REVIEW AND ASSESSMENT OF THE ENVIRONMENTAL IMPACT FROM DECOMMISSIONING OF TWO RUSSIAN NUCLEAR SUBMARINES

A report by Enviros Consulting Limited

Graham Smith, Duncan Jackson, Ian Barraclough, David Stone, Julie Tooley and Emma Kerrigan

Enviros Consulting Ltd
Culham Science Park
Abingdon
Oxfordshire OX14 3BD
United Kingdom

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Prepared under the management of:

Graham Smith – Project Manager

Directed, reviewed and approved by:

Ian Barraclough – Project Director

Client Address:

Statens Stralevern
Grini Naeringspark 13
PO Box 55
N-1332 Osteras
Norway

Ingar Amundsen

Tel +47 6716 2539
Fax +47 6714 7407
Email ingar.amundsen@nrpa.no

Enviros Contact Details:

Enviros Consulting Ltd
Building D5
Culham Science Centre
Abingdon
Oxfordshire
OX14 3DB

Graham Smith

Tel +44 1235 46 8811
Fax +44 1235 46 8828
Email graham.smith@enviros.com

Web www.enviros.com

EXECUTIVE SUMMARY

The Norwegian Government is funding contracts for the decommissioning of two "Victor II" Class nuclear-powered submarines from the Russian Federation's Northern Fleet, identified as numbers 625 and 627. The two submarines are being dismantled, respectively, by the Nerpa ship repair plant north of Murmansk on the Kola Peninsula, and by the Zvezdochka ship repair plant at Severodvinsk, near Archangel.

In relation to these two dismantling projects, the Norwegian Ministry of Foreign Affairs, through the Norwegian Radiation Protection Authority, appointed Enviros to review the environmental impact assessments undertaken by the shipyards, to conduct, as appropriate, independent Environment, Health and Safety studies of the proposed decommissioning activities, and to provide recommendations on Environment, Health and Safety performance.

The project was carried out primarily by review of relevant information supplied from the ship repair plants. Visits were made to both shipyards to facilitate exchange of information and understanding of the system for safety control and health and environmental protection. The scale of resource and time available for the review were quite limited so that only an overview of the situation could be determined. Nevertheless the following conclusions are drawn.

Information provided by the two yards indicates that systems are in place for process control and control of radioactive and other hazardous material. Certificates for each stage in the receipt, transfer and dispatch of materials were available for inspection.

It is evident that environmental impact assessments (EIAs) have been undertaken in connection with both shipyards. Full documentation has been hard to access and where translations have been provided they have been too late for detailed analysis within the current study. From the evidence we have, it is understood that the EIA studies form part of the implementation process rather than the decision making process. Consequently, they appear to not consider alternative options in detail, in order to identify the overall best practicable environmental option, or the best practicable means of implementation of each stage of work. Such consideration of options and justification of choice of processes is increasingly a feature of environmental management internationally. Nevertheless, on the basis of the information we have to hand, it is clear that the EIAs have been conducted in line with the current Russian Federation regulatory system.

Where EIA information has not been made available, independent assessments have been undertaken. The scope of these assessments has inevitably been more restricted than in a full EIA.

Subject to the points raised below, it is concluded that decommissioning of the two submarines has been undertaken in compliance with the applicable regulations. In addition, the safety requirements and methods for demonstrating compliance are broadly consistent with international recommendations and other national practice.

The option of not proceeding with defuelling the submarines is considered only to lead to continued risks of significant release of contaminants to the environment. Delay in subsequent dismantling of defuelled submarines would not lead to significant environmental hazards, though there would be continuing operational management issues requiring significant supervision.

It is recommended that future decommissioning work should be subject to continuing Environment, Health and Safety supervision, with increased emphasis on staged licensing; transparent regulatory inspection procedures; effective monitoring of compliance at the operational level; and evaluation of alternative techniques for implementing particular tasks. It is appropriate to recognise that national regulatory requirements and regulatory procedures are continually evolving, against a background of improved knowledge of the risks of radiation and other pollutants, and developments within international treaties and related Environment, Health and Safety standards, recommendations and guidance. A balanced and holistic approach is needed to take account of the spectrum of risks involved. In addition, while a clear separation of responsibilities has to be maintained, close cooperation between operators and regulators is to be encouraged.

The following issues are identified which relate to clarification of, or provision of, additional information, as well recommendations to support continuing improvement of Environment, Health and Safety performance.

- Definition of clearance levels applied to identification of waste which does not require management as radioactive waste.

- Methods employed for determining whether waste falls within clearance levels and/or within other waste categories.

- Further clarification of how hazardous wastes are managed in the short and longer term.

- Fuller information supporting the assumptions made within EIAs and related justification.

- Fuller information on safety requirements for towing submarines and methods for monitoring compliance.

- Although procedures are in place to maintain control over radiation exposures, and other environment, health and safety objectives, a clearer presentation that impacts (doses, risks etc) are as low as reasonably achievable could be valuable.

- Particular attention may be given to protection of workers involved in cutting operations during dismantling and the related inhalation hazard.

More broadly, it is noted that the decommissioning of two submarines represents only a relatively small part of the overall nuclear related activities in the region. Effective management of risks and resources is not a marginal issue. Therefore, it is suggested that the strategic Environment, Health and Safety implications of continued use and management of radioactive materials in the region should be evaluated, so as to help structure the further steps to be taken to improve nuclear safety, to safely decommission obsolete facilities and to effectively remediate contaminated ground.

1. INTRODUCTION

1.1 Background

The Norwegian Government, through its Ministry of Foreign Affairs (NMFA[1]), signed contracts on 30 June 2003 for financing the dismantling of two multi-purpose "Victor II" Class nuclear-powered submarines from the Russian Federation's Northern Fleet, identified as submarines numbers 625 and 627. The two submarines are being dismantled, respectively, by the Nerpa ship repair plant, north of Murmansk on the Kola Peninsula, and by the Zvezdochka ship repair plant, Severodvinsk, near Archangel. The contracts awarded to the two shipyards outline the main processes to be undertaken and stipulate that relevant assessments are to be undertaken, regulations complied with, and certification of handover at key steps to be completed.

Enviros Consulting Ltd (Enviros) has been appointed by the Norwegian Radiation Protection Authority (NRPA) on behalf of the NMFA to review, and independently assess where required, the potential environmental and radiological impacts arising from the decommissioning of these two Russian nuclear submarines. From this review, recommendations are to be made for improvement in the Environment, Health and Safety performance.

1.2 Objectives

The purpose of the review and assessment is to determine whether the decommissioning projects at Nerpa and Zvezdochka have been subject to formal environmental impact assessments and whether they are being carried out in accordance with applicable Russian Federation law and regulations and, so far as applicable to the circumstances, consistent with international recommendations and standards and other national good practice.

1.3 The decommissioning process

The key steps in decommissioning of the submarines are summarised below.

Prior to Dismantling
- Transport of the submarines to the shipyards for docking;
- Preparatory work before de-fuelling.

Dismantling
- Removal of spent nuclear fuel (SNF), radioactive waste and other waste materials;
- Loading of SNF into transport flasks;
- Removal of the bow and stern sections;
- Preparation of a three compartment hull.

Handling of Waste
- Transport of SNF for long term storage/disposal;
- Packing and storage of low and intermediate level radioactive waste;
- Packing and storage of chemically hazardous substances;
- Recycling of salvageable materials.

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[1] All acronyms are given in full at the first mention. A list of all acronyms is provided in Appendix A, along with supporting explanation, where appropriate.

Post-dismantling

- Towing of the three compartment hull to Saida Bay for storage.

A more detailed breakdown of steps in decommissioning is provided in Appendix B. We note that the term ‘decommissioning’, when applied to nuclear powered submarines is sometimes used to mean to take out of operational service. In this study we use it in the context of nuclear facility decommissioning which includes actions to allow removal of some or all regulatory controls, as suggested in the glossary of the International Atomic Energy Agency (IAEA, 2003). It may be noted that the most significant radioactive source term is in the SNF, and activities involving the SNF may require the most significant attention.

With respect to both submarine 625 and 627, it should be noted that much of the work has already been completed before this review commenced, e.g. transport of the submarines to the dismantling yards.

1.4 Endpoints of concern

The risks[2] arising at each stage of decommissioning should be determined and assessed in the context of Russian laws and regulations, taking due account of international conventions, regulations and recommendations. For routine operations, actions to mitigate impacts should be considered and for accident scenarios actions to reduce the probability of occurrence should be presented. The impact from both radiological and other chemically hazardous substances should be considered.

The endpoints of concern include impacts on humans, non-human biota (NHB) and the environment per se. For humans, individual and collective impacts on the workforce and the neighbouring populations are of relevance. In broad terms, an EHS study distinguishes impacts to the environment and health as those arising from planned events and discharges, whilst safety relates to loss of control, for example, loss of sources and material from the site, large scale accidents such as major fires, or implementation of incorrect workplace procedures. For this review only radiation impacts and impacts of other pollutants were included in the scope, e.g. physical risks to workers from falls or other accidents were not included.

1.5 Assessment of alternative options

Any environmental impact assessment or environment, health and safety study should review the impacts arising from the proposed actions in the context of alternative options, with a view to identify the best practicable environmental option (BPEO). In this study, the impact from decommissioning activities is compared with the alternative option of continuing to leave the submarines afloat for an indeterminate period prior to defuelling and decommissioning. Within a specific BPEO, it is common practice to demonstrate that Best Practicable Means (BPM) are employed to implement individual tasks.

[2] Throughout this study we use the term risk to describe the product of the scale of deleterious consequences arising from an event and the probability of occurrence of that event. Risk is a quantifiable factor but is occasionally used in a more qualitative fashion to describe relative magnitudes (IAEA, 2003).

1.6 Report Structure

Section 2 summarises the information made available for the review, including information from the NMFA via their inspections at the yards. Details are provided in Appendices.

Section 3 consists of a review of each task relative to EHS requirements and the EIA information supplied. There are differences in the practices adopted by, and documentation available from, the two shipyards at Nerpa and Zvezdochka. This review and assessment addresses both commonality and distinctions between the two yards as appropriate. Details of EHS issues, Russian Federation regulatory requirements and international guidelines are provided in Appendices.

Section 4 sets out the recommendations arising from the review and assessment.

2. INFORMATION AVAILABLE TO THIS STUDY

The general location of the two shipyards near Murmansk and Archangel is given in Figure 1. More detail is provided below.

Figure 1 General Location of FSUE Zvezdochka and Nerpa Shipyards

2.1 FSUE Zvezdochka: Submarine 627

The Federal State Unitary Enterprise (FSUE) Ship-Repair Yard at Zvezdochka is located in the town of Severodvinsk on the White Sea, in the Archangel region of Russia. The shipyard is well equipped with railway slips, floating and dry docks and ship repair facilities. In addition to its military and civil ship maintenance and decommissioning activities, the enterprise also undertakes such disparate activities as the construction of propellers, oil and gas exploration support, furniture making and diamond polishing.

Zvezdochka shipyard is reported by the Bellona Foundation (2003) to have dismantled 17 nuclear powered submarines up to 2001, including Yankee and Delta class vessels. The site currently has both Victor and Oscar class submarines in dock awaiting completion of dismantling and decommissioning.[3]

During NMFA inspections it was reported that there had been no “accidents or other discrepancies in the reactors” during the period that submarine 627 had been in operation and the shipyard was therefore able to carry out unloading of the fuel in accordance with the normal procedures. Within the Enviros review, a site visit was conducted in March 2004, and a report on the visit is given in Appendix C. This visit was made primarily to elicit further documentation and did not constitute a site inspection.

3 Personal observation made by one of the authors (D Jackson), based on information provided during a site visit, 4 March 2004.

Figure 2 Location of FSUE Zvezdochka

2.2 Nerpa: Submarine 625

The state owned Ship-Repair Yard at Nerpa is situated in the innermost part of Olenya Bay and falls under the auspices of the Ministry of Economy. The shipyard is equipped with railway slips, a dry dock and a floating dry dock equipped for defuelling and preparing submarines for fresh fuel.

Figure 3 Location of Nerpa

Nerpa shipyard was reported by the Bellona Foundation (2003) to have dismantled 9 nuclear powered submarines up to 2001, although the facilities have been enlarged to increase throughput. During NMFA inspections it was stated that the shipyard had dismantled 20 submarines to date, with a further 5 awaiting dismantling. The shipyard currently has the capacity to unload the fuel from 7 submarines per year. During 35 years of operations involving unloading spent fuel from nuclear powered submarines, no accidents had been reported.

A number of issues arise from previous inspections. These all relate to the hazard assessment and treatment of wastes. With respect to the dismantled bow and stern sections, an adequate explanation is required for how individual components and environmentally hazardous waste are dealt with. Similarly, reservations arise concerning the containerisation and storage of solid radioactive wastes and further information has been requested concerning the storage and transport of liquid radioactive wastes to the Zvezdochka shipyard for further treatment. It should be noted that these concerns primarily address requirements for information and need not imply that actual shipyard practices are unacceptable.

2.3 EHS documents received

Very limited information was received during the early phase of this study regarding the Zvezdochka shipyard. More complete information was received towards the end of the study period. Details of information requested are given in Appendix D, and EHS documents received are listed in Appendix E and are summarised below. Concern has been expressed that the status of some of the documents is unclear and that, more generally further information could be made available on the methods applied to ensure implementation of guidelines on handling radioactive material.

Much of the information supplied is not specific to NPS 625 and NPS 627. However many EHS issues are of site wide relevance, and so have application to this review.

In addition it is noted that a number of the documents appear to have been created or modified specifically for the NMFA, and copies of the original Russian documentation would in all cases be preferable as a statement of actual standard practice.

Table 1 Review of documents and practices

Transport of the submarines to the shipyards for docking We have not received any information from the Russian contractors about the regulations, under which the submarines were towed, or about the towing practices and associated safety measures adopted, or about emergency arrangements in place to manage any accident.
Preparatory work before de-fuelling Information provided gives details of the analyses performed for Zvezdochka of the radiological impacts of operations and possible accidents. For Nerpa, only very brief conclusions have been provided. Certificates from Zvezdochka declare that submarine 627 was ready for unloading of fuel, and that preparation has been carried out in accordance with named regulations. Brief radiological survey data around the reactor compartment were also given.

Removal of spent nuclear fuel (SNF), radioactive waste and other waste materials Information provided gives details of the analyses performed for Zvezdochka of the radiological impacts of operations and possible accidents. We have not seen any corresponding data for Nerpa, presumably because the unloading of fuel is managed separately (by the military) from the rest of the shipyard. Certificates from Zvezdochka declare unloading of fuel complete and reactor cover installed, and submarine 627 ready for dismantling; in particular, that solid and liquid radioactive wastes and petrol, oil, lubricants and flammable materials have been removed. Brief radiological survey data around the reactor compartment were also given.
Loading of SNF into transport flasks No information received specifically on this.
Removal of the bow and stern sections We received brief radiological data from Nerpa before and after dismantling work; for Zvezdochka, only before dismantling. For Nerpa, we had analysis of mechanisms by which harmful chemical substances are released to the air during dismantling work and assessment of releases. However, there was not an equivalent analysis of dust concentrations in the workplace and the corresponding acceptable levels. We have no information on these issues for Zvezdochka. From Nerpa, we also have some environmental monitoring results from July–December 2003 which indicate measured levels of activity on and around the site.
Preparation of a three compartment hull For Nerpa, information was provided on assessment of materials released to air during welding and painting operations. No equivalent information for Zvezdochka was provided.
Transport of SNF for long term storage/disposal For Nerpa, we have a statement that flasks have left the site. Otherwise, we have no information on this stage.
Packing and storage of low and intermediate level radioactive waste Some information was provided for both sites about amounts of waste: some of this (quite detailed) was in the Zvezdochka report received just prior to completion of this review. There is also some qualitative information on treatment and storage of wastes (particularly from Nerpa), plus additional information from observations and discussions during site visits. However, we had no information on any assessment of impacts or risks from this stage. No information was supplied about the arrangements at Saida Bay.
Packing and storage of chemically hazardous substances We have information on amounts of waste from both sites and, for Nerpa, some qualitative information on management practices including some references to relevant regulations. There was also some additional information from observations and discussions during site visits. For Zvezdochka, some information on management of such wastes was obtained from the NMFA inspections.
Recycling of salvageable materials We had little information on this, beyond observations made at both shipyards. Neither shipyard provided quantitative information about the criteria applied for the release of materials for recycling: they were qualitatively described as ‘background’ levels.
Towing of the three compartment hull to Saida Bay for storage We have not seen any indication of the regulations, under which the hulls will be towed, or about the towing practices and associated safety measures to be adopted, or about emergency arrangements to manage any accident.

3. REVIEW AND INDEPENDENT ASSESSMENT OF KEY STEPS

General consideration of EHS issues in submarine decommissioning are set out in Appendix F, along with a top down view of potentially relevant EHS issues relevant to each decommissioning step. The section below reviews the implications in the light of Russian regulatory requirements set out in Appendix G and international guidance described in Appendix H.

3.1 Transport of the submarines to the shipyards for docking

The submarines were towed to the two shipyards from the Gremikha Naval Base in the north-east of the Kola Peninsula, a distance approaching 500 km to Nerpa and around twice as far to Zvezdochka.

We have not received any information from the Russian contractors about the regulations, under which the submarines were towed, or about the towing practices and associated safety measures adopted, or about emergency arrangements in place to manage any accident. The towing procedures are understood to be similar to those adopted for the November Class submarine K-159, which sank in the Barents Sea in August 2003. Unlike the K-159, the Victor II submarines were reportedly not fitted with additional flotation aids, apparently because they were in much better condition than the November Class vessel.

The Russian Federation has ratified the International Convention for the Safety of Life at Sea 1974 (SOLAS). Amendments to Chapter VII of the Convention in 1999 and 2002 made the International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on Board Ships (INF Code) mandatory with effect from 1 January 2001 and the International Maritime Dangerous Goods Code (IMDG Code) mandatory with effect from 1 January 2004. The INF Code applies to ships engaged in the carriage of INF as cargo. It does not apply to warships, naval auxiliary or other ships used only on government non-commercial service. Both of these statements would appear to exclude a towed submarine from the scope of the Code. However, Administrations are expected to ensure ships are in compliance with the Code even if they do not fall strictly within its scope.

More specifically, the IMO's Maritime Safety Commission issued guidelines for safe ocean towing in 1998. These are not mandatory, but observance of such internationally endorsed guidelines would be evidence of applying good practice.

The Russian Federation is a Contracting Party to the Convention on Early Notification of a Nuclear Accident, and so would be required to notify the IAEA and potentially affected countries of any accident from which a release of radioactive material occurs or is likely to occur and which has resulted or may result in an international transboundary release that could be of radiological safety significance for another State.

It is possible to envisage a range of potential accidents that could affect a submarine during towing. Although we know that no such accidents occurred during the towing of NPS 625 and NPS 627, the potential consequences should be evaluated as part of an overall assessment dealing with risk management[4]. The K-

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[4] It is difficult, and not particularly helpful, to estimate the probability of any given towed submarine suffering a serious accident. The probability might be expected to increase as the distance towed, particularly in open sea, increases. The data that exist are largely for accidents on operational vessels. However a thorough scenario analysis of possible accident causes and evaluation of

159 accident clearly demonstrated the conventional maritime safety hazards to crew: indeed, from an individual perspective, the physical risks to crew members associated with sinking are likely to be far greater than other EHS impacts.

The submarine reactors would have been shut down prior to and throughout the towing operations. Accident scenarios might nevertheless be envisaged in which criticality could occur in the reactor fuel. Damage to the reactor vessel leading to ingress of water acting as a moderator (combined with the control rods being ineffective for some reason, e.g. accidentally withdrawn or damaged) could give rise to a risk of criticality. However, these would have essentially the same effect in terms of release of radioactive material as criticality scenarios considered for defuelling operations at the shipyard. If such an accident occurred out at sea, the consequences for crew on the submarine might be greater than if it occurred in the shipyard (because they would be unable to evacuate), but most other impacts would be lower because of the distance between the reactor and any members of the public and the greater dispersion of activity that would occur before anybody could come into contact with it. Even if such an accident occurred relatively close to shore in the fjords around Nerpa, Zvezdochka or Gremikha, the consequences for members of the public would be most unlikely to exceed those for a similar accident during fuel unloading.

More plausible accident scenarios would be those leading to the sinking of the submarine with the reactor remaining shutdown. Environmental impacts would depend upon radioactive (and other hazardous) material being released into the sea water. Observations from submarines and other vessels sunk previously indicate that this does not occur to any significant extent in the short term. In the longer term, the submarine might be salvaged, in which case the potential impacts would be averted, or material might gradually leak into the sea. Previous assessments performed, for example, for the IAEA's IASAP study of radiological conditions in the western Kara Sea, indicate that the radiological impacts to humans and marine organisms of long term degradation of submarine reactor fuel in shallow sea close to the coast of Novaya Zemlya are very low and result in less than 1μSv/a individual dose to the general public and no more than a few man Sv collective dose (IAEA, 1998).

Doses from a submarine accidentally sunk in the Barents Sea would be expected to be even lower. An accident close to shore in the fjords around Nerpa, Zvezdochka or Gremikha would have consequences closer to those estimated for Novaya Zemlya. As an indication of an upper bound, the IASAP study postulated that a hypothetical critical group of military personnel patrolling the banks of a fjord on Novaya Zemlya very close to locations in which radioactive wastes had been dumped could receive doses up to a few mSv/a. However, the scenario of an accident leading to the submarine sinking close to the shore in a fjord, and yet not being salvageable, is much less plausible than such an accident in open sea.

In addition to the radiological hazards that would be present during transportation, dismantling and decommissioning of the submarines, persistent organic pollutants (POPs) such as PCBs (polychlorinated biphenyls) and heavy metals such as cadmium and lead will be present in the waste products. For an accident at sea, the impact on local biota could be significant, affecting reproduction, development and disease resistance, but the dispersion provided by the sea would make any significant impact on human health very unlikely.

mitigation options could be used to reduce the overall risks. For example, planning transfers to avoid periods of more likely adverse weather conditions may be appropriate.

Hence, with the exception of the risks to crew, movement of the submarines to the shipyards prior to dismantling would pose only very minor risks to human health. However, the broader social and economic impacts of an accident (e.g. effects on the fishing industry in the Barents Sea) could be substantial, particularly since the Arctic is regarded as a sensitive, vulnerable ecosystem compared to other parts of the world (AMAP, 2002).

3.2 Preparatory work before de-fuelling

The main potential for EHS impacts during preparations for defuelling is associated with mishaps during the draining of various liquids and gases from the submarine. Two types of event could cause impact – leaks of hazardous fluids into the environment and fires or explosions involving flammable or explosive fluids. The former could have direct environmental and health effects; the latter would have direct safety impacts, but could also act as initiators leading to environmental or health impacts (e.g. an explosion could cause a leak).

An assessment for a leak at Zvezdochka of 173 MBq (considered to represent a maximum plausible loss of 0.5 m^3 of coolant) which was estimated to result in doses of about 3 μSv for divers working in the water and 4 nSv for people working on land near the water. For the release of all the primary coolant (Petrov, 1995), i.e. 74 TBq, these numbers would scale up to about 1 Sv to divers (though it is assumed divers would not go in the water if there had been an accident like that) and 2 mSv for the people on shore. This is very much a worst case: most of the fluids unloaded from the submarine are much less hazardous than the primary circuit coolant and most plausible leakage/spillage scenarios would involve only a fraction of the total amount of fluid.

The main hazards associated with pre-defuelling operations – fires and explosions – could also be initiating events for more serious accidents involving the reactor or fuel. However, these are of the same nature as the types of initiating event considered in accident analyses for fuel unloading (see below), and in this case the fuel is still enclosed in the submarine hull. The impacts would therefore be no more severe (and probably less severe) than the scenarios considered below.

Since the submarines are still afloat during preparatory work, they could conceivably sink. If this happened soon after docking, this could result relatively rapidly in leaks to the water of some or all of the fluids referred to above. The impacts of such leaks would presumably be similar to those already considered for leaks during the draining of fluids. Release of radioactivity from the reactor fuel into shallow water, particularly a confined body of water, close to the shore would be worse than the release to deep water in open sea considered for the towing stage. However, it may reasonably be assumed that a sunken submarine within the shipyard could readily be salvaged before any longer term leakage of radioactive or other hazardous material could occur.

3.3 Removal of spent nuclear fuel (SNF), radioactive waste and other waste materials

In order to remove the fuel, a hole has to be cut in the top of the reactor compartment. We assume that the worker doses and environmental releases related to this cutting are included in the estimates provided for the whole task of unloading the fuel. (Dose rates are, not surprisingly, higher around the reactor compartment than elsewhere on the submarine, although the highest dose rates appear to be at the bottom of the hull, not the top.)

The analysis for Zvezdochka predicted, based on experience with previous submarines and work regulations, that individual workers would not receive more than 2 or3 mSv from external gamma exposure during unloading of the fuel. These doses are only 10%–15% of the annual dose limit for workers, and therefore would not represent a significant health impact. However, this observation is qualified by two caveats. Firstly, these doses appear to exclude any exposure due to intakes of radionuclides. Provided standard precautions are taken, these are likely to be small compared to the external gamma doses. Secondly, the fuel unloading takes only about one month, so that workers engaged full time in such dose intensive work could potentially receive doses up to the limit of 20 mSv in the course of year. It is assumed that control measures on the site would ensure that individual workers' tasks are managed so that they do not exceed this limit.

We have not seen any corresponding data for Nerpa, presumably because the unloading of fuel is managed separately (by the military) from the rest of the shipyard. We have no reason to expect that doses would be substantially different from those at Zvezdochka.

The programme for unloading fuel at Nerpa indicates up to 47 staff being involved. They would not all be expected to receive the highest individual doses indicated above, and so the collective dose to the workforce is likely to be less than 0.1 man Sv.

The analysis of environmental radiological impact for Zvezdochka indicates doses to the public beyond the site boundary will not exceed 1 μSv/a for routine discharges, doses which would generally be regarded as negligible.

The analyses performed for Zvezdochka indicate potential doses off-site of less than 0.1 mSv/a (i.e. well below the dose limit for members of the public) for design basis accidents during unloading (dropping or damaging fuel assemblies, fire in a submarine compartment, accidentally discharging primary circuit coolant) and up to 37 mSv within a year for accidents beyond the design basis (37 mSv for criticality caused by flooding the reactor compartment, less than 0.1mSv for a submarine sinking during unloading, and 14 mSv for an aircraft crashing into the site). The evacuation criteria specified in NRB-99 are 50 mSv (Level A, below which action is definitely not necessary) and 500 mSv (Level B, above which action is definitely necessary)[5], so even the worst case accident would not trigger evacuation in Severodvinsk. The analysis carried out for Nerpa apparently gives a similar conclusion that beyond design basis accidents would not give doses high enough to require evacuation at Snezhnogorsk. Although we have not seen details of the results that lead to this conclusion, it is plausible based on broader experience.

The UK HSE's safety assessment principles (SAPs) for nuclear installations set out limits and objectives for the probabilities of accidents with given radiological consequences off site. For an accident giving rise to off-site doses between 10 and 100 mSv must have a probability less than 10^{-2} per year and the probability must be as low as reasonably practicable (ALARP) below this. For such an accident, a probability of 10^{-4} per year is the stated objective (i.e. if the probability is lower than this, it can be assumed to be ALARP). Vasiliev (2003) estimates frequencies of some possible accidents. For damage to a fuel assembly during unloading (one of the design basis accidents considered above) the frequency is relatively high ($6\ 10^{-3}$ per year), but the consequences are low. For the aircraft crash scenario (one of the beyond design basis accidents) the consequences are much more severe, but

[5] These criteria are broadly consistent with those considered internationally to be appropriate. For example, the International Basic Safety Standards published by the IAEA specify a generic "optimized" intervention level for temporary evacuation of 50 mSv within a period of a week or less.

the probability is estimated as 10^{-8} per year that an aircraft would fall on the reactor compartment of the submarine at the cooling stage. Considering the duration of the operation involving unloading of fuel, the probability of an aircraft falling on the reactor compartment during the period of unloading is evaluated as $2^\wedge10^{-9}$.

Most documentation we have seen does not give information on the consequences of such accidents for workers on the site. For the design basis accidents (e.g. dropping or damaging fuel) there is clearly potential for significant doses to a few workers. For those beyond design basis accidents involving aircraft crashes, missile strikes etc., the effects on workers of the initiating event would probably be worse than any effects from radioactive or chemical hazards. Accidents involving criticality could have very severe (possibly fatal) consequences for any worker on or close to the submarine at the time. Doses to workers are well below 0.1 mSv for a design basis accident, but up to 200 mSv for a criticality accident. In view of the low probabilities referred to above, however, these risks do not seem to be particularly significant compared to the routine general risks of shipyard work.

The accident scenarios considered here also give a reasonable indication of the possible impacts of a plausible terrorist attack. Indeed, the missile scenarios are identified as being representative of possible accidents or sabotage.

3.4 Loading of SNF into transport flasks

We would expect that this is essentially a continuation of the unloading task, and that routine impacts (e.g. doses to workers) would be included in (and would be a relatively small contribution to) the estimates for unloading the fuel. Although the procedure at Nerpa involves an extra stage in the transfer of fuel – the transfer by ship from Nerpa to the Atomflot facility at Murmansk – the fuel is loaded into flasks at Nerpa, and so any doses due to handling the flasks at Murmansk will be small compared to those incurred at Nerpa while the fuel is outside the flasks.

Similarly, the scenarios used in the accident analyses described above were sufficiently generic that they can be assumed to cover the loading of spent fuel into flasks as well as unloading from the submarine. If anything, the risks might be somewhat lower for loading the flasks, as there would not be a relatively vulnerable accumulation of fuel assemblies equivalent to the fuel remaining in the (open) reactor compartment during unloading.

3.5 Removal of the bow and stern sections

Monitoring results for Zvezdochka suggest that dose rates around the reactor compartment (0.5 μSv/h) are not greatly affected by the removal of the fuel, presumably because much of the gamma dose rate comes from activation products in the steel.

The highest external dose rate quoted in the reports we have seen (for Nerpa) is 40 μSv/h at one point inside the reactor compartment, however the maximum dose rate on the outside of the reactor compartment (which is presumably where workers will spend their time) is 12 μSv/h. A worker spending 500 hours, three working months (the dismantling work appears to have been conducted over a period of about three months) in such a dose rate could receive 6 mSv, 30% of the occupational dose limit of 20 mSv, but this is a highly localised maximum dose rate at a single point in the hull, not at all representative of the rate likely to be encountered on average. A more typical, but still probably conservative, 'average' dose rate around the main cutting points would be around 0.1–0.2 μSv/h. This corresponds to only about 0.05–0.1 mSv in the three working months assumed for dismantling. We do not have corresponding dose rate measurements for Zvezdochka, but the dose rates we do have (notably the 0.5 μSv/h mentioned above) suggest that they are probably comparable to those at Nerpa. Given that the estimated doses at Nerpa are so low, it is highly unlikely that those at Zvezdochka would be significant.

Given that the 3-compartment units include a relatively ‘clean’ compartment either side of the reactor compartment (0.1 μSv/h, the gamma dose rate measured around the non-reactor compartments, is close to background levels), the metal being cut to remove the bow and stern sections is unlikely to be significantly activated or contaminated (an assumption supported by the distribution of external gamma dose rates along the hull), and therefore little activity is likely to be released to the atmosphere during the cutting. Hence, neither the internal doses to workers nor releases of activity off-site are likely to be significant. (Air monitoring in the working cell at Nerpa after defuelling indicate that activity concentrations in air are consistently very low.)

The programme for work at Nerpa indicates up to about 100 people working on at least some part of the dismantling work. This suggests that the collective dose to the workforce is likely to be less than 0.01 man Sv.

The doses actually received by workers involved in the dismantling will have been monitored, but we do not have these data.

The most significant health and environmental impacts of this stage of the work are likely to be related to non-radioactive hazardous materials released to the atmosphere during cutting. Although there is reference in the documentation to ventilation and filtration arrangements, some of the cutting operations are necessarily conducted in confined spaces. Furthermore, observations during site visits in March 2004, suggested that workers engaged in cutting did not necessarily wear respiratory protection.

For Nerpa, the main mechanisms by which harmful chemical substances are released to the air during dismantling work and the basis for assessment of releases.

- For gas cutting, assumed AK steel as representative of the materials being cut, standard cutting speeds, etc.
- For scraping paint and other coatings off welds, lead was assumed as a worst case.

There is analysis of the dispersion of particulates, sulphur dioxide, carbon oxides and nitrogen dioxide (presumably from these cutting and scraping operations, plus the welding and painting associated with the next task below), concluding that the maximum concentrations at Snezhnogorsk are 10%–20% of the admissible levels.

However, there does not appear to be an equivalent analysis of dust concentrations in the workplace and the corresponding acceptable levels. There is an indication that blowers are used to drive dust out of the workplace and that 99% of dust is trapped in filters, but no indication of the dust levels actually experienced by the workers doing the cutting and scraping. However, the maximum allowable dust concentration cited in this context (0.1 mg/m^3) is the same as that for Snezhnogorsk town, not a value representative of dusty industrial environments. Vasiliev (2003) has expressed concerns that dust concentrations in confined workplaces can reach levels up to 30 times higher than acceptable limits, but this would not be greatly surprising if the limits were those for outdoor air in towns – 30 times 0.1 mg/m^3 is only 3 mg/m^3, which would be regarded as a moderately dusty industrial environment. In the event of ventilation arrangements failing, even higher levels could arise, but people would be unable to breathe in dust levels much above about 10 mg/m^3, regardless of the nature of the dust.

Hence, no assessment appears to have been made of the exposure of workers to airborne harmful substances in the course of this operation (a priori from modelling, or a posteriori from monitoring). However, this study is primarily focused on radiological impacts, we do not attempt to address this issue any further.

We have no information on these issues for Zvezdochka. There is no particular reason to expect there to be major differences compared to Nerpa, but nor do we have any basis for concluding that there are none.

Removal of the fuel significantly reduces the risks associated with potential accidents. There are no longer any criticality concerns, and the radiological consequences of conventional accidents (fires, explosions) are very much lower due to the very much reduced inventory.

Monitoring results from July–December 2003 at Nerpa indicate measured levels of activity of ^{90}Sr, ^{137}Cs and ^{60}Co in:

- Air at various locations on and off the site
- Deposited activity on site and in Snezhnogorsk town
- Soil on site and in Snezhnogorsk town
- Seaweed on and around the site
- Sea water at various points around the facility
- Fish in the “sanitary protection zone”

The measured values reported are consistently below – and usually well below – the relevant limits.

3.6 Preparation of a three compartment hull

The only aspect of preparing the hull for towing that might give rise to any significant EHS impact is the welding necessary to make the hull water tight and painting of the hull, which could have health implications in the form of worker exposure to chemically hazardous fumes.

For Nerpa, standards are cited as the basis for assumptions about materials released to air during welding and painting operations. Environmental impacts were addressed in the analysis mentioned above in the context of removing the bow and stern sections. The issues expressed about possible health impacts associated with dust levels in the workplace also apply here.

We have no equivalent information for Zvezdochka.

3.7 Transport of SNF for long term storage/disposal

At Zvezdochka, spent fuel flasks are loaded directly onto trains. At Nerpa, they are transferred by Atomflot ship *Lotta* to Atomflot’s facility at Murmansk[6], where they

[6] An undated statement from Nerpa cited that 64 containers of SNF had been transferred to Lotta for transfer to Mayak train at Atomflot depot.

are loaded on to trains for Mayak. From Murmansk, the rail journey must be around 3000 km; from Zvezdochka a little less.

Although we have not seen any certification documentation, we understand that the transport flasks used for carrying the spent fuel and the procedures applied satisfy the requirements set out in Russian regulations (and, by extension, those in the IAEA Transport Regulations). This would imply that shielding and contamination control will be such that routine handling of the packages will not result in any significant radiation exposure. It should also mean that the packages are extremely robust in the event of an accident on route, and are highly unlikely to leak, or fail catastrophically. In the highly unlikely event of a container failing as a result of an accident or sabotage, the potential consequences might be expected to be a fraction of those considered above for a major accident during unloading (the fuel from submarine 625, for example, are reported to take up 64 flasks[7], meaning that a single flask contains only 1/64 of the inventory), i.e. it is unlikely to create a situation in which evacuation of the population would be required. Given the highly unlikely nature of such an event, this does not seem to be a significant risk. As in the case of a towing accident, the wider implications of the impact of an accident could far exceed any direct human health impact. The wider social issues are addressed in a review carried out in relation to spent fuel transport across London (GLA, 2001).

3.8 Packing and storage of low and intermediate level radioactive waste

The facilities at both shipyards for treatment and packaging of solid low and intermediate level waste LILW are modern (built with western funding) and appeared to be well run.

At Zvezdochka, waste is not returned to the 3-compartment hulls, but is stored on the site. The storage conditions for some of this waste are a cause for further consideration. The more active wastes are stored in dedicated buildings, although there are questions about the robustness and security of these buildings and about their capacity to continue to accommodate expected future arisings. There does not appear to be any serious imminent risk associated with these concerns, but they will need to be addressed in the near future. Furthermore, some wastes, apparently those with lower levels of activity, are stored in drums in the open air on an area of hard standing. This is perhaps understandable in view of the pressure on storage space for more hazardous waste, but is unsatisfactory as a long term arrangement. Exposed to the elements, it is likely that some drums will begin to leak (if they have not done so already) and some activity will be released to the environment via drains or soil, or by direct washing into the sea. The small amounts of activity likely to be involved and the high dilution in the immediate environment will be sufficient to ensure that any radiological impact will be very low, but the probability of such an occurrence is high. Apart from the current practice being 'poor housekeeping', minor incidents of this nature could easily be blown out of proportion so as to reflect very poorly on the overall running of the shipyard.

At Nerpa, the waste is stored only for a relatively short period of time before it is placed in a 3-compartment hull (not necessarily that of the submarine from which the waste originated) for towing to Saida Bay. The issues described above do not therefore arise at Nerpa. We do not have information about the arrangements at Saida Bay – the management of LILW at Saida Bay is outside the scope of this

[7] This seems a large number of flasks for just two reactors. In the UK, the fuel from two submarine reactors could be carried in as few as four transport flasks.

project. However, storage of the waste in a 3-compartment hull afloat in the bay is also likely to be unsatisfactory as anything other than a short term arrangement.

Liquid wastes at Nerpa are either disposed of as part of the defuelling operation (e.g. primary coolant liquids) and dealt with by the military, or sent to Zvezdochka (the low level wastes). Receipt and treatment plants at Zvezdochka appear modern and well maintained. Treatment includes ion exchange to reduce concentrations of key radionuclides and volume reduction for storage.

3.9 Packing and storage of chemically hazardous substances

For Nerpa, most hazardous wastes are transferred elsewhere for disposal or management and therefore on-site storage is generally short term. indicates disposal routes for a range of chemically hazardous products (and, in some cases) applicable regulations/instructions.

- Luminescent lamps (stored)
- Loose insulation waste (stored)
- Special coatings (stored)
- Cables (insulation burnt off, copper recycled – I MINYa-481/2-97)
- Lubricants (burnt in boilers – I MINYa-494-98)
- Oil sludge (stored in special tanks, sediment sent to Snezhnogorsk TBO)
- Electrolyte (discharge to industrial sewage system – TU MINYa-169-98)
- Batteries (temporary storage in open air awaiting return to vendors)
- Galvanic production waste (processed, sent to Snezhnogorsk TBO polygon)
- Carbide sludge, acetylene production waste (sent to Snezhnogorsk TBO polygon)
- Timber waste (burnt in winter)
- Industrial waste (sent to ZKH polygon of Snezhnogorsk)
- Others – lubricant residues, coatings, foaming agents, glue, filler, asbestos-filled plastic, cable products (not specified – general statement that wastes are not new to the shipyard, no real change in environmental quality)

There were indications at Nerpa of a particular difficulty with storage of the rubber coating material (up to 400 tonnes per submarine), mainly because of the amount of space required.

For Zvezdochka, only limited information was obtained via NMFA inspections. It appears that most solid hazardous wastes are simply stored on the site because there are no disposal facilities nearby, although some are evidently removed from the site. A facility for sorting and storing potentially hazardous wastes is apparently being planned, but in the mean time many such wastes are stored unsorted in the open air in a variety of containers made at the site. Although the containers are welded shut, there appears to be little to stop them becoming corroded and potentially leaking.

3.10 Recycling of salvageable materials

Observations at both shipyards[8] suggested that there is strict control over the release of recyclable materials, at least with regard to ensuring that levels of radioactivity are sufficiently low. Although neither shipyard has provided quantitative information about the criteria applied for the release of materials, they were qualitatively described as ‘background’ levels. The dose rate measurements around the hulls suggest that materials from the bow and stern sections in particular are unlikely to have significant levels of radioactivity.

Although the monitoring procedures appeared to be thorough, it is possible that some material could inadvertently be released when it should not have been.

3.11 Towing of the three compartment hull to Saida Bay for storage

Although the potential impact of any accident during the towing of defuelled hulls would be much lower than for a fuelled submarine, the same basic considerations apply. We have not seen any indication of the regulations under which the hulls will be towed, or about the towing practices and associated safety measures to be adopted, or about emergency arrangements to manage any accident.

There is a significant difference between the two shipyards in that Nerpa is close to Saida Bay and the towing will be entirely within the Kola Fjord, whereas the journey from Zvezdochka to Saida Bay is around 1500 km, much of it in open sea.

For submarine 625, although the towing distance is very short, the hull will contain substantial amounts of radioactive and other hazardous waste. If the hull were to sink, some of these waste forms might allow relatively rapid release of radionuclides and other contaminants to the water. Hence, whereas an intact submarine sinking in the fjords might reasonably be expected to be salvageable before any release could occur, the hull sinking in the fjords might present a different environmental hazard [AMAP, 1998].

It may be noted that although the radioactive inventory within compartment hulls is not trivial, direct disposal of decommissioned and defuelled submarines to the sea bed does not lend to significant radiological impacts. See, for example, assessments carried out for British NPS (House of Commons Defence Committee, 1989). While the submarine and other circumstances are not exactly the same, the general implication is that the affect from the physical risks to employees, the EHS issues linked to an accident would not be major.

3.12 Security

The assessments we have seen focus on EHS impacts associated with normal operations and accidents. Deliberate acts of sabotage or terrorism cannot be ruled out but are also, by their nature, highly unpredictable.

3.13 Comparison with the ‘no action’ option

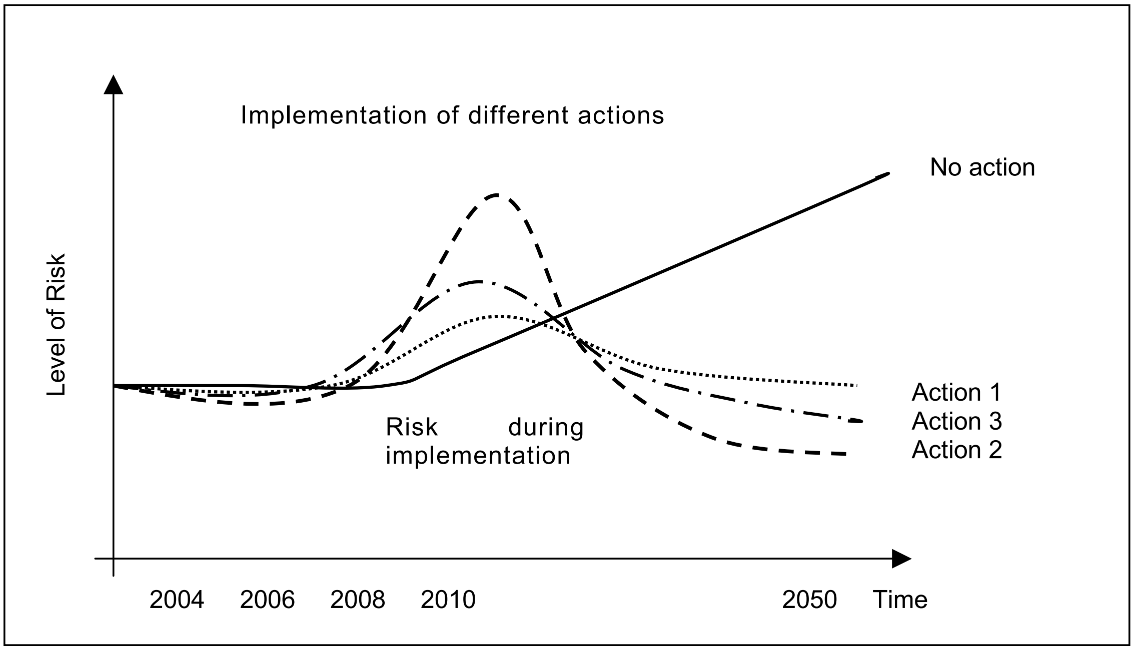
The option of not proceeding with defuelling the submarines is considered only to lead to continued risks of significant release of contaminants to the environment. Delay in dismantling of defuelled submarines does not lead to significant

[8] Based on personal observations by D Jackson during site visits March 2004 and discussions with site operators

environmental hazards, though there will be continuing operational management issues requiring significant supervision.

The risks and other impacts associated with defuelling submarines are incurred on the basis that they will in time be outweighed by the risks and impacts averted by eliminating the long-term hazard of a fuelled submarine gradually degrading in current storage locations. If no action were taken, then in the long term, even with continued active management of the vessel, the probability of an untoward event occurring resulting in detrimental consequences would continue to rise. Eventually something would result in release of contaminants to the environment. Actions taken now may result in an increase in risks in the short term but result in assurance of longer term safety, as schematically illustrated in Figure 4, in relation to the Lepse SNF storage vessel (Sneve and Smith, 2001).

Figure 4 Illustrative risk curves for different management options



We do not have information on the maintenance regimes for submarines laid up at Gremikha, but it is difficult to guarantee that submarines are maintained to such an extent as to prevent any loss of containment for the length of time that SNF remains hazardous.

As noted above however, other risks associated with actions of towing, defuelling and dismantlement that could give rise to risk within a shorter timescale. The decision makers need to consider the best course of action, taking into account short and long term risk, doses to workers versus doses to the public, and total collective dose. For example, there are risks associated with towing submarines from Gremikha to other shipyards for dismantling. The human health risks appear to be dominated by the physical risks to crew; the EHS impacts of routine towing or plausible accidents are not expected to be larger than those associated with indefinite storage.

While fuel is being unloaded, the radiological safety and health impacts may be temporarily increased relative to leaving the reactor core undisturbed. The fuel assemblies actually being unloaded at any given time are relatively exposed and may be dropped or damaged, and the reactor compartment is open and therefore relatively vulnerable. These risks cannot be entirely eliminated, but they can be kept to a minimum by strict observance of national and international regulations and good practices.

Different options will result in different impacts. For example, deferring dismantlement for 50 years, would result in substantial radioactive decay of Co-60, the dominant contributor to worker doses during dismantling, if done early (House of Commons Defence Committee, 1989). On the other hand, delay in dismantling would result in continued operational risks and costs. However, the EHS differences between early and delayed dismantling are relatively small compared with the implications of management of the SNF.

Final choice among options for dismantling should preferably be based on a clear understanding of all of the EHS issues as well as broader logistical, social and economic issues. Advantage may accrue from involvement of all stakeholders in the process of reaching a decision,

4. CONCLUSIONS AND RECOMMENDATIONS

Information provided by the two yards indicates that systems are in place for process control and control of radioactive and other hazardous material. Certificates for each stage in the receipt, transfer and dispatch of materials were available for inspection.

It is evident that environmental impact assessments (EIAs) have been undertaken in connection with both shipyards. Full documentation has been hard to access and where translations have been provided they have been too late for detailed analysis within the current study. From the evidence we have, it is understood that the EIA studies form part of the implementation process rather than the decision making process. Consequently, they appear to not consider alternative options in detail, in order to identify the overall best practicable environmental option, or the best practicable means of implementation of each stage of work. Such consideration of options and justification of choice of processes is increasingly a feature of environmental management internationally. Nevertheless, on the basis of the information we have to hand, it is clear that the EIAs have been conducted in line with the current Russian Federation regulatory system.

Where EIA information has not been made available, independent assessments have been undertaken. The scope of these assessments has inevitably been more restricted than in a full EIA.

Subject to the points raised below, it is concluded that decommissioning of the two submarines has been undertaken in compliance with the applicable regulations. In addition, the safety requirements and methods for demonstrating compliance are broadly consistent with international recommendations and other national practice.

The option of not proceeding with defuelling the submarines is considered only to lead to continued risks of significant release of contaminants to the environment. Delay in subsequent dismantling of defuelled submarines would not lead to significant environmental hazards, though there would be continuing operational management issues requiring significant supervision.

It is recommended that future decommissioning work should be subject to continuing Environment, Health and Safety supervision, with increased emphasis on staged licensing; transparent regulatory inspection procedures; effective monitoring of compliance at the operational level; and evaluation of alternative techniques for implementing particular tasks. It is appropriate to recognise that national regulatory requirements and regulatory procedures are continually evolving, against a background of improved knowledge of the risks of radiation and other pollutants, and developments within international treaties and related Environment, Health and Safety standards, recommendations and guidance. A balanced and holistic approach is needed to take account of the spectrum of risks involved (Smith, Sneve and Markarov, 2000). In addition, while a clear separation of responsibilities has to be maintained, close cooperation between operators and regulators is to be encouraged (Sneve, Amundsen, Westerlind and Smith, 2003).

The following issues are identified which relate to clarification of, or provision of, additional information, as well recommendations to support continuing improvement of Environment, Health and Safety performance.

- Definition of clearance levels applied to identification of waste which does not require management as radioactive waste.

- Methods employed for determining whether waste falls within clearance levels and/or within other waste categories.

- Further clarification of how hazardous wastes are managed in the short and longer term.

- Fuller information supporting the assumptions made within EIAs and related justification.

- Fuller information on safety requirements for towing submarines and methods for monitoring compliance.

- Although procedures are in place to maintain control over radiation exposures, and other environment, health and safety objectives, a clearer presentation that impacts (doses, risks etc) are as low as reasonably achievable could be valuable.

- Particular attention may be given to protection of workers involved in cutting operations during dismantling and the related inhalation hazard.

More broadly, it is noted that the decommissioning of two submarines represents only a relatively small part of the overall nuclear related activities in the region. Effective management of risks and resources is not a marginal issue. Therefore, it is suggested that the strategic Environment, Health and Safety implications of continued use and management of radioactive materials in the region should be evaluated, so as to help structure the further steps to be taken to improve nuclear safety, to safely decommission obsolete facilities and to effectively remediate contaminated ground.

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APPENDIX A. LIST OF ACRONYMS

ALARA	As Low As Reasonably Achievable
ALARP	As Low As Reasonably Practicable
BAT	Best Available Technique
BPEO	Best Practicable Environmental Option. This term has a specific meaning within the UK under the Environment Protection Act 1990. More generally it describes a process used to select the least environmentally damaging option from a range of alternative approaches. It is subject both to economic and social constraints.
BPM	Best Practicable Means for achieving a task within the context of EHS
CHS	Chemically Hazardous Substance. This term may include elements (e.g. various heavy metals), organic and inorganic compounds. In the context of this report, CHS is used to distinguish hazards which do not arise from radioactive materials and are not physical in nature (e.g. trips and falls).
EHS	Environment, Health and Safety.
EIA	Environmental Impact Assessment. Guidelines on interpreting the requirements of an EIA are available, but considerable scope in interpretation is noted. At its broadest, an EIA should be undertaken as part of a decision making process. It should encompass both alternative activities and mitigating actions, in order to support identification of the BPEO. It may extend to include social, economic and cultural impacts as well as the identification of more direct health-related risks to man and sustainability of environmental impacts.
FSUE	Federal State Unitary Enterprise. The shipyards at Severodinsk have been renamed and reclassified. Zvezdochka was formerly known as Ship Repair Yard 893 of the Russian State Centre for Atomic Shipbuilding.
IAEA	International Atomic Energy Agency
ILW	Intermediate Level Waste. The term is employed solely in the context of radioactive waste[9]. ILW is defined within regulations based on specific activity and external dose rates. It may be sub-divided between short lived (<30 year half-life) and long lived)
LLW	Low Level Waste. The term is employed solely in the context of radioactive waste. LLW is defined within regulations based on specific activity, external dose rates and longevity of radionuclides.
NHB	Non-Human Biota. Most EIAs now require specific consideration of impacts to biota other than man.
NMFA	Norwegian Ministry of Foreign Affairs
NPS	Nuclear Powered Submarine
NRPA	Norwegian Radiation Protection Authority
PCBs	Polychlorinated biphenyls
POPs	Persistent Organic Pollutants

[9] the explanations given here, for example, concerning radioactive waste definitions should not be interpreted as legal definitions. IAEA (2003) provides further explanation but details vary in different national frameworks.

SNF	Spent Nuclear Fuel

APPENDIX B. THE DECOMMISSIONING PROCESS

The decommissioning activities have been combined into steps to represent the various stages of the process: prior to dismantling, dismantling and handling of waste.

Step	Activity	Main tasks
Prior to dismantling	Transport of the submarines to the shipyards	• Towing of submarines. • Docking.
	Preparatory work before dismantling and de-fuelling	• Installation of scaffolding and mounting of platforms in cutting areas. • Equipping of lighting, low and high pressure lines, temporary earthing, telephones, ventilation, dewatering pipeline and fire fighting equipment. • Dewatering and steaming of holds and tanks. • Release of gases from high pressure gas systems. • Draining working media from pipelines. • Removal of petroleum, oils and other lubricants. • Cleaning of fuel and oil tanks and pipelines (followed by air analysis). • Dewatering of pipelines, bilges and dirty water tanks. • Unloading of storage battery. • Substitution of water into biological shielding tanks. • Removal of coolant from the primary circuit and water from circuits II and III. • Unloading of sorbants from the filters of circuits II and III. • Radiological examination of the vessel. • Radiological and conventional decontamination of compartments and equipment.
Dismantling	Removal of spent nuclear fuel, radioactive waste and other waste materials	• Removal of coating and insulation from superstructure and main hull in the area of cutting. • Removal of cables, pipelines and other fixtures from superstructure and hull in the area of cutting. • Removal of superstructure. • Removal of detachable plate, ballast and large foundations. • Unloading of SNF.
	Loading of SNF into flasks	• Interim storage in transport containers and temporary storage at the On-shore Defuelling Facility.

Step	Activity	Main tasks
	Removal of bow and stern sections	• Manufacturing of the docking set, placing vessel in dock, preparing vessel-trolley transporter and conveying vessel to covered berth. • Installation of scaffolding and platforms in cutting areas. • Installation of temporary equipment (lighting, earthing, communication system, fire-fighting pipelines, pipelines for dewatering and steaming of holds and tanks and ventilation) • Dewatering and steaming of holds and tanks. • Removal of fuel, oils and lubricants. • Removal of explosives and other flammable materials. • Removal of superstructure, remaining cables and pipelines. • Removal of detachable plates, ballast and other structures. • Formation of cut lines and cutting away of three-compartment unit and moving apart of units. • Cutting away of detachable plates and unloading of large equipment • Cutting of dismantled hull structure into separate parts. • Partition of fore and aft units into large units of 25 t. weight (cutting out of hull and hull structures, dismounting of equipment), unloading of units for the covered berth, delivering and unloading at the separation site. • Removal of garbage and waste, placing in containment and transporting away. • Unloading of structures, equipment, pipelines and cables from middle section. • Inspect for radiation and prepare certification.
	Preparation of the three compartment unit[10]	• Sealing of the submarine hull, inter-compartment and extremity bulkheads and welding of detached plates. • Manufacturing and mounting of devices for three compartment unit: towing gear, mooring gear, signal side lights and navigation signs, fenders etc. • Installation of protector shielding for the floating unit of the RC. • Analysis of floodability and stability and the laying of solid ballast. • Testing three compartments for leak proof-ness. • Painting of three compartment section and drawing on water line and depth marks. • Dismantlement of temporary services.
Handling of waste	Transport of SNF for long-term storage/disposal	• Load transport containers onto rail transporters. • Transport to Mayak • Receipt and storage/disposal
	Packaging and storage of low and intermediate level radioactive waste	• Volume reduction and processing of all liquid radioactive waste and solid radioactive waste. • Storage of processed liquid and solid radioactive waste at storage facility.

[10] The three compartment block consists of the reactor compartment and the two adjoining compartments.

Step	Activity	Main tasks
	Packaging and storage of chemically hazardous substances	• Volume reduction and processing of all liquid CHS. • Interim storage of processed liquid and solid CHS. • Transport to designated locations for long-term management.
	Recycling of salvageable materials	• Remove equipment, mechanisms, units, systems and pipelines and sort into ferrous and non-ferrous metals. • Remove electrical equipment. • Remove electrical cables and processing into copper granules and storage. • Remove special covers from inner and external hulls and process to rubber granules. • Remove insulation from pipelines and inner hull. • Cut external and inner hulls to Euro standard pieces (800 x 500 x 500 mm) and loading to storage.
Post-dismantling	Tow three compartment hull to Saida Bay for storage	• Taking of three compartment unit from covered in berth and launching. • Receipt at Saida Bay. • Continued monitoring whilst in floating dock.

Specific practices between the shipyards differ. In particular the three compartment hull is used at Nerpa to store solid radioactive wastes, which are then included in the inventory transported to Saida Bay. At Zvezdochka it is stated that no wastes are placed within the three compartment hull. At Nerpa the submarines are defuelled from a floating pontoon. This is undertaken within a dry dock at Zvezdochka.

APPENDIX C. REPORT ON SHIPYARD VISIT

Zvezdochka, 4th March 2004

The visit was undertaken by Malgorzata Sneve (NRPA), Ingar Amundsen (NRPA) Duncan Jackson (Enviros), and Tone Guldebranson (NMFA representative in Moscow). A number of discussions were held, informally off-site and more formally on-site, the latter including a series of technical presentations. In addition, a tour of the shipyard was made. During the shipyard tour the following places were visited, and observations made. However, it is emphasised that the tour did not constitute a site inspection and information made available was generally restricted in nature. During the visit the yard and harbour were ice bound.

The three compartment hull of Victor II Class submarine number 627 was visible on dry dock. It was evident that work was continuing to progress but it was not possible to evaluate in detail the tasks being undertaken. We were informed that the hull was essentially ready for floating and could be towed as soon as the yard became accessible.

The solid waste segregation and compaction plant was largely manually operated (comprising a glove box facility with posting ports and a separate compaction unit). As far as could be determined, the plant was free of contamination and appeared to be constructed and operated to acceptable standards. Change room procedures were observed.

The liquid waste treatment plant was observed from point of receipt of wastes to production of a concentrated liquor. The specific activities of received and final product materials were not clear. It appeared, on the basis of responses to queries, that incoming liquors which fell outside of the LLW criteria were diluted before acceptance. The liquid wastes were then physically filtered (through the equivalent of a sand bed to remove particulate material) and then passed through an ion exchange resin. Remaining liquids were then concentrated. Disposal of intermediate wastes (e.g. filtration products), the process of liquid volume reduction and control of off-venting materials and the final form of wastes (e.g. taking to dryness, grouting etc) and their disposal route were not discussed. As far as could be determined, the plant was free of contamination and appeared to be constructed and operated to acceptable standards. Change room procedures were observed.

Defuelling of spent nuclear was not observed, and no fuel transport flasks ready for transit were evident. A visit to the fuel transport flask loading facility indicated that, as far as could be determined, the plant was free of contamination and appeared to be constructed and operated to acceptable standards. Change room procedures were observed.

The interim storage of chemically hazardous substances had been raised as an issue of potential concern prior to the visit. No visit was made to the current storage facilities. However, the planned future CHS storage site was visited. At present this consists of a fenced compound with three silos currently used to store various materials. Emptying of one of the silos was underway at the time of the visit. It is not clear how near to construction the planned facility is. It appears that finance is currently available only to clear and level the site.

Recovery of high value metals from cables and instruments is undertaken in a specialised plant, which appears to produce final product metal (e.g. copper) of a high grade and with relatively low levels of dust in air or other obvious hazard that would be associated with stripping operations.

The interim store for containerised LLW was not visited. Comments made during the visit implied that remaining space is limited, although attempts to clarify this issue were not successful. A fenced compound currently in use as a low level radioactive contaminated scrap holding location was observed. Detailed observations were not made, but the scrap appeared to be exposed and no precautions were evident to prevent entry of washed off contamination to the site drains.

Scrap metal holding areas and the cutting facility were visited. It was stated that scrap was monitored on three occasions before being allowed off-site, although monitoring facilities were not visited.

An overall impression of the Zvezdochka shipyard is that its work practices are generally labour intensive compared with western experience. However, the yard is active and it is clear that submarines are being decommissioned in real time.

Western financed plants operate to high standards. Spent nuclear fuel defuelling, receipt and loading into transport containers is satisfactory. Liquid waste receipt, filtration and volume reduction is satisfactory. Solid LLW segregation, compaction and containerisation is satisfactory. Recovery of high grade metal from cables is satisfactory. Scrap iron and steel recycling appears to be adequately monitored prior to cutting and release for recycling, although we were not advised of clearance levels for residual contamination.

There are concerns over the adequacy and capacity of current storage for non-radioactive chemically hazardous substances. Plans for a new storage area are not far advanced and funding is uncertain.

There is uncertainty over capacity for continued accumulation of solid LLW on site (although further information may resolve this). Low level contaminated scrap is poorly stored, but limited in volume. Drainage was not investigated but leaching into drains via rainfall seems likely.

There is evidence of a safety culture prevalent within the workforce. Staff were willing to co-operate on a technical level although provision of information was not facilitated by a heavy bureaucratic process.

Nerpa, 20-21 March 2001

The visit was undertaken by Ingar Amundsen (NRPA) and Duncan Jackson (Enviros), accompanied by Tone Gulbdebranson (NMFA representative in Moscow). A number of tours of facilities and discussions were undertaken and copies of documents made available. Personnel of the shipyard were uniformly open and cooperative. Queries made in advance and during the visit were answered. The shipyard tour was conducted on 20th March and detailed discussions held on 21st March.

Submarines arriving at Nerpa for decommissioning are berthed alongside a floating dock (seen from a distance only). The hull section over the reactor compartment is cut through by employees of Nerpa. The submarine is then towed to a floating defuelling facility, operated by the military, where spent nuclear fuel is removed for transport to Mayak. Liquid radioactive wastes, such as the primary cooling circuit water, are also removed at this stage. The higher level liquid radioactive wastes go direct to Mayak. Low level wastes (e.g. shower water) go to Atomflotte “Seberinko” or to Zvezdochka for further processing. Wastes may be accumulated prior to dispatch in 50t floating vessels.

Once defuelled, the submarines are received into another floating dock and then taken into the dismantling hall. A number of preliminary procedures may be undertaken prior to receipt into the dismantling hall, such as removal of the rubber coating around the hull[11]. The rubber coating is currently stockpiled on site as there are no recipients for the material for recycling. This was stated to be a problem as space on the site is beginning to run out.

Radioactive wastes removed during dismantling are all packaged and returned to the reactor compartment prior to despatch to Saida Bay. The site tour included the fabrication plant where the waste containers are made. None were present at that time. Waste returned to the reactor compartment is not specific to that hull and reflects material on site at the time[12]. Between 10t and 30 t may be placed in a reactor compartment. The fabrication plant also constructs fishing vessels for coastal use and pontoons.

With German financing, Nerpa is currently constructing a dry interim storage pad for single unit reactor compartments. This is the preferred strategy and a dry storage pad is to be constructed at Saida Bay for receipt of single compartment units (due for completion September 2005). Existing 3 compartment hulls at Saida Bay and new 3 compartment hulls produced at Zvezdochka and Poliarny will all be received at Nerpa and reduced to single compartment units. At the time of the site visit, one single compartment unit had been produced and was stored on the partially constructed interim storage pad. It is believed that, in the future, these will be transported eight to a batch, via floating dock to Saida Bay.

Chemically hazardous substances removed during the dismantling process are temporarily stored on site prior to despatch to locations dependent on the type of materials. Waste oils are incinerated on site. These facilities were not visited. Scrap metal from the hall is reduced to manageable sized pieces in a guillotine and consigned in 10 t (road freight) or 100 t (sea freight) consignments to a receiving company in Finland. The guillotine was not in operation at the time of the visit, but the scrap metal compound was observed. There was no visit included to any monitoring location but we believe this to be comprehensive. Three monitoring stations are on site and further monitoring is conducted at Murmansk prior to export to a Finnish company. It is understood that further monitoring is undertaken there. No clearance levels were cited, but it was stated that no scrap metal is allowed off-site if it exceeds “background” levels of radioactivity.

A trip to Saida Bay was included in the visit, to Pier 1 of five piers (pier 2 was also visible). A number of units were moored at Pier 1, including the 3 compartment hull from Victor II No. 625. Older single compartment hulls had been prepared for long term storage in ‘shafts’ but were maintained afloat as this concept had been abandoned. The 3 compartment hull from the Kursk was also present at Pier 1.

[11] Two submarines were in the dismantling hall at the time of the visit. One was already reduced to 3 compartments, the other had only been received the day before but the rubber coating was entirely absent. It was stated that this vessel had been taken out of commission 15 years previously and stored afloat at Saida Bay. It was not clear at what stage the coating had been removed.

[12] This implies that waste is stored for some interim period on site and may be accumulated. The interim storage area was not visited and the period over which wastes may be stored prior to consignment to a hull is not known.

Documents made available during this visit are included in Appendix E.

APPENDIX D. REQUESTS FOR INFORMATION

Approaches for information were made via NMFA from Zvezdochka and Nerpa. The following list is indicative of the general content.

1. **List of contents, summary and conclusions from EIA study**

   Part 1 Dismantling of a nuclear submarine of Victor II class and its total scrapping. Environmental impact assessment. NJaDI.U671.0145.00.001 (FSUE NIPTB Onega)

   Part 2 Assessment of radioactive factors and their consequences in case of design and off-design accidents under the dismantling Victor II class submarine. NJaDI.U671.0145.00.001.1 (Engineering Centre for the Endurance, Reliability and Operation of Nuclear Energy Equipment of Minatom)

   Part 3 Analysis of the consequences of possible radiation accidents during the dismantling of Victor II class submarine. Radiation risk assessment. NJaDI.U671.0145.00.001.2 (State Design Bureau of Machine Building)

   Part 4 Evaluation of radiation sources in the Victor II class submarines under dismantling. Calculation of the effects of radiation on the environment and the population during a dismantling in accordance with plans. NJaDI.U671.0145.00.001.3 (Engineering Centre for the Endurance, Reliability and Operation of Nuclear Energy Equipment of Minatom).

2. **Information on transport of the submarines to Zvezdochka**

   a. location of where the submarines were transferred from (i.e. port from which towing commenced)
   b. procedure to determine sea-worthiness of vessel
   c. procedures to prevent release of materials in the event of unplanned incidents
   d. certificate of handover to Zvezdochka

3. **Spent nuclear fuel**

   a. radioactive inventory (even if indicative only).

Nuclide	**Bq or Ci**	**Nuclide**	**Bq or Ci**
^{55}Fe		^{99}Tc	
^{60}Co		^{137}Cs	
$^{59,63}Ni$		$^{154,155}Eu$	
^{90}Sr		Pu-alpha	
^{95}Zr			

^{241}Am

b. method of transport of fuel for final storage/disposal (e.g. rail/sea; route)

4. **Inventory of radionuclides in the reactor compartments of the submarine after defuelling, including liquid and solid waste not part of submarine structure**

Nuclide	**Bq or Ci**		
	Reactor Compartment	Other solid waste	Other liquid waste
^{55}Fe			
^{60}Co			
$^{59,63}Ni$			
^{90}Sr			
^{95}Zr			
^{99}Tc			
^{137}Cs			
$^{154,155}Eu$			
Pu-alpha			
^{241}Am			

5. **Planned discharges to air**

    a. amount and type of radioactivity
    b. amount and type of other hazardous chemical substance

6. **Planned discharges to water**

    a. amount and type of radioactivity
    b. amount and type of other hazardous chemical substance

7. **Planned solid wastes produced**

    a. amount and type of radioactivity
    b. amount and type of other hazardous chemical substance

8. **Environmental monitoring**

    a. what is sampled (e.g. air, water, groundwater, drains, seaweed, fish, grass/soil etc), how often, what locations
    b. results from monitoring: location, material, radionuclide concentration or other hazardous chemical substance concentration (i.e. the type of information presented during the discussions but expanded to include radionuclide results)

9. **Workplace monitoring**

    a. what is sampled (air, surface contamination, external radiation), how often, what locations
    b. results from monitoring: location, material, radionuclide concentration or other hazardous chemical substance concentration

10. **Exposure of the workforce and public**

    a. individual and collective radiation dose
    b. individual exposure to hazardous chemical substances with approximate numbers of people)

11. **Information on towing of dismantled 3 compartment hull for storage at Saida Bay**

    a. procedure to determine sea-worthiness of hull
    b. continuous surveillance programme

12. **Criteria for 'free release' of clean material post-decommissioning** (i.e. <x Bq or mCi per m^2, <y mRem per h)

APPENDIX E. DOCUMENTS OBTAINED RELATING TO EHS

Nerpa shipyard

No.	Date Received	Document	ID
N1D1	05.12.03	DECLARATION concerning completed radiological survey of reactor compartment on submarine 625 indicating conditions for how access is to take place. The radiation conditions allow work in the reactor compartment.*	34/2 – 179/1 02.10.03
N1D2	05.12.03	DECLARATION confirming that all fuel was removed from the reactors in submarine 625 during the period from 10.09.03 to 01.10.03.*	Undated
N1D4	05.12.03	DECLARATION confirming that monitoring of the radiation protection situation at the shipyard has taken place during the period from 28.10.03 to 4.12.03 in connection with dismantling of submarine No. 625.	34/2 – 220 04.12.03
N1D5	05.12.03	Passport No. 57/03* concerning transfer of 2000 kg of solid radioactive waste.	Undated
N1D6	05.12.03	Passport No. 7/03* concerning delivery of radioactive waste to a temporary storage facility.	Undated
N1D7	05.12.03	MEMORANDUM to Captain Sokolov (m/d 09602) that submarine 625 has been made ready for unloading of fuel.*	17.11.03
N1D8	05.12.03	List of 64 fuel containers transferred from submarine 625 to PM-12 and then to LOTTA (Murmansk Shipping Company).*	Undated. Signed by Shiskin (Nerpa), Starunskii (Marinen), Kashka (MSCo)
N1D3	05.12.03	Permit, No. R-71-03, for unloading of fuel from submarine 627	183017 24.09.03
N1D9	05.12.03	LICENCE to work with radioactive materials in connection with defence-related, nuclear installations. Issued by Minatom	B-30-0071 27.10.03
N1D10	05.12.03	LICENCE to dismantle military vessels and weapon systems. Issued by Gossudostroennie	AC 000299 26.03.02
N1D11	05.12.03	Dismantling of non-strategic submarine of class Victor-II. Explanatory memorandum.	R MINYa – 612 – 2003/671RT 04.12.03 Gorbunov
N1D12	05.12.03	Dismantling of non-strategic submarines of class Victor II at the shipyard Nerpa. Programme.	23.04.01 Akhunov
N2D1	29.01.04	DECLARATION concerning reloading of fuel from the storage ship LOTTA to 4 transport containers, type TK-18	23.12. – 24.12.03
N22D2	29.01.04	DECLARATION concerning reloading of fuel from the storage ship LOTTA to 6 transport containers, type TK-18	25.01. – 28.01.04
N2D3	29.01.04	Proposed procedure for verification of stages 003, 004 and 008*	
N2D4	29.01.04	CERTIFICATE for transport of 4 transport containers with fuel from submarine # 625 to Mayak for reprocessing.*	A.C. Plasnel (PO Mayak) 24.12.03
N2D5	29.01.04	CERTIFICATE for transport of 6 transport containers with fuel from submarine # 625 to Mayak for reprocessing.*	A.C. Plasnel (PO Mayak) 28.01.04
N2D6[13]	29.01.04	OVOS concerning dismantling of Victor-II submarine at Nerpa. Front page, table of contents and conclusion. Copy confirmed by notary.	NYaDI.Y671. 0415.00.002

[13] This was prepared by Onega for Nerpa and as such, Nerpa cannot make it available to Enviros.

No.	Date Received	Document	ID
N2D7	29.01.04	PERMIT for dismantling of Victor-II submarine, with conditions. Ministry of Natural Resources MurmanskOffice. Copy confirmed by notary.	40/2-1013 ot 17.12.03
N2D8	29.01.04	Nuclear and radiation safety at the shipyard. Organization and equipment.*	No 34/2 - 37
N2D9	29.01.04	AGREEMENT concerning incineration of solid, non-radioactive waste from Nerpa at Murmansk Incineration plant. Operating licence for the plant. List of waste.	No. 110-P
N2D10A	29.01.04	DECLARATION concerning inspection of submarine # 625, content of hazardous waste.	29.09.03, No. 41/2 - 141
N2D10B	29.01.04	DECLARATION concerning inspection of submarine # 625, content of hazardous waste.	28.11.03, No. 41/2 - 130
N2D11	29.01.04	AGREEMENT concerning use of waste dump in Sneznogorsk for hazardous waste. Not specified to apply to submarine #625.	Agreement No. 47
N2D12	29.01.04	AGREEMENT concerning delivery of waste of first class containing mercury to the the company ”Rik-Market”. The company’s operating licence.	Agreement No. 55
N2D13	29.01.04	INTERNAL AGREEMENT concerning delivery of 2750 m^3 water from septic tank on submarine #625 to treatment at the shipyard Nerpa.	4.12.03, No. 41/2 - 128
N2D14A	29.01.04	DECLARATION concerning delivery of oils from submarine #625 for incineration at the shipyard Nerpa.	9.12.03, No. 41/2 - 132
N2D14B	29.01.04	DECLARATION concerning incineration of oils from submarine #625 at the shipyard Nerpa.	15.12.03, No. 41/2 – 136
N2D15A	29.01.04	DECLARATION concerning delivery of oil/water from submarine #625 for incineration at the shipyard Nerpa.	9.12.03, No. 41/2 – 131
N2D15B	29.01.04	DECLARATION concerning receipt of oil/water from submarine #625 for incineration at the shipyard Nerpa.	18.12.03, No. 41/2 – 135
N2D16A	29.01.04	DECLARATION concerning delivery of fire extinguishers from submarine #625 to the shipyard Nerpa.	28.11.03, No. 41/2 – 129
N2D16B	29.01.04	DECLARATION concerning receipt of fire extinguishers from submarine #625 for physical-biological destruction at the shipyard Nerpa.	19.12.03, No. 41/2 – 133
N2D17	29.01.04	PASSPORT for 10 containers filled with solid radioactive waste.	Individual serial numbers and dates.
N2D18	29.01.04	INFORMATION concerning taking of samples, results and accreditation (?)of laboratories for monitoring of the environment.	No. 33/2 - 14
N2D19	29.01.04	MEMORANDUM concerning unloading of fuel at Nerpa autumn 2003.*	Undated
N2D20	29.01.04	ACCREDITATION of Nerpa’s analysis laboratory.	Gosstandart, 11.09.03
N2D21	29.01.04	ACCREDITATION of Nerpa’s dosimetre laboratory.	Gosstandart, 26.06.03
N2D22	30.01.04	DESCRIPTION of tank for liquid radioactive waste PEK-50.	
N2D23	29.01.04	List of documents issued in connection with transfer of reactor fuel from submarine #625 to train.*	Undated, unsigned
N2D24	29.01.04	General description of how the reactor fuel is handled.*	Undated, unsigned
N2D25	30.01.04	Measurements of radioactivity in the external environment	V. Alekesejeva, Gossanepidnadzor, January 2003
N2D26	30.01.04	Discharge permit and actual discharge of radioactive nuclides to air	Head of Department for Nuclear and Radiation Safety, Sutsjkov, 303.01.04

No.	Date Received	Document	ID
N2D27	30.01.04	Permit for use of barge No. 177 for storage of liquid radioactive waste.	V. Alekesejeva, Gossanepidnadzor, 20.11. 2003
N2D28	30.01.04	PASSPORT 8/03 for barge No. 177, filled with 7200 litres of liquid radioactive waste.	Recipient V.V. Lesukhin. 08.08.03
N2D29	30.01.04	CERTIFICATE for classing of ship KUT-1P.002 (barge). Valid to 04.06.08	Issued by the Russian Marine Register in Snezhnogorsk, 04.06.03
N2D30	30.01.04	Examples of certificates issued by Russia's state standardization organization for products (cutting torch, knife) manufactured at Nerpa.	ROSS RU.XT01.B00023
	20.03.04	Dismantling of Project 671 APS and its modifications at FSUE SRY Nerpa: Environmental Impact Report (1 page of Conclusions). †	NYaDI.U671.0415.00.002
	20.03.04	Akt No 34/2-235 (in Russian) †	
	20.03.04	Akt No 34/2-28 (in Russian) †	
	20.03.04	Act No. 34/2-30 "Controlnogo radiometricheskogo obsledovanya bloka zakaza zav. No. 625", of 20 January 2004. (Gamma dose rate measurements around the hull of submarine 625) †	
	20.03.04	Statement No. 34/2-83 "Rezultaty radiationnogo monitoringa atmosfer' rabochey zon' v reaktornom otseke pry utilizatii zakaza zav. No. 625 na SRZ 'NERPA'", of 21 March 2004 (Environmental monitoring data from Nerpa) †	
	12.03.04	Steinar Backe (2003). Dismantling of submarine No. 625 of Victor-II class. Institute for Energy Technology at NERPA Shipyard. Department for Environmental and Radiation Protection Assessment of radiation protection and environmental protection Rapport No. 1	
	12.03.04	Steinar Backe (2003). Dismantling of non-strategic submarine, class Victor-II, submarine no. 625. Report of inspection at the Nerpa shipyard, 4–5 December 2003	
	12.03.04	Steinar Backe (2003). Dismantling of submarine No. 625 of Victor-II class at NERPA Shipyard. Assessment of radiation protection and environmental protection	
	05.04.04	Determination of volumes of liquid, solid and gaseous (non-radioactive wastes) toxic wastes in NS dismantlement Reference no 41/2-36	Reference no 41/2-36
		Statement No. 34/2-179/1 on radiometric investigation of reactor compartment of NPS factory No. 625, of 2 October 2003	
		Assessment of radiation state of the order, serial No 625, during its stay at the SRZ "Nerpa", Approved 4 December 2003, Act 34/2-220	
		Statement on termination of works on OP-1 in reactor compartment of NPS 625	
		Cartogram of radiometric investigation of apparatus rooms (IV compartment, upper deck) and Table of gaugings, Annexes 1 and 2 to Statement no. 34/2-179/1	
		Passport No. 57/03 on the container with SRW loaded in the unit of NS SGP	
		Passport No 7/03 from 8/08/2003 on the batch of radioactive waste handing over to the temporary storage	
		The report on SNF transportation to "Atomflot" and processing at PC "Majak" under the contract between	

No.	Date Received	Document	ID
		Norwegian Ministry of Foreign Affairs and FSUE SRY “Nerpa” Stage 006 Licence No B-30-0071 dated 27.10.2003	

Documents marked * seem to have been specially created for the Norwegian inspection. Documents marked † were obtained from the shipyard during the visit.

Zvevdochka

Date received	Document	ID
28.11.03	DECLARATION confirming that the shipyard, systems, personnel and the equipment on submarine 627 have been made ready for unloading of fuel	25.09.03
28.11.03	DECLARATION confirming that submarine 627 has been made ready for unloading of fuel from reactors.	25.09.03
28.11.03	DECLARATION confirming that onshore installation has been made ready for receipt of fuel from submarine 627	25.09.03
28.11.03	Conclusion; environmental impact analysis of dismantling of the nuclear submarine class Victor-2 at Zvjozdotsjka	Kalistratov, 20.11.03 Nikitin, 27.11.03
28.11.03	DECLARATION on completion of works on SNF unloading from the reactors, SNF loading into containers TUK-108/1	17.11.03
28.11.03	DECLARATION on completion of preparation of Victor-II class submarine No. 627 for dismantlement.	28.11.03
28.11.03	Result radiachionnogo kontrolya	18.10. – 17.11. 03
28.11.03	Permit, No. R-74U-03, for unloading of fuel from submarine 627	357/693 08.10.03
By e-mail	DECLARATION confirming that submarine 627 has been placed in the floating dock	33-2/1685 05.12.03
By e-mail	DECLARATION confirming that submarine 627, floating dock 52, the wharf and the necessary vessels have been made ready for docking of the submarine.	29.11.03
By e-mail	The dismantling of one multipurpose ”Victor-II”. Safety Plan	I.G. Belyavtsev, Severodvinsk 2003
16.01.04	Permit, from Arkhangelsk county’s Committee for Natural Resources to handle hazardous waste at the shipyard.	No. 016507, dated 25 Jun 2002
12.03.04	Steinar Backe (2003). Dismantling of non-strategic submarine, class Victor-II, submarine no. 627. Report of inspection at the Zvezdochka shipyard 27–28 November 2003	
12.03.04	Steinar Backe (2003). Dismantling of non-strategic submarine, class victor-II, Submarine no. 627. Report of inspection at the Zvezdochka shipyard 15–16 January, 2004	
12.03.04	Steinar Backe (2003). Dismantling of submarine No. 627 of Victor-II class at FGUP MP Zvezdochka. Assessment of radiation protection and environmental protection	
24.03.04	Dismantlement of ns /nuclear-powered submarine/, project … and its modifications, at FGUP “MP “Zvezdochka” assessment of impact on the environment Part 4 Assessment of Activity Sources within the Reactor Facility of the Dismantled NS, Project of …. Type Estimation of Activity Release into the Environment and Exposure of Public under the Normal Conditions of Dismantlement NYaDI.U671.0415.00.001.3	NYaDI.U671.0415.00.001. 3

Date received	Document	ID
24.03.04	Federal State Unitary Enterprise Scientific & research and design & process bureau "ONEGA" November 2003. Dismantlement of ns /nuclear-powered submarine/, project … and its modifications, At FGUP "MP "Zvezdochka". Assessment of impact on the environment. Part 1. Nyadi.u671.0415.00.001.	Nyadi.u671.0415.00.001.
24.03.04	Dismantlement of NS /Nuclear-Powered Submarine/, Project … and its Modifications, at FGUP "MP "Zvezdochka" Assessment Of Impact On The Environment Part 2. Estimation Of Radiation Impact Factors During The Design-Basis And Beyond The Design-Basis Accidents In The Process Of Dismantling Of Ns, Project Of … Type. Assessment Of Radioactive Waste Quantity NYaDI.U671.0415.00.001.1	NyaDI.U671.0415.00.001. 1
24.03.04	Dismantlement of ns /nuclear-powered submarine/, project … and its modifications, at FGUP "MP "Zvezdochka". Assessment of impact on the environment. Part 3. Assessment of consequences of potential radiation accidents in the process of dismantling of ns, project of … type. Assessment of radiation risk. NYaDI.u671.0415.00.001.2	NYaDI.u671.0415.00.001. 2
23.04.04	Federal State Unitary Enterprise Scientific & research and design & process bureau "ONEGA" Dismantlement of "Victor-II" class NS at FGUP "MP "Zvezdochka". Environmental impact assessment. Section 1 Extract from NYaDI.U671.0415.00.001"Part 1. Assessment of chemical impact factors on the environment."	NYaDI.U671.0415.00.001
27.04.04	Federal State Unitary Enterprise Scientific & research and design & process bureau "ONEGA" dismantlement of "Victor-II" Class NS at FGUP "MP "Zvezdochka". Environmental impact assessment of radiation factors. Radiation risk assessment. Section 2 Extracts from the following: NyaDI.u671.0415.00.001.1 "Part 2. Estimation of radiation impact factors during the design-basis and beyond the design-basis accidents in the process of "Victor-II" class ns dismantlement. Assessment of radioactive waste quantity." NYaDI.u671.0415.00.001.2 "Part 3. Assessment of consequences of potential radiation accidents in the process of "Victor-II" class ns dismantlement. Assessment of radiation risk." NYaDI.U671.0415.00.001.3 'Part 4. Assessment of activity sources within the reactor facility of the dismantled ns of "Victor-II" class. Estimation of activity release into the environment and exposure of public under the normal conditions of dismantlement."	NYaDI.u671.0415.00.001. 1 NYaDI.u671.0415.00.001. 2 NYaDI.U671.0415.00.001. 3
	Act on placing the order on the DOU (docking support facility), No. 33-2/1615 dated 4 December 2003	
	Act on preparedness of the enterprise, systems and equipment of NS ser. No 627 and personnel for unloading of SNF from the reactors, from 25 September 2003	
	Act on preparedness of NS ser. No 627 and personnel for unloading of SNF from the reactors, from 26 September 2003	
	Act on completion of works on SNF unloading from the reactors, SNF loading in containers TUK-108/1; installation of reactor covers and handing over of apparatus baffles of	

Date received	Document	ID
	the reactor compartment to NS staff, from 17 November 2003	
	Act on preparedness of on-shore complex for unloading of SNF from the reactors of the order, serial No 627, from 25 September 2003	
	Act on completion of works on preparation of Victor-II class NS, serial No 627, for dismantlement, from 28 November 2003	

APPENDIX F. ENVIRONMENT, HEALTH AND SAFETY ISSUES

All tasks within the decommissioning process are analysed with respect to the possible environmental, health and safety environmental impacts that could arise. This analysis includes identification of radioactive and non-radioactive hazards and their potential impact on the environment. End points and issues of relevance are identified below.

- The highest dose likely to be received by an individual classified worker;
- The total (collective) dose likely to be received by classified workers;
- The highest dose likely to be received by an individual member of the public or non-classified worker;
- The total (collective) dose likely to be received by the local population;
- The total collective dose that may be received by the population as a whole and exposed groups in neighbouring countries;
- The highest doses that might be received by individual workers and members of the public in the event of plausible accidents during the task, and the estimated probability of each such accidents occurring;
- The total (collective) dose likely to be received by the local population in the event of such an accident;
- Environmental concentrations of radioactivity and impacts on non-human biota as a result of routine operation and plausible accident scenarios; and
- Environmental and human health impacts associated with non-radioactive contaminants (e.g. PCBs in cabling and insulation).

Environmental impacts are those that result from planned routine events and discharges and the endpoints include humans, NHB and concentrations in the environment. Health impacts are those to workers that result from routine events. Safety issues are those that result from the loss of control of hazardous substances and can affect, humans, biota and the abiotic environment (e.g. from loss of sources and material from the site, large scale accidents such as fires, or implementation of incorrect workplace procedures). In all cases the extent to which the size and/or likelihood of the impact might be reduced by adopting alternative methods must be considered.

Vasiliev [2003] discussed radioactive and toxic waste arisings from the decommissioning of multi purpose nuclear submarines and the assessment of the implications for environmental safety assurance in the north-west region of Russia. The assessment was made for the Nerpa shipyard and the nearby town of Snezhnogorsk and assumptions regarding climatic and topographic factors as well as the proximity of the town to the shipyard and the size of the local population were site specific. However, the identified radiological and chemical waste arisings and associated hazards are likely to be common to the decommissioning of other submarines of the same class and indicative of those that may arise at other sites. The key points are discussed below.

The decommissioning of nuclear submarines was found to present radiation hazards similar to other projects in the Russian Federation that involved the use of radioactive materials. The assessment of potential radiological impacts can follow the traditional approach adopted in the Russian Federation. Submarine dismantling was reported as also accompanied by the release of numerous harmful chemical substances and by the generation of large volumes of chemical waste presenting a potential threat to the workforce, local population and the environment.

Zvezdochka: Act of 26 September 2003 declares submarine 627 ready for unloading of fuel, and that preparation has been carried out in accordance with Provision NYaDI 0220.00.00.031, Directions 671 RT-906-156, and Protocol of 22 September 2003. Reactor compartment readings are: surface contamination < 10 beta particles per cm^2 per minute; gamma dose rate 0.5 μSv/h; airborne activity < 37 Bq/m^3. (Other Acts declare readiness of on-shore complex and of the enterprise, systems, equipment and personnel.)

Zvezdochka: Act of 17 November 2003 declares unloading of fuel complete and reactor cover installed. Reactor compartment readings are: surface contamination 620 beta particles per cm^2 per minute (c.f. < 10 before unloading); gamma dose rate 0.5 μSv/h (as before unloading); airborne activity < 37 Bq/m^3 (as before unloading). Act of 28 November declares 627 ready for dismantling; in particular, that solid and liquid radioactive wastes and petrol, oil, lubricants and flammable materials have been removed.

Nerpa: Act of 4 December 2003 indicates radiological data before and after dismantling work. For non-reactor compartments, gamma dose rates 0.1–0.3 μSv/h, beta contamination < 25 counts per cm^2 per min (up to 100 in passages on board), both before and after. For reactor compartment, gamma dose rates mostly 0.1–1 μSv/h but up to 40 μSv/h in spots, beta contamination up to 200 counts/cm^2/min in spots once dismantling started. 25 counts per cm^2 per minute is about 0.4 Bq/cm^2, which is in the realm of clearance levels.

Spent nuclear fuel presents the primary radiological risk, accounting for some 95% of the radioactive inventory of a nuclear submarine (~1 MCi). All stages and processes involved in its handling present significant nuclear and radiation hazards. Liquid radioactive wastes arisings present the next most significant radiological impact, primarily from the presence of primary reactor coolant fluid. The total volume may be as large as $100m^3$. Solid radioactive waste arisings include internal components of the reactor, instruments and wastes generated during the cutting of the hulls. Liquid radioactive waste is intended to be collected and treated at existing facilities whilst the solid radioactive waste is placed inside the reactor compartment of the decommissioned submarine for long-term storage.

Chemical wastes that present the greatest harm to human health (and presumably the environment) arise as gases and aerosols during dismantling operations and include cutting, welding, grinding and scraping. Gas cutting presents the major source of release to the atmosphere (and hence worker exposure) and is deployed at all stages of decommissioning. During the cutting and dismantlement of the hull and other structures, toxic materials can be produced in quantities up to 2 t. These include highly toxic materials that are considered by State Standards (GOST) as Hazard Classes 1 and 2 with examples including chromium, manganese and nickel oxides in mounts varying from several kilograms to 10s of kilograms. During cutting and dismantling, airborne loads in work areas have been known to exceed maximum permissible concentrations by as much as ~25 for nickel and ~30 for chromium. In addition high levels of industrial dusts have also been noted, presenting an additional occupational risk.

Hazard Class 2 materials are also represented by considerable quantities of liquid toxic wastes such as combustibles and lubricating materials and the electrolytic fluids in storage batteries (60 - 80 t). The bulk of the chemically hazardous waste is (~600 t) solid toxic waste which presents a risk in the absence of appropriate handling technologies. Approximately 400 t is rubber coating and a major concern is the resin based wastes including insulation materials which give off phenol-formaldehyde.

The occurrence of harmful chemical substances during decommissioning and dismantling can be summarised as originating primarily from the

- Hull and structure
  - Dismantling – solid toxic waste
  - Cutting into sections – gaseous waste and solid toxic waste
- Systems, components and mechanisms
  - Preparation for dismantling – gaseous waste, liquid toxic waste and solid toxic waste
  - Removal and dismantling - gaseous waste, liquid toxic waste and solid toxic waste
- Electrical equipment
  - Removal and dismantling – solid toxic waste
  - Cutting – solid toxic waste.
- Liquid waste
  - Chladone (contains ozone depleting chemicals including bromines and chlorines)
  - Chemical media contains heavy metals and is considered highly toxic.
  - Hydraulic liquids – toxic
- Gaseous waste
  - Aerosols – contain metal oxides – highly toxic and carcinogenic
  - Gaseous – contains nitrogen (~300 kg) and carbon oxides (~400 kg) and is considered highly toxic
- Solid waste
  - Resin based insulation – contains phenol-formaldehyde and highly toxic and carcinogenic
  - Combustibles which present fire hazard
  - Asbestos bearing wastes – toxic and carcinogenic.

In order to establish the impacts to health, safety and environmental impacts that may occur as a result of the hazards outlined above, the decommissioning activities have been combined into steps to represent the various stages of the process: prior to dismantling, dismantling and handling of waste. It is not prejudiced by any specific regulations or other experience, simply a top level identification of issues according to Enviros Independent staff view. The EHS impacts that occur at each step are detailed below:

Generalised EHS impacts

Step	Activity	Potential Impact		
		Environment	Health	Safety

Step	Activity	Potential Impact		
		Environment	Health	Safety
Prior to dismantling	Transport of the submarines to the shipyards	Routine emissions from the towing vehicle and from the submarine.	Routine radiological exposure of submarine crew. Routine exposure of submarine crew to potentially hazardous materials.	Reactor criticality incident – impact on crew. Release of nuclear materials – impact to crew, local population and environment. Release of potentially hazardous materials – impact to crew, local population and environment. Fire – impact on crew and potentially to local population and environment through loss of containment of radioactive and toxic materials. Flood – impact on crew and potential impact on local population and environment through release of radioactive and toxic materials. Sinking/capsizing of submarine – impact on crew and potential impact on local population and environment through the release of radioactive and toxic materials.
	Preparatory work before defuelling	Routine emissions associated with preparatory work: gases from HPG system, working media from pipelines, petroleum, oils and lubricants, water from pipelines, bilges and dirty water tanks, biological shielding medium, coolant from the primary circuit and water from circuits II and III. It is anticipated that the preparatory work will generate gaseous wastes, liquid toxic wastes and solid toxic wastes.	Routine radiological exposure of submarine crew associated with preparatory work including the draining of biological shielding medium, coolant from the primary circuit and water from circuits II and III. Routine exposure of crew to potentially hazardous materials associated with preparatory work, including gaseous, liquid toxic and solid toxic wastes as discussed under environmental impacts.	Reactor criticality incident. Release of nuclear materials – impact to crew, local population and environment. Release of radiologically contaminated materials (e.g. biological shielding medium) – impact to crew, local population and environment. Release of potentially hazardous materials – impact to crew, local population and environment. Fire - impact on crew and potentially to local population and environment through loss of containment of radioactive and toxic materials. Flood – impact on crew and potential impact on local population and environment through release of radioactive and toxic materials. Sinking/capsizing of submarine – impact on crew and potential impact on local population and environment through the release of radioactive and toxic materials.

Step	Activity	Potential Impact		
		Environment	**Health**	**Safety**
Dismantling	Removal of SNF, radioactive waste and other waste materials	Routine emission of radioactive materials to the environment. Routine emission of hazardous materials to the environment through required dismounting of coating and insulation on hull and gas cutting, welding, grinding and scraping of hull.	Routine exposure of crew to radiation and radioactive materials during removal of SNF – including residual primary coolant, internal components of reactor, instrumentation and waste generated during the cutting. Routine exposure to atmospheric emissions during gas cutting, welding, grinding and scraping of hull.	Criticality or self sustained nuclear reaction – impact to crew, local population and environment. Damage (e.g. dropping) of spent fuel assembly – impact to crew, local population and environment. Release/spillage of liquid (or gaseous) radioactive materials – impact to crew, local population and environment. Fire – impact to crew (and potentially local population and environment). Failure of ventilation in process compartments – high level of exposure of crew to hazardous substances.
	Loading of SNF into flasks	Exposure to radiation and radioactive materials	Routine exposure of crew to radiation and radioactive materials during removal of SNF.	Criticality or self sustained nuclear reaction – impact to crew, local population and environment. Damage (e.g. dropping) of spent fuel assembly – impact to crew, local population and environment.
	Removal of bow and stern sections	Emission of gaseous toxic materials/wastes during cutting. Emission of gaseous (including aerosols) toxic materials/wastes during preparation and dismantling of systems, components and mechanisms.	Exposure to solid and gaseous (including aerosol) toxic materials/wastes during dismantling and cutting of hull and structures. Exposure to solid, liquid and gaseous (including aerosol) toxic materials/wastes during preparation and dismantling of systems, components and mechanisms. Exposure to solid and aerosol toxic waste/material during loading of waste into containers and transportation to storage.	Fire – impact to crew (and potentially local population and environment). Failure of ventilation in process compartments – high level of exposure of crew to hazardous and toxic materials/wastes – especially aerosols and gaseous materials/wastes. Accidental release of solid, liquid and gaseous (including aerosols) toxic materials/waste to the environment – potential impact on local population and environment during loading into containers and transportation to storage.
	Preparation of the three compartment hull	Emission of gaseous toxic materials/wastes during the sealing of hull, inter-compartmental plates and extremity bulkheads and the welding up of detachable plates and equipment required for towing.	Exposure to gaseous toxic materials/wastes during the sealing of hull, inter-compartmental plates and extremity bulkheads and the welding up of detachable plates and equipment required for towing.	Release of nuclear materials – impact to crew, local population and environment. Release of potentially hazardous materials – impact to crew, local population and environment. Fire – impact on crew and potentially to local population and environment through loss of containment of radioactive and toxic materials.
Handling of waste	Transport of SNF for long-term storage/disposal			Damage (e.g. freight accident) of spent fuel assembly – impact to crew, local population and environment.

Step	Activity	Potential Impact		
		Environment	Health	Safety
	Packaging and storage of low and intermediate level radioactive waste	Emission of gaseous radioactive materials during handling. Discharge of liquid radioactive waste during handling and disposition of radioactive waste.	Radiological exposure of workers. Exposure of workers to hazardous waste/materials.	Accidental discharge of release of low or intermediate level waste - radiological impact to workers, local population and environment
	Packaging and storage of chemically hazardous substances	Discharge or disposal of potentially hazardous materials – impact on workers, local population and environment.	Exposure of workers to hazardous waste/materials.	Accidental discharge of hazardous or toxic waste/materials – impact on workers, local population and environment
	Recycling of salvageable materials			
Post-dismantling	Towing of the three compartment hull to Saida Bay for storage	Routine emissions from the towing vehicle.	Exposure of 'crew' to radiation and potentially hazardous materials during towing.	Sinking/capsizing – impact on crew and potential impact on local population and environment through the release of radioactive and toxic materials.

The impacts presented above are not specific to any location. At Nerpa an additional hazard is identified in the practice of returning solid radioactive wastes to the three compartment hull prior to towing to Saida Bay.

At Zvezdochka, Environmental Impact Analysis of the work associated with the dismantling of a nuclear submarine of Viktor II class has already been considered. The report discusses the geographical geological-hydrological, climate socioeconomic and medical-ecological characteristics of the site. An assessment of the radiological consequences of a design or beyond design accident including estimates of amount and activity concentration of waste, assessment of risk and dose to the public in the event of an accident and to workers, the public and the environment during dismantling in accordance with plans.

APPENDIX G. RUSSIAN REGULATORY REQUIREMENTS

Relevant documentation has been reviewed in order to obtain a complete understanding of the work conducted to date, the intended work in future, and of the regulatory environment in which the work is taking place. This includes identification of tasks required within an EIA/EHS study and the relevant regulatory framework. An EIA is defined in the Regulations on Assessment on Impacts of Planned Economic and Other Activities in the Environment (order number 372 of May 16th 2000 and registered by the Ministry of Justice on 4th July 2000 under number 2302). The Russian EIA process assesses the potential impacts from a planned activity, identifies potential negative impacts and environmental consequences, considers public opinion and determines measures to prevent or minimise any impacts. The aim of the process is to support decision making in an environmentally robust manner.

The National Environmental Impact Assessment procedure (REIAP) comprises two separate components; the EIA study (also known as OVOS), and the Ecological Expertise as part of the system of project or activity planning and design.

An EIA study, as discussed by Joint Norwegian-Russian Expert Group [2001], should include:

- Characterisation of the proposed project or activity and possible alternatives.
- An environmental study of the geographical area that may be affected by the proposed project which gives information on the environmental quality of the area and identifies potential and actual anthropogenic environmental stressors.
- A description of the possible environmental impacts of the proposed project and consideration of alternative options.
- An assessment of the risk, type and scale of potential environmental impacts of the proposed project including consideration of resulting social and economic consequences.
- Proposed measures to reduce, mitigate or prevent the most significant detrimental impacts with an estimation of the feasibility and effectiveness of the proposed measures.
- An assessment of the residual effects and impacts of the proposed activity.
- A comparison of the alternative and anticipated environmental impacts, social and economic consequences which should include the possibility of cancelling the proposed activity.
- A programme of environmental monitoring to be undertaken throughout the proposed project.
- Recommendations for monitoring and analysing the impacts or effects of the project following its implementation.

The aims of the Ecological Expertise, the final stage of the Russian Environmental Impact procedure, are:

- To establish that the EIA study conforms to the relevant environmental laws and regulations and that the implementation of the proposed project is acceptable from an environmental perspective.
- To prevent possible adverse environmental impacts and the resulting social, economic and other impacts in the event that the proposed project or activity is undertaken.

For projects that may present a radiological hazard or impact, both radiological and non-radiological impacts should be considered, in addition the points listed above, in the EIA procedure. Specific consideration should be given to:

- Radiation control, including:
  - Descriptions of exposure limits and radiation control targets under normal operational conditions and in the event of an accident situation.
  - Descriptions of the systems or protocols in place intended to ensure radiation control including occupational exposure and the regulation and control of radiological discharges to the environment and the resulting impacts.
  - Descriptions of the proposed technology and the protocols and procedures to be employed to ensure radiation control and protection during and after the operation of the proposed project.
- Radiation protection, including:
  - Description and characterisation of ionising radiation sources.
  - Occupational radiological protection limits, projected levels of occupational exposure, limits on the level of radiological impacts to the environment and the characterisation of radioactive waste arisings.
  - Descriptions of systems for radiological protection, including appropriate targets and principles for the routine operation of the project, transportation safety issues and principals and the control of radiation levels in workplaces.
- Radiation safety
  - Description of requirements for radiological protection for the public and environment during the routine operation of the facility and under abnormal event or accident conditions.
  - Discharge limits for routine operations and in the event of an accident.
  - Description and justification of systems for radioactive waste management.

The following Russian laws, decrees, regulations and norms have been identified as being of potential relevance but have in most cases not been reviewed. Items that are referred to in the documentation we reviewed for this project, are asterisked.

Federal laws

Laws which are asterisked have been noted also by the Russian contractors at Zvezdochka as being of particular relevance.[14] Comments on status or other observations are offered in parenthesis.

*On environmental protection, No. 7-FZ of 10 January 2002 (Environment – general provisions)

*On ecological expertise, No. 174-FZ of 1995, as amended by Regulation No. 650-FZ of 1998. (Environment – EIA)

*On the radiation safety of the population, No. 3-FZ of 9 January 1996. (Environment – radiological only, but for routine and accident impacts)

*On the sanitary and epidemiological well-being of the population, No. 52-FZ of 30 March 1999. (Environment – seems to include radiological and non-radiological, routine and accident)

[14] Information provided during a site visit, 4 March 2004.

*On atmospheric air protection, No. 96-FZ of 4 May 1999. (Environment – non-radiological and possibly also radiological)

*On industrial waste management, No. 89 of 24 June 1998.

*The Water Code of the Russian Federation No. 167-FZ of 16 November 1995, with the Amendments and Addenda of December 30, 2001, December 24, 2002 and June 30, 2003. (Environment – presume this would relate to radiological and non-radiological releases, routine and accidental)

On the use of atomic energy, No. 170-FZ of 1995, as amended by Federal Laws No. 28-FZ of 1997 and No. 94-FZ of 2001. (Environment, Health and Safety – general)

On protection of the population and territories from emergency situations of natural and man-caused character, No. 68-FZ of 1994. (Environment – presumably for radiological and non-radiological impacts of accidents)

On protection of the natural environment, No. 2060-1 of 19 December 1991, with Amendments and Addition of February 21, 1992, June 2, 1993, December 27, 2000, July 10, 201 and December 30, 2001. (Environment – general provisions, but not sure how this relates to the above)

The Land Code of the Russian Federation No. 136-FZ of25 October 2001, with the Amendments and Additions of June 30, 2003. (Environment – presume this would relate to radiological and non-radiological releases, routine and accidental)

On the fundamentals of labour protection in the Russian Federation, No. 181-FZ of 17 July 1999, as amended 2002 and 2003. (Health and Safety – presumably applicable to radiological and non-radiological hazards at work)

Labour Code of the Russian Federation No. 197-FZ of December 30, 2001, with the Amendments and Additions of July 24, July 25, 2002 and June 30, 2003. (Health and Safety – presumably applicable to radiological and non-radiological hazards at work)

On fire prevention, No. 69-FZ of 21 December 1994, as amended several times. (Safety)

Merchant Shipping Code of the Russian Federation No. 81-FZ of April 30, 1999, with the Amendments and Additions of May 26, 2001 and June 30, 2003. (Environment, Health and Safety, for transport only – might apply on route to Saida Bay, but probably not to earlier towing to shipyards)

Federal Law No. 18-FZ of 10 January 2003 Rules of the Railway Transport of the Russian Federation, with the Amendments and Additions of July 7, 2003. (Environment, Health and Safety, might possibly apply for transport of fuel to Mayak)

Federal Law No. 187-FZ of 30 November 1995 on the Continental Shelf of the Russian Federation, with the Amendments and Additions of February 10, 1999, August 8, 2001, April 22, June 30 and November 11, 2003. (Environment – transport, probably only applies for longer journeys)

Federal Law No. 155-FZ of July 31, 1998 on the Internal Sea Waters, Territorial Sea and Adjacent Zone of the Russian Federation, with the Amendments and

Additions of April 22, June 30 and November 11, 2003. (Environment – transport, probably applies for all sea journeys).[15]

Decrees of the President and Regulations of the Government

Decision of the Government of the Russian Federation No. 306 of March 14, 1997 on the Regulations of Decision-Making on the Location and Erection of Nuclear Installations, Radiation Sources and Storage Points.

Decree of the President of the Russian Federation No. 950 of August 29, 1997 on the Measures for Providing the Protection of Sea Biological Resources and the State Control in This Sphere. (Environment – Transport by sea)

Direction of the President of the Russian Federation No. 350 of 26 July 1995 on issues of governmental supervision of nuclear and radiation safety. (Environment, Health and Safety, but probably too high level to have direct impact)

Decision of the Council of Ministers of the Russian Federation No. 1118 of November 4, 1993 on the Adoption of the Convention on Transborder Influence of Industrial Accidents. (Environment – need to check what the Convention is about)

Regulation of the Government No. 1007 of 4 September 1999 about licensing of the activities for using radioactive materials and conducting works with uses of nuclear power for defence purposes. (Probably just administrative)

Regulation of the Government No. 93 of 28 January 1997 about order of elaboration of radiation-hygiene passports of organisations and territories. (Not sure what this is about – could be irrelevant or could be quite important)

On approving the Provision on Licensing of Activities Related to Utilization of Atomic Energy

On approving the Provision on licensing of international transportation by cars of passengers and cargoes and transportation of cargoes within the Russian Federation

On approval of the Rules of Presentation of Declaration of Industrial Safety of Hazardous Production Facilities

On organizing and implementing of production control over observance of production safety requirements at Hazardous Production Facility

On approval of the Charter on the Discipline of Employees of Organizations with Especially Hazardous Production in the Sphere of Utilization of Atomic Energy

About Unitary Federal Program Nuclear and Radiation Safety of Russia for 2000-2006

On approval of Conception of the System of the State Record and Control over Nuclear Materials

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[15] The Criminal Code of the Russian Federation No. 63-FZ of June 13, 1996 (Article No. 352) refers to Violation of the Rules of Navigation: "Violation of the rules for navigation or operation of warships, which has involved by negligence the death of a person, or any other serious consequences, shall be punishable by deprivation of liberty for a term of three to ten years." This would apparently be the basis for prosecuting the Captain overseeing the towing of the K-159.

On approval of Conception of the System of the State Record and Control over Radioactive Materials

Provision on State Record and Control over Radioactive Substances and Radioactive wastes in the Russian Federation

On Unified State System for the Prevention and Liquidation of Emergency Situations

On Forces and Facilities of Unified State System for the Prevention and Liquidation of Emergency Situations

On approval of Rules of forming, functioning and funding of regional emergency units of operators, using for liquidation of consequences during transportation of nuclear materials and radioactive substances

On classification of nature and man-caused emergency situations

On order of establishment and usage of reserves of material resources for liquidation of nature or man-caused emergency situations

On gathering and exchange of information in Russian Federation in the sphere of population and territory protection from nature and man-caused emergency situations

On entering into force instructions on terms and forms of information submission on population and territory protection from nature and man-caused emergency situations

Federal norms and regulations

Regulations on assessment of impacts of planned economic and other activities on the environment, 16 May 2000. (Environment – EIA)

Regulations for Environmental Impact Assessment in the Russian Federation, 18 July 1994. (Superseded by the above?)

Regulations for the carrying out of State ecological expertise (Environment – EIA)

Federal norms of radiation safety 1999 NRB-99. (Environment, Health and Safety – radiological. Basic safety standards. These are a subset of the State sanitary and epidemiological regulations and standards. Radiation safety standards are section 2.6.1. Seems that air quality standards are section 2.1.6. What about all the other sections?)

Federal basic sanitary rules for ensuring radiation safety 1999 (Presumably more detail on implementation of NRB-99?)

Federal hygienic requirements on atmospheric air quality assurance in the populated areas, SanPiN 2.1.6 1032-01 (Environment – non-rad air quality, I think - doesn't sound like it applies to workplaces, i.e. Health)

Federal sanitary rules for handling radioactive waste 2002 (Health and Safety – radiological)

Federal safety rules on storage and transferring of nuclear fuel at objects of nuclear power 1991. (Health and Safety – relevant to loading/unloading fuel?)[16]

Federal norms on heating, ventilation and air conditioning SNiP 2.04.05-91

Federal norms on construction climatology and geophysics SNiP 2.01.01-82

Federal sanitary standards in designing of industrial enterprises SN 245-71. (These sound as though they could be very relevant. On the other hand, they might turn out not to be).

GOST 17.2.3.07-78 (standard) Nature protection – Atmosphere – Rules of adoption of the admissible harmful substance limits in the releases of the enterprise (Not clear whether these are really the admissible limits) (Assume Environment – non-radiological)

Instruction on adoption of norms of pollutant releases into the air and water facilities, adopted 11 September 1989 (by whom?)

RD31. 15.01-89 (MOPOG-90) of Ministry of Navy of USSR. The Rules for hazardous goods shipments

OPBZ-83. Basic Rules for Safety and Physical Protection during Nuclear Materials Transportation

PBRTV-73 Rules for Safety during Radioactive Materials Transportation

RD31. 15.01-89. MOPOG. The Rules for hazardous goods shipments (As amended by RD31. 15.01-89. MOPOG)

Rules of Hazardous Goods Transportation by Rail

PBJA-06-00-96. Branch Rules for Nuclear Safety during using, reprocessing, storing and transporting of Nuclear Hazard Fissile Materials

PBJA-06-08-77. Rules for Nuclear Safety during Spent Nuclear Fuel Transportation

PBJA-06-09-90. Rules for Nuclear Safety during Transportation and Storing of Nuclear Hazard Fissile Materials

DOC 92-84-AN/905. Technical Instructions on Safe Transportation of Hazardous Materials by Air. International Civil Aviation Organization.

GOST 19433. Dangerous cargo. Classification and marking.

GOST 22901. Packaging containing nuclear reactor spent fuel assemblies. Types and main characteristics.

GOST 25461. Packaging containing nuclear reactor spent fuel assemblies. Requirements for nuclear safety calculation methods.

GOST 26013. Packaging containing nuclear reactor spent fuel assemblies. General technical requirements.

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16 There are several more detailed documents on handling of spent fuel listed in part VI of the Medbioextrem report on Basic Documents for Regulation of Nuclear and Radiation Safety on Conducting Works at FSUE “SevRAO” in Andreeva Bay.

GOST 95 745. VVER spent fuel assemblies. General requirements for delivery to regeneration plant.

GOST 95 10340. Cases for NPP nuclear reactor spent fuel assemblies. General technical requirements.

Transport guidance

In the particular case of transport, national regulations commonly reflect, adapt or incorporate international ones.

The safety of transport of radioactive material has always been treated as a potentially international issue, and the IAEA's Regulations for the Safe Transport of Radioactive Material have been a widely accepted international reference point since the 1960s. Over the years, the IAEA Regulations have gradually been harmonised with other, mode-specific international regulations for the transport of hazardous goods, such as those deriving from the 1960 International Convention for the Safety of Life at Sea (SOLAS). The INF Code for transport of irradiated nuclear fuel has been mandatory since 1 January 2001. The INF Code does not apply to warships, naval auxiliary or other ships used only on government non-commercial service, although Administrations are expected to ensure such ships are in compliance with the Code. In any case, it would probably not strictly apply to the towing of the two submarines to the shipyards, on the basis that the irradiated nuclear fuel is not being transported as cargo. Nevertheless, the INF Code should provide some indication of the standards of safety provision that might reasonably be expected. The whole IMDG (International Maritime Dangerous Goods) Code, of which the INF Code is a part, became mandatory on 1 January 2004, and presumably will be applicable to the towing of the three-compartment units from the shipyards to Saida Bay. The Codes would be relevant to Environment, Health and Safety.

The IAEA Transport Regulations would not strictly apply to the towing of the submarines from Gremikha Bay to the shipyards, because the spent fuel would be considered an integral part of the "means of transport" and is so excluded from the scope of the Regulations (para. 107). The reasoning for this exclusion is that an integral part of a vessel cannot be packaged in accordance with the requirements of the Regulations. On the return from the shipyard to Saida Bay, however, any radioactive waste in the three-compartment units would be considered to be cargo being transported and so the Regulations should be applicable.[17] In practice, the Regulations would not apply in either case if the operation was conducted by the military rather than by a commercial operator. Nevertheless, it should be reasonable to expect that the towing would be carried out in accordance with rules similar to the IAEA Regulations.

[17] The "means of transport" in both cases would be the towing ship plus the submarine, the latter being the equivalent of a trailer on a lorry or a rail carriage

APPENDIX H. INTERNATIONAL GUIDELINES

Environmental Impact Assessment (EIA) is not a fundamental principle of environmental protection, however it is a very important tool to be used when considering new projects whose development may severely impact upon the environment and society as a whole. The use of EIA was advocated in the Rio Declaration.

In the UK EIA is used to predict the likely impact of a project on the environment, and is used in conjunction with Strategic Environmental Assessment which is used to assess larger programmes. An EIA will occur before a preferred option is selected and will apply to all stages of a project. For some developments (including new NPP build) an EIA is a legal requirement, due to the magnitude of the potential effect both nationally and internationally. Often an EIA is combined with other assessments such as a safety case.

Non-prescriptive guidelines have been published by the EA for a number of industries including nuclear facilities (and the construction and decommissioning of) to provide guidance and consistency through the important scoping stage of assessment. Scoping is the identification of key issues within an EIA [EA, 2002b].

There is a lack of consistency as to how EIA is applied globally. For example, some countries conduct an EIA to gain knowledge about the negative impacts a project may have prior to consent in order to mitigate the effects. In some countries an EIA is part of the decision-making process. The level of public involvement also differs nationally.

IAEA

The Convention on Nuclear Safety, to which the Russian Federation is a Contracting Party, applies only to land-based civil nuclear power plants, and so nuclear powered submarines are outside its scope.

The Russian Federation is not a Signatory or Contracting Party to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (the Joint Convention) and therefore is not legally obliged to comply with it. The Joint Convention's scope is limited to spent fuel and radioactive waste resulting from civilian applications and to spent fuel and radioactive waste from military or defence programmes that have been transferred to and are being managed in exclusively civilian programmes, unless a Contracting Party chooses to declare spent fuel and radioactive waste within military and defence programmes to be within the scope.

Nevertheless, meeting the objectives and obligations set out in the Joint Convention would be considered to be evidence that a State is following international good practice in the management of its spent fuel and radioactive waste (especially since the objectives and obligations are largely based on the principles set out in the IAEA's Safety Fundamentals publication "The Principles of Radioactive Waste Management", the top level international consensus safety standards in the area). The Joint Convention obligations are fairly general in nature (and the objectives even more so). The relevant ones are summarised below. (Note that, in this context, the shipyards – or at least parts thereof – would be classed as spent fuel management facilities for the purposes of the Convention.)

Article 4

"Each Contracting Party shall take the appropriate steps to ensure that at all stages of spent fuel management, individuals, society and the environment are adequately protected against radiological hazards.

"In so doing, each Contracting Party shall take the appropriate steps to:

ensure that criticality and removal of residual heat generated during spent fuel management are adequately addressed;

ensure that the generation of radioactive waste associated with spent fuel management is kept to the minimum practicable, consistent with the type of fuel cycle policy adopted;

take into account interdependencies among the different steps in spent fuel management;

provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;

take into account the biological, chemical and other hazards that may be associated with spent fuel management;"

(These are the basic requirements for EHS measures.)

Article 5

"Each Contracting Party shall take the appropriate steps to review the safety of any spent fuel management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility."

Article 8

"Each Contracting Party shall take the appropriate steps to ensure that:

before construction of a spent fuel management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;

before the operation of a spent fuel management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph (i)."

(Neither of these would apply directly to an existing facility such as the shipyards, but the 'spirit' of the obligation is that there should be **prior** assessment of safety and environmental impact. This is consistent with the Norwegian attitude to EIA, but it is less clear how it fits with the Russian concept.)

Article 9

"Each Contracting Party shall take the appropriate steps to ensure that:

the licence to operate a spent fuel management facility is based upon appropriate assessments as specified in Article 8 and is conditional on the completion of a *commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;*

operational limits and conditions derived from tests, operational experience and the assessments, as specified in Article 8, are defined and revised as necessary;

operation, maintenance, monitoring, inspection and testing of a spent fuel management facility are conducted in accordance with established procedures;

engineering and technical support in all safety-related fields are available throughout the operating lifetime of a spent fuel management facility;

incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;

programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;"

Articles 11, 12, 15 and 16 impose largely similar obligations in relation to radioactive waste management.

Article 19 requires the establishment and maintenance of a legislative and regulatory framework providing for the establishment and enforcement of safety regulations and a licensing system, and clear allocation of responsibilities.

Article 20 requires an independent regulatory body with the authority, capability and resources to implement the legislative and regulatory framework.

Article 21 requires that the licence holder have primary responsibility for safety.

(The Russian system of effectively licensing individuals would seem to score quite well on this point.)

Article 22 requires that sufficient qualified staff and adequate financial resources be available for safety related activities.

Article 23 requires appropriate QA programmes to be established and implemented.

Article 24 requires the application of the ALARA principle and dose limits (*"which have due regard to internationally endorsed standards on radiation protection"*) to worker and public exposure, and measures to prevent (or mitigate the effects of) unplanned and uncontrolled releases of radioactive material to the environment.

Article 25 requires appropriate emergency plans, tested at an appropriate frequency.

Transport

As defined in the Joint Convention, off-site transport of spent fuel and radioactive waste is not considered to be part of spent fuel management and radioactive waste management, respectively. Furthermore, the Joint Convention article that applies specifically to such off-site transport, Article 27, applies only to "transboundary movement", a term which excludes transport from place to place within a State.

The Preamble to the Joint Convention refers to "existing international standards relating to the safety of the transport of radioactive materials": these would include specifically the IAEA's Regulations for the Safe Transport of Radioactive Material.

The IAEA Regulations place the main reliance for safety on proper packaging, and so the requirements are in large part concerned with defining requirements for packages and procedures rather than performance criteria. The IAEA Regulations are reflected in binding international regulations for the transport of hazardous materials by different means, e.g. the IMO Codes (see below) for maritime transport, and the UN Economic Commission for Europe's regulations for transport by land and inland waterways. It therefore seems reasonable to assume that the Russian regulations for transport will closely reflect the IAEA Regulations. (In response to an IAEA questionnaire, the Russian Federation in July 2002 indicated that its regulations were based on older versions of the IAEA Regulations, but that by 2003 new rules would have brought then into line with the current version.)

The Russian Federation has ratified the International Convention for the Safety of Life at Sea 1974 (SOLAS). Amendments to Chapter VII of the Convention in May 1999 made the International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on Board Ships (INF Code) mandatory with effect from 1 January 2001. Further amendments to Chapter VII in May 2002 made the International Maritime Dangerous Goods Code (IMDG Code) mandatory with effect from 1 January 2004.

The INF Code applies to ships engaged in the carriage of INF cargo. It does not apply to warships, naval auxiliary or other ships used only on government non-commercial service. Both of these statements would appear to exclude a towed submarine from the scope of the Code. However, Administrations are expected to ensure ships are in compliance with the Code even if they do not fall strictly within its scope.

Specific regulations in the Code cover a number of issues, including: damage stability, fire protection, temperature control of cargo spaces, structural consideration, cargo securing arrangements, electrical supplies, radiological protection equipment and management, training and shipboard emergency plans.

Further amendments to chapter VII in May 2002 made the International Maritime Dangerous Goods Code (IMDG Code) mandatory with effect from 1 January 2004.

Protection of the environment and explicit evaluation of impacts of ionising radiation on non-human biota is a developing international issue (IAEA, 1999). The technical basis for standards in this area is under continuing development, for example, within the European Community project ERICA. While a number of issues remain outstanding, gross impacts to the health of populations of non human biota are not to be anticipated for the activities under consideration in this review.

European Directives

European legislation presents requirements to be met at the national level by Member States and signatories of the European Agreement on Environmental Protection. EC Directives 85/337/EEC [1985] and 97/11/EC [1997] require Environmental Impact Assessments as an integral part of assessing the impact of operations such as the decommissioning of nuclear reactors. The Directives establish the basic principles and procedural requirements and allow Members States considerable discretion in the details of implementation into domestic legislation.

O'Sullivan et al. [1999] confirmed the Member States have legislation in place to implement the requirements of these Directives and that the application of these requirements is dependent on the nature of the hazards presented by the proposed project.

Where a proposed project presents potential radiological hazards, these must be addressed along with other, more conventional, hazards or impacts. The Directive does not specify social or economic hazards although most Member States include these as recognised best practice. Under the EC Directives on EIA, EIAs are required for projects relating to the following activities.

- reprocessing of irradiated nuclear fuel;
- production or enrichment of nuclear fuel;
- processing of irradiated nuclear fuel or high-level radioactive waste;
- final disposal of radioactive waste;
- storage, for a period of ten years or more, of irradiated nuclear fuels or radioactive wastes in a site other than that where it was produced.

Installations for the storage or processing of nuclear waste that are not included above may require an EIA if the development is deemed substantial or if a variation in the national authorisations controlling operations involving radioactivity is required.

Potential impacts to human health and the environment are an accepted major consideration in the acceptability of a proposed waste management activity. This should include explicit consideration of pathways and transport processes for the migration of radionuclides and other toxic materials through the local biosphere, human exposure and impacts to the wider environment. Assessment of radiological impacts should include:

- Individual and collective occupational dose impacts;
- Individual and collective public dose impacts;
- Impacts to the environment;
- Material resources and cultural heritage.

These impacts should be assessed for:

- Routine operational circumstances;
- Abnormal or on-off planned circumstances;
- Accident situations.

Each of the above should be considered over different temporal and spatial scales.

Additional information that is required for the EIA, as a minimum, should include:

- Summary of the proposed project with information about the facility, project plans and size.
- Description of the proposed activities to prevent, reduce and eliminate to greatest extent possible, significant adverse consequences.

Data required for the identification and assessment of possible environmental consequences following implementation of the project.

Norway

The purpose of conducting an EIA in Norway is to gain knowledge about the proposed project that may have significant impacts on the environment, natural resources or the local community in order to design mitigating efforts [ODIN 1999].

The required information and documentation is determined by the competent authority in consultation with the Ministry of the Environment, after public circulation and consultation. The assessments are made under the Planning and Building Act [MOE undated] and co-ordinated with requirements of the relevant laws and regulations. The established guidelines for EIA are based on the EC Directives discussed in Section 1.2 and certain activities are specified as compulsory for EIA, including those that involve operations with irradiated nuclear fuel.

Norwegian law on radiation protection and use [SHD 2000] has significant influence on the undertaking of EIA for nuclear facilities and activities. SHD [2000] is intended to radiation protection for workers, the general population and to facilitate the protection of the environment from possible detrimental effects caused by radiation. In addition to the consideration of 'conventional' impacts, as a minimum an EIA should consider and include:

- Radiological properties of the radiation source including, for example, its origins, treatment prior to storage and containment.
- Technical descriptions of the proposed facility or undertaking.
- Proposed actions for radiation control and monitoring in the working environment.
- Control of occupational radiation exposure, critical group exposure and environmental and general population exposure resulting from normal practice.
- Occupational, critical group, environmental and general public exposure resulting from hypothetical incidents.
- Proposed environmental monitoring prior to, during and after the proposed project.

United Kingdom

As a Member State of the European Union, the UK has implemented the basic principles outlined in Directive 85/337/EEC [1985] and 97/11/EC [1997] into domestic legislation. These are discussed in section 1.2 above. For example, EIA is implemented in England and Wales through the Town and Country Planning Act (Environmental Impact Assessment, England and Wales) Legislation [1999]. For projects involving the decommissioning of a nuclear power station or nuclear reactor, EU EIA requirements are transposed into UK wide law by the Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations [1992].

For projects involving the decommissioning of a nuclear facility or reactor, the 'developer' must submit an Environmental Statement (ES) to the regulatory authority to accompany an application to proceed with the project. The EIA must contain the following information:

- A description of the aspects of the environment likely to be affected significantly by the proposed project including, the population, fauna, flora, water, air, climatic factors, material assets (including architectural and archaeological heritage), landscape and the interaction between these factors.
- A description of the likely effects of the proposed project on the environment, covering the direct effects as well as any indirect, secondary, cumulative, short-term, medium-term, long-term, permanent, temporary, positive and negative effects of the project, resulting from:
    - The existence of the project;
    - The use of natural resources;
    - The emission of pollutants, the creation of nuisances and the elimination of wastes.
- A description by the 'developer' of the prospective methods used to asses the effects on the environment.
- Radiological impacts associated with a proposed development should include:
    - Individual and collective occupational dose impacts.
    - Individual and collective public dose impacts.
    - Impacts to the environment.
    - Material resources and cultural heritage.

  and should be undertaken for:
    - Routine operational circumstances.
    - Abnormal or on-off planned circumstances.
    - Accident situations.
- 'Conventional' impacts associated with a proposed development should include:
    - Summary of the proposed project with information about the facility, project plans and size.
    - Description of the proposed activities to prevent, reduce and eliminate to greatest extent possible, significant adverse consequences.
    - Data required for the identification and assessment of possible environmental consequences following implementation of the project.

Control of occupational exposure from ionising radiations was assessed during the 1970s by the International Commission on Radiological Protection (ICRP) and published as recommendations in 1977. The recommendations were used as the basis for European Council Directive 80/836/Euratom (amended by 84/467/Euratom). Most of these provisions were implemented in Great Britain by the Ionising Radiations Regulations 1985. ICRP reassessed the hazards from ionising radiations during the 1980s, which led to the Basic Safety Standards Directive (96/29/Euratom) that came into force on 13 May 1996 allowing four years for transposition to national law. The majority of the requirements of the BSS Directive were implemented by the Ionising Radiations Regulations 1999 (IRR99). IRR99 (S.I 1999 No 3232) replaced the Ionising Radiations Regulations 1985 (IRR85) (S.I.1985 No 1333), except for the requirement for special hazard assessments (regulation 26 IRR85) and related provisions, and the Ionising Radiations (Outside Workers) Regulations 1993 (S.I 1993 No 2379).

There is also a link to the Management of Health and Safety at Work Regulations (MHSW) with the requirement for employers to undertake a risk assessment. Under IRR99 employers must undertake a prior risk assessment before they start any new activity with ionising radiation. Once the work commences, regulation 3 of MHSWR requires the recording of the assessment (if there are five or more employees) and the maintenance of the risk assessment to keep it up to date where there has been a significant change in the matters to which relates. Regulation 5 of MHSWR also requires the making of arrangements for effective planning, organisation, control, monitoring and review of preventative and protective measures.

IRR99 apply to a large range of workplaces where radioactive substances and electrical equipment emitting ionising radiation are used. They also apply to work with natural radiation, including work in which people are exposed to naturally occurring radon gas and its decay products. Any employer who undertakes work with ionising radiation must comply with IRR99.

There is an HSC Approved Code of Practice (ACOP) in support of IRR99, which provides practical help for employers.

IRR99 require the prior authorisation of a practice and a prior risk assessment which should be carried out with a view to putting in place measures to restrict exposure.

In order to control doses to workers dose limits are set out in IRR99. The dose limits are:

For a classified radiation worker:

- 20mSv in a calendar year whole body
- 150 mSv in a calendar year to the lens of the eye
- 500 mSv in a calendar year to the skin averaged over 1cm2
- 500 mSv to hands, forearms, feet and ankles in a calendar year

For other workers:

- 1 mSv in a calendar year whole body
- 15 mSv in a calendar year to the lens of the eye
- 50 mSv in a calendar year to the skin averaged over 1cm2
- 50 mSv to hands, forearms, feet and ankles in a calendar year

There is an overriding limit of 100 mSv in any 5 year period with the dose I n no individual year exceeding 50mSv which can be used if it can be demonstrated that it is not possible to restrict doses further. All doses should be assessed and recorded and the application of the ALARP principle is of particular interest to UK regulators.

In order to plan exposures of workers, dose predictions should be made which are calculated estimates of doses based on such factors as predicted occupancy and measured or estimated dose rates. This will allow the identification of high dose tasks and together with the prior risk assessment will allow suitable measures to be identified

In order to comply with dose limits a system of dose control is required which ideally would be two fold. For statutory dose recording approved dosemeters such as thermoluminescent dosemeters (TLDs) could be used and assessed monthly. For day-to-day dose control local control dosemeters could be used. Ideally these would be direct read-out in nature and have the ability to have alarms set at appropriate dose levels. Should the dosemeter go into alarm state the worker should leave the radiation area and an investigation should be made. Good dosimetry practice would involve the recording of individual doses by person and by task after every entry into a radiation area so that doses for each task could be tracked and compared with dose predictions and dose plans.

Control of Doses in the event of an accident (e.g. during the dismantling of submarines) is governed by the Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR) implement the emergency preparedness aspects of the Euratom Basic Safety Standards (BSS) Directive (96/29/Euratom) Title IX, Section 1 for premises, transport by rail and transferring radioactive substances across public places, eg by fork-lift truck. The Department for Transport, Local Government and the Regions (DTLR) is responsible for implementing the BSS Directive for road, air and sea/inland waterway transport as necessary.

Articles 48 to 52 of BSS deal with emergency preparedness for radiation emergencies, which are implemented by REPPIR. For licensed nuclear sites REPPIR do not replace existing nuclear site conditions but compliance with the conditions will satisfy equivalent provisions in REPPIR.

REPPIR include a new provision for local authorities to charge nuclear operators for the preparation and regular review of off-site emergency plans, and for their testing, including the costs of testing incurred by the emergency services. This provision parallels an earlier provision in the Control of Major Accident Hazards (COMAH) Regulations 1999 for chemical and other so-called major hazards sites.

The IRRs require that if it is foreseen that a worker could receive a dose greater than 6 mSv under accident conditions that they are provided with suitable dosimetry.

The key features of REPPIR are:-

- identification of hazards and risk evaluation
- preparation of on and off-site emergency plans
- arrangements for review and implementation testing of plans,
- arrangements for charging for preparation, review and testing of emergency plans,
- setting of emergency exposure dose limits,
- measures for informing the general public both prior to and during an emergency,

The import and export of radioactive waste is controlled by Government policy, Review of Radioactive Waste Management Final Conclusions, 1995 (Cm2919). Transport of wastes into or out of the UK is rare, and each case is examined on its own merits. Regulators and the UK Government and any States that the ship will travel through must approve each journey. The IAEA Code of Practice on the International Transboundary Movement of Radioactive Waste, allows any country to prohibit the movement of radioactive waste through its territory (EEZ).

The transportation of nuclear materials is strictly governed by an established system of international regulations covering everything from the special transport casks, the design of the purpose-built ships, and the physical protection arrangements.

Require appropriate measures to be in place for physical protection of the material in line with internationally agreed commitments and reflecting the concern of all parties to prevent the proliferation of sensitive nuclear materials. This includes compliance with the recommendation of the IAEA that all other Category 1 nuclear material, should be accompanied during transport by an armed security escort.

Before a licence to move the waste can be approved, the operator must have a valid licence for storage/ disposal at the final destination. Licenses are given in accordance with legislation to ensure individuals, society and the environment are protected from radiation hazards, at present and in the future and require the following information.

- An Environmental Impact Assessment
- Safety Analysis Report
- Government approval
- Comprehensive list of the characteristics of the radionuclides/ waste being transported.
- Demonstrate compliance with the conditions of the authorisation
- A detailed demonstration of safety, to be reviewed and assessed by the regulatory body in accordance with defined procedures.

Licenses will have conditions or limitations on the activities, which if breached will result in penalties from written warnings, fines, to the withdrawal of the licence.

Summary

There are similarities in the principles and approaches to EIA between the Russian Federation, Norway and the countries of the European Union. For example, in the Russian Federation, EU Member States and Norway, a review of environmental conditions in the location of the proposed project is a common starting point to the EIA process.

Further similarities include the required characterisation of the radiation source and the commonality of the end points considered for impact assessment; e.g. individual and collective occupational and public doses, impacts to the environment. Issues of radiation protection are required to be addressed for normal operational conditions as well s under abnormal and accidental conditions.

Descriptions of technology to be used and approaches to controlling and minimising radiation levels in the work place, impacts on workers and the public and environmental impacts are common requirements to both national approaches and there are requirements for environmental monitoring programmes, both during and after the project to be defined to be defined and justified.

Whilst it is clear that there is a high degree of commonality between the Russian Federation and Norway with regard to the end points or criteria that must be addressed, there are differences between the approaches to EIA. Most apparent is that discussed in Markorov at al. [2000] which describes the aim of the EIA in the Russian Federation as facilitating the mitigation or avoidance of a planned activity whilst in EU countries and Norway there is a stronger emphasis on the role that EIA can play in a decision making process by gaining knowledge of the important negative aspects of a project prior to consent for an activity.