

Management of Wastes from New Nuclear Power Stations

Position Statement

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Doc No RWMDPP01

24 February 2009

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John Dalton
Head of Communications
Nuclear Decommissioning Authority (Radioactive Waste Management Directorate),
Curie Avenue
Harwell Campus
Didcot
Oxon
OX11 0RH
UK.

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Introduction

A number of questions have arisen over the geological disposal of higher activity radioactive wastes from new nuclear power stations. The purpose of this note is to set out a position statement on the Nuclear Decommissioning Authority's work on these wastes.

The note outlines Government policy, as stated in the two White Papers published in 2008 respectively on Nuclear Power and on A Framework for Implementing Geological Disposal, that it would be technically possible to dispose of new higher activity waste in a geological disposal facility. It describes the role of the NDA in the independent regulators' Generic Design Assessment process that will include a disposability assessment to evaluate the safety, security and environmental implications of geological disposal of the wastes specifically identified to be produced from new power stations. It is noted that the radionuclides produced in wastes from new nuclear power stations will be very similar in types and quantities to those produced from earlier designs in the generation of an equivalent amount of electricity. The note comments on what are currently thought to be the more significant differences in wastes from new nuclear power stations being considered, particularly spent fuel wastes. The long-term safety of the geological disposal of these wastes appears robust even to extreme scenarios of disposal container failure.

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Statement of Government Policy

In its June 2008 White Paper, "Managing Radioactive Waste Safely: A Framework for Implementing Geological Disposal", the Government states, "The nuclear consultation document¹ set out the Government's views on the feasibility and desirability of disposing of new build waste in a geological disposal facility including the balance of ethical considerations in relation to any decision to create new waste.

Following that consultation, the UK Government issued a White Paper on Nuclear Power². In this, the UK Government set out the following conclusion:

"Having reviewed the arguments and evidence put forward, the Government believes that it is technically possible to dispose of new higher-activity radioactive waste in a geological disposal facility and that this would be a viable solution and the right approach for managing waste from any new nuclear power stations. The Government considers that it would be technically possible and desirable to dispose of both new and legacy waste in the same geological disposal facilities and that this should be explored through the Managing Radioactive Waste Safely programme. The Government considers that waste can and should be stored in safe and secure interim storage facilities until a geological facility becomes available.

Our policy is that before development consents for new nuclear power stations are granted, the Government will need to be satisfied that effective arrangements exist or will exist to manage and dispose of the waste they will produce.

The Government also believes that the balance of ethical considerations does not rule out the option of new nuclear power stations."

Through the Generic Design Assessment process³ the nuclear regulators – Health and Safety Executive (HSE), Environment Agency and the Office for Civil Nuclear Safety (OCNS) – will assess the safety, security and environmental impact of power station designs, including the quantities and types of waste (gaseous, liquid and solid) that are likely to arise, their suitability for storage and their disposability⁴. The NDA will be involved in this work specifically to consider

¹ Department for Business, Enterprise and Regulatory Reform, "The Future of Nuclear Power, The Role of Nuclear Power in a Low Carbon UK Economy", Consultation Document, URN 07/970, May 2007.
www.berr.gov.uk/energy/whitepaper/consultations/nuclearpower2007/page39554.html

² Department for Business, Enterprise and Regulatory Reform, "Meeting the Energy Challenge: A White Paper on Nuclear Power", January 2008.
www.berr.gov.uk/energy/nuclear-whitepaper/page42765.html

³ The Health and Safety Executive, the Environment Agency, the Scottish Environment Protection Agency and the Office for Civil Nuclear Security, "Guide to Regulatory Processes for Generic Design Assessment of New Nuclear Power Stations", January 2007. Document available at www.hse.gov.uk/nuclear/reactors/toptier.pdf

⁴ The Environment Agency, "Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs", January 2007. Document available at www.hse.gov.uk/newreactors/guidance.html

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disposability of wastes being proposed at an early stage. The nuclear power station designs that are currently available have simpler structures⁵ than most existing facilities, use fewer materials and produce less waste than earlier generations of nuclear reactors.”

The Generic Design Assessment Process

The regulatory generic design assessment process that is now underway thus includes a disposability assessment that will be conducted by the NDA's Radioactive Waste Management Directorate (RWMD). This will be done under the terms of a protocol agreed with the regulators and the “requesting parties” (the proponents of the new nuclear power stations) to confirm that the specific wastes identified to be produced could be placed in a geological disposal facility (GDF) in line with requirements for safety, security and environmental protection. Two reactor types are currently being considered by RWMD under the process, the European Pressurised Water Reactor (EPR) and the Advanced Pressurised Water Reactor (AP-1000). There is no indication from current information that the new nuclear power station wastes will raise any disposability issues that have not been seen before. The disposability assessment process will consider the impact of new nuclear build wastes on the design and safety of the GDF as currently envisaged.

Waste characteristics

In order to carry out the required assessments NDA requires information on the amounts of waste, specifications of the materials present in the wastes, physical and chemical properties, radionuclide contents, and any proposals for designs of waste packages. For spent fuel, there are specific requirements for information on irradiation conditions, burn-up and heat output.

In terms of evaluating the impact on GDF design, the amounts of waste (volumes of operational and decommissioning ILW, numbers of spent fuel elements) are used to determine the dimensions of the underground excavations that would be required to accommodate the wastes.

In the case of spent fuel, the dimensions of the underground disposal area are also influenced by the heat output from the wastes at the time of disposal. This is because each disposal container has to have sufficient separation from adjacent containers to ensure that the temperatures of components in the isolating engineered barrier system stay below levels at which the components' performance might be compromised. This consideration of heat output is strongly conditioned both by the length of time that the power station operator will hold the spent fuel in interim storage, allowing the radioactivity and associated heat generation to decrease, and by the thermal properties of the rocks at a GDF site. A smaller number of fuel elements

⁵ United Kingdom Nirex Limited, “*The Gate Process: Preliminary analysis of radioactive waste implications associated with new build reactors*”, Technical Note, February 2007.

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would be used in the EPR or AP-1000 reactors to generate the same amount of electricity than in earlier designs of pressurised water reactors; however the heat output from each spent fuel element would be greater. Therefore the requirements for underground space for the disposal of spent fuel from the EPR or AP-1000 are thought likely to be broadly similar to those that would have been required for spent fuel used to generate an equivalent amount of electrical energy from an earlier design of pressurised water reactor.

In terms of evaluating the long-term safety of the GDF, the main consideration is the radionuclide inventory in the wastes. As already noted current information on the smaller amounts of the various categories of wastes that will be produced does not indicate that new, problematic radionuclides will be present or that safety-significant radionuclides will be present in disproportionately greater quantities. Since the energy produced in a nuclear reactor is in direct proportion to the number of nuclear fissions within the fuel elements, the amounts of fission products will be broadly similar to the amounts produced in earlier reactor designs to generate the same amount of electricity. The radionuclide that often gives the highest calculated radiological dose in GDF long-term safety cases is the fission product iodine-129. The amount of iodine-129 in the spent fuel from an EPR or AP-1000 reactor will be effectively the same as that produced in earlier reactor designs for an equivalent amount of generated electricity.

The long-term safety case for spent fuel disposal

The long-term safety of geological disposal is achieved by a combination of engineered barriers and the natural geological barrier to isolate and contain the radioactivity in the wastes. The safety case typically includes an assessment of the radiological impacts of possible releases of radionuclides from this multi-barrier containment system as a result of some failure of one or more of its components and of the natural processes occurring in the geological system in which the facility is located.

A typical safety case for the disposal of spent fuel includes an assessment of the failure of the engineered disposal container, including as a result of a defect in its manufacture since this is often seen as the most likely scenario for any release of radionuclides from the waste. It has been found that in this scenario the calculated radiological impacts are dominated by the release into groundwater of the fission product iodine-129 from the spent fuel in a penetrated container. This is because a significant proportion of fission product iodine is present in spent fuel in a readily releasable form and once released is highly soluble in water.

The packaging process whereby spent fuel assemblies are loaded and sealed into the disposal container will be undertaken in a carefully controlled manner and the integrity of seal welds will be checked to confirm their integrity before the loaded containers are emplaced in the GDF. Notwithstanding this highly engineered approach, national programmes such as that managed by Posiva in Finland have carried out a bounding calculation of the radiological impact of a

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release of this type from all spent fuel disposal containers simultaneously⁶. The resulting calculated radiological dose to a hypothetical person living near the disposal facility is below the regulatory limit showing that the safety of the system modelled is robust to even this unprecedented level of container failure with spontaneous release of all the readily releasable iodine-129.

As a result of higher burn-up in the fuels used in current reactor designs such as EPR, more iodine-129 is produced in each fuel element and the ceramic fuel matrix becomes more porous so that more of the iodine-129 is in a readily releasable form. This situation was modelled in a European waste management research programme from which it was concluded that a conservative seven-fold increase in the releasable fraction of iodine-129 should be applied to the highest burn-up PWR fuel now envisaged, relative to the fraction applied in safety cases for the disposal of spent fuel from earlier, lower burn-up PWR designs⁷. This factor has been included in the safety assessment that supports the recent Posiva (Finland) Environmental Impact Assessment for the geological disposal of spent fuel from the additional EPR reactor now under construction at Olkiluoto. A seven-fold increase in the releasable fraction of iodine-129 from high burn-up EPR fuel was considered in respect of the modelling of the impact of simultaneous penetration of all the disposal containers referred to above to show that safety would remain robust to even this extreme scenario⁸.

It must be remembered that in the UK we have robust, effective and independent regulation. A number of regulatory organisations are responsible for scrutinising the safety case that would support any proposed development of a geological disposal facility and then deciding whether to give authorisation to proceed. Permission to proceed would only be given if the safety case met all the relevant regulatory requirements.

As the implementing organisation for geological disposal of higher activity wastes, NDA is supporting the regulators' Generic Design Assessment of designs for new nuclear power stations. In particular the disposability of spent fuel is being considered. A number of issues related to the characteristics of this waste are being examined and their effects on the long term safety case for disposal are being identified. Early results have not identified any issues which are not being addressed for the existing legacy wastes and nuclear materials.

⁶ Posiva Oy (Finland), Environmental Impact Assessment Report: Expansion of the Repository for Spent Fuel, 2008, p.136.

⁷ Nagra (Switzerland), Spent Fuel Evolution under Disposal Conditions-Synthesis of Results from EU Spent Fuel Stability (SFS) Project, A Report of the Spent Fuel Stability Project of the Euratom 5th Framework Programme, NTB 04-09, 2005.

⁸ Posiva Oy (Finland), Environmental Impact Assessment Report: Expansion of the Repository for Spent Fuel, 2008, p.137.

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