optimum balance between the various factors in the policy.

4.5.1. This criterion addresses the ease of compliance of the various options with UK decommissioning policy.

4.5.2. Points of consideration include but are not restricted to the list shown in the table below.

4.5.3. **Table 4.5.1: Issues Relevant to 5-POL**

#	TOPIC	ISSUE
A	**UK Decommissioning policy**	• Compliance with UK Policy. • Act in accordance with Government Policy, including decommissioning management of LLW and ILW.
B	**Waste consignment/ disposal strategy**	• Use of BPEO/BAT/BPM. • Dose to workers to be ALARP. • Dose to public to be ALARA. • Minimising environmental impact.
C	**Waste packaging**	• Packaging in such a manner that does not preclude disposal options for safe and effective long term waste management.
D	**Waste form**	• Avoidance of the creation of wastes in a form that forecloses options for safe and effective long term waste management.
E	**Time**	• Decommissioning to be undertaken as soon as reasonably practicable. • Justification of decommissioning timetable.

4.5.4. Assumptions

4.5.5. See Annex A, Section A19.

4.5.6. Data

4.5.7. The two main sources of UK decommissioning policy are the 1995 Command 2919 paper [4.2.3] and the 2004 amendment to Command 2919 [4.5.1].

4.5.8. Decommissioning of a nuclear building/facility in the UK context is interpreted within the context of the SDP as the dismantling of a nuclear submarine.

4.5.9. Command 2919 describes a 3 stage decommissioning strategy, which consists of de-fuelling immediately after reactor shutdown, dismantling buildings external to the reactor shield 5 to 10 years later and demolishing the reactor after 100 years after shutdown. Command 2919 also describes a variation on the 3 stage strategy, namely a safestore strategy, whereby active buildings are put under care and maintenance for about 30 years after shutdown. Arguments in favour of this variation are that it allows more time for radioactive decay and for further advances in technology and that it can be more cost effective. Arguments against are that late decommissioning leaves the physical decommissioning work to future generations; could lead to leakage of radioactivity; and sacrifices the opportunity of using the knowledge and experience of those who have worked on particular sites in the decommissioning process. Command 2919 concluded that in general the process of decommissioning nuclear plants should be undertaken as soon as reasonably practicable to do so, taking account of relevant factors. A decommissioning strategy needs to be drawn up by the operators and the timetable justified. Demonstration of the adequacy of the financial provision to implement the strategy needs to be provided.

4.5.10. It is interesting that Command 2919 mentions the MOD submarine dismantling project, stating that "MOD has based its long-term plans for the disposal of radioactive waste arising from the reactor compartments on the availability of the Nirex repository in about 2010".

4.5.11. According to the 2004 amendment to Command 2919 [4.5.1], the following needs to be considered.

- Decommissioning operations should be carried out as soon as reasonably practicable. The Government recognises that decommissioning operations may involve two or more separate stages spanning a number of decades. It may also be appropriate to delay particular operations to benefit from new or developing technologies or from further development of existing best practice, or to take advantage of radioactive decay.

- The strategy should take into account all relevant factors, assessing and presenting them in a transparent way underpinned by objective information and arguments. These include minimising waste generation and providing for effective and safe management of wastes.

- Decommissioning strategies need to take into account relevant developments in UK radioactive waste management policy.

- The Government considers that decommissioning strategies should seek to avoid the creation of radioactive wastes in forms which may foreclose options for safe and effective long term waste management.

- Strategies should harness the benefits of radioactive decay and should maximise the amount of materials suitable for re-use of recycling.

- Through best practical means (BPM) strategies, the volume of radioactive waste created should be minimised, particularly the volume of ILW.

- Decommissioning wastes should be packaged in a way that does not preclude disposal options.

- Operators may wish to bring forward operations to utilise existing skills or knowledge.

4.5.12. The document titled "*Ministry of Defence Policy for Decommissioning and the Disposal of Radioactive Waste and Residual Nuclear Material arising from the Nuclear Programme*" [4.5.2] states MOD's policy for decommissioning and disposal of radioactive waste and residual nuclear materials arising from defence activities. It emphasises that MOD is committed to act in accordance with Government Policy on Nuclear Material including that on decommissioning, management of LLW, and management of higher activity wastes.

4.5.13. The principal MOD requirements [4.5.2] are summarised below.

1. Produce and maintain a decommissioning and disposal strategy for the MOD's nuclear programme.
2. Ensure through the use of best practicable means (BPM) that due consideration is given to avoiding or minimising the generation of radioactive waste and residual nuclear material at every stage of any activity involving radioactive materials.
3. Ensure through BPM that risks and doses to people now and in the future are kept as low as reasonably practicable.
4. Ensure through BPM that harm to the environment, now and in the future is minimised as far as is practicable.
5. Ensure, from conceptual stage, that for all activities involving radioactive materials, the method of eventual disposal has been considered and resources identified for all waste that is held or will be generated in the future.
6. Conform, where reasonably practicable, to the Environment Agency's Radioactive Substances Regulation and Environmental Principles, follow the Environment Agency risk screening and appraisal methodologies and the Health and Safety Executive requirements on the treatment and interim storage of radioactive waste.

4.5.14. MOD has recently (September 2011) issued its first steps towards implementing its 2007 policy described in [4.2.5]. This strategy document provides the basis for a coherent approach to decommissioning and disposal across the defence nuclear programme. The strategy addresses the management and decommissioning and disposal of current and future MOD nuclear liabilities, including those associated with SDP.

4.5.15. [4.5.6] states that before any decommissioning, dismantling and disposal activities can commence, the regulators must be satisfied that these activities are necessary and safe, and that the risk to the public, workers and the environment arising from these activities are acceptable and As Low as Reasonably Practicable (ALARP) and that Best Available Techniques (BAT) are used.

4.5.16. The prioritisation of decommissioning is based on a range of factors that include: hazard reduction, safety, security, public and worker radiation dose, environmental impact and costs. The approach is to reduce hazards in a progressive, systematic and timely manner consistent with decommissioning as soon as reasonably practicable. Care and maintenance of site and facilities will be part of the considerations between cessation of operations and the start of decommissioning, recognising the potential worker radiation dose benefits. This involves making the facility safe and secure and placing it under routine surveillance.

4.5.17. In some instances, the MOD will need to consider decommissioning timescales in conjunction with other stakeholders. For example, VULCAN NRTE is reliant on the neighbouring Dounreay NDA site for services and there are benefits in co-ordinating decommissioning activities. The MOD, site owners and operators and the NDA will work closely to ensure the approach to decommissioning and disposal ensures a reduction in overall radiological and environmental risk and best value for money for the UK tax payer.

4.5.18. [4.2.5] states that MOD wastes will continue to be managed in accordance with the waste hierarchy and policy [see Refs 5 and 6 of [4.2.5].

4.5.19. Decommissioning activities will produce radioactive and non-radioactive wastes.

For reasons, including practicality and value for money, radioactive and non-radioactive wastes will be segregated and managed in a manner consistent with the waste hierarchy. The aims are to prevent, minimise, reuse, recycle and responsibly dispose of wastes in that order of preference.

4.5.20. Radioactive waste will be disposed of immediately unless there is no disposal route or there a benefit in decay storage in terms of worker radiation dose or transition from ILW to LLW.

4.5.21. Waste must be securely packaged for storage, transportation and for disposal.

4.5.22. The development and maintenance of the services that the MOD's industrial partners and the MOD's supply chain provide is of critical importance to the effective delivery of decommissioning and disposal. The MOD's performance programme initiatives support of the development and implementation of this strategy. The MOD's decommissioning an disposal activities have potential to be of concern to the communities in which they take place. The MOD will address this in accordance with establish policies and practices. The MOD understand the importance of these activities to local communities and will consider public engagement on a case by case basis taking account of Government policy and environmental and planning laws. The MOD will support the NDA on public consultation on issues that relate to the DNP.

4.5.23. All of the above indicates that MOD policy for the decommissioning of nuclear facilities is consistent with UK decommissioning policy.

4.5.24. Issues relevant to the SDP, taken from these sources, are discussed below. Additional information is provided in Annex A (Section A5).

4.5.25. Public Consultation Issues

4.5.26. Public consultation raised a number of issues relevant to this criterion and these are summarised below.

Radioactive Waste Inventory

- The 2010 Radioactive Waste Inventory has estimated the quantity of waste produced up to 2100 assuming a continuing nuclear-powered submarine programme. So there is no reason to rush into the disposal of waste from decommissioning submarines if it is assumed that this waste will continue to arise until at least 2100 (NFLA).

Deferred Dismantling

- NFLA agrees that indefinite afloat storage is not an acceptable option. However it notes in particular from the Environment Report conclusions that deferring the dismantling of the Reactor Compartments or Reactor Pressure Vessels would allow the radioisotopes to decay naturally over time. A significant reduction could be expected in gamma emissions from the decay in the short-lived isotopes within the RPV, such as Cobalt 60. This in turn would reduce the amount of shielding needed in the size reduction facility. However, the activity of longer lived isotopes such as Iron 55 and Nickel 63 will only fall slightly, so the quantities of ILW would remain largely unaffected for many decades (See

Section 7 of the reference [4.5.4] (NFLA).

Future Generations

- MOD may wish to consider the issues which were taken into account in setting Scottish Government Policy which related to the balance between leaving burdens for future generations and leaving future generations the freedom to make choices (SCCORS).

- Intergenerational equity will be a key consideration for the (Scottish) Implementation Strategy along with the following issues:

  - What research and development may be needed to deliver the Implementation Strategy.
  - How new innovations and technology will be considered to inform future decisions; skills and experience can be maintained over long timescales.
  - How best practice and experience elsewhere in the World is considered. (Excerpt from Scotland's Higher Activity Radioactive Waste Policy 2011) [4.5.5].

4.5.27. Discussion

4.5.28. All of the SDP options will need to comply with all relevant UK policy and strategy issues and guidelines relevant to the decommissioning of nuclear submarines. The MOD policy documentation referenced above highlights MOD's commitment to complying with all applicable policy, strategy and guidelines relevant to the decommissioning of nuclear submarines.

4.5.29. The Do Minimum option does not comply with the UK policy stated above, that decommissioning and disposal operations should be carried out as soon as is reasonably practicable.

4.5.30. Discussion is required on a number of issues, including:

- Does the Do Minimum option comply with the UK decommissioning policy?

- Are any of the options in conflict with the national decommissioning policy and strategy?

- How well do the different options balance the various policy considerations and policy objectives?

- What are the issues arising from the Public Consultation comments?

- Does this criterion discriminate between the options?

4.6. 1-OP: Impact on the Maritime Enterprise Impact and Wider MOD Operations

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011

DATA REPORT.

Considerable amendments have been made to this section.

The scope of 1-OP has been clarified to avoid duplicating analyses that properly sits within the WLC model and Investment Appraisal. It is important that consideration of this criterion is confined strictly to impacts on military capability or operational effectiveness that cannot be mitigated by financial means. Thus this criterion does not address the coherence of options with strategic initiatives (such the Maritime Change Programme) that are focussed upon cost savings to MOD as such coherence is properly represented within the Investment appraisal.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant changes were made to the 1-OP supporting data as a consequence of the workshops.

It was agreed that the focus of this criterion should be the impact on military operations, ignoring financial aspects which are covered in the cost model. Changes in military capability were considered by some to be completely covered by the cost model, but some were of the opinion that changes in military capability are not simply cost issues.

4.6.1. This criterion addresses the non financial impact of the SDP options on the MODs Maritime Enterprise and the wider MOD operations.

4.6.2. This criterion relates to the impact of each of the options on the military capability and operational effectiveness of MOD. It is concerned with impacts which cannot be mitigated solely by expenditure increases.

4.6.3. This criterion does not address the coherence of options with strategic initiatives and delivery of programmes or commercial frameworks such as the Maritime Change Programme, (MCP), where the purpose of such initiatives is purely cost saving – as this I properly addressed within the Investment appraisal.

4.6.4. The principal activities to be undertaken under SDP are listed below and the potential impacts identified. These were taken from the 2011 MCDA scoring workshop report [4.1.1].

4.6.5. **Table 4.6.1: Issues Relevant to 1-OP**

#	TOPIC	ISSUES
A	Berthing	• The more (and longer) LUSMs are stored afloat, the greater the potential impact on dockyard operations and on the berthing requirements for the rest of the fleet. • There may be a requirement for extended berthing capacity to cope with the larger Vanguard class submarines. • Relevant data include the numbers of submarines will need to be stored afloat, their durations and their impact on dockyard operations. • Options which free up berthing space (compared to other options) should score relatively higher under this criterion and vice versa.
B	Physical Space	• Competition for physical space at the dockyards to accommodate facilities such as dismantling and/or ILW size reduction and storage could impact adversely on the construction of other fleet facilities at MOD sites, including the initial dismantling dockyards. • Options which require less physical space compared to others should score relatively higher under this criterion and vice versa.
C	Business Cases	• Business Cases for future submarine classes and supporting infrastructure or other related programmes must address disposal and decommissioning costs, and wider sustainability issues. • Options which adversely impact (compared to other options) on these Business Cases should score relatively lower under this criterion and vice versa.
D	Fleet Operations	• Different options may have different impacts on Fleet operations. • Examples of adverse impacts include delays to the production of future classes of submarines, physical lack of berthing space and (to a lesser degree) the requirement for escorts for submarines being transported between dockyards. • Options which adversely impact (compared to other options) on fleet operations should score relatively lower under this criterion and vice versa.

4.6.6. Subject-Matter experts (SMEs) will set the scene and lead the dialogue, by provision and discussion of the following:

- Overview of berthing capacity issues for LUSMs and future classes of submarines, including the requirement for extended berthing capacity to cope with the larger Vanguard class submarines.

- Overview of the details of Successor programme and the Business Cases for future submarine classes.

- Overview of relevant fleet operations which could be impacted by the SDP.

- Lead the discussion on the relevance to the SDP options to the issues identified above and identification of the positive and negative impacts of the main SDP options on the above criteria.

- Discussion on whether this is a discriminating criterion.

4.6.7. Assumptions

4.6.8. See Annex A, Section A20.

4.6.9. Data

4.6.10. It was suggested at the March 2011 MCDA Criteria Workshop that since siting of interim store is an issue relevant to this criterion, data on the footprint of the waste store could be a useful input to this discussion. The information contained in [4.6.1, 4.6.2 and 4.6.3] is summarised in Annex A (Section A6) and provides information on the footprints of the various types of stores. These are discussed below.

4.6.11. The store will contain either RCs, RPVs or packaged waste. If the latter, the store will contain waste streams 7G104 (neutron activated long lived ILW) and 7G102 (neutron activated short lived ILW which becomes LLW after a period of at least 30 or so years). Waste stream 7G102 will be disposed of at the LLWR and waste stream 7G104 at the proposed GDF.

4.6.12. The evolution of the store is still at an early stage and only very limited site specific details are available. The calculated footprints for the various stores are shown in Annex A Section A6.

4.6.13. The MDAL assumption is that the storage areas shown below are required:

4.6.14. **Table 4.6.2: Storage Surface Areas**

Type of Store	**Surface Area Required**
Reactor Compartment	11,600 m^2.
Reactor Pressure Vessel	801 m^2.
Packaged Waste	2,200 m^2.

4.6.15. It is fairly intuitive, that storage of an RC will require the highest surface area of the three options, since a large section of the submarine is involved for this option. It is not so intuitive that packaged waste will require more storage space than RPVs.

4.6.16. The assumed stacking height for an RPV is 4 metres. The 1.2 high metre NDA boxes are stacked 3 high, resulting in an overall height of 3.6 metres. Therefore the stacking heights for both options are similar.

4.6.17. The fourteen packaged waste boxes will be stacked in 14/3 = 4.7, rounded up to 5 columns. The surface area required for one column is ca. 2.9 m^2 and for 5 columns is ca. 14 m^2. This compares with a surface area requirement of 3.6 m^2 for an RPV.

4.6.18. The different surface area requirements is why packaged waste will require more storage space than RPVs. This difference is a reflection of the different packing fractions for the two options. Initial dismantling, size reducing and packaging produces a waste volume which is greater than the original volume of the RPV.

4.6.19. There is no previous experience of storing submarine RCs or RPVs in the UK but there is considerable experience (within the civil nuclear programme) of storing packaged waste.

4.6.20. There is international experience in the US, Russia and France of storing submarine RCs.

4.6.21. Public Consultation Issues

4.6.22. Public consultation raised issues relevant to this criterion as summarised below.

RC Storage at Rosyth

- One criteria – Impact on Maritime Enterprise – meant that storing all 27 Reactor Compartments at Rosyth received a low score, because the footprint of the RC interim store would be comparatively very large (ca.11,600 m^2). Locating such a store at Rosyth would have an adverse effect on the ability to decommission or re-develop Rosyth, which in turn could have a negative impact on the maritime enterprise (NFLA).

Weighting

- There were only a small number of other comments which explicitly addressed the impact on the MOD operations, although many more commented on the impact on alternative uses (PCR Section 12.5). The clear implication of some comments is that the weighting on this criterion should be low compared to (for instance) the weighting on safety and environmental impacts.

4.6.23. Discussion

4.6.24. An RC interim store requires the largest footprint of the three options. There is no previous UK experience but there is international experience of storing RCs.

4.6.25. An RPV interim store requires the least storage space. There is no UK or international experience of storing multiple separated submarine RPVs.

4.6.26. A packaged waste interim store requires about three times more storage space than the RPV store. There is considerable UK and international experience of storage of packaged ILW.

4.6.27. Other issues of relevance under this criterion include not exceeding berth capacity for LUSMs, and possibly the requirement for extended berthing capacity to cope with the larger Vanguard class submarines.

4.6.28. The successful implementation, to time and cost of a programme to dismantle legacy submarines and manage the waste arisings in line with national strategy and with minimum impact on the environment should improve the overall sustainability of the submarine enterprise and de-risk the business cases for Successor and MUFC in terms of sustainability and disposal costs.

4.6.29. Discussion is required on a number of issues, including:

- Which of the issues above cannot be mitigated by increased expenditure? This should act as a filter to further consideration within the MCDA.
- How does the SDP need to support MOD's wider Maritime Programme?
- Discussion on berthing capacity issues for LUSMs and future classes of submarines, including the requirement for extended berthing capacity to cope with the larger Vanguard class submarines.
- Discussion on relevant fleet operations which could be impacted by the SDP.
- Discussion on how a successful SDP improve the sustainability of the submarine enterprise and de-risk the business cases for Successor and MUFC.
- Discussion on the relevance of the storage surface areas required for the three main options to this criterion. Note that the storage surface area is also of relevance to 4-ENV and 5-ENV.
- Issues arising from Public Consultation.
- Does this criterion discriminate between the options?

4.7. 2-OP: Flexibility of Dismantling Approach to Managing Future Classes

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

Information on future submarines has been added.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant changes were made to the 2-OP supporting data as a consequence of the workshops.

It was agreed that the focus of this criterion should be on the flexibility of the options to dismantle existing and future classes of submarines, including PWR3s.

4.7.1. This criterion addresses the degree to which the future classes of submarine (e.g. Astute and Successor (SSBN (F)) may be accommodated within the dismantling process. While the current approvals do not include disposal of Astute class or Successor submarines, the project is required to retain the flexibility to become "future submarine capable", namely that the dismantling facilities will be sized and flexible enough to accommodate future classes of submarines.

4.7.2. The criterion addresses the flexibility of the dismantling approach to managing future classes of submarines. SDP includes PWR 1 and PWR 2 reactors in its programme. The issue is whether the dismantling strategy chosen for decommissioning of PWR 1 and PWR 2 reactors is applicable to the PWR3 reactors of future submarines.

4.7.3. Points of consideration include, but are not restricted to, the list below:

4.7.4. **Table 4.7.1: Issues Relevant to 2-OP**

#	**Topic**	**Issue**
A	Future Classes	• The scope of SDP encompasses 27 submarines but excludes Astute, Successor and MUFC. • Relevant data on PWR 1, PWR2 and PWR3 desirable. • How easily can these classes be accommodated by different SDP options.
B	Reactor Design	• Can the facilities procured for any one option be readily extended to accommodate future reactor designs? • What impact will the SDP approach and the facilities used for dismantling have on the design of future classes of submarines? • Conversely: What impact will the design of future classes of submarines have on SDP approach and the facilities used for dismantling? • What is the bearing of newer reactors, (which are being designed to go through life without refuelling), on the different options.
C	Timing	• Future classes may become easier to dismantle due to the existence of better records, and their designs should take account of the whole lifecycle of the submarine, including dismantling. What bearing might this development have on the different options? • Conversely, the existing size reduction and packaging facility may be past its useful life when Successor comes out of service and a new facility may be required.

#	Topic	Issue
D	Uncertainties	• Some options commit SDP to design decisions potentially before the design details of Successor or MUFC are known. Timing and sequencing will have a bearing on the ability of an option to dismantle these future classes.

4.7.5. Subject-Matter experts will set the scene and lead the dialogue, by provision and discussion of the following:

- Explanation of the relevant attributes of future classes of submarines and how they compare with existing submarines.
- Information to allow discussion of the impact of an RC/RPV with different dimensions/activities on SDP processes such as dismantling, storage and transportation.
- Identification of any options which cannot be used for the dismantling of future classes of submarines.
- Discussion on whether this is a discriminating option.

4.7.6. Assumptions

4.7.7. See Annex A, Section A20.

4.7.8. Data

4.7.9. The table below lists the type of data which would be useful when comparing current and future submarines.

4.7.10. **Table 4.7.2: Comparative Dimensions of Current and Future RPVs**

Attribute	PWR1	PWR2	PWR3
RPV Mass RPV Height RPV Width RPV Length RPV Volume RPV External Dose	**Data will be discussed verbally by relevant SMEs at the workshop.**		
RC Mass RC Height RC Width RC Length RC Volume RC External Dose	**Data will be discussed verbally by relevant SMEs at the workshop.**		

4.7.11. Public Consultation

4.7.12. Public consultation raised a number of issues relevant to this criterion and these are summarised below.

Through-Life Design Strategy

- An integrated strategy to achieve the optimum end of life plant configuration may significantly reduce risk for future submarines and achieve a better overall safety justification for the defueling, layup and dismantling stage. There is potential for even more substantial gains if the proposed dismantling solution could be integrated with the design of future submarine classes, such as the future SSBN successor design that is taking place at present. Such a complete through-life design strategy from the outset would offer future risk reduction and cost benefits at the dismantling stage (NI).

Solve Waste Problems before Building New Submarines

- The Nuclear Submarine Forum argued that it was irresponsible and unethical to build new submarines before a solution had been found for how to deal with the radioactive waste they would generate (NFLA).

- Because we cannot be certain that a solution to the nuclear waste problem is feasible it would be unethical to create further waste. NFLA will therefore, continue to press the MOD not to order any further nuclear powered submarines (NFLA).

4.7.13. Discussion

4.7.14. The scope of the SDP encompasses 27 submarines, 23 of which are PWR 1s and 4 are PWR 2s. The specific attributes relevant to this discussion could include RPV mass, volume, construction materials, neutron flux, extent of neutron activation, concentrations and distribution of key radionuclides (e.g. Co-60, Ni-59, Ni-63) and others. See Table 4.7.2 above.

4.7.15. If the specific attributes of future reactors are not as onerous (e.g. substantially decreased radiation doses, smaller dimensions etc.), or are comparable with those of PRW 1 and/or PWR 2 reactors, this could generate a high degree of confidence that a similar dismantling strategy for future submarines could be deployed.

4.7.16. It is speculated that future classes of submarine are likely to become easier to dismantle. For example, records for new submarines should be better than those for legacy submarines and future designs should take account of the whole lifecycle of the submarine, including dismantling.

4.7.17. It may be that when Successor comes out of service, existing facilities (e.g. size reduction and packaging facility) could be past their useful life and a new facilities will be required.

4.7.18. It is noted that newer reactors are being designed to go through life without refuelling. It is not clear what the significance of this is to this criterion.

4.7.19. Some options (e.g. RPV removal, size reduction and storage as packaged waste) will commit the SDP to design decisions (e.g. on the Size Reduction Facility) potentially before the design details of Successor or MUFC are known. Timing and sequencing may well be key differentiators between options.

4.7.20. This criterion may behave similarly to flexibility towards opportunities as discussed under Criterion 1-POL.

4.7.21. Discussion is required on a number of issues, including:

- How do the existing classes of submarine compare to future classes.
- What are the principal differences?
- What (if any) is the significance of newer reactors being designed to operate through life without refuelling.
- How flexible are the various options to the dismantling of future classes of submarines?
- Potential impacts of SDP on design of future reactors and of design of future reactors on SDP. Note that improving future submarine or reactor designs for the purposes of dismantling is covered under 4-OP (Transferable Dismantling Knowledge).
- What issues arise from Public Consultation?
- Does this criterion discriminate between the options?

4.8. 3-OP: Threat to Skill and Experience Set

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

Issues arising from Public Consultation have been added and assumptions have been included.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant changes were made to the 1-OP supporting data as a consequence of the workshops.

It was agreed that the focus of this criterion is on the skills and experience of people, whereas the focus of 4-OP is on knowledge.

4.8.1. This criterion addresses the issue that first hand knowledge of the design, maintenance and operation of nuclear submarines will be lost over time to the dockyards. Simultaneously, the dismantling programme may put pressure on potentially scarce specialist skills or conversely, help to create new skills.

4.8.2. Points of consideration include, but are not restricted to the list below:

4.8.3. **Table 4.8.1: Issues Relevant to 3-OP**

#	Topic	Issue
A	Loss of operational knowledge	• Some options involve deferring dismantling for a considerable length of time. • With the passage of time, memories fade. • What are the implications of loss (or a gradual decrease) of the current knowledge base held by operational staff?
B	Availability of SQEP	• How difficult would it be to acquire sufficient SQEP from the wider nuclear community to adequately perform submarine dismantling. • How might SQEP availability vary between sites? • Could SDP impact adversely on the availability of SQEP to undertake other tasks associated with the submarine enterprise?
C	Future nuclear skills	• For dismantling activities occurring over the longer term, is there an opportunity to take advantage of future skills and expertise advances developed elsewhere within the nuclear industry, nationally or internationally? • Will the SDP contribute to the maintenance of a SQEP base in the UK?

4.8.4. Assumptions

4.8.5. See Annex A, Section A20.

4.8.6. Data

4.8.7. It was suggested during the 2011 MCDA criterion workshop that for discussion purposes approximately 100 specialist nuclear posts would be required for the full dismantling of a submarine. This includes the removal of plant, through to the operation of the Size Reduction and Packaging Facility and preparation for off-site transport of waste.

4.8.8. Public Consultation Issues

4.8.9. Public consultation raised a number of issues relevant to this criterion and these are summarised below. Most relate to synergies with other work. There were also suggestions that the MOD should set SDP more clearly within a wider strategic commitment to submarine and other MOD work at Devonport, so that the community can clearly see a strategic benefit to offset the perceived problems associate with host ILW stores in particular. Local authorities also talks in term of needing a “strategic partnership” before agreement could be reached.

RPV Storage

- The main arguments for the RPV storage option…include good fit with current skills available within the dock yard.

Packaged Waste

- The main arguments *for* the packaged waste option…the development of technology and skills happens early in the programme, complete process proven early.

Devonport

- The main arguments for the use of Devonport for dismantling… refit work has synergies with dismantling and Devonport already has extensive skills and experience in submarine work.

Ship-breaking at the Dismantling Site

- There are benefits in breaking the submarines at the dismantling site. The skills and hazardous waste disposal routes already exist.

4.8.10. Discussion

4.8.11. This criterion assesses the likely availability of the required skills at the time that the dismantling activities will be undertaken. In general, the longer dismantling activities are delayed, the greater the risk that knowledge of existing processes and the industrial skill set will be lost.

4.8.12. For example, RC separation and storage have been implemented in the USA, France and Russia. Therefore, skills exist in other countries for the preparation of RCs for storage. Although there is no direct experience of RC separation and storage in the UK, there is a considerable body of knowledge at the proposed dismantling sites. This includes personnel who maintain and operate submarines (and in particular the specific submarines addressed in the SDP scope of work). This experience will be invaluable in the preparation of the RCs for interim storage. If RC dismantling is delayed by a number of years, this current operator knowledge and experience of the construct of nuclear submarines and their reactor systems may be lost. In the event of deferred dismantling, it will therefore be essential to maintain detailed records of each individual submarine, since suitably qualified and experienced personnel skilled in the maintenance of submarines would no longer be available.

4.8.13. Significant use of the existing skill set would be made during the removal of the RPVs, and preparation for interim storage. This skill set could be lost if RPV removal is delayed by a number of years. However, because there is no existing experience of size reduction of RPVs within the submarine community, delays to the size reduction programme would not have an impact on the required skill set.

4.8.14. Early dismantling and storage as packaged waste takes advantage of the existing knowledge and experience of SQEP within the UK and further afield. Early dismantling would allow the knowledge base (e.g. on the status and operational history of submarines) of operational staff to be meaningfully utilised.

4.8.15. There are some activities, (e.g. waste characterisation and design of decommissioning and dismantling processes) where specialised local knowledge and experience would be very useful. However, waste characterisation skills may well be available from the civil nuclear industry and the impact of delayed dismantling will probably be minimal. The impact of delayed dismantling on the skill set required to design the submarine decommissioning process will probably depend on specific technical issues and more data will be required to fully understand this impact.

4.8.16. It should be recognised that experience may exist elsewhere within the nuclear industry which could be readily transferred to the submarine reactors. This viewpoint was expressed during the original ISOLUS options study [4.8.1], in which it was stated that delaying the final dismantling work would make it possible to take advantage of future skills and expertise advances developed elsewhere within the nuclear industry, including internationally, in the intervening period.

4.8.17. Discussion is required on a number of issues, including:

- Will there be a significant threat to the skill and experience set if a time-deferred option was chosen?
- Will each of the proposed dismantling sites be able to acquire sufficient SQEP to adequately perform submarine dismantling?
- What are the issues from Public Consultation?
- Does this criterion discriminate between the options?

4.9. 4-OP: Transferable Dismantling Knowledge

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

This section has been re-written to reflect additional information on overseas dismantling programmes. Issues related to Public Consultation have been addressed and assumptions have been added.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant changes were made to the 1-OP supporting data as a

consequence of the workshops.

It was agreed that the focus of this criterion is on knowledge, whereas the focus of 3-OP is on people.

4.9.1. This criterion covers the beneficial exchange of knowledge within MOD and within the UK nuclear enterprise.

4.9.2. The criterion also addresses the beneficial exchange of knowledge to overseas organisations responsible for submarine dismantling.

4.9.3. Points of consideration include, but are not restricted to, the list below, taken from the 2011 Data Report .

4.9.4. **Table 4.9.1: Issues Relevant to 4-OP**

#	Topic	Issue
A	Knowledge Exchange within MOD	• The knowledge gained by MOD during SDP may be transferable to the design of future reactors. • Conversely, the knowledge gained by MOD during design of future reactors may` be transferable to the SDP. • What is the potential benefit to the MOD's maritime and nuclear enterprises of sharing knowledge acquired during submarine dismantling? • Conversely, what is the potential benefit to SDP of sharing knowledge acquired during the MOD's maritime and nuclear enterprises?
B	Knowledge Exchange with other UK organisations	• What is the potential benefit to the UK's nuclear enterprises (public and private) of sharing knowledge acquired during submarine dismantling? • Conversely, what is the potential benefit to SDP of sharing knowledge acquired from the UK's nuclear enterprises (public and private)?
C	Knowledge Exchange Overseas	• What is the potential for mutual benefit through information exchange with overseas Governments (e.g. France, US, Russia) responsible for submarine dismantling?

4.9.5. Assumptions

4.9.6. See Annex A, Section A20.

4.9.7. Data

4.9.8. No data is considered necessary for discussion of this criterion.

4.9.9. Public Consultation Issues

4.9.10. Public consultation raised a number of issues relevant to this criterion and these are summarised below.

- Consultation resulted in comments on the benefits of making use of lessons learned from SDP in the design of new boats. Although there were a range of observations relating to overseas practice and its applicability in the SDP context, there were no direct comments on the benefits to the MOD of being able to share experience. Having said which, it might be inferred that some comments implied that the MOD could benefit (presumably in risk and cost terms) from following the French practice.
- Future classes could be designed with an agreed dismantling strategy in mind. An alternative view was that although flexibility to deal with future classes would be useful, it should not be given priority over finding the best solution for current classes.
- …comments referred to the opportunities to learn lessons which could be applied to the design of future boats… the opposite position was expressed that SDP was only acceptable if such information from SDP was not used in this way.
- There were a range of comments on overseas practice, including the following.
    - MOD should ensure it learns the lessons from countries already dismantling submarines.
    - If other countries use RC separation, why is the UK doing something different?
    - France started by storing separated RCs but is now going to process them into a form compatible with eventual waste disposal.
    - American practice is a simple, pragmatic approach which avoids complex project risk.
- See also the comment from the Nuclear Institute contained in para 4.7.12.

4.9.11. Discussion

4.9.12. What is the potential for each of the main options, for mutual benefit through information exchanges with designers of future submarines, other MOD organisations, the UK nuclear industry and overseas Governments responsible for submarine dismantling?

4.9.13. Transfer of knowledge to and from the submarine design community is considered mutually beneficial. The timing of the imparted knowledge is important. For example, SDP information imparted before detailed submarine design work is undertaken will probably be more valuable than information shared once the submarines have been manufactured.

4.9.14. Transfer of knowledge to and from the UK civil nuclear industry could be beneficial to both parties. For example, if MOD is required to construct a new interim store, any assistance on the design, construction, operations and decommissioning which the civil nuclear industry could provide, would be helpful.

4.9.15. Although there is considerable experience in other countries (i.e. US, France, Russia) of RC separation, no other countries are currently implementing RPV removal or packaged waste options which involve size reduction of an RPV.

4.9.16. France is expected to embark on an RC de-planting (including RPV removal) programme (known as 'Level 3' Decommissioning) followed by disposal of waste at the Centre de l'Aube radioactive waste disposal facility. It is understood that Russia has facilities for RPV removal but no details are available on when they would be put to use. Some interchange of information between the UK and France has already taken place and further exchange could be beneficial to both parties.

4.9.17. Russia is thought to have the facilities for removal of RPVs but no further details are available.

4.9.18. If the UK was to exchange this information with selected allied countries, the basis of this information exchange would need to be agreed between the various countries.

4.9.19. Discussion is required on a number of issues, including:

- What is the potential benefit to MOD (including designers of future submarines) of sharing knowledge acquired through SDP?
- What is the potential benefit to other UK organisations (public and private) of sharing knowledge acquired during the dismantling of submarines?
- What is the potential for mutual benefit for information exchange with overseas organisations responsible for submarine dismantling?
- Given that the timing of the imparted knowledge is important (i.e. the sooner the better), what elements of this criterion discriminate between the options?

4.10. 1-H&S: Worker Dose: Dismantling, Storage and Transportation

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

This section has been re-written to include more interpretation of the Babcock Marine study on worker dose during normal dismantling operations. Scoring graphs generated during the 2011 MCDA workshops were added. Issues arising from Public Consultation have been added. Assumptions have also been added.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant changes were made to the 1-H&S supporting data as a

consequence of the workshops.

4.10.1. This criterion addresses the radiation doses to workers during the SDP dismantling activities, including storage and transportation.

4.10.2. Points of consideration include but are not restricted to the list shown in the table below, taken from the 2011 MCDA scoring workshop report [4.1.1].

4.10.3. **Table 4.10.1: Issues Relevant to 1-H&S**

#	TOPIC	ISSUES
A	**Numbers of workers**	• If the collective dose during SDP activities is 50 man mSv and the workforce consists of 50 personnel, then the average dose per worker is 1mSv. • If the number of personnel increases or decreases through the SDP activities, the average dose per worker decreases or increases accordingly.
B	**Dismantling**	• The worker dose associated with early RPV removal (Options 2 to 9) could be higher than delayed RPV removal (Option 1) as early RPV removal takes less advantage of decay storage. • Dose accrued during initial dismantling could reduce with time as the methodologies applied and associated timescales are refined with each submarine dismantled.
C	**Storage**	• The Do Minimum option involves afloat storage for longer periods than other options however this will have minimal or no impact on worker radiation doses. • Waste packages (RCs, RPVs and packaged waste) must be made passively safe prior to interim storage therefore the need for maintenance and inspection will be minimised thereby not introducing a significant contribution to dose.
D	**Transportation**	• Dose rates from waste packages are strictly regulated by UK Transport Regulations and the doses accrued during transport are considered very low.

4.10.4. Assumptions

4.10.5. See Annex A, Section A21.

4.10.6. Data

4.10.7. **Dismantling**

4.10.8. Workers could be exposed to ionising radiation during any of the SDP operations including RC separation, RPV removal, transportation, size reduction, storage and disposal.

4.10.9. External exposure comes mainly from the gamma rays emitted by Co-60 which has a half life of 5.23 years. Over a period of Co-60 10 half lives (ca. 50 years), the dose rates will reduce by a factor of 2 to the power of 10 which is approximately 1000. Radiation dose rates will therefore decrease with time and this should reduce worker dose.

4.10.10. A dose assessment was produced by Babcock Marine [4.10.1] with the objective of calculating the radiation doses associated with each of the main submarine dismantling options. Annex A (Section A10) explains the terminology used and provides examples showing how the various types of radiation doses (i.e. effective dose, collective dose and cumulative collective dose) are calculated. A short synopsis of the methodology and results of the Babcock Marine report is provided below.

4.10.11. **Dose Assessment for [redacted]**

4.10.12. The Babcock Marine report [4.10.1] carried out a normal radiation dose associated with implementation of each of the three main options (i.e. RC Removal, RPV Separation and Packaged Waste). It is stressed that this assessment only considered doses from normal operations, not those from accident conditions.

4.10.13. The report was produced in 2009/2010 and at that time, [redacted] had been identified as the first submarine to be dismantled. This submarine has the highest average dose rates of all of the LUSMs (as measured by the RC Low Level Dose Rate (LLDR) system discussed in Annex A, Section A10). Dismantling was projected to take place during 2013. The LLDR at the time of disposal (2013) was predicted from LLDR survey data produced in 2006. A submarine dismantling sequence for the 23 PWR1s was produced and dismantling dates ascribed on the basis on one submarine per year. It was emphasised that changing the sequencing would alter the LLDR at the time of dismantling and alter the cumulative collective dose results.

4.10.14. A package of work was then developed by the project team (in conjunction with health physics) for each of the options. Trafalgar class operational refit data was used to calculate the doses for each of the proposed work packages and these were then scaled accordingly. The scaling took account of the variations in the LLDRs, variations in task durations (e.g. some refit tasks would not be undertaken during submarine dismantling) and variations in average LLDRs during dismantling, as a consequence of removal of high dose rate items early in the work package. In addition, a lower limit of 5 microSv per hour within the RC was established. Any calculated doses below this value were discarded and replaced with this lower limit.

4.10.15. The results of the dose assessment on [redacted] and the 23 PWR1s in the

Fleet are shown below.

4.10.16. **Table 4.10.2: [redacted] and Fleet (23 PWR1s) Dismantling Dose Summaries**

A	B	C	D
Option Description	**[redacted]: Collective Dose (man mSv)**	**PWR 1 Fleet: Cumulative Collective Dose (man mSv)**	**PWR 1 Fleet: Average Collective Dose per Submarine (man mSv)**
Option 1	**9**	**201**	**9**
RC separation, interim storage and delayed RPV size reduction	(Initial Activities = 3 man mSv) (Deferred activities = 6 man mSv)		
Option 2	**47**	**523**	**23**
RPV removal, interim storage and delayed RPV size reduction			
Option 3	**50**	**589**	**26**
RPV removal, size reduction and interim storage			

4.10.17. **RC Separation Option**

4.10.18. **Column A**: This shows the three main SDP strategic options under consideration when the Babcock Marine report was written. The previous Option 1 maps to current options 1D and 1R. The previous Option 2 maps to current options 2D, 3-4D, 2-4B, 9D and 9B. The previous Option 3 maps to current options 5D, 6-7D, 5-7B, 8D and 8B.

4.10.19. **Column B:** This shows the collective dose (i.e. the total amount of radiation received by the workforce) for each of the main options. The estimated 9 man mSv for the RC separation option consists of two sets of doses, incurred at different times. One set of radiation doses would be incurred during initial activities, e.g. when preparing the RC for separation; separating the RC from the rest of the submarine; preparing the RC for transport; and care and maintenance during interim storage. Note that there will be a period of radioactive decay before the RC is separated. The dose incurred during these initial activities was calculated at 3 man mSv. The second set of radiation doses would be incurred during deferred activities, e.g. removing lagging, removing steam generators, main coolant pumps and associated pipework at a later date. The dose incurred during deferred activities was calculated at 6 man mSv. The estimate includes an allowance for interim storage activities and placement of packaged waste in the GDF. The total collective dose for immediate and deferred activities is 9 man mSv. This dose will be shared among many people. Given that a range of skill sets (up to 50 workers is assumed) spanning 3 or more decades will be required and the rate of production of separated RCs will be one per year, the effective dose to any individual worker is estimated to be 9/50 = 0.18 mSv per annum, i.e. less than 1 mSv per annum.

4.10.20. **Column C:** The 23 PWR1 submarines were sequenced in the order that they would be dismantled and the average dose rate (LLDR) calculated for that date. The collective dose for each submarine was calculated and a running total produced for both the immediate and deferred activities. Most of the doses were independent of the LLDR, since immediate tasks would be undertaken outside the RC and deferred tasks would have the benefit of additional decay storage. Multiplying the 9 man mSv by the number of PWR1 submarines (23) gives a value of 207 man mSv, which approximates to the calculated cumulative collective dose of 201 man mSv.

4.10.21. **Column D:** Dividing the cumulative collective dose (201 man mSv) by the number of PWR1s (23) provides an average collective dose per submarine of 9 man mSv. Because the calculation in Column C is virtually independent of the LLDR, the value in Column D is similar to that in Column B.

4.10.22. **RPV Removal Options**

4.10.23. Column B: This shows the estimated collective dose (47 man mSv) for the option involving RPV removal and delayed size reduction. This dose arises predominantly from initial activities such as removing the main coolant pumps, pressuriser, associated pipework, lagging, steam generators from a submarine after a period of radioactive decay. The dose estimate includes an allowance for interim storage activities and placement of packaged waste in the GDF. The collective dose is slightly lower than that for packaged waste, since the main deferred activity (size reduction) will take place after a considerable period of decay storage, but is based on the assumption that the degree of radiation protection is the same as that provided by a hot cell. Slightly less dose will therefore be accrued compared to the packaged waste option. Given that a range of skill sets (up to 50 workers is assumed) will be required and the rate of production of RPVs will be one per year, the effective dose to any individual worker is estimated to be 47/50 = 0.94 mSv per annum, i.e. less than 1 mSv per annum.

4.10.24. Column C: This shows the accumulation of the collective doses (shown in Column B) over the 23 PWR1 fleet submarines to produce a cumulative collective dose of 523 man mSv. It is illustrative to multiply the dose in Column B (47 man mSv) by the number of PWR1 submarines (23). This gives a value of 1081 man mSv, which is a factor of approximately 2 higher than the calculated value (523 man mSv); the calculated value is lower since none of the other submarines has a dose rate (as measured by LLDR system) which is higher than that of [redacted]. If worst case dose data had been used in this calculation, this would have overestimated the cumulative collective dose.

4.10.25. Column D: This shows the average collective dose per submarine (23 man mSv) which is calculated by dividing the cumulative collective dose (523 man mSv) by the number of PWR1s (23). The Babcock Marine data indicate a collective dose range of between 14 and 47 mSv with an average of 23 man mSv.

4.10.26. **Packaged Waste Options**

4.10.27. Column B: The estimated collective dose of 50 man mSv for the packaged waste options consists predominantly from initial activities such as removing the main coolant pumps, pressuriser, associated pipework, lagging, steam generators. Very little dose would be associated with subsequent operations, like for example RPV size reduction and packaging, since these would be carried out using hot cells. The dose estimate includes an allowance for interim storage activities and placement of packaged waste in the GDF. The collective dose is slightly higher than that for RPV removal (as explained in the previous paragraph) and considerably higher than that for RC separation. Given that a range of skill sets (up to 50 workers is assumed) will be required and submarines will be dismantled at a rate of one per year, the effective dose to any individual worker is estimated to be 50/50 = 1 mSv per annum. It is anticipated that the actual doses will be reduced as experience of the dismantling process increases, therefore the average individual dose associated with dismantling (including storage and transport) will probably be <1 mSv per annum.

4.10.28. Column C: Dividing the cumulative collective dose (589 man mSv) by the number of PWR1s (23) resuts in an average collective dose per submarine of 26 man mSv. The Babcock Marine data indicate a range of between 17 and 50 mSv with an average of 26 man mSv.

4.10.29. **Summary**

4.10.30. Option 1: RC Separation

4.10.31. Option 1 accrues the lowest collective dose of all of the options. This is because the majority of the dose is from deferred activities (2040 onwards). .

4.10.32. If the collective dose (of 9 man mSv) is equally shared among 50 workers and the rate of dismantling is one submarine per year, the dose to any individual worker will be 0.18 which is considerably less than 1 man mSv per annum.

4.10.33. The similarity between the average and worst case collective dose means that annual doses will be low irrespective of which submarine is being dismantled.

4.10.34. **Option 2: RPV Removal and Interim Storage**

4.10.35. Option 2 accrues the second highest collective dose of all of the options. This is because the majority of the dose is from early (2016 onwards) deplanting of the RC.

4.10.36. If the collective dose (of 47 man mSv) is equally shared among 50 workers and the rate of dismantling is one submarine per year, the dose to any individual worker will be 0.94 which is less than 1 man mSv per annum.

4.10.37. The difference between the average (23 man mSv) and worst case (47 man mSv) collective doses indicates that annual doses will vary depending on which submarine is being dismantled. The two most common values are 14 and 29 man mSv. The Option 2 collective dose for [redacted] is sufficiently higher than the other to be interpreted as a statistical outlier. The doses incurred during the initial dismantling of [redacted] may be the most challenging to keep below the basic safety objectives. Subsequent submarines should be less onerous.

4.10.38. **Option 3: Packaged Waste**

4.10.39. Option 3 accrues the highest collective dose of all of the options. This is because (like Option 2) the majority of the dose is from early (2016 onwards) deplanting of the RC.

4.10.40. If the collective dose (of 50 man mSv) is equally shared among 50 workers and the rate of dismantling is one submarine per year, the dose to any individual worker will be 1 man mSv per annum.

4.10.41. The difference between the average (26 man mSv) and worst case (50 man mSv) collective doses indicates that annual doses will vary depending on which submarine is being dismantled. The two most common values are 17 and 32 man mSv. The Option 3 collective dose for [redacted] is sufficiently higher than the others to be interpreted as a statistical outlier. The doses incurred during the initial dismantling of [redacted] may be the most challenging to keep below the basic safety objectives. Subsequent submarines should be less onerous.

4.10.42. **MCDA 2011 Considerations**

4.10.43. The table below converts the values shown above in Table 4.2 to individual doses. This is achieved by dividing the Column B and D values by 50, the number of workers who will share the dose, as discussed above.

4.10.44. **Table 4.10.3: Individual Dismantling Doses**

A	B	C
Option Description	**[redacted] Individual Dose per annum (mSv)**	**PWR 1 Fleet: Average Individual Dose per annum (man mSv)**
Option 1 RC separation, interim storage and delayed RPV size reduction	**0.18**	**0.17**
Option 2 RPV removal, interim storage and delayed RPV size reduction	**0.94**	**0.45**

A	B	C
Option Description	[redacted] **Individual Dose per annum (mSv)**	**PWR 1 Fleet: Average Individual Dose per annum (man mSv)**
Option 3 RPV removal, size reduction and interim storage	**1**	**0.51**

4.10.45. The targets and the legal limit for effective dose in a calendar year for any person on a site exposed to sources of ionising radiation under normal operations are shown in the table below.

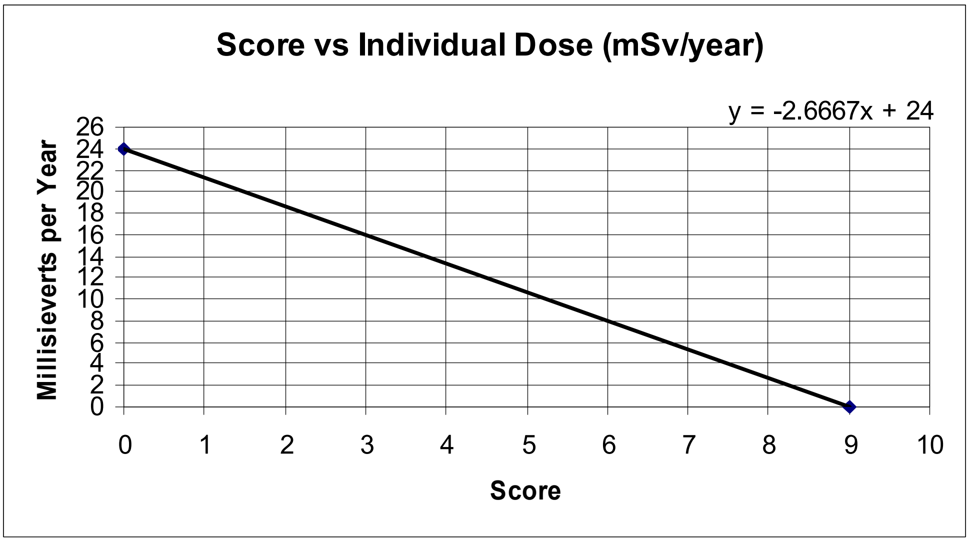
4.10.46. **Table 4.10.4: Basic Safety Limits and Objectives**

Category	Basic Safety Limit (BSL) (Legal Limit)	Basic Safety Objective (BSO) (MOD)
Employees working with ionising radiation:	20 mSv/year	1 mSv/year
Other employees on the site	2 mSv/year	0.1 mSv/year

4.10.47. It is illegal for worker doses to exceed the BSL and highly desirable for worker dose not to exceed the BSO. The BSL/BSO range was used during MCDA 2011 as the basis of a scoring system. If the Basic Safety Limit = 24 mSv/year (Illegal) the dose score was attributed a “0” (bad) and if the Basic Safety Objective = 0 mSv/year then the dose score was attributed a “9” (good).

4.10.48. The figure below shows a graph of the individual doses (mSv per year) plotted against score.

4.10.49. **Figure 4.10.1: Graph of Individual Dose against Score**



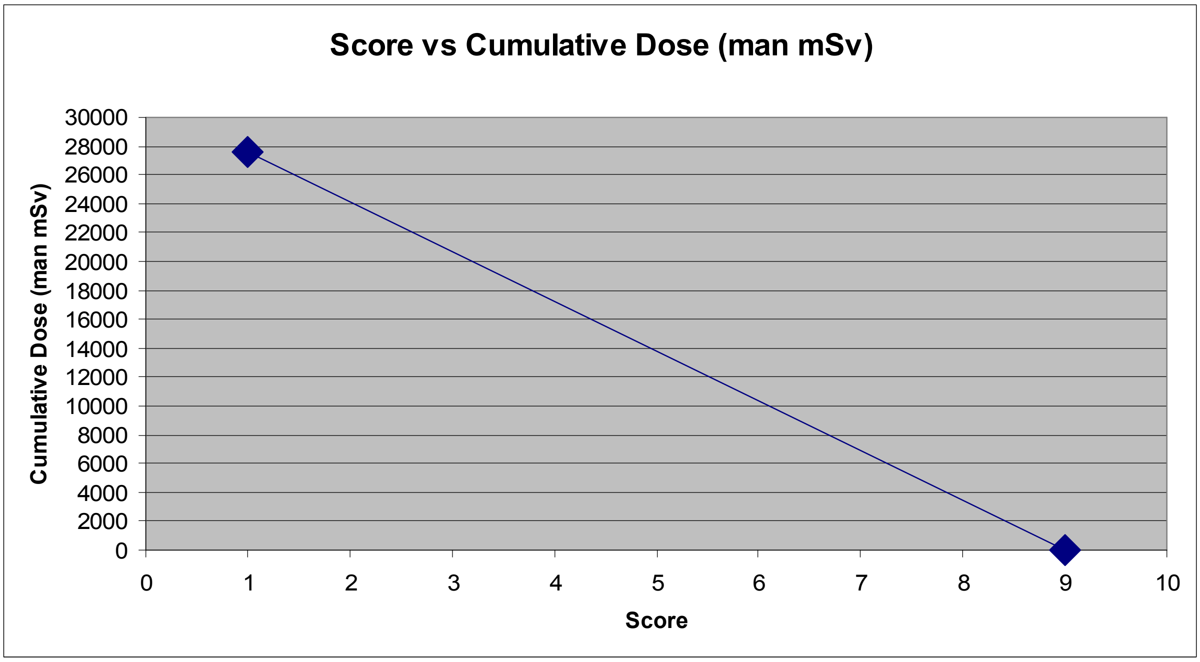
4.10.50. Extrapolation of the graph shows that the individual doses in Columns B and D of Table 4.2 score between 8 and 9. More accurate scores are shown in the table below.

4.10.51. **Table 4.10.5: Scores Extrapolated from Dose**

Table X Column	y (mSv/y)	x (Score)
B	1	8.6
B	0.94	8.6
B	0.18	8.9
C	0.17	8.9
C	0.45	8.8
C	0.51	8.8

4.10.52. A similar plot, this time of cumulative dose (rather than individual dose) was produced. The upper limit was based on 50 workers on 23 submarines accruing a dose of 24 mSv per annum, i.e. 50 x 23 x 24= 27600 man mSv. This was attributed a dose score of “1” (bad). A cumulative dose of 0 mSv/year, was attributed a dose score of “9” (good). The relevant plot is shown below.

4.10.53. **Figure 4.10.2: Graph of Cumulative Dose against Score**



4.10.54. Extrapolation of the graph shows that the cumulative doses (i.e. 210. 523 and 589 man mSv) all score between 8 and 9.

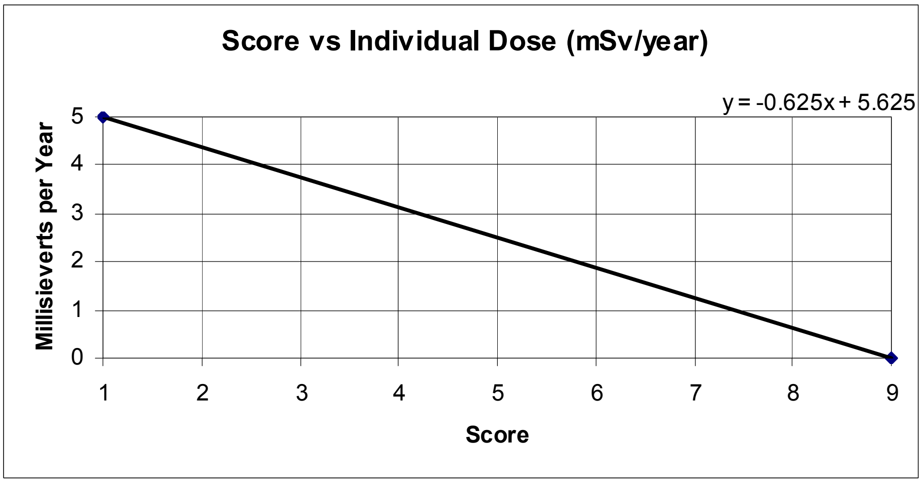
4.10.55. MCDA 2012 Considerations

4.10.56. The figure below shows a graph of the individual doses (mSv per year) plotted against score, this time with 5 mSv per year, recognising that in Devonport, this is the site limit and no single radiation worker has exceeded this dose over the past 20 or so years.

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

Note that the 5mSv upper limit was not considered during MCDA 2011. It was put forward during MCDA 2012. The attendees agreed to be guided by this upper limit, but would not be constrained by it and would retain the freedom to score accordingly.

4.10.57. **Figure 4.10.3: Graph of Score against Individual Dose**



4.10.58. **Table 4.10.6: Scores Extrapolated from Dose (based on above figure)**

y (mSv/y)	x (Score)
1	7.4
0.94	7.5
0.18	8.7
0.174	8.7
0.454	8.3
0.512	8.2

4.10.59. Similar results would be obtained if the cumulative doses had been the subject of the analysis.

4.10.60. **Storage**

4.10.61. Workers could be exposed to ionising radiation when the submarine is being stored afloat (e.g. during maintenance operations) and during interim storage of RCs, RPVs and packaged waste.

4.10.62. Although the Do Minimum option would involve afloat storage for longer periods than the other options, this will probably have no or very little impact on worker radiation doses compared to other options which include deferred dismantling.

4.10.63. The Babcock Marine report [4.10.1] made the assumption that the maintenance and inspection of the RPV or packaged ILW during the interim storage period was not considered to contribute significantly to the ca. 1 man mSv per annum collective dose described above. This is a reasonable assumption, since waste packages need to be made passively safe prior to storage and the need for maintenance and inspection will therefore be minimised.

4.10.64. **Transportation**

4.10.65. Workers could be exposed to ionising radiation during the transportation of a submarine, RC, RPV or packaged waste.

4.10.66. The Babcock Marine report included preparation for transport in the calculation of the doses accrued from the dismantling operations, therefore this issue is not addressed further in this data report. Worker doses accrued during transportation were not addressed, because they were judged to be very low.

4.10.67. The dose rates from waste packages are strictly regulated by the UK Transport Regulations [4.10.2]. For all transport packages, NDA has stipulated [4.10.3] that under the conditions of non-exclusive use, the dose rate at 1 metre from the surface shall not exceed 0.1 mSv/h and the dose rate from the external surface shall not exceed 2 mSv/h. The upper limits for the dose rate from transport packages are those defined for exclusive use and these are discussed below.

4.10.68. If the size reduced waste is packaged into a 3m3 box waste package, it will be transported through the public domain within a reusable shielded transport container (e.g. SWTC-285) and this is designated as a Type B transport package. Calculations using the MicroShield software package [4.10.4] indicated that dose rates both at the surface of a 3m3 box waste package and at a distance of 1 metre from such a package would be below the relevant transport limits.

4.10.69. If an RPV is transported as a Type B package, it will be transported through the public domain within a shielded transport container, still to be defined. The same dose limits discussed above apply.

4.10.70. If the waste package or RPV is transported as an IP-2 package, there is an additional requirement that the dose rate at a distance of three metres from the unshielded surface of the grouted wasteform should not exceed 10 mSv per hour. The additional shielding afforded by the annulus between the waste and the package and by the package construction and shielding material cannot be taken into account in meeting this requirement. The radiation level at the outer edges of a vehicle carrying an IP-2 package must not exceed 2 mSv/h. Preliminary calculations [4.3.3] indicate that this requirement can be met.

4.10.71. Exclusive use is defined by the IAEA Transport Regulations [4.10.5, 4.10.6] as “the sole use, by a single consignor, of a conveyance or large freight container, in respect of which all initial, intermediate and final loading and unloading is carried out in accordance with the consignor or consignee”. If all of these conditions cannot be met, transport is deemed to take place under non-exclusive use.

4.10.72. The ultimate upper limits for the dose rate from transport packages are those defined for exclusive use and these are shown below.

- The dose rate at 2 metres from the surface of a transport package shall not exceed 0.1 mSv/h.
- The dose rate on its external surface shall not exceed 10 mSv/h.

4.10.73. RWMD states that waste packages resulting in transport packages with higher radiation levels may be permitted but this would be dependent on the approval certificate for the transport container, the operational procedures applied during transport and the operational safety case for a GDF.

4.10.74. A specimen calculation is shown below based on the requirement, that under the conditions of non-exclusive use, the dose rate at 1 metre from the surface of an RPV or a waste package will not exceed 0.1 mSv/h.

4.10.75. For example, if a transport operator spent 0.5 hour per journey, for 10 journeys, at a distance of 1 metre from a waste package which was emitting radiation measured at 0.1 mSv/hour at a distance of 1 metre, he/she would accrue a maximum dose of 0.5 mSv. At 10 such journeys per year, the maximum dose would be 0.5 mSv per annum. The collective dose rate for 2 such operators would therefore be 1 man Sv per annum. Assuming that the residence times, the number of journeys and the package dose would be less than the stated values, the collective dose rates will be less than 1 man mSv per annum.

4.10.76. It is concluded that the average collective worker dose associated with transportation will be <1 man mSv per annum.

4.10.77. Public Consultation

4.10.78. The main safety concern was routine and accidental public dose, but public consultation also raised a number of issues relevant to worker dose. A representative selection is included below. The main themes were the way the MCDA methodology had been applied to distinguish between dismantling options, and the inherent characteristics of the different technical options that led to different worker dose profiles. There was a widespread desire for more, and more detailed, information on work and public dose.

Dose Rates as Low as Reasonably Achievable (ALARP)

- Several respondents argued that the analysis should recognise the benefits of achieving ALARP dose rates, not just keeping within statutory limits – and options should be scored according to the margin by which they meet regulatory safety targets and sensitivity testing must address margins. Arguably, these comments relate to a misreading of the published MCDA analysis, which MOD felt did in fact conform to this principle (see PCR Section 14.2). Similarly, some felt low weightings on worker dose implied a low level of importance, which MOD felt was not actually the case under the weighting framework used.

Preference for Options

- The position most frequently expressed by respondents was in support of the RPV option but a significant number – nearly two thirds as many – supported the RC option. Most of these appear to have done so on the grounds that it entails less accident risk, worker dose, and/or routine emissions to the environment. Many supporting RPV also seem to have preferred RC in principle because of the lower worker dose, but settled for the RPV option because it was the least intrusive option that did not have the major practical issues the RC option did.

- The considerations which led people to arrive at these conclusions appear, however, to vary, depending on whether they believed the MOD's dose predictions or not, whether they believed the current dose/risk model or not, and whether they thought radiological risk could be traded off against other factors. Section 8.2 of the PCR contains an analysis.

Perspective on Meeting Legally Required Standards

- The Environmental and Health and Safety criteria appear to have scored low because all options are expected to be able to meet legal minimum requirements. In the NFLA view this is beside the point. The chosen management option should be required to use the Best Available Techniques and they should generate discharges and doses which are As Low As Reasonably Achievable. Nowhere in the Operational Analysis are RC Separation and RPV Removal Options compared from this standpoint (NFLA).

- MOD argues that … health and safety and environmental factors…did not discriminate significantly between the effectiveness of the options because, in its assessment, all options could be designed to achieve the legally required standards. There is an important and high profile case where a similar approach was strongly criticised by a Public Inquiry Inspector (C S McDonald, 'Cumbria County Council - Appeal by United Kingdom Nirex Ltd', 21 November 1996). In that case, the Inquiry Inspector criticised Nirex's MCDA for attaching little importance or weight to the different margins by which alternative potential sites for a GDF were likely to be able to meet the then regulatory safety targets. He also criticised the company's subsequent failure to comply with the precautionary principle by taking these different margins forward into the ranking of sites. In the light of this case, we consider that MOD would be well advised to undertake specific sensitivity testing to explore the impact of assigning significant weight to the different margins by which different options achieve legally required environment and health and safety standards (NuLeAF).

Application of BAT (Best Available Techniques) and ALARA (As Low as Reasonably Achievable)

- The chosen management option should be required to use the Best Available Techniques and they should generate discharges and doses which are As Low As Reasonably Achievable. Nowhere in the Operational analysis are RC Separation and RPV removal Options compared from this standpoint (NFLA).

- Although the SEA claims that both worker doses and planned discharges are predicted to remain within currently permitted limits for the RPV removal option, it fails to make a comparison with the RC removal option or argue that it meets the ALARA principle (NFLA).

- There were some differences between estimates of radiation exposure to workers between the options. It concludes however that it did not distinguish between the options as all estimates were low relative to statutory limits and typical employer dose constraints. This conclusion does not address the legal requirement to ensure the doses remain as low as reasonably achievable (ALARA) in addition to being below statutory limits. …some discussion of how radiation exposures will be kept as low as reasonably achievable would seem appropriate also (SCCORS).

Worker Dose Weighting

- Worker dose during dismantling, transport and storage were weighted at zero because this is dealt with as part of the investment appraisal to be consistent with the NDA's ways of doing things. This would appear to particularly skew the results towards options involving cutting into the Reactor Compartments rather than leave them intact (NFLA).

Sensitivity Analyses

- MOD would be well advised to undertake specific sensitivity testing to explore the impact of assigning significant weight to the different margins by which different options achieve legally required environment and health and safety standards (NuLeAF).

Option Characteristics

- The consultation documents do not give enough information to argue the case that RPV removal is the best option. This currently looks as though it has a higher risk of accidental discharges, higher actual discharges into the environment and a higher worker dose in comparison to the RC removal option (NFLA).

- The arrangements for handling the RPV and other waste in a dock should be engineered to ensure that these operations present no more risk (industrial as well as radiological) than that associated with the alternative option to carry out operations in a shore based facility (NI).

- We agree with the project's conclusions that considerations of nuclear safety (for both the public and any workers involved) do not discriminate between the options. The radiological hazard is stable and relatively modest and well understood compared to other nuclear dismantling projects already successfully completed elsewhere in the UK (NI).

Perspective on Radiation Dose

- The maximum dose to a member of the public is equivalent to eating about 80 grammes of Brazil nuts. The occupational dose to a worker involved in the dismantling work is equivalent to between 1 and 13 Transatlantic flights per year, and less than having one CT scan (NI).

4.10.79. Discussion

4.10.80. The Public Consultation make use of the term (ALARA) rather than ALARP.

4.10.81. ALARA (As Low as Reasonably Achievable) is used by the International Commission on Radiation Protection (ICRP) and the International Atomic Energy Agency (IAEA) (and hence the international community) in relation to risk, including radiation doses. ALARA is used when dealing with doses to the public (e.g. from environmental discharges), since the impact of these doses is based on ICRP guidance documentation.

4.10.82. ALARP (As Low as Reasonably Practicable) is the UK definition of ALARA. ALARP tends to be used in the UK for worker dose and is referred to in the 1974 Heath and Safety at Work etc. Act. The concept of “reasonably practicable” lies at the heart of the British health and safety system. It is a key part of the general duties of the Health and Safety at Work etc. Act 1974.

4.10.83. ALARA takes social and economic factors into account. whereas ALARP suggests a balance between risk and benefit. In some UK nuclear industry reports [e.g. 4.10.7], ALARP is used for worker dose, but the caveat is often added that this infers ALARA for public dose.

4.10.84. The discussion below is based around the values shown in Table 4.10.3 above.

4.10.85. All operations will be subject to ALARP assessments to ensure that worker doses will be as low as reasonably practicable. As shown above, the worker doses will vary between options, but they should all be ALARP. Note that a considerable amount of resources and expenditure will be directed at maintaining low operator doses during operation of the size reduction and packaging facility. Any additional resources (and expenditure) should be directed at further reducing the (already low) dose rates associated with removal of high dose primary circuit items. These issues will be addressed further in the Investment Appraisal.

4.10.86. To provide some perspective to the dose values discussed above, it should be noted that the annual dose for the average person within the UK from background radiation is 2.7 mSv and the annual individual worker dose legal limit is 20 mSv per annum. Moreover, the doses estimated above for dismantling are less than 1% of the through-life collective dose for a Trafalgar Class submarine.

4.10.87. Discussion is required on a number of issues, including:

- Appreciation of the variations in collective and cumulative collective doses for each option.
- Appreciation that all of the estimated SDP doses for each option are relatively low.
- The application of ALARP with reference to worker dose accrued during dismantling operations.
- Public consultation issues (e.g. ALARP, ALARA, weighting, sensitivity, RC versus RPV option).
- Does this criterion discriminate between the options?

4.11. 2-H&S: Non Radiological Impact on Workers

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

Public Consultation text and assumptions have been added.

[redacted]

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant changes were made to the 2-H&S supporting data as a consequence of the workshops.

4.11.1. This criterion considers the non radiological hazards and impact on the workforce of SDP activities.

4.11.2. Points of consideration include but are not restricted to the list shown in the table below, taken from the 2011 MCDA scoring workshop report [4.1.1].

4.11.3. **Table 4.11.1: Issues Relevant to 2-H&S**

#	TOPIC	ISSUES
A	**Transportation**	• The scope of transportation includes submarines, RCs, RPVs and packaged waste. • The modes of transport are rail, road and sea. • Issues include loading/unloading, collisions etc.) • Conventional safety hazards associated with transport: include those associated with machinery, fork lift trucks, personal injury etc.
B	**Dismantling**	• Site infrastructure (ability to dismantle submarines) • Dismantling technologies and methodologies.
C	**Hazard identification**	• Effective identification of hazards and hazardous materials (e.g. asbestos) prior to dismantling.
D	**Workforce**	• Availability of skilled and suitably experienced and qualified personnel (currently and in the future)
E	**Storage**	• Accidents during maintenance and inspections during interim store
F	**Industrial Accidents**	• Slips, trips, falls, cuts, burns, dropped loads, chemicals etc.

4.11.4. Assumptions

4.11.5. See Annex A, Section A21.

4.11.6. Data

4.11.7. There are numerous hazards associated with ship breaking and some of these are summarised below. Annex A (Section A12) contains a check list of hazards which could be relevant to the SDP.

[redacted]

4.11.8. Data:

4.11.9. **Hazard Groups**

4.11.10. **Access:** Working at height, slips, trips and falls, confined spaces, work on or near water.

4.11.11. **Fire:** Combustible, ignition and oxygen sources.

4.11.12. **Hazardous Substances:** Health hazards associated with using and the creation of toxic/harmful substances, asbestos.

4.11.13. **Machinery:** Mechanical and non mechanical e.g. moving parts of machinery, heat, dust, noise.

4.11.14. **Musculo-Skeletal Hazards**: Manual handling, Upper limb disorders.

4.11.15. **Physical Energy**: Noise, vibration, temperature extremes, pressure/vacuum.

4.11.16. **Psycho-Social:** Stress, work patterns, lone working.

4.11.17. **Work Equipment**: General, electrical.

4.11.18. **Workplace**: Thermal comfort, lighting, space.

4.11.19. **Workplace Transport**: Moving vehicles.

4.11.20. Conventional safety is covered under the Health and Safety at Work etc. Act 1974 [4.11.1] and there is a large amount of supporting legislation which apply to more specific hazards including (but not limited to):

- Control of Asbestos.
- Confined Spaces.
- Work at Height.
- Electricity at Work.
- Fire.
- Hazardous Substances.
- Lifting Operations.
- Machinery.
- Manual handling.
- Noise.
- Vibration.
- Work Equipment.

4.11.21. The companies or organisations responsible for any such project are instructed to:

- Comply, as a minimum, with all applicable health and safety legislation and regulations at all places of work.
- Comply with all other requirements by regulatory bodies or clients.
- Provide safe conditions and practices of work.

- Clearly define the responsibilities and duties of all employees involved with the project.
- Consult with employees in the development of arrangements for safety, and work with them to achieve their implementation.
- Provide employees, contractors and visitors with suitable and adequate information, instruction and training to safeguard their health and safety.
- Select contractors who have effective safety management systems for work at the Company's or its clients' premises.
- Co-operate with and support clients and landlords in developing safe working practices.
- Design plant, equipment and facilities that are safe to construct, operate, maintain, and, dismantle and demolish.

4.11.22. Public Consultation Issues

- Only a very few comments explicitly addressed conventional risks to workers. An example is included below. A number of comments relating to the choice between RC and RPV options did, however, note the challenges (and by inference, risks) of removing and moving intact RCs, and appeared to place considerable significance on worker risk in making their selection.

- The arrangements for handling the RPV and other waste in a dock should be engineered to ensure that these operations present no more risk (industrial as well as radiological) than that associated with the alternative option to carry out operations in a shore based facility (NI).

4.11.23. Discussion

4.11.24. Accidents can happen on any industrial plant or site. Generally, the more complex and bigger the plant or project and the more the plant is used, the higher the unmitigated risk of accidents.

4.11.25. Dismantling sites will require a robust safety culture and all work must be monitored and reviewed by safety professionals. Risk assessment and hazard identification will be required from the initial desk study phase through to the completion of physical work. For example pre-identification of hazardous substances (see [4.11.2] such as asbestos will mitigate risks to the workforce.

4.11.26. Discussion is required on a number of issues, including:

- Is this criterion adequately defined and does it address all of the relevant issues?

- Are there any issues arising from the Public Consultation process?

- Does this criterion discriminate between the options?

4.12. 3, 4 and 5-H&S: Potential for an Unplanned Radiological Release during Dismantling, Transportation and Storage

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

Text on Public Consultation and Assumptions have been added.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant changes were made to the 3, 4 and 5-H&S supporting data as a consequence of the workshops.

4.12.1. This criterion considers in a qualitative manner, the risk of an unplanned radiological release during the SDP dismantling operations, including transportation and storage of radioactive waste. Note that all of the submarines will be de-fuelled before dismantling.

4.12.2. It is intended to score these risks as three separate criteria, however, for the purposes of this document, all three are addressed together.

4.12.3. Assumptions

4.12.4. See Annex A, Section A21.

4.12.5. Data

4.12.6. For the purposes of this discussion, radiological release includes external exposure from radiation release as well as internal exposure from contamination release.

4.12.7. An unplanned radiation release could arise from inadvertent exposure to the gamma rays emitted by Co-60. This isotope is the most predominant gamma emitter inside a submarine. Co-60 has a half life of 5.27 years. Over a period of 10 half lives, the dose rates will reduce by a factor of ca. 1000. Radiation doses should therefore decrease with time.

4.12.8. An unplanned release of contamination could arise for example, because of penetration of a closed circuit/system, releasing airborne contamination into the atmosphere. If ingested or inhaled, the contamination would expose the workers to an internal radiation dose.

4.12.9. An unplanned radiological release is interpreted in this report as a maximum <u>*credible*</u> unplanned release, rather than a maximum <u>*possible*</u> unplanned release. This can be derived from a facility safety assessment, but such an assessment could only occur after strategic decisions have been taken and the project proceeds into more detailed design work leading to planning and regulatory assessments. At this stage, it is only possible to apply SME judgement and to consider the examples provided below which are based on experience within the civil nuclear industry.

4.12.10. **Public Consultation Issues**

4.12.11. Public consultation raised a number of issues relevant to this criterion and these are summarised below.

Packaged Waste Option

- More work needs doing to investigate whether the packaged waste option can be pursued without undue radiological dose and release.

Risk of Radiological Accident

- There was a strong perception from some members of the public that the SDP would inevitably lead to an increase in both radioactive discharges and the risk of a radiological accident.

4.12.12. Discussion

4.12.13. **3-H&S: Dismantling**

4.12.14. During operations to separate the RC, two major cuts will be made down the submarine, bringing with it a risk of unplanned radiation and contamination release. The RC is essentially self shielding apart from on the underside, where radiation shine could occur. The RC will be decay stored for long periods, therefore the risks associated with its eventual deplanting and subsequent waste management are considered low.

4.12.15. The RPV removal and interim storage options will probably carry more risk (than the RC separation option) of inadvertent radiological exposure. Examples where workers may inadvertently be exposed to external radiation include prolonged exposure during stripping out of the primary circuit and proximity to the RPV during removal. There is also a risk of an unplanned release of contamination when breaking connections between sections of pipework (e.g. separating the nozzles from the RPV).

4.12.16. The RPV removal and size reduction options may carry most risk of an unplanned radiological exposure during the size reduction and packaging process. Examples include the potential for radiation and contamination leakage from manipulators, failure of a hot cell window during size reduction operations and exposure during man-entry to a hot cell for maintenance or other purposes.

4.12.17. It is stressed that the above risks are speculative and that their probabilities and impacts will be minimised though good practice.

4.12.18. Points of consideration include but are not restricted to the list shown in the table below, taken from the 2011 MCDA scoring workshop report [4.1.1].

4.12.19. **Table 4.12.1: Issues Relevant to 3-H&S**

#	TOPIC	ISSUES
A	**Dismantling Operations**	• Separation of the RC from the submarine could result in an unplanned radiation and contamination release. • RPV removal options carry a higher risk of unplanned radiological exposure than RC separation as the connections between the RC and RPV must be broken to facilitate the removal. • Early size reduction and packaging operations carry most risk of unplanned radiological exposure due to the invasive nature of the operation. The risk reduces following a period of decay storage prior to size reduction. • Characterisation works, where physical samples are removed for analysis, could result in an unplanned radioactive release. • All dismantling activities will be in accordance with risk assessments to minimise the potential for unplanned release.
B	**Radiation Release**	• Unplanned radiation release could occur under accident conditions. • Radiation release could occur during dismantling operations through e.g. accidental removal of shielding in reactor compartment or through exposure to relatively small sources of radiation. • Radiation exposure could also occur during cutting and removal operations of ancillary services (e.g. effluent tanks, pipework).
C	**Contamination Release**	• Unplanned contamination release could occur under accident conditions through liquid and gaseous discharge routes. • One example of the latter is failure of the extract systems.
D	**Safety**	• All dismantling activities will be undertaken in accordance with safety legislation and ALARP/ALARA. • The probability of unplanned radiological exposure will be minimised through good practice.
E	**Management**	• Mitigations include effective management, supervision and training before and during dismantling operations

4.12.20. **4-H&S: Transportation**

4.12.21. Transport packages for all options will be required to satisfy the extant Transport Regulations [4.10.2]. Approvals for transportation will only be given once the regulator is satisfied that the possibility of incidents and accidents has been minimised and that the radiological content of a package can be effectively contained if an incident/accident were to occur.

4.12.22. The packaged waste option will probably carry minimal risk of an unplanned radiological release during transportation. It uses an approved storage container which must comply with the transport regulations, including those which limit the contents and the external dose rates. Therefore the probability of an unplanned radiological release during transportation will be very small.

4.12.23. Provided the passive safety and regulatory requirements for transportation of RCs and RPVs have been met, these should also carry minimal risk during transportations.

4.12.24. In the report on transportation accidents and incidents [4.3.5], it was stated that up to half a million packages containing radioactive materials are transported to, from and within the UK every year, by rail, road, sea and air. It is recognised that many of these involved small packages which are not relevant to the SDP. During 2009, 32 accidents and incidents occurred. None of these 32 reported events resulted in any significant external or internal radiation doses to workers or members of the public.

4.12.25. Points of consideration include but are not restricted to the list shown in the table below, taken from the 2011 MCDA scoring workshop report [4.1.1].

4.12.26. **Table 4.12.2: Issues Relevant to 4-H&S**

#	TOPIC	ISSUE
A	**Transportation**	• Transportation is covered under 3-POL • All transportations are in accordance with UK Transport Regulations. All transport packages (RC, RPV and $3m^3$ boxes) must be approved for transportation by the Regulators. • Approvals require the probability of incidents and accidents to be minimised and demonstrate that the radiological content is effectively contained under accident conditions. • Transportation of RCs, RPV and packaged waste all carry minimal risk of unplanned radiological release. • Submarine transportation – unplanned radiological release could occur if the submarine suffered an impact during its transportation to the initial dismantling site which could in turn lead to the vessel sinking. Unplanned radioactive release could result under these conditions.
B	**Safety**	• All transportations will be undertaken in accordance with Transport Regulations, safety legislation and ALARP/ALARA. • All packages are approved for transport by the Regulator prior to their use.

4.12.27. **5-H&S:Storage**

4.12.28. During the storage period, the potential for an unplanned radiological release is linked to the passive safety of each of the packages. A passively safe wasteform is one in which the waste is chemically and physically stable, and is stored in a manner that minimises the need for safety mechanisms, maintenance, monitoring and human intervention, and that facilitates retrieval for final disposal.

4.12.29. Issues relating to passive safety will include the integrity of the storage container under normal storage conditions taking account of existing and future contents, the latter resulting from degradation of the existing contents during interim storage. CRUD and free liquids will need to be removed. The packages must be periodically inspected during storage.

4.12.30. Storage of packaged waste will probably carry minimal risk of an unplanned radiological exposure. This option uses an approved storage container which has been specifically designed for long-term interim storage and final disposal. Therefore, it has been designed to retain structural integrity and the possibility of inadvertent radiological exposure during the storage period will be very small.

4.12.31. Provided the passive safety requirements for RCs and RPVs have been met, these options should also carry minimal risk, albeit at a risk level slightly higher than that for packaged waste. It is noted that making RCs passively safe could be challenging.

4.12.32. Points of consideration include but are not restricted to the list shown in the table below, taken from the 2011 MCDA scoring workshop report [4.1.1].

4.12.33. **Table 4.12.1: Issues Relevant to 5-H&S**

#	**TOPIC**	**ISSUES**
A	**Storage**	• Unplanned release is linked to passive safety of the packages. • Packaged Waste – minimal risk of unplanned radiological exposure from packaged waste. The approved storage containers are specifically designed for long term interim storage and final disposal. The design ensures the integrity of the structure is retained and the unplanned radiological exposure during storage should be very small. • RC and RPV storage – provided the passive safety requirements are met the risk of unplanned radiological release during storage should be minimal, although at a slightly higher risk than for packaged waste.
B	**Accident**	• An unplanned radiological release could occur if an accident happens e.g. whilst positioning the packages, RC's or RPV's in the interim store. • The containers could be dropped when being lifted by cranes or by forklift. • Damage to the containers could occur if the forks damage the package or containers.

#	TOPIC	ISSUES
C	**Safety**	• All storage operations will be undertaken in accordance with appropriate safety legislation and ALARP/ALARA. • The probability of unplanned radiological exposure will be minimised through good practice, training and an inspection and maintenance program. Risk assessments will be produced for all aspects of work in the store.

4.12.34. Discussion

4.12.35. Discussion is required on a number of issues, including:

- Does deferring initial dismantling operations decrease or increase the risk of an unplanned radiation release?
- Issues raised by members of the public during the Public Consultation process.
- Does this criterion discriminate between the options?

4.13. 1-ENV: Radiological Discharges to the Public

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT

The scoring guidance from MCDA 2011 and additional text on BPEO and BAT have been added.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

Significant changes were made to the 1-ENV supporting data as a consequence of the workshops. Additional data relating to the impacts on the critical group of radiological releases during initial dismantling was included in both the text and corresponding annex of 1-ENV. This additional data informs both 1-ENV (Radiological Discharges to the Public) and 2-ENV (Radiological Discharges to the Environment).

4.13.1. This criterion considers the impact of both planned and unplanned liquid and gaseous radiological discharges on members of the public. This includes consideration of the existing sources of emissions, the nature of the likely releases and the impact on the critical group. It also addresses the characteristics of the potentially affected communities (which will include demographic profile of sensitive groups, such as children and pregnant women) through exposure to releases.

4.13.2. An unplanned radiological discharge is interpreted in this report as a maximum *credible* unplanned release, rather than a maximum *possible* unplanned release, as defined in 3, 4, 5-H&S above. At this stage, it is only possible to apply SME judgement on unplanned releases and to consider the examples provided below which are based on experience within the civil nuclear industry.

4.13.3. Assumptions

4.13.4. See Annex A, Section A22.

4.13.5. Data

4.13.6. Whilst the nature of radiological releases is determined by the technical nature of the dismantling and storage processes, the impact on the public is determined by where these activities take place. Data is provided below on the two known initial dismantling sites at Devonport and Rosyth. The possible location of interim ILW storage is not known beyond those sites, hence no further site-specific information is presented.

4.13.7. **Devonport**

4.13.8. Plymouth's resident population of 256,700 is 49.2% male and 50.8% female. 53,000 are under 18 and 38,474 people are over 65 years old. The average life expectancy in Plymouth is slightly below the UK average but going up overall; however, some more deprived areas have lower than average values [4.13.1]

4.13.9. A 2006 NHS study [4.13.2] reported that Plymouth has higher cancer rates than the national average; however no geographic association was detected between cancer rates and distance to the Tamar Estuary, and no excess of cancers known to be radiation-sensitive was found. The excess of cancers was however statistically linked to socio-economic deprivation, and in particular smoking.

4.13.10. Devonport is a radon-affected area due to the prevalence of igneous bedrock underlying west Devon and Cornwall. 5 to 10% of dwellings in the Devonport area have been assessed as having radon levels above the accepted Action Level of 200 Becquerels per m^3 of air [4.13.3].

4.13.11. Existing licensed activities at Devonport Dockyard Ltd. include permitted releases to air, sewer and the Hamoaze estuary. The radionuclides include Cobalt-60, Carbon-14 and Tritium, as well as nuclides of lower radiological significance.

4.13.12. **Table 4.13.1: Annual Liquid Discharge Limits from Devonport Royal Dockyard**

LIQUIDS

Radionuclide/ Group	**Annual Limit to the Hamoaze**	**Annual Limit to Sewer**
Tritium	700 GBq	2 GBq

Carbon-14	1.7 GBq	
Cobalt-60	0.8 GBq	0.35 GBq
Other Radionuclides	0.3 GBq	0.65 GBq

4.13.13. **Table 4.13.2: Annual Gaseous Discharge Limits from Devonport Royal Dockyard**

GASES

Radionuclide/ Group	Annual Limit to Air
Tritium	4 GBq
Carbon-14	43 GBq
Argon-41	15 GBq
Beta/ gamma activity associated with particulates	0.3 MBq

4.13.14. In 2009, the dose to the ‘critical group’ (i.e. those people with the highest feasible exposure) as a result of DRDL’s discharges was calculated to be 2.7 μSv (0.0027 mSv) per year. This is less than 0.3% of the statutory limit of 1 mSv per year [4.13.4] and is considered to be of low radiological significance. The UK average annual dose from all sources is about 2.7 mSv per year, whilst average annual doses from radon alone in Cornwall have been estimated at 6 mSv [4.13.5]

4.13.15. **Data: Rosyth**

4.13.16. Fife’s resident population of 363,500 is 48.3% male and 51.7% female. The trend in Fife is of gradually improving health. Between 1995 and 2004, death rates from cancer, coronary heart disease, strokes and respiratory disease all fell significantly; West Fife now has male life expectancy significantly better than the Scotland average, whilst for females the rates are around average [4.13.1] Fife is not a radon-affected area, with less than 1% of dwellings above the Action Level.

4.13.17. The incidence of cancers around Rosyth is not significantly elevated. The incidence of childhood leukaemia and non-Hodgkin lymphoma is close to that expected (ratio = 1.03) but does appear to decrease with distance from the Naval Base. This is being investigated further [4.13.6].

4.13.18. Existing licensed activities at Rosyth Dockyard include permitted releases to air, sewer and the Forth Estuary. They include Cobalt-60, Carbon-14 and Tritium, as well as nuclides of lower radiological significance. The regulatory limit for Rosyth is 1.0 mSv per year.

4.13.19. **Table 4.13.3: Annual Liquid Discharge Limits from Rosyth Royal Dockyard**

LIQUIDS

Radionuclide/Group	**Annual Liquid Limit**
Tritium	3 GBq
Cobalt-60	0.3 GBq
Other radionuclides	0.3 GBq

4.13.20. **Table 4.13.4: Annual Gaseous Discharge Limits from Rosyth Royal Dockyard**

GASES

Radionuclide/ Group	**Annual Limit to Air**
Tritium	4 GBq
Carbon-14	43 GBq
Argon-41	15 GBq
Beta/ gamma activity associated with particulates	0.3 MBq

4.13.21. In 2009, gaseous discharges from Rosyth were below the limit of detection, and gamma dose rates could not be distinguished from background. Tritium and Cobalt-60 discharges to the Firth of Forth continue to decline and are well below authorised limits. In 2009, doses to those in the immediate vicinity of Rosyth were assessed to be less than 0.005 mSv (<0.5% of the dose limit of 1 mSv) [4.13.7].

4.13.22. Case Study

4.13.23. In 2001, Babcock Marine produced a document which contained an application to SEPA for an Authorisation under RSA 93 to disposal of wastes arising from the dismantling of Renown at Rosyth Royal Dockyard (SRD) [4.13.8].

4.13.24. The scope of the dismantling process included cleaning the primary circuit using and established chemical process, removing the contents of the reactor compartment, removal and on-site (AWAF) storage of the RPV.

4.13.25. **Planned Discharges**

4.13.26. **Liquid Wastes**

4.13.27. The process to dismantle Renown would give rise to liquid low level radioactive waste, but the disposal of wastes arising from this process was not covered by existing disposal authorisations, since the dismantling of Renown was considered to be a decommissioning project and therefore a new practice.

4.13.28. **Methodology**

4.13.29. **Radiological Source Term**

4.13.30. The volumes and radionuclide content of the various liquid waste streams were quantified, based on historical data and sampling and analysis data (e.g. tritium).

4.13.31. **Treatment prior to Discharge**

4.13.32. Best Practical Means (BPM) was used to minimise the activity of the liquid wastes that were to be discharged. The Effluent Treatment Plant (ETP) would be used to treat effluents prior to discharge to the River Forth, via the Low Active Effluent Discharge (LAED) line.

4.13.33. **Discharge Data**

4.13.34. The volumes and activity concentrations of the liquid discharges were quantified and this allowed calculation of the total volumes and radionuclide activities to be discharged.

4.13.35. **Comparison with Existing Authorised Limits**

4.13.36. The predicted activities to be discharged were compared to the extant authorised limits for disposals of liquid wastes and to historical discharge data from 1992 to 2000. This allowed a view to be taken on whether the discharge limits would need to be increased for the dismantling of Renown. Comparisons were also made with discharges from other UK nuclear sites, to put the Rosyth discharges in context.

4.13.37. **Environmental Monitoring**

4.13.38. Environmental monitoring is routinely carried out by Babcock to assess the impact of its radioactive waste discharges. Independent monitoring programmes (SEPA, DERA Radiation Protection Services: (DRPS)) are also carried out. The data derived from these Environmental monitoring data was presented and summary conclusions drawn.

4.13.39. **Radiological Assessment**

4.13.40. The radiological impact of liquid discharges to the Firth of Forth from Renown dismantling was assessed.

4.13.41. The PC CREAM software package was used to assess radiation doses to individuals in the Rosyth critical groups (and collective doses to the “European Population”).

4.13.42. The pathways included ingestion of fish, molluscs, crustaceans, inhalation of seaspray, external gamma and external beta irradiation from activity in beach sediments, external exposure to gamma radiation and beta radiation in fishing gear.

4.13.43. The critical group was (conservatively) assumed to be represented by an individual who consumes seafood and is exposed to sediments and sea spray.

4.13.44. The total dose to the critical group was derived and compared to a number of other limits and values.

4.13.45. **Radiological Assessment Results: Liquids**

4.13.46. The radiation dose to a member of the critical group was assessed at 4.6×10^{-5} (i.e. 0.000046) microSieverts per year. The most significant radionuclide was C-14 and the pathway of greatest significance was the consumption of fish.

4.13.47. The above radiation dose is less than the recommended annual dose limit for members of the public (1000 microSieverts per year), less than the 300 microSieverts per year recommended in the NRPB response to the 1990 recommendations of ICRP, and less than the average natural background radiation (2,200 microSieverts per year).

4.13.48. **Best Practicable Environmental Option (BPEO)**

4.13.49. The above data and other data generated in support of the discharge authorisation was used to determine the BPEO for the management and disposal of liquid wastes generated from the processes used to dismantle Renown.

4.13.50. **Gaseous Wastes**

4.13.51. A similar exercise was carried out for gaseous wastes, this time using different sources terms, abatement technologies and radiation pathways.

4.13.52. **Radiological Assessment Results: Gases**

4.13.53. The radiation dose to a member of the critical group was assessed at 2.3×10^{-2} (i.e. 0.023) microSieverts per year. The most significant radionuclide was C-14 and the pathway of greatest significance was the consumption of grain products and milk products.

4.13.54. The radiation dose is less than the recommended annual dose limit for members of the public (1000 microSieverts per year), less than the 300 microSieverts per year recommended in the NRPB response to the 1990 recommendations of ICRP. The dose to the critical group is also significantly less than the 10 microSieverts per year which is the dose that has widespread international agreement for being sufficiently low to be of no regulatory concern.

4.13.55. **Summary of Discharge and Dose Data**

4.13.56. The tables below summarise relevant environmental discharge and dose data contained in the 2001 Application to SEPA for the dismantling of Renown. The quantities of radionuclides provided in the tables are those requested in the 2001 Application.

4.13.57. **Table 14.13.5: Renown: Liquid Discharges and Dose Rate Data**

Liquid Discharges	Value	Units
• Co-60	20	MBq
• Tritium	500	MBq
• Beta emitting radionuclides (other than Co-60 and tritium)	20	MBq
• Liquid volume	ca. 25	Cubic metres
• Radiation dose to a member of the critical group	0.000046	microSv/year
• Most significant radionuclide	Beta emitters (assumed to be represented by C-14)	
• Pathways of greatest significance	Consumption of fish	

4.13.58. **Table 14.13.6: Renown: Gaseous Discharges and Dose Rate Data**

Gaseous Discharges	Value	Units
• C-14	330	MBq
• Tritium	50	MBq
• Beta emitting radionuclides (other than Carbon-14 and tritium)	0.1	MBq
• Radiation dose to a member of the critical group	0.023	microSv/year
• Most significant radionuclide	C-14	
• Pathways of greatest significance	Consumption of grain products and milk products	

4.13.59. **Applicability to 1-ENV and 2-ENV Criteria**

4.13.60. There are some differences between current SDP intentions and the 2001 Application to SEPA. For example, decontamination of the primary circuit is addressed in the 2001 Application to SEPA but will not be part of SDP. This indicates that the 2001 radiological source data may be an overestimate. In spite of some differences, the data contained in the 2001 Application to SEPA are considered applicable to SDP. It is in fact the only relevant available data which addresses both discharges and dose rates to the critical group.

4.13.61. **SDP Waste Generating Processes**

4.13.62. There are two processes which will give rise to the majority of the liquid and gaseous effluents. These are RPV removal and size reduction of the RPV to create packaged waste.

4.13.63. As discussed above, the radiation dose to the critical group from RPV removal is that derived in the 2001 Application to SEPA. However, there are no available data from operation of an RPV size reduction facility.

4.13.64. Operation of a size reduction facility will involve more metal cutting than RPV removal, therefore there will be more cooling and decontamination liquids to be dealt with. A size reduction facility also has to deal with the CRUD inside the RPV. The 2001 Application to SEPA data did not address the CRUD inside the RPV. This might be a basis to suggest that operation of a size reduction facility will lead to production of more liquids and possible higher discharged activities compared to RPV removal.

4.13.65. However, it could be argued that, as stated in the 2001 Application to SEPA, that liquid wastes streams will be treated, repeatedly if necessary, until the concentration of the Co-60 (and presumably other radionuclides) is below a level at which further treatment will not yield any significant improvement. In other words, application of the abatement technologies will be optimised to ensure very low levels of discharges. This might be a basis to suggest that the discharges from both facilities will be similar.

4.13.66. It is concluded that, for the purposes of this document, the radioactivity content of both sets of environmental discharges from the dismantling and waste management of Renown can be regarded as similar and that the doses to the critical groups will also be similar.

4.13.67. **Summary of Doses to the Critical Group**

4.13.68. Each of the main options involves discharges of both liquids and gases during both RPV removal and size reduction. The maximum dose to the critical group(s) would arise if both operations were conducted at the same time. The maximum dose would be 2 x 0.023046 = 0.046092 microSieverts per year, rounded up to 0.05 microSieverts per year.

4.13.69. Thus the maximum dose to the critical group for planned discharges to the Rosyth environment associated with the dismantling of Renown is estimated at about 0.05 microSieverts per year.

4.13.70. **Unplanned Discharges**

4.13.71. The arguments above relate to planned discharges. This section relates to unplanned discharges but excludes those associated with major accident scenarios. A radiological incident/event could give rise to unplanned liquid and gaseous discharges. For a given incident scenario, facilities which have high quantities and concentrations of radioactivity have the potential to discharge more than their lower activity counterparts. The dose to members of the public from unplanned discharges could well be lower for time-deferred operations compared to those undertaken immediately.

4.13.72. Thus the highest unplanned dose to members of the public would be from the Packaged Waste option (which involves immediate RPV removal and immediate size reduction) and the lowest unplanned dose would be from the RC option (which involves deferred RPV removal and deferred size reduction). Unplanned doses from the RPV option (which involves immediate RPV removal and deferred size reduction) would be somewhere in between.

4.13.73. The relative proportions of radiation doses to members of the public from planned and unplanned environmental discharges is by definition difficult to predict.

4.13.74. **Differentiation between Rosyth and Devonport**

4.13.75. The 2001 Application to SEPA is based on dismantling at Rosyth. Equivalent dose data for dismantling at Devonport are not yet available.

4.13.76. The discussion below explores to what extent the Rosyth dose data described above can applied to Devonport.

4.13.77. The application of the abatement technologies/techniques (e.g. filtration, ion exchange) and the types and quantities of radioactivity discharged to the environment from both sites will not vary significantly between sites.

4.13.78. The transport mechanisms by which discharged radioactivity is carried from the point of discharge to the critical groups will be similar, but there will be variations in the specific pathways depending on local factors.

4.13.79. The two sites have broadly similar groups of people, who can potentially be exposed to radiation from discharges to the environment. These include local fishermen, anglers, beach users and seafood consumers. The 2010 RIFE reported that the most exposed group at Rosyth were adults (local fishermen, beach users) spending time on shoreline sediments. The most exposed group at Devonport was adults spending a long time over riverside sediments. None of the doses were greater than 5 microSieverts per year.

4.13.80. However, these critical groups are at varying distances from the discharge points on the sites and their habits (e.g. food consumption, occupancy rate) and those of the members of the public will vary considerably.

4.13.81. It is therefore not possible at this stage, to quantify the differences between the dose impacts on the public arising from similar environmental discharges from Rosyth and Devonport.

4.13.82. However, it could be argued that similar environmental discharges from Rosyth and Devonport will have a similar environmental impact and will result in broadly similar doses to the public. The caveat is that this does not take into account the different pathways from the discharge points to the environment or the habits (e.g. food consumption, occupancy rate) of the members of the public at either of the sites.

4.13.83. **Scoring Scale**

4.13.84. In 2002, the Environment Agencies, the Food Standards Agency and the NRPB tabulated radiation protection criteria [4.13.9] for members of the public. These are summarised below.

- **1000 microSv per year:** Legal dose limit set out in the European Basic Safety Standards and implemented in UK through the Ionising Radiations Regulations (IRR 99).
- **500 microSv per year:** Site constraint from UK Government introduced when the nuclear industry was being restructured.
- **300 microSv per year:** Source constraint from NRPB (National Radiological Protection Board) and also recommended in Cm-2919.
- **20 microSv per year:** Threshold at low doses contained in Cm-2919 and in the document “Tolerability of Risks from Nuclear Power Stations”. This value is consistent with HSE SAPs (Safety Assessment Principles).
- **10 microSv per year:** Threshold at low doses and quoted in the 2001 Application to SEPA and other documents as having widespread international agreement for being sufficiently low to be of no regulatory concern. It should be noted that all doses no matter how small, remain subject to ALARA. This is achieved through application of BPM to limit and control authorised discharges to waste to the environment.

4.13.85. **Suggested Upper Scoring Limit**

4.13.86. It is suggested that the upper scoring limit of 10 microSieverts per year is adopted for scoring purposes. This is 1% of the legal limit.

4.13.87. **Suggested Lower Scoring Limit**

4.13.88. It is suggested that the lower scoring limit is 0 microSieverts per year, which corresponds to zero liquid and zero gaseous discharges.

4.13.89. **Suggested Scoring Scale**

4.13.90. Values in between the upper and lower limits should be described in qualitative rather in numerical terms. Thus:

- Score 0: Greater than regulatory concern. (For example, doses >10 microSieverts per year).
- Score 1: Equal to regulatory concern (For example, doses = 10 microSieverts per year).
- Score 2: Intermediate (For example, doses at the higher end of the range between 1 and 10 microSieverts per year).
- Score 3: Less than regulatory concern. (For example, doses at the lower end of the range between 1 and 10 microSieverts per year).
- Score 4: Intermediate. (For example, doses at the higher end of the range between 0.1 and 1 microSieverts per year).

- Score 5: Considerably less than regulatory concern. (For example, doses at the lower end of the range between 0.1 and 1 microSieverts per year).
- Score 6: Intermediate. (For example, doses between 0.01 and 0.1 microSieverts per year).
- Score 7: Near zero dose impact on the public. (Near zero environmental discharges. Radiation doses to the public from dismantling greater than 0 microSv per year. Majority of analyses below limits of detection. For example, doses less than 0.01 microSieverts per year).
- Score 8: Intermediate. (For example, doses much less than 0.01 microSieverts per year).
- Score 9: Zero dose impact on the public. (Zero environmental discharges. All analyses below limits of detection. Radiation doses to the public from dismantling of 0 microSv per year. All analyses below limits of detection. For example, doses = 0 microSieverts per year).

4.13.91. It is stressed that the above is for guidance only and should not constrain the scoring.

4.13.92. Public Consultation

4.13.93. See Section 4.19.

4.13.94. Discussion

4.13.95. All of the three main options (RC separation; RPV removal and interim storage; and RPV removal, early size reduction and interim storage of packaged waste) involve common life cycle activities, the principal difference between the options being when particular activities are undertaken. Consequently, the issues associated with each stage of the life cycle apply across all of the technical options. There will be minor differences depending on the exact techniques employed.

4.13.96. Scheduled Operations: As a result of radioactive decay, delaying any activity that involves work with radioactive material will result in a reduction of the total activity that could potentially be discharged to the environment during dismantling and storage operations. Immediate dismantling of the RPV into packaged waste could result in greater mitigated discharge to the environment (and hence to the public) than deferred dismantling.

4.13.97. It must be borne in mind, however, that a statutory environmental permit will be required to undertake submarine dismantling, irrespective of the selected option. Permitting will make it necessary to demonstrate that any discharges to the environment are minimised, and are within defined limits. It will also be necessary to demonstrate that any waste generating processes, waste treatment and disposal options are consistent with the principles of BAT (Best Available Techniques) and that adequate research and development have been carried out in support of the choices made.

4.13.98. Unplanned Releases: An unplanned radiation release could arise from an incident involving the gamma radiation emitted by Co-60, or the beta radiation emitted by other long and short-lived isotopes.

4.13.99. The risk of a credible unplanned release of radioactivity into the environment will intuitively increase in proportion to the extent of RPV dismantling, although it decreases with time. Hence, the risks associated with an unplanned event are ordered in the same way as for factors 3, 4 and 5-H&S, although they would be expected to be significantly smaller than they could be for workers.

4.13.100. At this stage, it is only possible to apply Subject-Matter Expert (SME) judgement and to consider the examples provided, based on experience within the civil nuclear industry. It is assumed that the risk of accidental discharge is very low hence the radiological dose to the public will continue to be below statutory limits. This will be clarified by the SMEs at the workshop. It is recognised that this low level of risk may not be the public's perception. In this respect, anxiety relating to operational activity and in particular the radioactive waste element of site's operation may have a negative effect on the wellbeing of some within the local population.

4.13.101. The Best Available Environmental Option (BPEO) is explained in [4.2.5] as a procedure that establishes, for a given set of objectives, the option that provides the most benefits or the least damage to the environment as a whole, at acceptable costs in the long term as well as in the short term. Options are reviewed through a systematic consultative and decision-making process which emphasises the conservation of the environment.

4.13.102. The Best Available Technique (BAT) is explained in [4.2.5] as a way of preventing and where not practicable, minimising waste generation and discharges to the environment. A similar term "BATNEEC" (Best Available Technique Not Entailing Excessive Cost) has been used in the past by the Environment Agency, but is no longer used. Best Practicable Means (BPM) continues to be used.

4.13.103. One interpretation of BPEO is that it is a high level term (used for optioneering purposes) which sits above BAT. BAT is at a lower level and addresses the technologies/techniques which can be used to prevent or minimise discharges to the environment. Examples of BAT would include filtration, ultra-filtration and ion-exchange used in liquid effluent treatment plants.

4.13.104. Another, more recent interpretation is that both terms mean the same. The EA [4.5.3] believe BAT to be broadly the same concept as BPEO and BPM and to deliver the same level of environmental protection. Where operators were already using BPM/BPEO, they would therefore satisfy the requirements of BAT when England and Wales changed to BAT (ca. 2009). EA also considered that the process for assessing BAT is the same as that for BPEO/BPM.

4.13.105. BPEO is used in Scotland, whereas BAT is used in England and Wales.

4.14. 2-ENV: Radiological Discharges to the Environment

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT

The scoring guidance from MCDA 2011 and additional text on liquid and gaseous discharges have been added.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant changes were made to the 2-ENV supporting data as a consequence of the workshops. The additional data contained in 1-ENV (Radiological Discharges to the Public) is intended to also inform 2-ENV (Radiological Discharges to the Environment).

4.14.1. This criterion considers the impact of planned and unplanned liquid and gaseous radiological discharges on the environment. This will include consideration of the existing sources of emissions, the nature of the likely releases and the characteristics of the receiving environment. This criterion covers a range of possible environmental impacts including any aspects associated with biodiversity and nature conservation, soil and geology, air and water. By its very nature, this criterion is very similar to 1-ENV, since dose to the public will be via the wider environment, through air, water, soil and food.

4.14.2. Assumptions

4.14.3. See Annex A, Section A22.

4.14.4. Data: Environmental Discharges (Under Normal Operations)

4.14.5. The predominant mechanisms for release of radioactivity into the environment under normal operations are:

- discharge of liquids containing soluble and insoluble radionuclides; and
- release of gases containing radionuclides in gaseous or particulate form.

4.14.6. Information generated as part of the initial submarine dismantling concept design (being undertaken by Babcock Marine) is shown below. It is cautioned that this is preliminary information which may change with time.

4.14.7. **Liquids**

4.14.8. The principal liquid arisings from initial dismantling are shown below.

- Potassium chromate solution inside the Primary Shield Tank.
- Water inside the RPV.
- Facility process arisings.
- Handwash arisings (including showers, toilets).
- Active laundry for washing clothing used in active areas (optional).
- Liquid effluents from the radiochemical laboratory.

4.14.9. it is noted that no decisions have yet been made on the management of these wastes.

4.14.10. **Potassium Chromate**

4.14.11. Each submarine PST contains approximately 25 tonnes of a 1 % to 2% solution of potassium chromate. If the dismantling rate is one submarine per year, the annual arisings will be at least 25 tonnes per year. Flushing the PST to remove residual material will cause an increase in this volume.

4.14.12. The PST will be drained and the liquids collected in a mobile tank (often referred to as a bowser), sampled and analysed and then transferred to 200 litre drums. These drums will then be transported to an external site for processing and disposal. The Best Practicable Environmental Option in England for this waste is believed to be incineration.

4.14.13. it is not envisaged that any of the above liquids will be discharged to the environment around the initial dismantling site. Some tritium may be discharged to the environment during incineration.

4.14.14. **RPV Water**

4.14.15. Each submarine RPV contains some water containing boronated compounds and possibly small amounts of neutron activated products (such as Co-60, Ni-63, C-14, Tritium) inside the Reactor Pressure Vessel (RPV).

4.14.16. Each submarine contains approximately one cubic metre of this solution, therefore if the dismantling rate is one submarine per year, the annual arisings will be about one cubic metre per year. If the RPV head needs to be removed and replaced, and water is added for radiation protection purposes, the total volume of water will increase.

4.14.17. The RPV will be drained and the liquids collected in a mobile tank, sampled and analysed and then processed using a portable effluent treatment plant. The treatment processes will include filtration but more details are not yet available.

4.14.18. After treatment, any solid waste arisings will be transported to an external site for processing and disposal. Any low activity liquids remaining after processing may be discharged to sea, provided they are below the authorised limits. Alternatively, if the volumes were low, they could be solidified (e.g. using cement) and treated as solid waste. No decisions have yet been made on the management of this waste stream.

4.14.19. **Facility Process Arisings**

4.14.20. These arisings consist predominantly of water which could contain small quantities of neutron activated products (such as Co-60, Ni-63, C-14, Tritium) generated by facilities where size reduction and other processes are taking place.

4.14.21. Liquids will be collected in a holding tank, sampled and analysed and then processed using a portable effluent treatment plant. The treatment processes will include filtration but more details are not yet available.

4.14.22. After treatment, any solid waste arisings will be transported to an external site for processing and disposal. Any low activity liquids produced may be discharged to sea, provided they are below the authorised limits. Alternatively, if the volumes were low, they could be solidified (e.g. using cement) and treated as solid waste.

4.14.23. **Handwash Arisings**

4.14.24. These waste stream consist predominantly of water from dockside or non dockside facilities. Handwash arisings may contain radionuclides (such as Co-60, Ni-63, C-14, Tritium) at very low concentrations. For example, if a worker is found to be contaminated with radioactivity and washes this off inside a shower, the resultant water would become slightly contaminated with very small quantities of radioactivity.

4.14.25. The liquids will be collected in a holding tank and sampled and analysed. They would be transferred by bowser to a discharge point or discharged directly to sea via an authorised route. The total amount of radioactivity discharged to the environment is anticipated to be very low. No decisions have been made on the management of this waste stream.

4.14.26. In the civil nuclear industry, such waste streams would be designated as high volume, low activity and where possible would be discharged to sea via authorised discharge routes. Very often the radioactivity concentrations of such waste streams are below relevant limits of detection.

4.14.27. **Laundry**

4.14.28. This waste stream consists predominantly of liquids generated during operation of the active laundry, used to clean the clothes used by workers.

4.14.29. It is not yet clear if an active laundry will be used.

4.14.30. The liquid effluent consists of water potentially containing radionuclides (such as Co-60, Ni-63, C-14, Tritium) at very low concentrations. For example, if the clothing worn by worker is contaminated with radioactivity and this cleaned in the laundry, the resultant water would become contaminated with very small quantities of radioactivity.

4.14.31. These are high volume low activity liquids and would be treated in a similar manner described above for handwash arisings.

4.14.32. **Radiochemical Laboratory**

4.14.33. This waste stream consists predominantly of liquids from the radiochemical laboratory which could contain radionuclides (such as Co-60, Ni-63, C-14, Tritium). For example, if a liquid sample is taken for analysis and other materials (e.g. scintillating fluids) are added to facilitate its assay, the resulting fluids could be contaminated with radioactivity.

4.14.34. It is not yet clear if an on-site radiochemical laboratory will be used.

4.14.35. These are low volume potentially high activity liquids and would be treated in a similar manner described above for RPV water.

4.14.36. **Gaseous Releases**

4.14.37. All SDP facilities that have the potential to become radioactively contaminated will be fitted with ventilation systems. These facilities include the submarine Reactor Compartment, the In Dock Installation, any facilities used for size reduction, storage etc, the laundry, radiochemical laboratory and any mobile plant used (e.g. that for liquid effluent treatment).

4.14.38. Typically air will be drawn from an area through coarse pre-filters and then through high efficiency (HEPA) filters which will capture 99.9% or better of particulates with diameters above 0.3 micrometers. These solids will eventually be disposed of as solid waste. Tritium, carbon-14, halogens and noble gases will not be captured in the HEPA filters and may be discharged to atmosphere. The amounts of radioactive gaseous to be discharged are anticipated to be low.

4.14.39. **Variations between Options**

4.14.40. The volumes and activities of liquids discharged from a facility will depend on the operations involved and the size, nature, duration and timing of a particular facility.

- The RC separation option(s) may generate small amounts of liquid process wastes from intrusive operations to make the unit passively safe. Larger amounts may be generated from the eventual size reduction of the RC.
- The RPV removal options will generate liquid process wastes from intrusive operations to remove and size reduce the LLW and ILW components inside the RC.
- Immediate size reduction has the potential to discharge more radioactivity into the environment compared to that anticipated for deferred size reduction.

4.14.41. The volumes of gaseous arisings will vary with the activities involved and the durations of operations. The total quantities of discharged radioactivity will be low and may not vary significantly between the options.

4.14.42. **Data: Devonport**

4.14.43. Gaseous discharges could be generated during size reduction operations. Liquid discharges could be generated from water-jet cutting, the decontamination of removed components and reactor pressure vessel draining.

4.14.44. Plymouth has nine Sites of Special Scientific Interest. Devonport is immediately adjacent to the Plymouth Sound and Estuaries Special Area of Conservation (EU designation under the Habitats Directive), and within 5km of the Tamar Estuaries Complex Special Protection Area (EU designation under the Wild Birds Directive).

4.14.45. Existing licensed activities at Devonport Dockyard are as described in Table 14.1 for ENV-1. They include permitted releases to air, sewer and the Hamoaze estuary. They include Cobalt-60, Carbon-14 and Tritium, and other radionuclides.

4.14.46. In 2007, nuclide concentrations were below the limit of detection in the majority of marine samples, such that the dockyard's contribution to the natural background radiation dose was indistinguishable [4.13.4]. The radionuclides discharged into Plymouth Sound continue to be of low radiological significance [4.13.7]

4.14.47. **Data: Rosyth**

4.14.48. Fife's coastland and wetlands are important sites for migrating wildfowl and breeding seabird populations. Fife has 48 SSSIs, two SACs, two SPAs, one Ramsar site (designated at International level for internationally-important wetlands); seven local nature reserves and one regional park.

4.14.49. Licensed activities at Rosyth Dockyard include permitted releases to air, sewer and the Forth Estuary. They include Cobalt-60, Carbon-14 and Tritium and other radionuclides. The regulatory limit for Rosyth is 0.5 mSv per year.

4.14.50. In 2009, gaseous discharges from Rosyth were below the limit of detection. Tritium discharges to the Firth of Forth remained steady, whilst those for Cobalt 60 continue to decline. Both are well below authorised limits [4.13.7].

4.14.51. Further information on radioactive discharges at Rosyth is provided under 1-ENV, in the sections which discuss the Babcock proposal for dismantling Renown [4.13.8].

4.14.52. Public Consultation

4.14.53. See Section 4.19.

4.14.54. Discussion

4.14.55. All of the three main options (RC separation; RPV removal and interim storage; and RPV removal, early dismantling with storage as packaged waste) involve common life cycle activities, the principal difference between the options being when particular activities are undertaken.

4.14.56. **Scheduled Operations:** As a result of radioactive decay, delaying any activity that involves work with radioactive material will result in a reduction of the total activity that could potentially be discharged to the environment during normal operations. Immediate dismantling of the RPV into packaged waste could therefore result in greater mitigated discharge to the environment than deferred dismantling.

4.14.57. However, an Environmental Permit issued by the Environment Agency (and equivalent consent in Scotland) will be required to undertake submarine dismantling irrespective of the selected option. It will be necessary to demonstrate that any discharges to the environment are both minimised, and within the limits defined in the site permit. It will also be necessary to demonstrate that any waste generating processes, waste treatment and disposal options are consistent with the principles of BAT (Best Available Techniques) and that adequate research and development has been carried out in support of the choices made.

4.14.58. **Unplanned Releases:** An unplanned radiation release could arise from the gamma radiation emitted by Co-60, or the beta radiation emitted by other long and short-lived isotopes.

4.14.59. The risk of a credible unplanned release of radioactivity into the environment will intuitively increase in proportion to the extent of RPV dismantling, although it decreases with time. Hence, the risks associated with an unplanned event are ordered in the same way as for factors 3, 4 and 5-H&S, although they would be expected to be significantly smaller than they could be for workers. At this stage, it is only possible to apply SME judgement and to consider the examples provided based on experience within the civil nuclear industry. It is assumed that the radiological dose to the environment from unplanned releases will continue to be below statutory limits, and the risk of accidental discharge is very low. This will be clarified by the SMEs at the workshop.

4.15. 3-ENV: Non-Radiological Impact on the Public

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT

No changes have been made to 3-ENV.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant changes were made to the 3-ENV supporting data as a consequence of the workshops.

4.15.1. This criterion considers the non-radiological impact on the public of SDP activities. These activities include discharges of non radiological solids, liquids and gases into the environment, the creation of hazardous wastes, the safety risks associated with transportation of heavy, bulky items, and issues which could cause a statutory or non-statutory nuisance to the local communities, such as noise, vibration, dust and light pollution.

4.15.2. Assumptions

4.15.3. See Annex A, Section A22.

4.15.4. Data

4.15.5. The construction of the dismantling and storage facilities will require a range of materials to be transported onto the site (included aggregates, concrete, steel, timber and metals). The likely amounts of these materials that will be required cannot be ascertained at this early stage.

4.15.6. Dismantling of the submarines will generate a variety of potentially hazardous waste streams (e.g. mineral oils, hydraulic fluids, refrigerant gasses, asbestos and PCBs) as well as substantial quantities of material that will require processing, transportation and recycling.

4.15.7. Public Consultation

4.15.8. See Section 4.19.

4.15.9. Discussion

4.15.10. For all the options, the level of potential impact will be dependent on the site selected for dismantling and for storage and in particular, the proximity of proposed activities to sensitive receptors.

4.15.11. There is potential for construction, dismantling and interim storage activities to impact on the local environment (e.g. dust generation from earthworks, demolition, construction, and exhaust emissions from vehicles and plant) which could be a cause of local nuisance and disturbance.

4.15.12. Whilst all three technical options would ultimately lead to the production of packaged waste, the phasing of the construction of some site components could differ across the technical options. Construction disturbance could be greatest for the RC storage option if a large new-build facility of ca. 11,600 m2 is required. Conversely, the specialist equipment for the packaged waste option may also require development of a new and bespoke facility. Both RC separation and RPV removal will require two phases of development, which may keep levels of noise and vibration low, but create two separate incidences of disturbance.

4.15.13. Operational activities may result in increased noise and vibration which could have a negative effect on the health and well-being of the local community. Causes of noise and vibration may include the use of cutting equipment and HGV movements required to transport materials, equipment and waste to/from the site.

4.15.14. The Devonport and Rosyth dockyards are located approximately 385 miles and 175 miles respectively by road and rail from the LLWR in Cumbria. Following interim storage and taking into account distance only, there is a greater potential for transport of LLW from Devonport to have a greater noise and vibration impact associated with the transport of waste.

4.16. 4-ENV: Non-Radiological Impact on the Environment

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT

The scoring guidance from MCDA 2011 has been added and the text on biodiversity and Nature Conservation has been updated.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant changes were made to the 4-ENV supporting data as a consequence of the workshops.

4.16.1. This criterion covers a range of possible environmental impacts including any aspects associated with air, soil and geology, water and biodiversity and nature conservation. The data presented below for Devonport and Rosyth are taken from the SEA Scoping Report [4.13.1]. The assessment will draw on the provisional outputs from a number of the environmental topics assessed in the SEA. These provisional SEA outputs will be used to complete a 'pre MCDA' assessment of options to feed into the assessment against this criterion and which will be presented at the workshop. Sequentially, the effects on environmental media/pathways (air, soil and water) will be considered before assessing the implications for the receptors (biodiversity and habitats).

4.16.2. Assumptions

4.16.3. See Annex A, Section A22.

4.16.4. Data: Devonport

4.16.5. Air quality in Plymouth is generally good, with the key pollutants being Nitrogen Dioxide (NO_2) and fine particulates (PM_{10}.) In 2009, annual average nitrogen dioxide (NO_2) levels in Plymouth were between 32 and 42.7 µg m^{-3} against a statutory target of 40µg m^{-3}. There are three Air Quality Management Areas (AQMAs) in Plymouth: 2 for NO_2; 1 for PM_{10}.

4.16.6. Plymouth has four geological SSSIs and a large number of unlicensed, historic waste disposal sites containing a variety of wastes, many of which were closed prior to 1974.

4.16.7. Inland water quality is generally good; 65% are in good biological condition and 100% are in good chemical condition. Plymouth Sound and Estuaries SAC and the Tamar Estuaries Complex SPA are protected water features. The water in Plymouth Sound has good ecological quality, but poor chemical quality.

4.16.8. Plymouth has nine SSSIs, one SAC and one SPA (the Tamar Estuaries Complex, which is predominantly in favourable condition). Current threats to the designated features of SACs and SPAs are mainly from increased coastal development, dredging and increased marine activity. Plymouth has six designated Local Nature Reserves, mostly situated on the eastern side of the city.

4.16.9. Data: Rosyth

4.16.10. Air quality in Fife is generally good. There are no AQMA's covering Rosyth dockyard or its vicinity.

4.16.11. Fife (including Clackmannanshire) has 24 geological SSSIs and 7,000 potentially contaminated sites, mainly as a result of the area's industrial heritage.

4.16.12. In Fife, water quality is relatively good. In 2007, 80% of bathing waters in Fife met quality standards. In 2006, 20% of rivers were rated as having excellent water quality; 42% were rated as good; 26% were rated fair; and 12% were rated as poor. River basin management plans are reducing agricultural and point source pollution.

4.16.13. Fife's coastland and wetlands are important sites for migrating wildfowl and breeding seabird populations. Fife has 48 SSSIs, two SACs, two SPAs, one Ramsar site, seven local nature reserves and one regional park. The environmental problems and threats affecting biodiversity in Fife include habitat fragmentation from development; invasive species; climate change impacts; agricultural practices; and land and freshwater pollution (including nutrient enrichment). Fife's wetlands, in particular, appear to be declining due to changes in habitat distribution and land use.

4.16.14. Public Consultation

4.16.15. See Section 4.19.

4.16.16. Discussion

4.16.17. **Air**

4.16.18. Construction, dismantling and interim storage activities could impact local air quality if unmanaged. However, the greatest potential impact is anticipated to be associated with transport of materials and waste to/from site.

4.16.19. Local air quality impacts associated with construction activities could be greatest for the RC separation option if a new build facility is required. Storage at the point of generation would minimise air pollution by minimising transport distance.

4.16.20. **Soils and Geology**

4.16.21. Construction could impact on soil quality and increase contamination risks for existing pollutants.

4.16.22. By contract, redevelopment or new build is likely to require any existing contamination in the soil to be remediated as a requirement of the EIA.

4.16.23. **Water**

4.16.24. Construction, dismantling and interim storage activities may increase demand for water resources, affect the amount of wastewater and surface run-off produced and affect water quality. Water impacts associated with the RC option have the potential to be greater due to the size of the footprint of the facility, which in turn has the greatest potential to affect existing surface run off rates. The actual effects will depend on existing conditions and the extent to which Sustainable Urban Drainage Systems (SUDs) are used.

4.16.25. Any impacts on water quality and the distribution of marine sediments at Devonport from SDP activities could impact on the adjacent Plymouth Sound SAC. It is noted that the SAC is particularly sensitive to oil pollution.

4.16.26. Assuming that limited modifications would need to be made to the existing docking facilities and no additional channel works or dredging is required, no significant adverse impacts on the distribution of marine sediments is anticipated. However, there could be the potential for effects if activities result in a significant impact on water quality, which in turn could alter the marine ecosystem (i.e. a breakdown in saltmarsh habitat).

4.16.27. The interim storage of ILW is unlikely to have any adverse impacts on water, as the ILW would be effectively contained within a secure sealed environment and any run-off would be contained and treated to statutory quality parameters prior to discharge.

4.16.28. **Biodiversity and Nature Conservation**

4.16.29. The Devonport and Rosyth dockyards are well-established dockyards, comprising buildings, dockyard infrastructure and hard-standing.

4.16.30. There is the potential for SDP activities at Devonport dockyard to affect designated nature conservation sites, protected species and the structure and function of ecosystems, due to the close proximity of the Plymouth Sound SAC (which lies adjacent to the dockyard) and the Tamar Estuaries Complex SPA and Ramsar site. These designations provide a very high degree of protection for the area; the potential for any activities to affect the features for which the sites are designated must be determined by undertaking a Habitats Regulations Assessment.

4.16.31. There is also the potential for SDP activities at the Rosyth dockyard to affect designated nature conservation sites and protected species, given the proximity of the Firth of Forth SPA and Ramsar site.

4.16.32. The bigger the storage footprint, the more potential there is for an impact on biodiversity. The footprint of RC storage is estimated in Annex A (Section A6) at 11,600m^2; the Packaged Waste option at 2.200m^2 and the RPV option 801m^2.

4.16.33. The choice of technical option would alter the timing of SDP activities and therefore when effects may be felt.

4.16.34. Should intact RCs and/or the fore and aft sections of the submarines have to be moved by heavy-lift vessel under the RC option, additional dredging would be needed within the confines of the breakwater to create sufficient depth of sheltered water in which to load and unload the vessels. The only deep sheltered water within Plymouth Sound is in the commercial shipping lanes and it is unlikely that permission could be obtained to use them. However, the statutory protections in place for the sea bed would effectively prevent any additional capital dredging from taking place outside of the currently-dredged channels at Devonport, unless no viable, non-damaging alternatives could be found and Imperative Reasons of Over-riding Public Interest (IROPI) could be proven.

4.16.35. As a result, the movements of RCs/ fore and aft sections in and out of Devonport transport are unlikely. This effectively threatens the viability of Option 1D.

4.16.36. The interim storage of ILW is unlikely to have any adverse impacts on biodiversity, as the ILW would be effectively contained within a secure sealed environment.

4.17. 5-ENV: Impact on the Built Environment

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant changes were made to the 5-ENV supporting data as a consequence of the workshops.

4.17.1. This criterion considers the effects of any new facility on the built environment. This includes of cultural heritage, land use, landscape and townscape and the potential opportunities for sustainable design and construction.

4.17.2. Cultural heritage, including architectural and archaeological heritage, within this context is defined as below-ground and upstanding evidence of past human activity and encompasses artefacts, buried and underwater archaeological sites, earthworks, buildings, battlefields, historic gardens, historic landscapes, wrecks, hedgerows and ancient woodland.

4.17.3. Landscape in this context is defined by The European Landscape Convention as '*an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors*'. This definition is stated as covering natural, rural and urban areas and . the urban-rural fringe, including land, inland water and marine areas. Visual effects are those effects that influence how people see a landscape or townscape, such as the erection of a building.

4.17.4. The data presented below for Devonport and Rosyth are taken from the SEA Scoping Report [4.13.1]. The assessment of this criterion will draw on the provisional outputs from three environmental topics assessed in the SEA (cultural heritage, land use and materials and landscape and townscape). These provisional SEA outputs will be used to complete a 'pre MCDA' assessment of options to feed into the assessment against this criterion and will be presented at the workshop.

4.17.5. Assumptions

4.17.6. See Annex A, Section A22.

4.17.7. **Data: Devonport**

4.17.8. Plymouth has 37 Scheduled Ancient Monuments, 750 listed buildings and 14 conservation areas. Many of Plymouth's most important buildings are associated with the Dockyard; there are 85 listed buildings within Devonport Naval Base (embracing all MOD and Babcock landholdings) which is over 11% of the total number of listed buildings within Plymouth. Three of these are at risk. English

Heritage considers that Devonport as a whole has major significance as one of the most important historic dockyards in Europe.

4.17.9. Plymouth's diverse landscape includes historic waterfronts and dockyards; parkland, hilltop planting, steep wooded slopes, ridges and valleys. There are two Areas of Outstanding natural Beauty (AONBs) in Plymouth. Dartmoor National Park is situated to the north-east of the city.

4.17.10. **Data: Rosyth**

4.17.11. Fife has 260 Scheduled Ancient Monuments 4,910 listed buildings and 48 Conservation Areas. There 2 listed buildings in Rosyth Dockyard, both of which are in the nuclear licensed site.

4.17.12. Fife is composed of mainly open countryside, and includes six Areas of Great Landscape Value (AGLV) (covering 70,640 ha). Fife's wetlands appear to be progressively reducing, and there is a general trend of increasing development pressure on landscapes in the area.

4.17.13. Public Consultation

4.17.14. See Section 4.19.

4.17.15. Discussion: Devonport

4.17.16. Devonport dockyard has a rich and significant built heritage. The potential adverse effects from the SDP could include direct loss, vibration effects on the structural stability of buildings, and dust deposition on structures. There is however, potential for the project to return those buildings identified 'at risk' to viable use.

4.17.17. Since RC storage requires a large storage facility, the potential for SDP activities to impact on cultural heritage and landscapes is significant., The RPV removal option would require the least space (801m^2), as only the RPV would remain, and the packaged waste option would require 2,200m^2. Since these facilities are considerably smaller, the risk of significant effect is greatly reduced. More details are provided in Annex A (Section A6).

4.17.18. There is potential for development at Devonport to impact on the landscape character of the Tamar Valley AONB, 1km to the west of the site. SDP activities could also impact on the setting and character of the Devonport Conservation Area and Devonport Registered Park and Garden immediately south, or Stonehouse Peninsula Conservation Area adjacent to the Devonport Conservation Area.

4.17.19. Discussion: Rosyth

4.17.20. The potential for effects on the built environment also occurs at Rosyth; however, as there are only 2 listed buildings, the significance of these is likely to be less.

4.17.21. There is potential for development within the Rosyth dockyard to impact on the landscape character of the Area of Great Landscape Value (AGLV) to the north-west. SDP activities could also impact on the setting and character of listed buildings, Conservation Areas and Rosyth Castle scheduled monument in the wider surrounding area.

4.18. 6-ENV: Impact from the Natural Environment

COMMENT ON THE DIFFERENCES BETWEEN THIS SECTION AND THE 2011 DATA REPORT.

COMMENT ON AMENDMENTS MADE TO THIS SECTION AFTER COMPLETION OF THE 2012 WEIGHTING AND SCORING WORKSHOPS.

No significant changes were made to the 6-ENV supporting data as a consequence of the workshops.

4.18.1. This criterion covers the vulnerability of the options to flood risk, coastal change (including sea level rise) increased storm frequency and intensity, increases in temperatures and changes in rainfall patterns caused by climate change. It also includes seismic vulnerability.

4.18.2. Assumptions

4.18.3. See Annex A, Section A22.

4.18.4. Data: Devonport

4.18.5. The UK's Climate Projections (UKCP09) [4.18.1] show that the country as a whole is likely to experience hotter drier summers, warmer wetter winters and rising sea levels, particularly in the South East of England. This is likely to have a significant effect on a range of environmental conditions, including the water environment. This may impact on submarine dismantling and storage operations.

4.18.6. Key findings from the UKCP 09 for Devonport by 2050 (High Emissions scenario) are shown below:

- Mean winter mean temperature increasing by between 1.3 and 3.4ºC (central estimate 2.3ºC).
- Mean summer temperature increasing by between 1.4 and 5ºC (central estimate 3.2ºC).
- Winter rainfall increasing by between 3.1% and 37.2%
- Summer rainfall decreasing by between 1.3% and 56.2%

4.18.7. UKCP09 estimates that by 2050 under the High Emissions scenario, it is very likely (between 5% and 95% probability) that sea levels at Devonport will rise by between 11cm and 34cm, when compared to 1990 levels. The central estimate is an increase of 22cm.

4.18.8. The Tamar Catchment Flood Management Plan (CFMP) predicts a total sea level rise of 90cm by 2100.

4.18.9. There is a recorded history of flooding within the Tamar catchment, especially where river flooding coincides with Spring tides. In Plymouth, the main sources of flooding are direct (tide/waves) and indirect (caused by the tide submerging drainage outlets). A significant amount of flooding in Plymouth is caused by ineffective drainage and insufficient sewer capacity.

4.18.10. A small stretch of North Yard (comprising the Western Promontory fronting the estuary), and land to the east of the Basin fronting the Estuary lie within the 1 in 75 yr (0.3% annual probability) flood envelope; these areas of the dockyard therefore are at high risk of flooding.

4.18.11. Devonport is in an area of the UK where seismic activity is low. The associated hazard from seismic activity is considered low by the British Geological Survey.

4.18.12. Data: Rosyth

4.18.13. Rosyth lies within the 1 in 200 year (0.5% annual probability) flood envelope and is therefore at medium to high risk of coastal flooding.

4.18.14. Key findings for Scotland East by 2050 under the High emissions scenario are shown below:

- Mean winter temperature increasing by between 1 and 3.7ºC (central estimate 2.2ºC).
- Mean summer temperature increasing by between 1.8 and 5.7ºC (central estimate 3.5ºC).
- Winter rainfall increasing by between 1% and 25%
- Summer rainfall decreasing by between 0% and 33%.

4.18.15. The relevant UKCP09 central estimate for 2050 for the High Emission scenario sea level change is for a mean sea level rise of 24.4 cm compared to 1990 levels.

4.18.16. Rosyth is in an area of the UK where seismic activity is low; indeed earthquakes are almost completely absent from eastern Scotland. The associated hazard from seismic activity is considered low by the BGS.

4.18.17. Public Consultation

4.18.18. See Section 4.19.

4.18.19. Discussion

4.18.20. Both Devonport and Rosyth are vulnerable to coastal inundation or sea level rise related to climate change or extreme weather conditions.

4.18.21. Isostatic rebound following the last ice age means that Rosyth is actually rising (slower sea level rise) and Devonport is sinking (more rapid sea level rise).

4.18.22. The potential for new infrastructure dismantling to increase flood risk as a result of surface water run-off is not expected to be significant, as both sites are already largely developed, and sustainable drainage systems would have to be incorporated where necessary.

4.18.23. Assuming that limited modifications would need to be made to the existing docking facilities and no channel works or dredging is required to accommodate the SDP activities at Devonport and Rosyth, no significant adverse impacts on coastal processes and/or erosion rates is anticipated. However, if dredging were needed to accommodate RCs, this situation would be likely to change.

4.18.24. Both sites are at risk (in planning terms) from the proximity of UK, European and International designations and the protected species that they contain. As discussed above, development cannot adversely affect the integrity of a European protected site; this must be ascertained via a project-level Habitats Regulations Assessment. –

4.19. 1 to 6-ENV: Public Consultation Issues

4.19.1. Public consultation raised a number of issues relevant to this criterion. A selection of responses are summarised below.

Radioactive Discharges

- There was a strong perception from some members of the public that the SDP would inevitably lead to an increase in both radioactive discharges and the risk of a radiological accident. As a result, it was felt that the SEA had either under-played or 'glossed over' the potentially significant impacts that any increase in dose could have on peoples' health. This view was not expressed however in any of the organisational or Regulator responses.

- A parallel concern was expressed by some individuals about the risk of increased discharges into the wider environment and the effects this could have on wildlife, water quality, fisheries and local beaches. Some concerns were noted about the transparency of the relationship between the Environment Agency and the MOD and the ability of the regulatory agencies to enforce standards effectively against another government department.

- Although the SEA claims that both worker doses and planned discharges are predicted to remain within limits for the RPV Removal option, it fails to make a comparison with the RC removal option or argue that it meets the ALARA principle (NFLA).

- Assertions were made that keeping radioactive discharges below statutory discharge limits was not adequate, as these could not guarantee people's safety, given that any dose has the potential to cause harm. That acceptable safety levels can evolve (usually downwards) over time, and that the effectiveness of the Regulatory Authorities could be called into question were also given as reasons why the SDP should reduce further harm to the environment and to the public as far as possible, rather than accept discharges below permitted levels.

- The Environmental Report's conclusions about the projected (very low) radiological doses to the public, discharges into the environment and accident risks were criticised, given the lack of technical data available at this stage on projected inventories and emissions of each technical option (and the lack of a clear definition of what constitutes a 'significant' effect in the NTS). Related concerns were expressed about the conclusion that adhering to Statutory controls during dismantling, transport and storage will prevent any adverse effects.

- A small number of respondents thought that the benefits of continuing afloat storage were underestimated with respect to minimising radioactive discharges and accident risk. Criticism was also expressed about the lack of detailed environmental assessment for the ILW storage options.

- Only one disadvantage is given for the RPV Removal and Storage option. MoD needs to give much more information about the implications of cutting into the reactor compartment in order to remove the reactor pressure vessel. The SEA Non-Technical Summary suggests that the following should be added: Risk of accidentally discharging radioactive contaminants marginally higher than for RC separation” (NFLA).

- A more complete assessment would compare discharges and worker doses for the three options by listing likely radio-isotopes released with estimates of the level of radioactivity. A draft application for a radioactive discharge authorisation would have been one possible way to present the information. It is impossible to properly compare the three options from the point of view of the environmental principles mentioned above without this information. It is not sufficient to argue that discharges will remain within authorised limits – the chosen process also needs to meet the ALARA principle.

- The consultation documents do not give enough information to argue the case that RPV Removal is the best option. This currently looks as though it has a higher risk of accidental discharges; higher actual discharges into the environment and a higher worker dose in comparison to the RC Removal option (NFLA).

BAT and ALARA

- The conclusion that the MOD’s proposed option would not have any significant environmental effects was also questioned by some, on the basis that they believed certain elected representatives remain opposed to submarine dismantling, even after reviewing all of the evidence The Environmental and Health and Safety criteria appear to have scored low because all options are expected to be able to meet legal minimum requirements. In the NFLA view this is beside the point. The chosen management option should be required to use the Best Available Techniques and they should generate discharges and doses which are As Low As Reasonably Achievable. Nowhere in the Operational Analysis are RC Separation and RPV Removal Options compared from this standpoint” (NFLA)

- Although the SEA claims that both worker doses and planned discharges are predicted to remain within currently permitted limits for the RPV Removal option, it fails to make a comparison with the RC removal option or argue that it meets the ALARA principle. The fact that discharges of radioactivity into the environment are expected to remain within currently permitted limits is beside the point. Applying the environmental principles outlined in the Government’s Statutory Guidance to the Environment Agency would suggest that the Best Available Technique (and applying the precautionary principle) would be the technique which involves least discharges into the environment” (NFLA).

Submarine Transportation

- Some respondents felt that the SEA also down-played the risks of transporting submarines. They argued that relying on statutory safety requirements was not good enough and did not allow the safety of the options to be properly compared.

- The point was also made that minimising the complexity and number of steps (e.g. minimising transport or the number of cuts into the activated materials) should be further promoted as an effective avoidance measure.

Environmental Monitoring

- Many people felt that radiation monitoring should be more proactive around the possible sites and not rely solely on the existing Radioactivity In Food and the Environment (RIFE) arrangements. By contrast, one respondent argued that the resource and expense of monitoring should be proportional to the likelihood of unanticipated effects occurring and should be aligned with data collection requirements for other purposes; i.e. do not develop expensive SDP-specific monitoring but strengthen the existing monitoring arrangements of site radiation levels and publicise them more.

Environmental and Health and Safety Criteria as Option Discriminators

- We note that despite the assertion that environmental factors did not discriminate significantly between options… Figure 11 includes a "largest overall environmental impact" disadvantage against the RC separation and storage option and Figure 12 includes a "reduced risk of disturbance to local community" advantage against the Rosyth dockyard option. Although we are not disagreeing that these are legitimate findings, we would like to be able to see that they are underpinned by a more accessible and focused approach to sensitivity testing which systematically explores the discriminatory power of environmental and health and safety factors. Such an approach might also help identify further advantages and disadvantages associated with particular options from different stakeholder perspectives (NuLeAF).

5. References

#	Title	Originator	Reference / Version	Date	Classification
1.1	SDP User Requirement Document	[redacted]	DISM/SDP/420 /1679/Issue 4.0	February 2011	Restricted Commercial
1.2	Managing our Radioactive Waste Safely – CoRWM's Recommendations to Government.	Committee on Radioactive Waste Management	CoRWM Doc 700	July 2006	None
2.1	SDP Integrated Options	[redacted]	Issue 1.0	February 2011	Protect Policy
2.2	SDP Technical Options Analysis Paper	[redacted]	Issue 2.1	September 2010	Restricted Commercial (+ Another version marked "Protect – Policy)
2.3	MPOS Study Data Report	[redacted]	89330/PDT/TA F6/006 Issue B	July 2010	Protect Policy
2.4	SDP Site Criteria and Screening Paper	[redacted]	Issue 2.0	18th March 2011	Protect Policy
2.5	Options De-selection Paper	[redacted]	Issue 0.1	May 2012	Protect Commercial
3.1	Discussion of MCDA Criteria – Threshold and Objective values	[redacted]	Issue 1.0	28th March 2011	Protect Commercial
4.1.1	Scoring Workshop Report	[redacted]	Issue 1.0	2011	Protect Commercial
4.1.2	SDP Opportunities Register	[redacted]	None	March 2011	Restricted
4.1.3	SDP Public Consultation Report	MoD		2012	None
4.1.4	The Principles of Radioactive Waste Management	IAEA	IAEA Safety Series 111-F	1995	None
4.2.1	Conditions for acceptance (CFA) by LLW Repository Limited of Low Level Waste for Disposal at the Low Level Waste Repository	LLWR	CFA Issue 02/08	2008	None

#	Title	Originator	Reference / Version	Date	Classification
4.2.2	The Policy for the Long Term Management of Solid Low Level Radioactive Waste Management in the United Kingdom	DEFRA, DTI and the Devolved Administrations	None	26 March 2007	None
4.2.3	Review of Radioactive Waste Management Policy Final Conclusions" (Cm-2919)	Department of Environment		July 1995.	None
4.2.4	Response to the Report and Recommendations from the Committee on Radioactive Waste Management (CoRWM)	UK Government and the developed administrations,		2006 and 2010	None
4.2.5	MOD Nuclear Liabilities: Management Strategy	MOD		2011	None
4.2.6	UK Strategy for the Management of Solid Low Level Radioactive Waste from the Nuclear Industry. UK Nuclear Industry LLW Strategy Consultation Document	NDA	None	2009 and 2010	None
4.2.7	ILW Government Statement on Decommissioning 2004	UK Government		2004	None
4.3.1	Transport Options for Decommissioned Submarines	MOD: S&MO IPT	S&MO/252/17	March 2009	Restricted
4.3.2	Reactor Pressure Vessel Transport and Disposal Technical Feasibility.	Babcock Marine Devonport Royal Dockyard Limited.	000019419	June 2010	Restricted
4.3.3	RPV Transport	Nuvia Ltd.	2011/0330 Issue 0.0 (Draft)	30 March 2011	Restricted
4.3.4	Options for transportation of decommissioned submarine reactors.	BNFL Environmental Services		March 2004	Company Confidential

#	Title	Originator	Reference / Version	Date	Classification
4.3.5	Radiological Consequences Resulting from Accidents and Incidents Involving the Transport of Radioactive Material in the UK - 2009 Review	[redacted]	HPA-CRCE-003.	July 2010.	None
4.4.1	US-UK Mutual Defence Agreement (MDA)	US/UK		1958	
4.4.2	Classification Guide for British Naval Nuclear Propulsion Plant	MOD		2001	Restricted
4.4.3	Outline Security Plan for Storage of Packaged Waste	MOD [redacted]		2011	Restricted
4.5.1	The Decommissioning of the UK Nuclear Industry's Facilities – Amendment to Command 2919, DTI Paper	Department of Trade and Industry		September 2004	None
4.5.2	Ministry of Defence Policy for Decommissioning and the Disposal of Radioactive Waste and Residual Nuclear Material arising from the Nuclear Programme	MOD	Issue 5	09 Oct 2007	None
4.5.3	RSR: Principles in the Optimisation of Radioactive waste	Environment Agency	Version 2.0	April 2010	None
4.5.4	Strategic Environmental Assessment – Environmental Report	MOD	Issue 1.0	2011	Unclassified
4.5.5	Scotlands Higher Activity Waste Policy	The Scottish Government		2011	None
4.6.1	SDP: ILW Store Functional Specification. Basis for ILW Storage Facility Area Assumption – Reactor Compartments	[redacted]	Version 1.0	2011	Protect - Management

#	Title	Originator	Reference / Version	Date	Classification
4.6.2	SDP: ILW Store Functional Specification. Basis for ILW Storage Facility Area Assumption – Reactor Pressure Vessel	[redacted]	Version 1.0	2011	Protect - Management
4.6.3	SDP: ILW Store Functional Specification. Basis for ILW Storage Facility Area Assumption – Packaged Waste	[redacted]	Version 1.0	2011	Protect - Management
4.8.1	ISOLUS Technical Options Analysis Paper	MOD	Version 2.1	September 2010	Protect -Policy
4.10.1	Submarine Disposal Options- Normal Dose Assessment Calculations	Babcock Marine	000015104Submarine Disposal / TAF 005	2010	Restricted
4.10.2	Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations	Department for Transport	Ref. No. SI 2009 No. 1348.	2009	None
4.10.3	Interim Storage of Higher Activity Waste Packages: Integrated Approach: Industry Guidance	NDA	Issue 1	2011	None
4.10.4	Packaged Waste Container Selection Phases 1, 2 and 3 Combined Reports	Nuvia Ltd.	Issue 1.0	December 2010	XXXXXXXXXX
4.10.5	Regulations for the Safe Transport of Radioactive Material. IAEA Safety Standards. Safety Requirements	IAEA	No. TS-R-1	2009	None
4.10.6	Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material. IAEA Safety Standards.	IAEA	Safety Guide No. TS-G-1.1 (Rev 1)	2008	None

#	Title	Originator	Reference / Version	Date	Classification
4.10.7	ONR Guidance on the Demonstration of ALARP		T/AST/05 Issue 04 Revision 1	2002	None
4.11.1	Health & Safety at Work etc. Act	UK Government		1974	None
4.11.2	HMS [redacted] Green Passport	Babcock Marine		March 2010	Protect - Commercial
4.13.1	Submarine Dismantling Project - Strategic Environmental Assessment: Final Scoping Report, March 2011, Defence Equipment and Support.	SDP/ DE&S	Issue 1.0	March 2011	None
4.13.2	Cancer Incidence in Plymouth (Follow-up Report)	NHS South West Cancer Intelligence Agency		2009	None
4.13.3	Indicative Atlas of Radon in England and Wales.	Health Protection Agency		2008	None
4.13.4	Environmental Monitoring for Radioactivity around Devonport Royal Dockyard – Annual Report.	Defence Nuclear Safety Regulator		2007	None
4.13.5	Ionising Radiation Exposure of the UK population	Health Protection Agency	2005 Review	2005	None
4.13.6	COMARE Tenth Report (2005). The incidence of cancer around nuclear installations in Great Britain.	COMARE	Tenth Report	2005	Unclassified
4.13.7	Radioactivity in Food and the Environment – 15th Report.	EA/ FSA/ NIEA/ SEPA joint report.	15th Report	2010	None
4.13.8	HMS Renown Dismantling Proposal	Babcock		2004 (TBC)	Restricted

#	Title	Originator	Reference / Version	Date	Classification
4.13.9	Principles for the Assessment of Prospective Public Doses. Interim Guidance.	EA, FSA, NRPB	Interim report	December 2002	None
4.18.1	DEFRA, UK Climate Projections 09, http://ukcp09.defra.gov.uk/content/view/20/6	DEFRA		2009	Unclassified
A.2.1	SDP App1	[redacted]		9 December 2010	
A.2.2	Babcock Marine Report on the Rolls Royce Waste Characterisation studies	Babcock Marine		2011	Restricted
A.2.3	Environment Agency: Frequently Asked Questions	Environment Agency	http://www.environment-agency.gov.uk/static/documents/Business/LLW_FAQ_April_2011.pdf	April 2011	None
A.2.4	The 2010 UK Radioactive Waste Inventory	NDA	http://www.nda.gov.uk/ukinventory/	2010	None
A.2.5	UK Strategy for the Management of Solid Low Level Radioactive Waste from the Nuclear Industry	NDA	http://www.nda.gov.uk/documents/upload	201	None
A.10.1	NII Technical Assessment Guide (TAG) Radiological Analysis – Normal Operation:	NII	T/AST/043 Issue 1	2009	None
A.10.2	Statistics Glossary (Web)	Easton and McColl	http://www.stats.gla.ac.uk/steps/glossary		None
A.10.3	Your Dictionary (Web)		http://www.yourdictionary.com/estimate		None

Annex A: Supplementary Information

A.1 Criterion 1-POL: Flexibility and Robustness to Opportunities and Risk

A.1.1 The text below provides additional information on the SDP risk management process, with reference to the Assessment and Demonstration phases.

A.1.2 The Assessment phase covers all of the preliminary work required to allow the Demonstration phase to proceed. This phase includes option selection, public consultation, planning applications, site selection and other work required before demonstrating the applicability of the industrial process to submarine dismantling. A successful outcome would allow the project to proceed to the Demonstration phase.

A.1.3 The Demonstration phase will involve the dismantling of one or more submarines to demonstrate process feasibility and applicability. The initial works will include obtaining the necessary planning permissions and approvals etc., to proceed. Depending on which option is chosen this could include approvals for the construction and operation of facilities to size reduce, package, store and transport ILW. A successful outcome would allow the project to proceed to the manufacturing phase and if this was successful, the industrial process and lessons learned would then be applied to the dismantling of the remaining submarines.

A.2 Criterion 2-POL: Compliance with Extant UK Policy and Strategy on Radioactive Waste Management

A.2.1 Estimates are provided below of the amount of LLW which will be produced during dismantling, together with the amount which will be recycled and the amount which will be disposed of [A.2.1]. It is cautioned that these are indicative quantities which are currently being updated to reflect recent waste characterisation modelling studies [A.2.2].

LLW Assumption

Past public consultation data was –

Total tonnes of ILW/LLW	[redacted]
Assumed ILW	[redacted]
Assumed LLW	[redacted]
MDAL ILW Assumption is now	[redacted]
Therefore LLW should be	[redacted]
Further considerations –	
Activated LLW from the RPV is therefore	[redacted]

[redacted]

[redacted]

to

[redacted]

Contaminated LLW external to the RPV [redacted]

It is assumed that 95% of this will be decontaminated and recycled, leaving [redacted] tonnes of LLW for disposal.

Total LLW (tonnes) for disposal is therefore [redacted]

A.2.2 **VLLW**

A.2.3 Very Low Level Radioactive Waste (VLLW) is a sub-category of LLW [A.2.3]. This is broken down into 'low volume' and 'high volume' VLLW, each of which has its own definition. Low volume VLLW meets the following three criteria:

- Each $0.1m^3$ of waste contains less than 400 kBq of total activity or single items contain less than 40 kBq of total activity.
    - For wastes which contain Carbon-14 or Hydrogen-3 (tritium): In each $0.1m^3$, the activity limit is 4,000 kBq for Carbon-14 and Tritium taken together; and
    - for any single item, the activity limit is 400 kBq for Carbon-14 and Tritium taken together.
- The waste originates from non-nuclear premises.
- No more than $50m^3$ per year of waste is disposed of, unless the waste is incinerator residues, in which case no upper volume limit applies.

A.2.4 High volume VLLW meets the following two criteria:

- The maximum activity is 4 MBq per tonne of total activity. For waste containing Tritium, the concentration limit for Tritium is 40 MBq per tonne.
- The waste originates from nuclear premises, or (for wastes other than incinerator residues) it is from non-nuclear premises in quantities of more than 50 m^3 per year.

A.2.5 **LLW**

A.2.6 There are two principal types of LLW produced by the SDP and both are described below with reference to their identification numbers in the national radioactive waste inventory [A.2.4].

A.2.7 Waste stream 7G102 (the national UK inventory number) consists mainly of neutron activated metals inside the RPV. It is short lived solid ILW that contains Co-60 which will decay to LLW levels within a period of about 30 years. It will not contain significant quantities of Ni-63 or other long lived isotopes. This type of waste will not be recycled. The waste will be disposed of at the LLWR.

A.2.8 Waste Stream 7G103 consists mainly of contaminated metals and other materials. It is solid LLW which can be consigned to the LLWR for disposal immediately, i.e. as soon as it is generated. It consists primarily of contaminated metals, but may also include secondary wastes such as overshoes, protective clothing and other items.

A.2.9 **ILW**

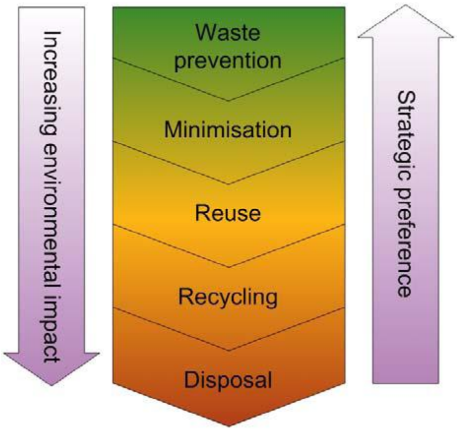
A.2.10 Waste stream 7G104 [A.2.4] is long lived ILW which will remain so for the duration of the interim storage period and beyond. It consists predominantly of neutron activated metals. None of this waste stream can be recycled.

A.2.11 An interim storage period will allow for a significant decay of the Cobalt-60 activity in waste stream 7G104 (mainly activated metals), but not of the longer lived isotopes such as Nickel-63. Therefore, the interim storage period will not result in any reduction of the amount of ILW in the waste. The quantity of ILW produced will depend to some extent on the efficacy of the segregation techniques used during size reduction.

A.2.12 **Waste Hierarchy**

A.2.13 The UK strategy is to ensure that LLW waste arisings and the requirements for its disposal are minimised. The underlying objective is to keep the LLW disposal site in Cumbria open for as long as possible. LLW managers should plan their waste management activities in accordance with waste management hierarchy principles [4.2.3] presented below.

A.2.14 **Figure A2.1: The Waste Hierarchy**



A.2.15 **Prevention:** Waste prevention is the highest level of the waste hierarchy and potentially yields the greatest financial and environmental benefits compared to the other elements of the hierarchy.

A.2.16 **Minimisation:** Minimisation of the amount of waste to be managed as LLW can include:

- Separation of mixed wastes.
- Reduction in activity levels through decontamination.
- Characterisation of waste to allow appropriate sentencing. Note that at present, the UK Government is not considering any change in approach to the classification of LLW.
- Sorting and segregation into material types (e.g. metals or high volume VLLW); segregation at source where possible.
- Decontamination of facilities and materials prior to decommissioning has significant potential to minimise amount of LLW.
- Decay storage of waste to exempt or levels suitable for alternative management options may have benefits but there are significant challenges that need to be overcome, including rigorous characterisation before and after storage, regulatory requirements etc. Decay storage is particularly useful for wastes containing short lived radionuclides.
- The effective use of exemption orders requires quality assured waste characterisation to ensure wastes are properly sentenced. The strategy aims to make maximum use of exemption orders.

A.2.17 **Re-use:** Re-using materials and equipment (e.g. after decontamination) defers waste production and extends the life of resources.

A.2.18 **Recycling: –** The strategy recognises metal treatment and recycling as the main recycling technologies.

A.2.19 **Disposal:** The aim of the strategy is to ensure continued capability and capacity for LLW management. Where waste does require disposal it should be achieved in the most optimised way to minimise the impact of the disposal activities.

A.2.20 **Strategy**

A.2.21 MODs strategy for dealing with LLW in contained in [4.2.5]. As expected, MOD advocates the waste hierarchy approach presented above. In addition, MOD will ensure that its radioactive wastes will be classified and treated to optimise the use of UK facilities.

A.2.22 The MOD strategy is applicable to MOD nuclear liabilities throughout the UK. MOD's LLW in Scotland will be managed in accordance with the UK policy (not Scottish policy) on LLW [A.2.5].

A.2.23 It is worth noting that all non Dounreay LLW produced in Scotland is disposed of at the LLWR currently located in Cumbria. It is also understood that there are no VLLW disposal sites in Scotland.

A.2.24 **Creation of Wastes:** None of the options will involve the unnecessarily creation of wastes. It will be necessary to create wastes when the submarines are dismantled.

A.2.25 **Waste Minimisation by appropriate design and operation:** This will be addressed during the design and operations phase of the SDP.

A.2.26 **Minimisation of quantities of ILW and LLW:** Waste stream 7G102 (mainly activated metals) contains short lived ILW which will decay to LLW to be disposed of at the LLWR. Minimisation of the quantities of short lived ILW will therefore result in production of more LLW. Minimisation of the quantities of ILW is consistent with the ILW management strategy. If only limited segregation of activated LLW (Waste Stream 7G102) is carried out for the packaged waste option, this option might result in production of less LLW (but more ILW for disposal), when compared to the other options. On the other hand, if more effort is put into segregation of ILW from LLW there is likely to be significant "consequential additional" LLW waste produced (e.g. more cutting discs, loose trash, used personal protective equipment and others) in comparison with limited or no segregation.

A.2.27 **Characterisation:** The same waste characterisation data will be used for all of the options.

A.2.28 **Waste volumes:** The volumes of waste streams 7G102 and 7G104 will impact on the footprint of the interim decay store and will therefore have an impact on cost. This will be addressed within the Investment Appraisal.

A.2.29 **Recycling:** Waste stream 7G103 (mainly contaminated metals) will be recycled (where applicable) to produce a lower category waste and residual LLW for disposal at LLWR.

A.2.30 **Decay:** Both the RC separation and the RPV removal options make provision for the in-situ decay of short lived ILW. The reduction in the Co-60 content will result in reduced external dose rates and will allow the eventual dismantling process to be performed with less shielding requirements. The packaged waste options involve real time size reduction under high dose rate conditions, hence the need for heavily shielded facilities (i.e. hot cells).

A.2.31 The strategy is to apply the waste hierarchy more effectively to the management of LLW. Where the preference for higher levels of the waste hierarchy cannot be met and disposal is necessary, it must be optimised to minimise the overall impact of LLW management on people and the environment.

A.2.32 The **Proximity Principle** is an important consideration for the management of waste and suggests that waste planning should "*enable waste to be disposed of in one of the nearest installations*". The UK LLW policy recognises that transport is a very sensitive issue for communities affected by LLW management.

A.2.33 **Managing our Radioactive Waste Safely – CoRWM Recommendations to Government**

A.2.34 In September 2001, UK Government and devolved administrations instigated the first stage of its Managing Radioactive Waste Safely programme (MRWS). The second stage began in July 2002 when Government published its response to the 2001 consultation, followed in 2003 by the appointment of the independent Committee on Radioactive Waste Management (CoRWM). Government commissioned CoRWM to oversee a review of options for the long term management of the UK's higher activity radioactive waste and to recommend the option, or combination of options, that could provide a long term solution, providing protection for people and the environment. Their objective was to provide recommendations which inspired public confidence and were practicable in securing the long term safety of those wastes. CoRWM began its work in November 2003 and delivered its recommendations in its report to Government in July 2006 [4.2.4].

A.3 Criterion 3-POL: Scope/Extent of Transportation of Submarines and Radioactive Waste

A.3.1 No additional information.

A.4 Criterion 4-POL: Unauthorised Access to Classified Materials during Dismantling, Storage and Transportation

A.4.1 No additional information.

A.5 Criterion 5-POL: Compliance with Extant UK Decommissioning Policy

A.5.1 **Decommissioning**

A.5.2 The Decommissioning of the UK Nuclear Industry's Facilities, Amendment to Command 2919, was published by DTI during September 2004 [4.5.1].

A.5.3 This statement of the UK Government and devolved administrations policy on the decommissioning of nuclear facilities updates and replaces the previous statement contained in the "Review of Radioactive Waste Management Policy Final Conclusions" (Cm-2919) published in July 1995 [4.2.3].

A.5.4 Decommissioning operations should be carried out as soon as reasonably practicable. The Government recognises that decommissioning operations may, however, involve two or more separate stages spanning a number of decades. It may also be appropriate to delay particular operations to benefit from new or developing technologies or from further development of existing best practice, or to take advantage of radioactive decay.

A.5.5 Each operator is expected to produce and maintain a decommissioning strategy and plan for its site, which the Government expects will take into account stakeholder views. Strategies should include a comprehensive site decommissioning plan for safely carrying out the decommissioning process with due regard to security and protection of the environment.

A.5.6 The strategy should take into account all relevant factors, assessing and presenting them in a transparent way underpinned by objective information and arguments. These include:

- Ensuring worker and public safety
- Maintaining site security
- Minimising waste generation and providing for effective and safe management of wastes
- Minimising environmental impacts including reusing or recycling materials if possible
- Maintaining adequate site stewardship
- Using resources effectively, efficiently and economically
- Providing adequate funding
- Maintaining access to an adequate and relevant skills and knowledge base
- Using existing best practice wherever possible
- Conducting research and development to develop necessary skills or best practice
- Consulting appropriate public and stakeholder groups on the options considered and the contents of the strategy.

A.5.7 These factors should be applied throughout each decommissioning programme. Operators decommissioning strategies need to take into account relevant developments in UK radioactive waste management policy. The Government considers that decommissioning strategies should seek to avoid the creation of radioactive wastes in forms which may foreclose options for safe and effective long term waste management. Strategies should harness the benefits of radioactive decay and should maximise the amount of materials suitable for re-use of recycling. Through BPM strategies the volume of radioactive waste created should be minimised, particularly the volume of ILW. Decommissioning wastes should be packaged in a way that does not preclude disposal options. Operators may wish to bring forward operations to utilise existing skills or knowledge.

A.6 Criterion 1-OP: Impact on the Maritime Enterprise

Table A6.1: Interim Storage Surface Area Requirements (Footprint)

Interim Storage Option	**Interim Storage Option**	**Comments**
Reactor Compartment	11,600 m^2	Area required for storage of intact Reactor Compartments based on 27 submarines each producing one RC. The storage facility includes the RC package vault, receipt, dispatch, inspection and maintenance facilities and office/admin areas. See [4.6.1].
Reactor Pressure Vessel	801 m^2	Area required for defueled RPV based on 27 submarines each producing one RPV. The storage facility includes the RPV package vault, receipt, dispatch, inspection and maintenance facilities and office/admin areas. See [4.6.2].
Packaged Waste	2200 m^2	Area required for a storage facility for ILW in 3m^3 NDA boxes based on 27 submarines each requiring 14 boxes (473 in total). See [4.6.3]. See below for calculation.

Table A6.2: Packaged Waste Store Footprint

Quantity of 3m^3 Boxes	
No. of boxes per boat	= 14
No. of boats	= 27
Total no. of boxes	= 378
+ 25% to allow for future classes	= 473
Dimensions of 3m^3 Box	

Height	= 1200 mm
Width	= 1700 mm
Length	= 1700 mm
ILW Store Basic Arrangement	
Matrix size	= 8 boxes x 24 boxes
Minimum spacing between box ends	= 1 m
3 Aisles between boxes	= 2 m
Perimeter spacing	= 3.1 m
Stack height	= 3
Resulting ILW Vault Internal Dimensions	
Matrix width	= 66.8 m
Matrix depth	= 20.6 m
Total working width	= 73.0 m
Total working depth	= 26.8 m
Total store area	= 1956.4 m^2
Total Facility Area	
ILW Vault	= 1956.4 m^2
Receipt/Dispatch/Inspection / maintenance bay	= 100 m^2
Fork lift truck bay	= 81 m^2
Admin	= 25 m^2
Total	= 2162.4 m^2
Rounded	**= 2200 m^2**

A.7 Criterion 2-OP: Flexibility of the Dismantling Approach to managing future Classes

No additional data.

A.8 Criterion 3-OP: Threat to Skill and Experience Set:

No additional data.

A.9 Criterion 4-OP: Transferable Dismantling Knowledge

No additional data.

A.10 Criterion 1-H&S: Worker Dose: Dismantling, Storage and Transportation

Terminology

The NII Technical Assessment Guide [A.10.1] provides advice to those responsible for assessing radiation dose to workers. Section 4.9 states that:

- The dose to each of the operators will normally be determined from the predicted dose rates where the operators are likely to be positioned for the tasks and the expected periods of time likely to be spent doing the task. Assessors should ensure that all significant tasks have been included and that the estimates of the dose rates, exposure times and radiation attenuation are sufficiently conservative. For the purposes of ALARP considerations, the dose estimates should be based on <u>best estimate values</u> for these parameters”. However, no definition of best estimate value is provided in this reference.

An “estimate” is defined in [A.10.2] as an indication of the value of an unknown quantity based on observed data and “to estimate” is defined in [A.10.3] as to calculate approximately. “Best estimate” is variously defined as a realistic or actual estimate.

The above definitions can be combined and applied to provide the following meaning:

- A best estimate of worker dose is one which is based on real data relating to dose and exposure time for activities similar to those which would be encountered during submarine dismantling. This is consistent with the approach used by Babcock Marine in their estimates of normal worker collective dose. Their calculated doses for SDP operations were based, where possible, on the actual collective dose accrued by workers carrying out similar tasks during the refitting of operational submarines.

The Babcock Marine assessment was based on the [redacted] submarine, which is one of the highest dose-rate submarines as measured by the LLDR system (described below). The Babcock Marine assessment can be described as a “best estimate” of the collective dose from a “worst case” submarine

Low Level Dose Rates (LLDR)

The LLDR is a system devised by MOD to provide a summary indicator of ambient dose rates (in microSieverts per hour) within and near the RC of a submarine. The system is based on approximately 50 dose rate measurements taken at specified locations within and around an RC. These measurements are made for all of the fleet submarines when not at sea, at a specified number of days after reactor shut-down, to allow stabilisation of the ambient dose rates. The arithmetic mean of the measured dose rates is then calculated and this provides an average value (the LLDR) for each submarine. A general rule for laid up submarines (LUSMs) is that the LLDR will reduce by a factor of 2 for every Cobalt-60 half life (5.27 years).

Worked Examples illustrating the Various Types of Radiation Doses

Effective Dose: Worker 1 spends 4 hours removing the lagging from pipework in a submarine RC where the background radiation dose-rate is 20 microSieverts per hour. Worker 1 would receive an effective radiation dose of 4 x 20 = 80 microSv. If the task requires 2 people, working together, Worker 2 would also receive 80 microSv.

Collective Dose: The collective dose from the above operations would be the total amount of radiation received by the workers, i.e. 2 x 80 = 160 man microSv.

Collective Dose: If the same 2 workers carry out the same operations, each for 4 hours, but this time inside a submarine RC where the background radiation dose-rate is 10 microSieverts per hour, (i.e. lower than the previous submarine), the collective dose would be the total amount of radiation received by the workers, i.e. 2 x 40 = 80 man microSv.

Cumulative Collective Dose: The cumulative collective dose of the 2 workers is 160 + 80 = 240 man microSv. The average cumulative collective dose per submarine is 240/2 = 120 man microSv per submarine.

Cumulative Collective Dose: Based on the above average, the predicted cumulative collective dose from repeating the above operatons on 10 submarines is 120 x 10 = 1200 man microSv. This equates to each worker receiving 60 microSv per submarine.

Cumulative Effective Dose: The predicted cumulative effective dose of Worker 1 over 10 submarines is 60 x 10 = 600 microSv. The predicted cumulative effective dose of Worker 2 over 10 submarines is 60 x 10 = 600 microSv.

In the example given above, 2 workers each require 4 hours to completely remove the lagging from pipework in a submarine RC where the background radiation dose-rate is 20 microSieverts per hour. If 4 workers are used and the task can be completed in 2 hours, the effective dose to each of the operators would be 2 x 20 = 40 microSv. The collective dose would be 4 x 40 = 160 man microSv. Thus increasing the workforce reduces the effective dose to individual operators but has no impact on the collective dose.

For example, a collective dose of 50 man microSv can be interpreted as one person accruing a dose of 50 microSv, 10 people accruing a dose of 5 microSv, 50 people accruing a dose of 1 microSv and so forth.

A.11 Criterion 2-H&S: Non Radiological Impact on Workers

Biological Hazards

- Hot water systems (Legionella). (Change rooms, drinking water supplies)

Chemical Hazards

- Creation of flammable atmospheres. (Use of gases, fuels. Dust generation)
- Exposure to hazardous substances, (COSHH). (Solvents, fuels, oils, etc.)
- Work with Asbestos. (Asbestos lagging, mineral fibres)
- Work with Lead.
- Work with Beryllium.
- Inhalation of vapours, gases, particles. (From numerous decommissioning tasks: cutting etc.)

Electric Hazards

- Damage to/from electrical equipment. (High/Low Voltage, On board electrical circuits, portable electrical equipment)
- Work with exposed live conductors. (Submarine electrical systems)
- Maintenance of electrical equipment.(Tools and equipment associated with decommissioning)
- Use of 240V not 110V on construction/decommissioning site work (Possible occurrence)

Environmental Hazards

- Working in confined spaces. (Areas of submarine)
- Hot/Cold working environment >55°C <5°C. (Inside and outside of submarine)
- Working in adverse weather conditions. (Dismantling locations in Scotland or Southern England)
- Poor lighting. (Within vessel and on dockside)
- Working in high noise levels. (Cutting, burning operations)
- Poor ventilation (dusts and fumes). (Resulting from cutting etc.)
- Inadequate floor coverings (slips trips falls). (Especially during breaking of vessel and on the dockside)
- Poor Access/Egress. (Routes in and out of the vessel)
- Escape routes. (Escape routes from potential confined spaces)
- Wastes build up and segregation of waste (fire risks/leaching).(During all phases of the dismantling process)
- Working near, above or on water. (Work undertaken at dockyard)

Ergonomics

- Poor design of working environment/equipment. (Equipment use leading to hand arm problems vibration etc.)
- Work with visual display units. (Desk based tasks during dismantling)
- Manual handling, white finger, Repetitive Strain Injury issues. (Use of tools during dismantling: burning, cutting)

Fire Explosion Hazards

- Spraying of flammable liquids/vapours. (Degreasing activities etc.)

- Fire potential of combustibles/ waste accumulation. (Flammable wastes accumulated during the dismantling process)
- Fire explosion of flammable liquids/dusts and gases. (Fuel/oil storage tanks on or off vessel)
- Poor storage of chemicals (i.e. oxidising with Inflammable).(Chemicals: cleaning materials, lubricants, fuels etc.)

Mechanical Hazards

- Incorrect installation of equipment. (Equipment used during the dismantling process)
- Access to dangerous machinery (poor/no guarding). (Hand tools: grinders, cutters etc.)
- Entanglement in rotating machinery. (Hand tools)
- Traps/Nips from moving parts of equipment. (Hand tools mechanical and electrically driven)
- Abrasive wheels.(Cutters, grinders)

Physical Hazards

- Failure of pressurised systems. (Hydraulics, compressed air supplies)
- Storage and stacking of goods. (Stacking of waste/recyclable materials)
- Compressed air/pressure systems or stored energy (including pressure water jetting). (On-board compressed air systems, pressure water jetting equipment)
- Use of sharp equipment/hand tools. (Hand tools)
- Use of compressed gas cylinders. (Gas cutting equipment)
- Incorrect use of hand/power tools (cutting/grinding/drilling). (Insufficient training on equipment)
- Working at heights/scaffolds/ ladders. (Dismantling operations on the vessel)
- Overhead obstructions. (Overhead obstructions within the vessel)
- Falling Objects to (head/feet). (Items generated by dismantling operations)
- Slips/trips/falls (same level and at height). (Work undertaken on board vessel and sites adjacent to the vessel)
- Contact with hot/cold objects/liquids. (Items generated from hot works)
- Hazards leading to eye injuries. (Cutting, grinding, pressure jet washing)
- Equipment causing vibration white finger. (Hand operated power tools)
- Hoists, slings, lifting equipment, cranes. (From lifting operations associated with dismantling)
- Safe place of work and access/egress. (Work areas associated with dismantling)
- Soldering/welding/brazing/cutting. (Dismantling operations: cutting)
- Repetitive work. (Cutting etc.)
- Workplace to hot/cold. (Cutting operations within vessel)
- Work in Confined Spaces.(Operations within the vessel)
- Hot Work. (Hot Works: cutting etc.)

Psychosocial Hazards

- Sources of stress. (Demands on time)
- Poor shift patterns, excessive working hours. (Long shifts, insufficient breaks)

- Improper, inadequate information/instruction/ training supervision or selection.
- Dismantling operations: supervision, use of SQEP.

Transport Hazards

- Loading/unloading of vehicles. (Waste/recyclable material loading. Delivery of equipment)
- Dangers from reversing/manoeuvring of vehicles/overhead crane movements. (Site movement, traffic)
- Operation of forklift trucks/ other workplace transport equipment. (Vehicular movements at the dockside)
- Travel/Transport issues to and from sites/Air/Sea/Road.
- Submarine transport.
- Worker commuting etc.
- Poor/No segregation of pedestrian and traffic movements. (Traffic planning on or adjacent to the vessel)

Human Factors

- Trained personnel. (SQEP employees, supervisors, managers)
- Physical capability. (SQEP personnel)
- Mental capacity. (SQEP personnel)
- Young Person. (Use of young persons during dismantling operations)
- Ergonomics. (Manual handling, repetitive operations)

A.12 Criterion 3, 4 and 5-H&S: Potential for an Unplanned Radiological Release during Dismantling, Storage and Transportation

No additional data.

A.13 Criterion 1-ENV: Radiological Discharges to the Public

No additional data.

A.14 Criterion 2-ENV: Radiological Discharges to the Environment

No additional data.

A.15 Criterion 3-ENV: Non-radiological Impact on the Public

No additional data.

See store footprint data in Section A6 of this annex.

A.16 Criterion 4-ENV: Non radiological Impact on the Environment

See store footprint data in Section A6 of this annex.

A.17 Criterion 5-ENV: Impact on the Built Environment

No additional data

A.18 Criterion 6-ENV: Impact from the Natural Environment

No additional data

A.19 MDAL Assumptions for 1-POL to 5-POL

Assumptions

Selected MDAL assumptions relevant to the Government and MOD policy criteria are listed below. Additional assumptions are contained in the SDP MDAL.

Table A.19.1: MDAL Assumptions for 1-POL to 5-POL

Relevant Criteria	#	Assumption
All-POL	1.03	MOD, DE&S, DSM, ISM, and other appropriate Government policies and procedures will apply throughout the SDP.
All-POL	2.07	Existing departmental/ministerial commitments will be honoured by the SDP.
All-POL	2.14	DECC and Scottish Government support is required to enable consideration of NDA sites for ILW storage.
All-POL	2.06	The SDP Demonstrator will prove the industrial process.
All-POL	23.09	A revised (SDP) strategy will be published every five years, to reflect the progress being made and to ensure it remains up to date
1-POL	21.32	Changes in GDF entry conditions for disposal of ILW (such as size weight or radioactive inventory) might, in the future, allow for whole RPVs to be disposed of without the need for size reduction. This would offer significant savings in the cost of developing, operating and decommissioning a size reduction facility and potential improvements in effectiveness.
2-POL	15.07	It is assumed that a national LLW repository will be available for the life of the project.
2-POL	23.13	It is envisaged that liability for the waste will be transferred to the NDA at the stage of ILW being disposed of in the proposed GDF.
2-POL	15.18	RWMD letter of compliance will be required for packaged ILW prior to interim storage and disposal in the GDF.
2-POL 5-POL	23.03	Before starting work on a Demonstrator, the MOD would first need to obtain site specific planning and regulatory approvals (as required) for: • the Demonstrator initial dismantling activity; • the ship recycling activity that follows initial dismantling; and • the interim storage solution for the ILW arising from the Demonstrator and, if appropriate, subsequent submarines as well.
2-POL 5-POL	11.05	It is assumed that it is practical to achieve Radiological Clearance of Vessels outside the RC.
2-POL	2.05	All submarines entering SDP will already have been defueled.
2-POL	21.06	The SDP will generate no HLW.

Relevant Criteria	#	Assumption
2-POL	21.20	The ILW resulting from initial dismantling must be stored until the proposed GDF is ready to accept it for disposal. The current planning date for the proposed GDF to begin receiving waste is 2040 but, as it will receive waste from a number of other sources, it may be many more years before it is ready to receive ILW from SDP. Storage facilities will therefore be designed to safely and securely hold waste for up to 100 years, to protect against any changes to the GDF timescales, in line with CoRWM's recommendations.
2-POL	23.11	ILW volumes are estimated to be between 19 and 58 tonnes per submarine, which equates to between 513 and 1566 tonnes of ILW in total, for 27 submarines. LLW volumes are estimated to be between 91 and 154 tonnes per submarine (giving between 2,457 and 4,158 tonnes of LLW in total). VLLW volumes are estimated to be 62 tonnes per submarine (giving 1,674 tonnes in total).
2-POL	15.16	A minimum of 7 and a maximum of 14 off $3m^3$ boxes will be required to package the 25 tonnes of ILW arising from size reduction of an RPV which has been decay stored for 10 years.
2-POL	23.10	The vast majority of the material arising from the submarine hulls (more than 100,000 tonnes in total) will be high-grade steels and other valuable metals such as copper wiring, lead ballast and other metals in electronic components. All of these will be recyclable, and will help offset the cost of the recycling.
3-POL	16.05	The MOD has overall responsibility for the transportation of Intermediate Level Waste both from a planning, logistical and cost perspective.
3-POL	4.11	It is assumed for planning & options analysis purposes that LUSMs can be transported from their current base to the chosen dismantling site.
3-POL	16.07	RPV transport is feasible, most likely as an IP2 container, by road or sea. Rail transport of PWR1 may be feasible, dependant on overall dimensions of the transport package.
4-POL	25.03	All dismantling work on the Reactor Compartment must take place at a site that holds an appropriate civil nuclear Licence, whether this is at a new or an existing facility.
4-POL	2.03	The security requirements for non nuclear dismantling require a UK based solution.
4-POL	2.04	Security issues prevent a foreign solution for RC separation or dismantling.
5-POL	23.06	At the end of project life, all facilities built as part of the project will either have to be converted for use for other purposes or decommissioned.
5-POL	13.04	The Euratom Treaty does not apply to the use of nuclear energy for military activities and MOD is therefore, not under any duty to provide the EU Commission with data on SDP plans for decommissioning under Article 37 of the Treaty.

A.20 MDAL Assumptions for 1-OP to 4-OP

Selected MDAL assumptions relevant to the operational criteria are listed below. Additional assumptions are contained in the SDP MDAL.

Table A20.1: MDAL Assumptions for 1-OP to 4-OP

Relevant Criteria	#	Assumptions
All-OP	1.07	The planned In-Service Date for the Submarine Dismantling Project is 2019.
All-OP	1.13	Devonport and Rosyth are the only sites being considered for storage of laid-up submarines before they are dismantled.
All-OP	1.15	3 basin Devonport meets its 14 boat SSN maximum capacity by 2020 and current safety case (FSC 130) is aligned to this date.
All-OP	4.03	The SDP throughput assumption is a minimum of 1 submarine per year.
All-OP	4.10	The Demonstrator boat in Rosyth would be Swiftsure.
All-OP	7.26	The size reduction facilities and the waste handling facilities require a combined footprint of 5,000m².
All-POL	11.01	Whole RC disposal is not compatible with the Geological Dismantling Facility, therefore a cut-up solution will be adopted before final disposal in the GDF.
All-OP	11.02	DSA will take on disposal of non nuclear parts of boat dismantling and recycling
All-OP	21.27	No submarines will be dismantled until a storage solution has been agreed. Regulations are in place to enforce this commitment
1-OP	11.06	For the purposes of the Waste Package selection, a 10 year decay period from shut down to dismantling has been assumed. This is a rounded approximation to the time required to take the submarine out of service, take it through the DDLP process and dismantle it.
1-OP	17.01	Any submarines leaving service with the Royal Navy are planned to remain at Devonport until there has been a decision on the dismantling solution.
1-OP 2-OP	17.06	It is assumed that on decommissioning, V Class SSBNs will be defueled and enter the dismantling process as soon as is reasonably practicable. Negation of the requirement for Long Term Berthing in a non-tidal basin.
1-OP	17.07	Devonport 3 Basin cannot be used as a LUSM storage facility for V Class submarines.
1-OP	21.09	Seven out-of-service submarines are stored at Rosyth Dockyard and 10 are at Devonport Dockyard.All submarines leaving service in future will be stored at Devonport awaiting dismantling; no further submarines will be stored at Rosyth.
2-OP	21.14	Dismantling of the new Astute Class,and the next planned class of submarine (known as 'Successor') will be subject to future decisions and are not within the scope of the SDP
3-OP	21.25	Both Devonport and Rosyth sites have past or current experience of submarine maintenance and of nuclear decommissioning and therefore a workforce with existing skills and experience in these areas.

A.21 MDAL Assumptions for 1-H&S to 5-H&S

Selected MDAL assumptions relevant to the health and safety criteria are listed below. Additional assumptions are contained in the SDP MDAL.

Table A21.1: MDAL Assumptions for 1-H&S to 5-H&S

Relevant Criteria	#	Assumptions
1-H&S	22.02	Dose statistics for the Devonport site show that < 10% of radiation workers receive greater the 1mSv per annum and over the past twenty years no single worker has exceeded 5mSv. It is not anticipated that SDP will significantly alter or affect these levels.
1-H&S	25.05	Delaying the point at which the reactor is dismantled and the ILW is packaged will maximise the amount of radioactive decay that can take place, which will in turn minimise the radiological dose to workers.
2-H&S	23.01	It is not physically possible for there to be a nuclear accident (involving release of fission products) during submarine dismantling.

A.22 MDAL Assumptions for 1-ENV to 6-ENV

Selected MDAL assumptions relevant to the environmental criteria are listed below. Additional assumptions are contained in the SDP MDAL.

Table 22.1: MDAL Assumptions for 1-ENV to 6-ENV

Relevant Criteria	#	Assumptions
All-ENV	12.02	MOD has committed to fulfil the requirements of EU Directive 2001/42/EC (as transposed into UK legislation) and undertake an SEA in conjunction with the assessment of strategic options.
ALL-ENV	25.04	Whichever site(s) are finally chosen, further site-specific Environmental Impact Assessment (and possibly a site-specific Habitats Regulations Assessment) will be required, by law, before any development can take place. Environmental permits will also be required for the site(s) to operate. All of these will be public documents and open to comment
2-ENV 4-ENV	21.15	Dismantling work is unlikely to increase radioactive or non-radioactive discharges into the environment above the current permitted levels; any proposal to do so would require new permissions to be granted by the Environment Agency or Scottish Environment Protection Agency.
5-ENV	21.39	If the RC has been separated from the submarine leaving the separated front and rear sections, these cannot be towed and they will have to be transported by barge or heavy lift ship for which deep water is required. Depending on the site, this may require additional dredging of the sea bed which could impact the marine environment.
5-ENV	25.07	The River Forth is deep enough to avoid the need for additional dredging, so consequentially any damage to the protected mudflats could be avoided and so the effects on biodiversity for Rosyth are lower than for Devonport.

Relevant Criteria	**#**	**Assumptions**
5-ENV	12.05	It is assumed that intact submarines can be safely wet towed. Although transportation of the separated RCs/ fore and aft sections may require the use of a barge or heavy lift ship, it is assumed that this will not require additional (capital) dredging to be undertaken.
5-ENV	12.06	**Site Constraints** - it is assumed that there is land within the existing dockyards to accommodate new development. No further land take outside of the existing dockyards would be required.
5-ENV	12.11	**Duration of the construction phase for SDP facilities (Stages I and II)** - Whilst the exact duration and scale of construction works cannot be determined, it has been assumed that development on an undeveloped, 'greenfield' site would require the construction of more supporting infrastructure and ancillary facilities than the other site types; and would therefore take longer than for the other land use categories. Development of an 'existing' site is assumed to take the shortest amount of time.
5-ENV	21.21	Transporting intact submarines between existing licensed sites has very few environmental effects, beyond those of the exhaust emissions of the transport and escort ships.